DEPARTMENT: Environmental Health

COURSE NUMBER: EH 520       SECTION NUMBER: 001

CREDIT HOURS: 3       SEMESTER: Fall 2018

COURSE TITLE: Human Toxicology

COURSE LOCATION AND HOURS: CNR 1051; Tuesday and Thursday, 10:00a-11:20a

INSTRUCTOR NAME: W. Michael Caudle, PhD

INSTRUCTOR CONTACT INFORMATION:

EMAIL: william.m.caudle@emory.edu

PHONE: 404-712-8432

SCHOOL ADDRESS OR MAILBOX LOCATION: Claudia Nance Rollins Building, Room 2033

OFFICE HOURS: By appointment

Teaching Assistant(s):
Julia Sobolik
EMAIL: julia.sobolik@emory.edu

COURSE DESCRIPTION
The goal of this course is to introduce the student to the basic principles of toxicology. Humans are exposed to a variety of dangerous substances through occupational and environmental exposures. In order to interpret the public health implications of these exposures one must have a good understanding of how these compounds get into the body, how they are processed in the body, and how they damage particular organ systems. To accomplish this, students will gain practical knowledge of the workings of specific organ systems and will be able to identify particular environmental chemicals and their mechanisms of action that underlie organ toxicity. This information will be conveyed through lecture material and reinforced by relevant readings, in-class discussion, and additional assignments that are focused on ensuring that the toxicological topics are further evaluated and considered in the context of current environmental and human health concerns and do not simply exist as stand alone facts.
MPH/MSPH FOUNDATIONAL COMPETENCIES:
- Explain how environmental and occupational exposures to chemicals and other agents impact human health.
- Explain how biological and genetic factors influence environmental toxicity.

CONCENTRATION COMPETENCIES:
- Be able to list the potential cellular targets of toxic compounds
- Be able to discuss how metabolism can impact the toxicity of a compound
- Be able to explain the basis of organ specific toxicity
- Be able to give an example of a lung-, kidney-, liver-, CNS, immuno-toxin, and explain its mechanism of action
- Be able to give an example of a carcinogen and its mechanism of action
- Be able to explain how exposure science, and the measurement of plastics and flame retardants influences environmental health
- Be able to effectively communicate the toxicological concerns for a given agent

EVALUATION
Your grade in this class will be based upon four exams and a series of short in-class and take home assignments.

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<tr>
<th>Component</th>
<th>Weight</th>
<th>Grade</th>
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<tbody>
<tr>
<td>Exam 1</td>
<td>20%</td>
<td>A-----90-92</td>
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<tr>
<td>Exam 2</td>
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<td>B+-----87-89</td>
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<td>Exam 3</td>
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COURSE STRUCTURE

Exams: Exams will be composed of multiple choice, short answer, and short essay questions. All information covered on the exam will be presented in the lecture. If exam material is coming from other sources I will be explicit about the sources and the material you need to understand. Each exam will be worth 100 pts.

Additional Assignments: Additional assignments will be worth 100 pts (cumulative) and will be made up of short, in-class and take home assignments that will serve to enrich the understanding of the lecture material. A major portion of these points will come during the Discussion session that will be held prior to each exam. Discussion sessions will occur during class time and will serve as a mini-review session for the upcoming exam. While the exact format of each Discussion session may be different, they will require the attendance and participation of each student. These sessions are designed to assist students in their exam preparation by reinforcing the lecture material through various exercises and ensuring that students are able to effectively synthesize, integrate, and apply the lecture material to novel toxicological situations. In other words, are you flexible with your toxicological knowledge and can you use it to solve similar toxicological problems not explicitly presented in class?

EHS PhD Students: Students in the PhD program will be responsible for completing 4 additional assignments related to the course material. These assignments will require interaction and understanding of relevant primary literature and the ability to critically appraise and discuss the toxicological aspects. Each assignment will be graded Pass/Fail.

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<tr>
<th>MPH/MSPH Foundational Competency</th>
<th>Representative Assignment</th>
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| Explain how environmental and occupational exposures to chemicals and other agents impact human health | 1. Exams  
2. In-class discussion sessions  
3. Take-home assignments |
| Explain how biological and genetic factors influence environmental toxicity | 1. Exams  
2. In-class discussion sessions  
3. Take-home assignments |

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<th>EH Concentration Competency</th>
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| Be able to list the potential cellular targets of toxic compounds | 1. Exams  
2. In-class discussion sessions  
3. Take-home assignments |
| Be able to discuss how metabolism can impact the toxicity of a compound | 1. Exams  
2. In-class discussion sessions  
3. Take-home assignments |
| Be able to explain the basis of organ specific toxicity | 1. Exams  
2. In-class discussion sessions  
3. Take-home assignments |
| Be able to give an example of a lung-, kidney-, liver-, CNS, immuno-toxin, and explain its mechanism of action | 1. Exams  
2. In-class discussion sessions  
3. Take-home assignments |
| Be able to give an example of a carcinogen and its mechanism of action | 1. Exams  
2. In-class discussion sessions  
3. Take-home assignments |
| Be able to explain how exposure science, and the measurement of plastics and flame retardants | 1. Exams  
2. In-class discussion sessions |
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<th>Influences environmental health</th>
<th>Be able to effectively communicate the toxicological concerns for a given agent</th>
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<td>3. Take-home assignments</td>
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<td>1. Exams</td>
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<td>2. In-class discussion sessions</td>
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<td>3. Take-home assignments</td>
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**COURSE POLICIES**

**Course Textbook and Supplemental Readings:**

Textbooks: There is not a required textbook for this course. However, I do recommend *Casarett and Doull’s Essentials of Toxicology (3rd Edition)*. This book is the abbreviated version of the *Casarett and Doull’s Toxicology: Basic Science of Poisons*.*Casarett and Doull’s (C&D) Essentials of Toxicology* is a very good book if you are looking for a succinct overview of the basics of the topics we are covering. I use this textbook as a very general template to develop many of the lectures in this course. While it does not encompass all of the material that we discuss, it does serve as an excellent starting point to review some of the general anatomy and physiology of the organ systems, as well as some of the basic toxicological properties and health effects. *The Casarett and Doull’s (C&D) Basic Science of Poisons* is the Toxicology bible! This goes into much more detail than the C&D Essentials book, but it can be overkill for this class. I recommend purchasing this book if you are really into Toxicology and want to continue to dig deeper into the topics we cover. If you do not want to purchase this book, I will post a PDF version of the Basic Science of Poisons (7th Edition) on Canvas that you will be able to download and use.

Supplemental Readings: Each topic discussed in this course has corresponding supplemental reading materials aligned with it. Some of these are news articles related to the topic being discussed, or may be research literature related to this topic. These readings are meant to provide a relevant, real-life discussion of the topic we are covering in class, which can facilitate the learning process. These readings are not required, but are there for your engagement if you want more information about a lecture topic.

Extra Credit: I do not give extra credit assignments. I have purposefully designed this course to facilitate student success with the material. For example: 1). Limit amount of material students are responsible for on each exam (3-5 lectures), 2). Provide an in-class discussion session prior to each exam to allow students the opportunity to further solidify their understanding of the material, and 3). I am easy to reach and always willing to discuss class material, either via email or in person. But, I cannot help you if I do not know you are having a problem.

Attendance: I do not take daily attendance and it is not part of your grade. If you are going to miss a class, especially a Discussion session or an exam, please let me know ahead of time. I have no problem working with you to make up this assignment, within reason. However, if you miss a Discussion session or an exam and do not make it up, you will lose points for that assignment.

Technology in the Classroom: As the course material is primarily administered through Canvas, it is imperative to have access to some form of technology, which can
be used during class. Feel free to bring laptops, tablets, cell phones, whatever you need to facilitate your interaction with the material and learning.

**Recording Class Lectures:** Each year several people ask if I am or will record class lectures so that they can go back and watch them. As a general policy in this course, I do not record my lectures. I feel that there are a variety of opportunities and resources offered in this class to address any questions or confusion that may arise from the material. However, you are more than welcome to create an audio recording of the lectures.

**Success in this Course:** I won’t lie to you. This class is difficult. It purposefully blends equal parts human anatomy, physiology, and toxicology, to appreciate the impact that exposure to environmental toxicants has on human health. In order to accomplish this, we will need to cover a significant amount of material throughout the semester. While this may seem daunting, I assure you that I have been very considerate of several different factors when developing course materials and assignments, including learning preferences, experience with science, and the fact that you have other courses and life activities that also take priority. Although there is not a “formula” to follow that will ensure your success in this course, below are a few tips that I hope will help you put this class into perspective and allow you to truly engage with the material:

- Interact early and often with the course materials
- Create study groups
- Ask me questions if you are having trouble
- Develop an understanding of the material, rather than just memorizing it
- Use the textbook, supplemental readings, and internet to help develop an understanding of the material and make it relevant
- Stay on top of your assignments and due dates

**RSPH POLICIES**

**Accessibility and Accommodations**

Accessibility Services works with students who have disabilities to provide reasonable accommodations. In order to receive consideration for reasonable accommodations, you must contact the Office of Accessibility Services (OAS). It is the responsibility of the student to register with OAS. Please note that accommodations are not retroactive and that disability accommodations are not provided until an accommodation letter has been processed. Students who registered with OAS and have a letter outlining their academic accommodations are strongly encouraged to coordinate a meeting time with me to discuss a protocol to implement the accommodations as needed throughout the semester. This meeting should occur as early in the semester as possible. Contact Accessibility Services for more information at (404) 727-9877 or accessibility@emory.edu. Additional information is available at the OAS website at http://equityandinclusion.emory.edu/access/students/index.html
Mental Health
Emory University is invested in supporting the varied mental health needs of its diverse students, which involves attention to both individual student needs and the needs of its overall student body. Emory University’s Counseling & Psychological Services (CAPS) provides free, confidential services for students including: initial assessments, crisis intervention, community referrals, brief individual, couples, and group counseling; consultation; community outreach services; and educational workshops. An Emory student interested in arranging an appointment can call (404) 727-7450 or come to CAPS between 8:30 a.m. and 5:00 P.M., Monday through Friday. Additional information is available through the CAPS website at http://studenthealth.emory.edu/cs/index.html

Additionally, if you find that you are struggling with any aspect of this course, please do not hesitate to get in touch with me and schedule a meeting. I am more than happy to work with you to ensure the most positive learning experience in this class.

Honor Code
You are bound by Emory University’s Student Honor and Conduct Code. RSPH requires that all material submitted by a student fulfilling his or her academic course of study must be the original work of the student. Violations of academic honor include any action by a student indicating dishonesty or a lack of integrity in academic ethics. Academic dishonesty refers to cheating, plagiarizing, assisting other students without authorization, lying, tampering, or stealing in performing any academic work, and will not be tolerated under any circumstances.

The RSPH Honor Code states: “Plagiarism is the act of presenting as one’s own work the expression, words, or ideas of another person whether published or unpublished (including the work of another student). A writer’s work should be regarded as his/her own property.”
(http://www.sph.emory.edu/cms/current_students/enrollment_services/honor_code.html)

COURSE CALENDAR
Week 1
Aug 30  Introduction to Course (Caudle)
Topics:
- Me, talking and saying weird stuff
- Overview of syllabus
- Why do we need to appreciate toxicology?
- Toxicology is current: A quick reminder that toxicology impacts our lives

Readings:
3. Silver et al., (2017) Prenatal naled and chlorpyrifos exposure is associated with deficits in infant motor function in a cohort of Chinese infants
4. Finn and O'Fallon (2017) The emergence of environmental health literacy-From its roots to its future potential

**Week 2**

**Sept 4**

**Toxicant Disposition (Caudle)**

*Topics:*
- Routes of exposure and absorption across biological membranes
- Distribution of toxicants in the body
- Toxicant excretion
- How toxicant disposition applies to toxicology research

*Readings:*
1. Casarett and Doull's Essentials of Toxicology (C&D): Chapter 5

**Sept 6**

**Mechanisms of Toxicity (Caudle)**

*Topics:*
- Biological and physiological factors that affect toxicity
- Cellular targets of toxicity
- Cellular adaptation and repair
- MPTP and Parkinson disease: A model compound

*Readings:*
1. C&D: Chapter 3

**Week 3**

**Sept 11**

**Biotransformation/Metabolism (Caudle)**

*Topics:*
- Goals of biotransformation
- Phase I and Phase II enzymes
- Genetic variation in biotransformation
- Chemical modification of biotransformation

*Readings:*
1. C&D: Chapter 6
2. Wirgin et al., (2011) Mechanistic basis of resistance to PCBs in Atlantic Tomcod from the Hudson River
Sept 13  Liver Toxicology (Caudle)
Topics:
- General function and anatomy of the liver
- Pathology associated with liver damage
- Toxicants involved in liver toxicity

Readings:
1. C&D: Chapter 13

Week 4  Kidney Toxicology (Caudle)
Sept 18
Topics:
- General anatomy and function of the kidney
- Chemicals that affect specific sites in the kidney
- Tattoo ink: Mickey Mouse kicking a soccer ball and kidney damage

Readings:
1. C&D: Chapter 14

**PhD Assignment #1: Modulation of Biotransformation in Liver Toxicity**

Sept 20  Class Discussion

Week 5  Exam I
Sept 25
This exam will cover lecture material discussed:
1. Toxicant Disposition
2. Mechanisms of Toxicity
3. Biotransformation
4. Liver Toxicity
5. Kidney Toxicology

Sept 27  Reproductive Toxicology (Caudle)
Topics:
- Reproductive development
- Chemicals and mechanisms involved in reproductive toxicology
- Using stem cells to study reproductive toxicology
- Chemicals involved in developmental toxicology

Readings:
1. C&D: Chapters 10 and 20
2. Elliot et al., (2017) A systematic evaluation of chemicals in hydraulic-fracturing fluids and wastewater for reproductive and developmental toxicity

Week 6
Oct 2  
Neurodevelopment and Neurotoxicology (Caudle)  
Topics:  
- General overview of neurodevelopment  
- Specific aspects of the neuron that mediate its function  
- Toxicants that target the neuron and neurological function  
- Studying developmental neurotoxicology in the lab  

Readings:
1. C&D: Chapter 16

Oct 4  
Respiratory Toxicology (Hu)  
Topics:  
- Anatomy and function of the respiratory pathway  
- Pathology and mechanisms involved in lung damage  
- Lung damage caused by specific toxicants

Readings:
1. C&D: Chapters 15 and 29
4. Air pollution article

Week 7
Oct 9  
Fall Break (No Class)
Oct 11  **Immunotoxicology (Caudle)**  
*Topics:*  
- Major organs of the immune system  
- The immune response and cells that mediate it  
- Specific chemicals and their impact on the immune system  
- Asthma and allergies  
- The hygiene hypothesis  

*Readings:*  
1. C&D: Chapter 12  
3. Scudellari (2017) Cleaning up the hygiene hypothesis  
4. Grandjean et al., (2017) Serum vaccine antibody concentrations in adolescents exposed to perfluorinated compounds

**Week 8**  
Oct 16  **Environmental Carcinogenesis (Caudle)**  
*Topics:*  
- Stages of carcinogenesis  
- Proto-oncogenes and tumor suppressors  
- Genotoxic and non-genotoxic mechanism of carcinogenesis  
- Oxidative stress and receptor-mediated carcinogenesis  
- Novel therapeutic approaches to cancer  

*Readings:*  
1. C&D: Chapter 8  

**PhD Assignment #2: Neurotoxicity and Neurodevelopment**

Oct 18  **Class Discussion**

**Week 9**  
Oct 23  **Exam II**  
*This exam will cover lecture material discussed:*  
1. Reproductive Toxicology  
2. Neurodevelopment and Neurotoxicology  
3. Respiratory Toxicology
4. Immunotoxicology  
5. Environmental Carcinogenesis

Oct 25  
**Analytical Toxicology (Caudle)**  
**Topics:**  
- Utility of biomonitoring in environmental health  
- Application of biomonitoring to address specific EH questions  
- Integration of biomonitoring into the exposome

**Readings:**  
1. C&D: Chapter 32  
3. Watkins et al., (2016) Urinary 3-phenoybenzoic acid (3-PBA) levels among pregnant women in Mexico City: Distribution and relationships with child neurodevelopment

**Week 10**  
Oct 30  
**Pesticide Toxicology (Caudle)**  
**Topics:**  
- Overview of pesticide production, regulation, and policy  
- Targets and health effects of commonly used insecticides  
- Targets and health effects of commonly used herbicides  
- How we study pesticide neurotoxicity in the lab

**Readings:**  
1. C&D: Chapter 22  

Nov 1  
**Flame Retardant Toxicology (Caudle)**  
**Topics:**  
- History and evolution of flame retardants  
- Use and disposition in consumer products  
- General health effects of exposure

**Readings:**
Week 11
Nov 6

**Plastic Toxicology (Caudle)**

*Topics:*
- History of plastic manufacturing and use
- General overview of different chemicals found in plastics
- Plastics in our oceans
- Deposition and health effects of plastic exposure

*Readings:*

Nov 8

**Environmental Health Policy/Environmental Justice (Caudle/Smarr)**

*Topics:*
- History of Environmental Health Policy
- Overview of major EH policies
- EH policy framework
- Role of EH policy in environmental justice

*Readings:*

**PhD Assignment #3: Analytical Toxicology**

Week 12
Nov 13  Class Discussion

Nov 15  Exam III
1. Analytical Toxicology
2. Pesticides
3. Flame Retardants
4. Plastics
5. Environmental Health Policy/Environmental Justice

Week 13
Nov 20  Thanksgiving (No Class)
Nov 22  Thanksgiving (No Class)

Week 14
Nov 27  Animal and Plant Toxicology (Caudle)
Topics:
- Animal venoms as toxicological agents
- Animal poisons and mechanism of toxicity
- Therapeutic properties of venoms and poisons

Readings:
1. C&D: Chapters 26

Nov 29  Waterborne Toxicity (Sobolik)
Topics:
- Water as a critical exposure pathway
- Introduction to enteric pathogens
- Pathology and mechanisms involved in enteric disease outcomes
- The gut microbiota in enteric disease

Readings:
- TBD

Week 15
Dec 4  Drugs of Abuse (Guillot)
Topics:
- Why are drugs so much fun? Pathways and mechanisms
- Inhalants
- Amphetamines
- Dissociatives
- Up and coming drugs that will split your brain

Readings:
2. Ashok et al., (2017) Association of stimulant use with dopaminergic alterations in users of cocaine, amphetamine, or methamphetamine

**PhD Assignment #4: Shared Molecular Targets of Natural and Man-Made Neurotoxic Compounds

Dec 6  Class Discussion

Week 16
Dec 11  Exam IV
This exam will cover lecture material discussed:
1. Waterborne Toxicity
2. Plant and Animal Toxins
3. Drugs of Abuse