Toxicology Curriculum Webinar Series

December 14, 2021
11:00 PM-12:00 PM ET
Welcome

Virginia Crisp
NCABR
Speakers

Joshua Gray, PhD
US Coast Guard Academy

Eva Oberdörster, PhD
Southern Methodist University

Mindy Reynolds, PhD
Washington College
Overview for Webinar

- Introduction—Joshua Gray
- Systems Toxicology—Eva Oberdörster
- Discussion of Additional Examples
- Preparation for Next Session January 2022
Introduction

Joshua Gray, PhD
US Coast Guard Academy
Learning Frameworks for Other Courses at CourseSource.org
Toxicology Core Concepts

- **Evolution**—evolution drives the interplay between toxicants/toxins and xenobiotic defense mechanisms and justifies the use of model organisms.

- **Biological Information**—differences in genomes and environmental exposure drive differences in susceptibility and responses to toxicants.

- **Risk Assessment and Risk Management**—epidemiology and historical events together with science drive regulatory responses to risk to individuals and the environment.

- **Systems Toxicology**—toxicants affect cellular, organ, individual, and ecological systems.

- **Pathways and Transformations of Energy and Matter**—interaction of toxicants with organisms described through paradigms in dose response, ADME, and toxico-/pharmacokinetics.
Integrate Core Competencies Throughout the Curriculum

• **Ability to apply the process of science**—biology is evidence-based and grounded in the formal practices of observation, experimentation, and hypothesis testing

• **Ability to use quantitative reasoning**—biology relies on applications of quantitative analysis and mathematical reasoning

• **Ability to use modeling and simulation**—biology focuses on the study of complex systems

• **Ability to tap into the interdisciplinary nature of science**—biology is an interdisciplinary science

• **Ability to communicate and collaborate with other disciplines**—biology is a collaborative scientific discipline

• **Ability to understand the relationship between science and society**—biology is conducted in a societal context
Learning Goals: Systems Toxicology

• How do cells respond to exposure toxicants?
  ▪ Ex: interaction of toxicants with major classes of cellular macromolecules.

• How are organs affected by exposure to toxicants?
  ▪ Ex: discuss the important role the liver plays in xenobiotic metabolism.

• How are body systems affected by exposure to toxicants?
  ▪ Ex: predict/explain possible toxicological consequences after exposure to drugs/chemicals below and above safe limits.

• How do toxicants affect an organism’s development and reproduction?
  ▪ Ex: discuss the downstream effects that occur from exposure to an endocrine disrupting chemical.

• How do toxicants move through the environment to affect ecosystems?
  ▪ Ex: explain concepts of bioavailability and bioconcentration.
OBERDORSTER CASE STUDIES

Case studies from facilitator Eva Oberdorster

Attachment(s)

Oberdorster 4:Physiology-Woljd.pdf
Uploaded: 11/29/2021
DOWNLOAD

Oberdorster 4:Endocrinology.Syllabus Fall 2021.pdf
Uploaded: 11/29/2021
DOWNLOAD

Uploaded: 11/29/2021
DOWNLOAD

Oberdorster 4:Hyperthyroid.pdf
Uploaded: 11/29/2021
DOWNLOAD

Oberdorster 4:The Birds.pdf
Uploaded: 11/29/2021
DOWNLOAD

Oberdorster 4:Atrial Insufficiency.pdf
Uploaded: 11/29/2021
DOWNLOAD

Oberdorster 4:BotTox and honey.pdf
Uploaded: 11/29/2021
DOWNLOAD

and more...
Organ Systems Covered: Student “Favorites” in Blue

- **Integumentary**
  - Cystic Fibrosis—CFTR mutation affects numerous systems

- **Neural (CNS & PNS)**
  - Types of neuropathologies: axono-, myelino-, neurono-, transmission
  - Marijuana as a trigger of schizophrenia
  - MeHg and the Mad Hatter story
  - MeOH and blindness (BBB discussion)
  - Tetanus & BoTox (importance of mechanism of action)
  - Venoms vs. Poisons

- **Cardiovascular**
  - Tetrodotoxin
  - Warfarin—the dose makes the poison
Organ Systems Covered: Student “Favorites” in Blue

- **Respiratory**
  - Fibrosis; *Asbestosis* and Silicosis
  - Particulate Matter and lung deposition patterns; PM$_{2.5}$ rule
  - **COPD**; pink puffer vs. blue bloater

- **Renal**
  - Renal clearance; calculations of various toxins/toxicants
  - **Glucose as a toxin**

- **GI**
  - Liver and Phase I/Phase II biotransformation; P450s

- **Wrap-up:**
  - History of Clinical Trials; how James Lind “cured” scurvy
  - Pharmacokinetics/dynamics, dose-response, epi-/genetics
Organ Systems Covered: Student “favorites” in blue

- **Endocrine**
  - Pineal: melatonin and blue light
  - Thyroid
    - Iodide pills after Fukushima (radiation exposure)
    - Dioxin/AhR; overlap T3/T4 and Immune System
  - HPA Axis (steroidogenesis)
    - EDCs which affect steroid hormones
- **Skeletal**
  - Radium and *Radium Girls*
- **Reproductive**
  - Teratology
  - More EDCs for androgens, estrogens, progestins
Discussion
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• How are body systems affected by exposure to toxicants?
  ▪ Ex: predict/explain possible toxicological consequences after exposure to drugs/chemicals below and above safe limits.

• How do toxicants affect an organism’s development and reproduction?
  ▪ Ex: discuss the downstream effects that occur from exposure to an endocrine disrupting chemical.

• How do toxicants move through the environment to affect ecosystems?
  ▪ Ex: explain concepts of bioavailability and bioconcentration.
How Do Toxicants Move Through the Environment to Affect Ecosystems?

- Environmental toxicants and how they move through soil, atmosphere, and water
- Bioavailability and different organisms
- One Environmental Health Approach
  - Case study presented at the 2021 Virtual SOT meeting
- Toxicology Integration
How Do Cells Respond to Exposure to Toxicants?

- Discuss enzyme kinetics and the differences between competitive and noncompetitive inhibition.
  - Students examine receptor activation and ligand binding with this paper as an example.
- Medical use of agonists and their interaction with receptors
  - One particular example is illustrated with this paper as I discuss opioids
- Biochemistry and Toxicology Integration
How Are Organs Affected by Exposure to Toxicants?

• Role of the liver in xenobiotic metabolism
  ▪ Importance of the smooth endoplasmic reticulum
  ▪ Enzymatic processes involved in biotransformation in the liver
    – Ethanol and acetaminophen are excellent examples
    – Role of antioxidants
• General Biology, Biochemistry, Toxicology Integration
Describe the Importance of the Bioactivation Process for Prodrugs

- Discuss methanol bioactivation to formaldehyde and subsequent metabolism to formic acid.
  - Role of bioactivation enzymes
  - Competitive inhibition by ethanol treatment
  - Ethanol is also toxic, but to lesser extent
- Polymorphisms in acetaldehyde dehydrogenase
- *Biochemistry*
Describe the Susceptibility of the Brain to Particular Pesticides

- Discuss why pesticides are capable of neurotoxicity
  - Blood brain barrier penetration
  - Limited response of nervous system to repair
  - Heavy dependence on glucose effect on susceptibility to toxicants
- **Eminent Toxicologist Lecture by Dr. Marion Ehrich**
- **Anatomy/Physiology, Pathobiology**
Differentiate the Relationships in Toxicology: Additive, Synergistic, Antagonist, and Potentiation

- Estrogen receptor ligands
  - Artificial estrogens
  - Tamoxifen and estrogen receptor antagonists
  - Endocrine disruptors
- SAR relationships between the chemicals
- Biochemistry, Molecular Biology, Ecology
Summary of Discussion
ToXchange Discussion Community
Undergraduate Toxicology Curriculum Discussion Group

LATEST DISCUSSIONS LIST

Reminder and login for tomorrow's Toxicology Curriculum ... By: Vivian Choy an hour ago
Posted in: Undergraduate Toxicology Curriculum Discussion Group
Dear Undergraduate Educator, This is a friendly reminder. Tuesday, December 14 at 11:00 am ET, is the fifth webinar in the Toxicology Curriculum Webinar Series. This is the link to connect to the webinar: https://us02web.zoom.us/j/88112837417?pwd= appears to be valid.

RE: SOT/NCABR TOX CURRICULUM WEBINAR SERIES-PREPARING ... By: Caryn Egan 1 day ago
Posted in: Undergraduate Toxicology Curriculum Discussion Group
Everyone, In preparation for the next webinar, Dr. Oberdorster has provided many case studies. These have been posted to the community library. Once you log into the Undergraduate Toxicology Curriculum Discussion Group community, select the...

RE: SOT/NCABR TOX CURRICULUM WEBINAR SERIES-PREPARING ... By: Caryn Egan 1 day ago
Posted in: Undergraduate Toxicology Curriculum Discussion Group

RECENT SHARED FILES LIST

Oberdorster Case Studies
By: Caryn Egan 1 day ago
Posted in: Undergraduate Toxicology Curriculum Discussion Group
Case studies from facilitator Dr. Oberdorster

Webinar 4 Materials
By: Caryn Egan 2 days ago
Posted in: Undergraduate Toxicology Curriculum Discussion Group
Recording of Webinar 4

Tubert Syllabus
By: Caryn Egan 2 days ago
Posted in: Undergraduate Toxicology Curriculum Discussion Group
Course syllabus

Recording of Toxicology Curriculum Webinar #4
By: Caryn Egan 2 days ago
Posted in: Undergraduate Toxicology Curriculum Discussion Group
Recommended Reading to Utilize the Undergraduate Learning Framework

Vision and Change reports @ www.visionandchange.org

Undergraduate Toxicology Learning Framework paper from ToxSci. https://doi.org/10.1093/toxsci/kfz090

“Adopting the Undergraduate Toxicology Learning Framework” webinar https://www.toxicology.org/education/edu/ugWebinars.asp (a shorter version of Webinar 1)

Topic: Risk Assessment and Risk Management
January 2022

Facilitators
Joshua Gray, PhD
US Coast Guard Academy

Mindy Reynolds, PhD
Washington College

Annie Jarabek
US EPA

George Woodall, PhD
US EPA
Toxicology Curriculum Webinar Series

1. An Introduction to the Core Concepts of Toxicology—September 1

Toxicology Core Concept:

2. A Focus on Evolution—September 29
3. Biological Information: Toxicology and the Genome—October 18
4. Pathways and Transformations of Toxicants, from Dose-Response to ADME—November 22
5. Systems Toxicology—December 14 11:00 am ET
6. Risk Assessment—January
7. A Culmination of Core Concepts to Teach Toxicology—February
Not Currently a Member of the Toxicology Curriculum Discussion Group?
Contact: virginia.crisp@ncabr.org
Undergraduates receive complimentary registration!

Undergraduate Education Program Sunday 8:00 am-5:00 pm

• Introduction to toxicology topics
• Focus on graduate school preparation, meet with academic program representatives
• Students are in mentoring groups

Student/Postdoctoral Mixer Sunday 7:30-9:00 pm

Undergraduate Student Meeting Tuesday 12:30-1:30 pm

…and more!
Early Bird Registration Deadline January 28

For Undergraduate Faculty

• Education Poster Session (date TBD)
• Plenary: Precisely Practicing Medicine from 700 Trillion Points of Data, Atul Butte, UCSF
• Undergraduate Educator Network Meeting Monday 4:00 pm
• CourseSource Workshop Monday, 1:45-4:30 pm
• Other scientific and poster sessions
• Networking
Publishing Educational Toxicology Exercises in CourseSource: A Step-by-Step Workshop for Preparing Your Manuscript

Monday, March 28 1:45pm - 4:30pm

The goals of this session are to train current and future toxicology educators to use CourseSource and to inspire them to submit their own inclusive, evidence-based educational resources supporting the Society's Undergraduate Toxicology Learning Framework.
Abstract Submissions Due December 3

NCSOT ANNUAL MEETING

Theme: Environmental Justice & Public Health
Registration and Awards info is coming soon

January 19 | 9 AM - 5 PM
Presented virtually via WebEx
Registration is free!
Details will be posted at: https://www.toxicology.org/groups/rc/nc/meetings.asp

Keynote Speakers

Dr. K. Lily Wu
Staff Toxicologist at Office of Environmental Health Hazard Assessment (Cal EPA)

Dr. Emmanuel Obeng-Cyasi
Assistant Professor
North Carolina A&T State University

Abstract Submissions Due December 3
Thanks for Your Participation!