

## **Molecular Toxicology: Chemical and Biological Mechanisms (PHRM 5900) – Spring 2026**

**Course Director: Trevor M. Penning, Professor of Systems Pharmacology and Translational Therapeutics; Director, Center of Excellence in Environmental Toxicology**

**Email:** [penning@upenn.edu](mailto:penning@upenn.edu)

**Course Goals:** Exposures to foreign compounds (drugs, carcinogens, and pollutants) can disrupt normal cellular processes leading to toxicity. This course will focus on the molecular mechanisms by which environmental exposures lead to end-organ injury and to diseases of environmental etiology (neurodegenerative and lung diseases, and reproduction and endocrine disruption). Students will learn the difficulties in modeling response to low-dose chronic exposures, how these exposures are influenced by metabolism and disposition, and how reactive intermediates alter the function of biomolecules. Mechanisms responsible for cellular damage, aberrant repair, and end-organ injury will be discussed. In addition, students will discuss the relationship between genetics and epigenetics and environmental exposures. Students will learn about modern predictive toxicology to classify toxicants, predict individual susceptibility and response to environmental triggers, and how to develop and validate biomarkers for diseases of environmental etiology. Students are expected to write a term paper on risk assessment on an environmental exposure using available TOXNET information. This course is required for those pursuing the Certificate Program in Environmental Health Sciences.

**Format:** 60-minute lectures; three times per week on Monday/Wednesday/Friday

**Course Materials:** Casarett & Doulls: Toxicology: The Basic Science of Poisons (7<sup>th</sup> – 9<sup>th</sup> Ed) and relevant literature. Full e-text of the 9<sup>th</sup> edition is available via Penn Libraries.

**Pre-requisites:** Undergraduate course work in biochemistry and chemistry essential. Exceptions allowed based on past course work. Please consult with the Course Director.

**Students:** All 1st and 2nd year BGS students with required prerequisites; Residents in Environmental and Occupational Health, and Professional Master's Students (e.g. MPH and MTR).

**Accommodations for Students with Disabilities:** The University of Pennsylvania provides reasonable Accommodations to students with disabilities who have self-identified and received approval from the Office of Student Disabilities Services (SDS). If SDS has approved your request for accommodations, please make an appointment to meet with me as soon as possible in order to discuss the arrangements for your accommodations. If you have not yet contacted Student Disabilities Services, and would like to request accommodations or have questions, you can make an appointment by calling (215) 573-9235. The office is located in the Weingarten Learning Resources Center at Stouffer Commons, 3702 Spruce Street, Suite 300. Please visit the SDS website at <http://www.vpul.upenn.edu/lrc/sds/index.php>. SDS services are free and confidential.

## **Molecular Toxicology Course Schedule- IMPORTANT PLEASE READ**

**Course Times:** Mondays, Wednesdays, and Fridays: **1:45PM - 2:45PM**; a few classes are **1:45PM - 3:45PM** as highlighted in gray on the schedule.

**Location:** Smilow 10-146  
Smilow 11-146

### **Spring 2026 Schedule**

| <b>Week</b>                   | <b>Date</b>             | <b>Location</b>    | <b>Topic</b>   | <b>Lecturer</b>              |
|-------------------------------|-------------------------|--------------------|--|------------------------------|
| <b>GENERAL PRINCIPLES</b>     |                         |                    |  |                              |
| 1                             | W, Jan 14               | Smilow 11-146      | Introduction /Orientation  | Trevor Penning, PhD          |
|                               | F, Jan 16               | Smilow 11-146      | Regulatory Policy-FDA, EPA   | Inna Strakovsky, MRA, RAC    |
| 2                             | M, Jan 19               | MLK Day – No Class |  |                              |
|                               | W, Jan 21               | Smilow 11-146      | General Principles: Dose Response & Exposures                        | Trevor Penning, PhD          |
|                               | F, Jan 23               | Smilow 11-146      | Metabolism Phase I<br>Metabolism Phase II                            | Trevor Penning, PhD          |
| 3                             | M, Jan 26               |                    | No Class   | Trevor Penning, PhD          |
|                               | W, Jan 28               |                    | No Class   | Trevor Penning, PhD          |
|                               | F, Jan 30               | Smilow 11-146      | Chemical Carcinogenesis by Genotoxic Agents                          |                              |
| 4                             | M, Feb 2<br>1:45-3:45pm | Smilow 11-146      | Chemical Carcinogenesis by Non-Genotoxic<br>Problem Set 1-Metabolism | Trevor Penning, PhD          |
|                               | W, Feb 4                | Smilow 11-146      | DNA Adducts and Their Repair   | Cátia Marques, PhD           |
|                               | F, Feb 6                | Smilow 11-146      | Mutagenesis and Mutational Signatures                                | Jeffery Field, PhD           |
| 5                             | M, Feb 9                | Smilow 11-146      | Problem Set 2-Carcinogenesis   |                              |
|                               | W, Feb 11               | Smilow 11-146      | Heavy Metal Toxicity   | Clementina Mesaros, PhD      |
|                               | F, Feb 13               | Smilow 11-146      | Reactive Oxygen Species  | Vladimir Muzykantov, MD, PhD |
| 6                             | M, Feb 16               | Smilow 11-146      | Mitochondrial Dysfunction  | Ian Blair, PhD               |
| <b>GENE-DRUG INTERACTIONS</b> |                         |                    |  |                              |
|                               | W, Feb 18               | Smilow 11-146      | Transcriptome-Analysis   | John Tobias, PhD             |

| Week   | Date                       | Location                  | Topic  | Lecturer                          |
|--|----------------------------|---------------------------|--|-----------------------------------|
|  | F, Feb 20<br>1:45pm-3:45pm | Smilow 11-146             | Toxicogenetics – Toxicology and DNA Variation<br>Toxicogenomics – Toxicology and RNA Expression        | Ted Burczynski, PhD               |
| 7  | M, Feb 23<br>1:45pm-3:45pm | Smilow 11-146             | Risk Assessment Assignment<br>MID-TERM   | Trevor Penning, PhD               |
| <b>BIOMARKERS &amp; BIOSENSORS</b>             |                            |                           |  |                                   |
|  | W, Feb 25                  | Smilow 11-146             | Exposure & Response<br>Biomarkers  | Clementina Mesaros, PhD           |
|  | F, Feb 27                  | Smilow 11-146             | Protein Biomarkers – Proteomics  | Cátia Marques, PhD                |
| 9  | M, Mar 2                   | Smilow 11-146             | Biosensors   | Yuanwen Jiang, PhD                |
| <b>ORGAN-BASED TOXICOLOGY</b>                  |                            |                           |  |                                   |
| <b>GI-TOXICITY</b>                             |                            |                           |  |                                   |
|  | W, Mar 4                   | Smilow 11-146             | Hepatotoxicity   | Ian Blair, PhD                    |
|  | F, Mar 6                   | Smilow 11-146             | Microbiota   | Gary Wu, MD                       |
| 10   | M, Mar 9 –<br>F, Mar 13    | Spring Break – No Classes |  |                                   |
| 11   | M, Mar 16                  | Smilow 11-146             | Biliary Toxicity   | Rebecca Wells, MD                 |
| <b>INHALATION TOXICITY</b>                     |                            |                           |  |                                   |
|  | W, Mar 18                  | Smilow 11-146             | Inhalation Toxicology 1:<br>Respiratory Physiology   | Jelte Kelchtermans, MD            |
|  | F, Mar 20<br>1:45pm-3:45pm | Smilow 11-146             | Inhalation Toxicology 2:<br>Mechanisms of Lung;<br>Injury/Toxic Responses of the<br>Respiratory System | Sharon McGrath-Morrow,<br>MBA, MD |
| 12   | M, Mar 23                  | Smilow 11-146             | Asthma and Immune System   | Hajera Amatullah, PhD             |
|  | W, Mar 25                  | Smilow 11-146             | Lung Cancer  | Roger Kim, MD, MSCE               |
|  | F, Mar 27                  | Smilow 11-146             | Mesothelioma   | Trevor Penning, PhD               |
| <b>NERVOUS SYSTEM</b>                          |                            |                           |  |                                   |
| 13   | M, Mar 30                  | Smilow 11-146             | Overview of the Nervous System   | Holly Elser, MD, PhD              |
|  | W, April 1                 | Smilow 11-146             | Sleep Disturbance  | Sigrid Veasey, MD                 |
|  | F, April 3                 | Smilow 11-146             | Mechanisms of Neurotoxicity  | Aimin Chen, MD, PhD               |
| 14   | M, April 6                 | Smilow 11-146             | HTS Neurotoxicants   | Eva-Maria Collins, PhD            |
| <b>REPRODUCTIVE &amp; ENDOCRINE DISRUPTION</b> |                            |                           |  |                                   |

| Week                          | Date                         | Location      | Topic   | Lecturer  |
|-------------------------------|------------------------------|---------------|---|---|
|                               | W, April 8<br>1:45pm-3:45pm  | Smilow 10-146 | Environmental Reproductive Epidemiology<br><br>Endocrine Disrupting Chemicals | Sunni Mumford, PhD<br><br>Gregory Krischen, MD, PhD |
|                               | F, April 10                  | Smilow 11-146 | Mechanisms of Reproductive Disruption-Male                                    | Colin Conine, PhD                                   |
| 15                            | M, April 13                  | Smilow 11-146 | In utero Genetic Imprinting   | Marisa Bartolomei, PhD                              |
|                               | W, April 15                  | Smilow 11-146 | Epigenetics   | Yu-Chien Lien, PhD                                  |
| <b>ALTERNATIVE APPROACHES</b> |                              |               |   |   |
|                               | F, April 17                  | Smilow 11-146 | Data Integration  | Aalim Weljie, PhD                                   |
| 16                            | M, April 20                  | Smilow 11-146 | High Throughput Screening   | David Shultz, PhD                                   |
|                               | W, April 22                  | Smilow 11-146 | New Alternative Methods   | Michael Pack, MD                                    |
|                               | F, April 24                  | Smilow 11-146 | Predictive Toxicology and TOX 21st Century                                    | Joseph Romano, PhD                                  |
| 17                            | M, April 27                  | Smilow 11-146 | Exposure Biology Informatics  | Joseph Romano, PhD                                  |
|                               | W, April 29<br>1:45pm-3:45pm | Smilow 10-146 | Risk Assessment Presentations   |   |
|                               | FINAL-W, May 6               | Smilow 11-146 | Final Examination   |   |

#### Evaluation:

Mid-Term: 30%

Final Exam: 40%

Risk Assessment Paper: 30%

Text: Casarett & Doulls: Toxicology: The Basic Science of Poisons (7th – 9th Ed)

#### Questions on individual lectures can be sent by email to:

| Lecturers:              | Email Address                           |
|-------------------------|---|
| Hajera Amatullah, PhD   | hajera.amatullah@Pennmedicine.upenn.edu |
| Marisa Bartolomei, PhD  | bartolom@pennmedicine.upenn.edu         |
| Ian Blair, PhD          | ianblair@upenn.edu                      |
| Michael Burczynski, PhD | tedburczynski@gmail.com                 |
| Aimin Chen, MD, PhD     | aimin.chen@pennmedicine.upenn.edu       |
| Colin Conine, PhD       | conine@upenn.edu                        |
| Holly Elser             | holly.elser@pennmedicine.upenn.edu      |
| Jeffrey Field, PhD      | jfield@upenn.edu                        |
| Yuanwen Jiang, PhD      | ywjiang@seas.upenn.edu                  |
| Gregory Kirschen, MD    | gregory.kirschen@Pennmedicine.upenn.edu |
| Jelte Kelchtermans, MD  | kelchtermj@chop.edu                     |
| Roger Kim, MD, MSCE     | roger.kim@pennmedicine.upenn.edu        |

| <b>Lecturers:</b>              | <b>Email Address</b>                 |
|--------------------------------|--------------------------------------|
| Yu-Chin Lien, PhD              | ylie@pennmedicine.upenn.edu          |
| Catia Marques, PhD             | catia.marques@pennmedicine.upenn.edu |
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| Rebecca Wells, MD              | rgwells@pennmedicine.upenn.edu       |
| Gary Wu, MD                    | gdwu@pennmedicine.upenn.edu          |