UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Applied Environmental Biology

2627-1-F7503Q002

Aims

Knowledge and understanding
Knowledge of environmental influences on the biology of living organisms and humans; principles of general and environmental toxicology (exposure, dose-response relationship); molecular and cellular mechanisms of toxic action of pollutants (absorption, distribution, biotransformation of xenobiotics, cellular and tissue damage); principles of toxicological risk assessment and frontier research areas (nanotoxicology, biological effects of micro- and nanoplastics).

Applying knowledge and understanding
Ability to apply the acquired knowledge through laboratory activities focused on current environmental issues and experimental models (in vitro and in vivo), and to critically address aspects related to environmental health by posing specific questions and verifying doubts.

Making judgements
Ability to assess anthropogenic impacts on environmental health (chemical, biological, physical, health, and climate impacts) and to identify mitigation measures and environmental compatibility; ability to critically analyze scientific literature and technical-regulatory documents, evaluating the advantages, disadvantages, and limitations of different methodologies and technologies.

Communication skills
Ability to communicate environmental information, ideas, problems, and solutions to both specialist and non-specialist audiences, using appropriate technical-scientific language; ability to deliver public oral presentations (including through seminars, flipped classrooms, and group activities) and to participate constructively in group discussions.

Learning skills
Ability to consult international scientific literature (including in English), databases, and technical reports from research centers, governments, and international organizations; ability to work toward goals both in teams and independently, through the conscious use of the scientific method as a working tool.

Contents

The following contents characterize the course.

Development of an animal organism: structure and function at the different levels of the biological organization.

Principles of general and environmental toxicology: toxic agents, exposure and biological responses.

Environmental determinants of health (biotic/abiotic, natural/anthropogenic).

Mechanism of molecular and cell toxicity, adsorption, distribution and biotransformation of xenobiotics.

Development of the damage at cellular and tissutal level.

Regulations, experimental models and methods in environmental and human toxicology.

Introduction to the toxicological risk evaluation.

Historic and modern examples of environmental pollution from domestic, industrial and agricultural sources and their effects on health.

Frontiers of the environmental biology and toxicology: nanotoxicology and applications for the sustainable and safe development of nanotechnology

Detailed program

Part I: From cell to organism: the development of the animal complexity and the environmental influence.

Principles of reproductive and developmental biology, comparative and evolutionary. Structure and function of the main organs and apparatus (skin, respiratory, digestive, urogenital and nervous).

Primary and secondary body barriers and interactions with environmental factors.

Evolutive, structural and functional adaptations to the environmental changes. An overlook to the human.

Part II. Principles of general and environmental toxicology

Environmental determinants of health. Characteristics of the exposure. Classification of the toxic effects. Acute and chronic toxicity, dose-response effect. Definition of the effective and non-effective doses (concentrations), LC50, NOAEL, LOAEL. In vitro and in vivo experimental models to study toxicity. Classic and highthroughput tests.

From xenobiotic bio-interactions to the biological damage.

Mechanisms of adsorption, disposition elimination of the Xenobiotics in the living organism and their biochemical transformation: hydrolysis, reduction, oxidation and conjugation. Mixed function oxidises, cytochrome P450 and Glutathion systems. Metabolizing enzyme inductions and toxicological consequences. Toxicokinetic models. Formation of electrophiles, free radicals nucleophiles, redox active reactants.

Molecular and cellular mechanisms of toxicity: reactions of the toxicants with the target molecules and effects on

cells and tissues. Cellular homeostasis dysregulation, inhibition of ATP and macromolecular synthesis, damages of the cellular membranes, oxidative stress and damages.

Development and consequences of the genetic damage.

DNA damages and repair mechanisms. The disrepair consequences. Apoptosis, necrosis and autophagy processes. Chemical carcinogenesis process. Definition of cancer. Mechanism of action of the chemical carcinogens, experimental models to evaluate the carcinogenic agents.

Principles of reproductive and developmental toxicology.

Mechanism of action of the endocrine disrupting chemicals on the gonad development and functionality, developmental abnormalities and teratogenicity. Maternal exposure and embryo-fetal toxicity.

Toxicity directed to specific organs:

Toxic responses of the liver, the kidney, the respiratory apparatus, the cardiovascular system, the nervous system.

Part III. Applied environmental biology and toxicology

Bio-interactions, effects and mode of action of heavy metals, PCB and dioxins, pesticides, complex mixtures, particles and fibres (from asbestos to nanoparticles). Nanobiology and nanotoxicology: principles and applications. “Environmental and Health Safety” (EHS) and Safety-by-Design (SbD) concepts. Concepts and methods for the toxicological risk assessment in humans.

Follow-up from research and literature: effects of pesticides on aquatic organisms, effects of atmospheric particulate matter on human health, bio-interactions and effects of nanostructured materials, including micro and nanoplastics

Laboratory and classes courses will be performed to describe and use in vitro and in vivo models in toxicology for the study of the effects of environmental pollutants.

During the course specific seminars by invited speakers will be held.

Prerequisites

Basic knowledge in cell and animal biology and biochemistry.

Teaching form

The course will allow to get 8 credits, and will be delivered according to the following modality:

- delivered didactics: 24 lessons of 2 h
- interactive teaching: 5 laboratory activities of 4 h

Upon specific agreements with the students, some lessons may be held from remote, in synchronous modality.
All the activities will be held in presence. For the laboratory activities, the class will be subdivided in 2 different groups. The presence during these lab activities is mandatory.

Textbook and teaching resource

Slides and registrations of the lessons, scientific papers and other supporting materials will be made available by the teacher.

Textbooks (hard copies)
-Struttura e processi vitali negli animali (Solomon, Martin, Berg), EdiSES
-Elementi di Tossicologia (Caserett & Doull) CEA
-Tossicologia (Galli, Corsini, Marinovich) Piccin
-Eco-Devo: Ambiente e Biologia dello Sviluppo (Gilbert, Hepel), Piccin

On-line textbook
Environmental Toxicology, an open online textbook
https://maken.wikiwijs.nl/147644/Environmental_Toxicology__an_open_online_textbook#!page-5658449

Semester

First semester

Assessment method

Oral examination
The discussion will be based on the arguments of the classroom and laboratory activities and on the comprehension and critical review of a scientific paper.
As alternative to the discussion of a paper, the students may chose to work in group to prepare a presentation based on an argument from the scientific literature/case study. The presentation should be delivered to the class in seminar form at the end of the course. Such work will be avaluated before the examination sessions and will contribute to the final score of the oral examination.

Office hours

After appointment to be fixed by e-mail (paride.mantecca@unimib.it)

Sustainable Development Goals

GOOD HEALTH AND WELL-BEING | LIFE BELOW WATER | LIFE ON LAND