



DigiOmica

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WP3 DigiOmica collaborative learning in Integrated omics for environmental sustainability

Module 5: *Integrated Omics in Ecotoxicology*

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- **Educational goals:** the aim of this module is to present knowledge about:
 - To provide background information on the fields of ecotoxicology and the basic principles and types of omics technologies
 - To understand how to interpret omics data in ecotoxicology research
 - To highlight the application of the omics data in environmental risk assessments

➤ Summary

Ecotoxicology is the study of the effects of environmental pollutants on living organisms. The use of omics technologies in this field provides a molecular level understanding of biological responses in organisms, enabling more comprehensive and sensitive analyses. Within the scope of omics technologies, genomics investigates the genetic structure of organisms and how changes in this structure respond to environmental stressors; transcriptomics investigates gene expression profiles; proteomics investigates the structure and function of proteins; metabolomics investigates metabolite profiles and changes in metabolic pathways; and epigenomics investigates the effects of environmental factors on epigenetic modifications. The ecotoxicological aspects of aquatic and terrestrial ecosystems and their possible relationship with omics concepts are examined. In addition, air pollution is examined within the framework of omics concepts. The relationship of the human organism, which has an important place in food webs, with pollutants is explained with omics concepts.

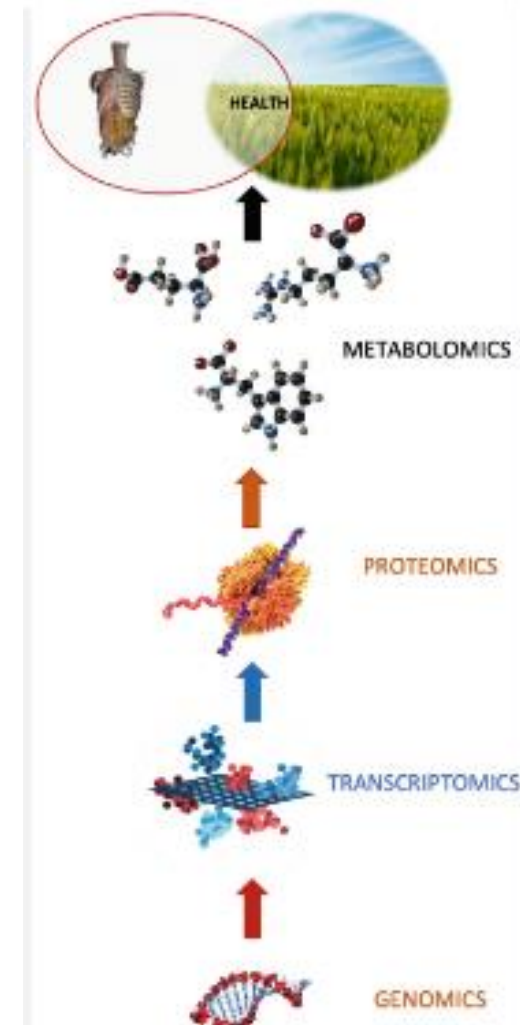
- **Expected learning outcomes:** Upon completion of this Module the learners will be able to:
 - Have general information about the science of ecotoxicology integrated with omics technologies
 - Integrate the data from omic technologies to assess the molecular responses of organisms to environmental toxicants
 - Explain how ecotoxicology uses omic technology to assess biomarkers of exposure, impacts, and susceptibility in organisms.
 - Learn the usage areas of omics technologies in aquatic and terrestrial ecosystems
 - Learns the usage areas of omics technologies in the field of human health

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➤ 1. Introduction

In ecological research, investigating genes, mRNA, proteins and metabolites is very important in terms of examining the effects of pollutants. Omics research, developed to examine genes, mRNA, proteins and metabolites, has gained momentum in recent years. These omics techniques, used in an ecological sense, focus on examining the toxic effect mechanisms of pollutants or substances as a result of acute and chronic exposure. Environmental omics aims to identify target and non-target organisms, perform risk assessment, perform environmental monitoring, and reveal their effects on human health (Kesheri et al. 2024).



Omics in ecotoxicology (Farrel 2022)

➤ 2. Using Omics Data in Ecotoxicology

2.1 Aquatic Ecosystems

To evaluate the effects of pollutants in aquatic ecosystems on aquatic organisms within the scope of different omics technologies

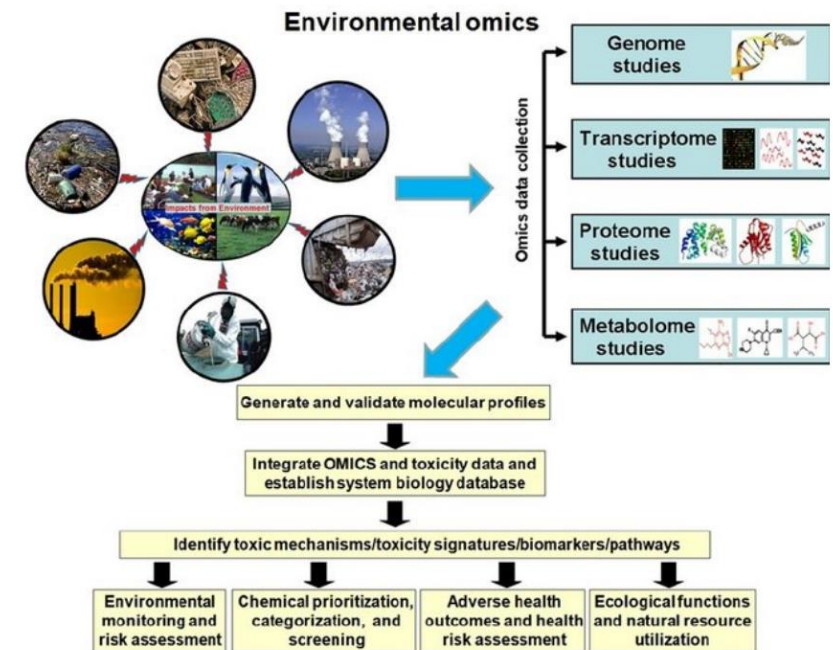
In aquatic ecosystem health studies, examining aquatic organisms is very important in environmental change and pollution analysis. With the development of omics technologies, the number of water ecotoxicity investigation studies is increasing day by day. Single omics methods or multi-omics methods enable the depiction of multidimensional datasets for holistic interpretation of the molecular responses of biological systems. Thus, the health of aquatic ecosystems is examined (Nam et al. 2022).

➤ 2. Using Omics Data in Ecotoxicology

2.2 Terrestrial Ecosystems

To evaluate the effects of pollutants in aquatic ecosystems on aquatic organisms within the scope of different omics technologies

The effects on terrestrial organisms affected by pollution in terrestrial ecosystems are examined with omics technologies. It is especially investigated with metagenomic and transcriptomic analyzes in soil microbial communities (Processor 2015).



Omics in terrestrial ecosystem (Ge 2013)

➤ 2. Using Omics Data in Ecotoxicology

2.3 Air Pollution and Ecotoxicological Effects

To evaluate air pollution ecotoxicologically in the context of different omics technologies

Air pollution not only causes many effects on living organisms, but also can cause fatal diseases such as lung cancer in terms of human health. The effects of acute or chronic exposure to air pollution are examined with omics Technologies (Xu et al. 2022).

➤ 2. Using Omics Data in Ecotoxicology

2.4 Human Health and Environmental Impacts

To examine the effects of pollutants on human health with omics technologies

Environmental toxicology can be examined in two parts: human health toxicology and toxicology of other living organisms. Since human toxicology focuses on a single species and usually an individual, it is easier than the toxicology of other living organisms. Therefore, it enables omics studies to be carried out quickly and easily (Sauvé 2014).

➤ 3. Conclusion

In ecotoxicology studies, the effects of pollutants on wildlife and human populations are examined with omics technologies. There are many studies investigating omics technologies of different types of organisms living in aquatic and terrestrial ecosystems. Other studies examining the contamination of living organisms and human health due to air pollution make it possible to investigate different genes, mRNA, proteins and metabolites. With these studies, risk assessment can be made in a wide range of areas.

➤ 4. References

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