



Erasmus Mundus Joint Master Degree  
**in Environmental Contamination and Toxicology**

**ECT+ EMJMD**  
CATALOGUE OF COURSES

**2020-2025**



## A Joint MSc Programme (120 ECTS)

ECT+ EMJMD is a Joint European MSc programme aimed at forming multidisciplinary graduates of transverse research profile, by attracting highly qualified and motivated students from around the world into a fully integrated world class EU MSc programme.

The ECT+EMJMD programme provides students with competences and skills to develop their career in the following fields of the area of environmental contamination and toxicology:

- Advanced Analytical Chemistry
- Translational Ecotoxicology
- Pollutant Biogeochemistry
- Integrative Ecotoxicology
- Water and Wastewater Pollution and Management
- Marine Ecotoxicology
- Contamination and Remediation of Soils
- Arctic Contamination and Toxicology
- Applied and Regulatory Ecotoxicology

Both staff exchange and student mobility are promoted under a balanced ECTS scheme. Every student must spend at least 30 ECTS each in three different Partner Universities.

Successful students will achieve a Joint/Multiple MSc degree (120 ECTS) awarded by the three Partner Universities through which the studies have been undertaken.

**ECT+ EMJMD Secretariat**  
R&D CENTRE FOR EXPERIMENTAL  
MARINE BIOLOGY AND BIOTECHNOLOGY  
(PLENTZIAKO ITSAS ESTAZIOA;  
PIE-UPV/EHU)

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[www.ectplus.eu](http://www.ectplus.eu)



# Erasmus Mundus Joint Master Degree in Environmental Contamination and Toxicology

[www.ectplus.eu](http://www.ectplus.eu)

| 1. BIOGEOCHEMISTRY OF ENVIRONMENTAL POLLUTANTS               |   |   |  |   |  |
|--|---|---|--|---|--|
| Biogeochemistry of environmental pollutants                  | Applied environmental biogeochemistry               |   | Hydrology, water cycle and global change   | Biogeochemical cycles in the ocean  | Carbon, nutrient, greenhouse gases dynamics in marine ecosystems and geological oceanography                         |
| 2. ECOLOGY AND ECOPHYSIOLOGY                                 |   |   |  |   |  |
| Terrestrial and Aquatic Ecology and Ecophysiology            | Ecological Quality assessment in coastal ecosystems | Physiological energetics of marine organisms          | Functional ecology in aquatic systems      | Sustainable management of ecosystem services                                    | Marine ecology   |
|  | Eutrophication and harmful algae                    | Degradation and rehabilitation of estuaries           | Stress ecology                             |   | Biology of marine mammals  |
| 3. ENVIRONMENTAL AND ANALYTICAL CHEMISTRY                    |   |   | 5. ENVIR DATA ANALYSIS                     |   |  |
| Environmental and Analytical Chemistry                       | Environmental chemometrics                          | Monitoring networks                                   | Metrology in aquatic systems               | Analytical environmental chemistry  | Mathematical analysis and modelling methods applied to the environment / Introduction to Marine Ecosystems modelling |
| Data Analysis in Environmental Sciences                      | Advanced instrumental analysis                      | Univariate & multivariate analysis                    |  | Techniques for detection of organochemical pollutants in the Arctic environment |  |
| 4. FUNDAMENTALS IN TOXICOLOGY AND ECOTOXICOLOGY              |   |   | 7. ERA OF CHEMICALS                        |   |  |
| Fundamentals in Aquatic Ecotoxicology                        | Ecotoxicology                                       | Ecotoxicology and risk quantification                 | Environmental risk assessment fundamentals | Environmental risk assessment: REACH & CPL                                      | Environmental biosafety  |
|  | Comparative Endocrinology and Endocrine Disruption  | Ecotox & biodegradation of marine pollutants          | Environment and public health              | Risk communication (online)   | Advanced course on Euclid (online)   |
| 6. ADVANCED ENVIRONMENTAL TOXICOLOGY                         |   |   |  |   |  |
| Histology and histopathology of aquatic animals              | Soil & sediment contamination and toxicology        | In vitro toxicity assays                              | Advanced Ecotoxicology                     | Arctic environmental toxicology   | Arctic environmental pollution, distribution and processes   |
| Envir monit & risk assess in aquatic systems                 | Environmental (toxic)genomics                       | Cellular and molecular biomarkers                     | Genetic resistance to pollutants           | Toxicogenomics and toxicoproteomics   | Genetic toxicology   |
| 8. RESEARCHER CAREER IN ECT                                  |   |   |  |   |  |
| INCYTA: Research in environmental contamination & toxicology | Introduction to research activities                 | Contamination social awareness & environmental ethics | Professional practice- research (9)        | Special syllabus for Master Degree  | CAREER START UP IN ECT   |
| Free choice: /Practicum / Multicultural integrat in EU/ ...  | Professional practice I - research stage /external  | Professional practice II - research stage /external   | Master thesis                              |   |  |



| MODULE   | COURSE   | ects                                   | TYPE     | SEM | UNIV      |   |      |
|--|--|--|----------|-----|-----------|---|------|
| MODULE 1. BIOGEOCHEMISTRY OF ENVIRONMENTAL POLLUTANTS                            | Biogeochemistry of environmental pollutants  | 6                                      | C UBx    | 1   | UBx       |   |      |
|  | Biogeochemical cycles in the ocean   | 6                                      | OP       |     | ULiège    |   |      |
|  | Carbon, nutrient, greenhouse gases dynamics in marine ecosystems and geological oceanography                         | 6                                      | OP       |     |           |   |      |
|  | Hydrology, water cycle and global change   | 4                                      | C UPPA   |     | UPPA      |   |      |
| MODULE 2. ECOLOGY AND ECOPHYSIOLOGY  | Terrestrial and Aquatic Ecology and Ecophysiology  | 6                                      | C UBx    | 1   | UBx       |   |      |
|  | Biology of marine mammals  | 6                                      | OP       |     | ULiège    |   |      |
|  | Marine ecology   | 6                                      | C ULiège |     | ULiège    |   |      |
|  | Functional ecology in aquatic systems  | 6                                      | C UPPA   |     | UPPA      |   |      |
|  | Sustainable management of ecosystem services   | 7,5                                    | OP       | 2   | NTNU      |   |      |
|  | Stress ecology   | 6                                      | C UPO    |     | UPO       |   |      |
|  | Ecological Quality assessment in coastal ecosystems  | 4                                      | OP       |     | EHU       |   |      |
|  | Eutrophication and harmful algae   | 4                                      | OP       |     |           |   |      |
|  | Degradation and rehabilitation of estuaries  | 4                                      | OP       |     |           |   |      |
|  | Physiological energetics of marine organisms   | 4                                      | OP       |     |           |   |      |
|  | MODULE 3. ENVIRONMENTAL AND ANALITICAL CHEMISTRY   | Environmental and Analytical Chemistry | 6        |     | C UBx     | 1 | UBx  |
|  |  | Metrology in aquatic systems           | 6        |     | C UPPA    |   | UPPA |
| Monitoring networks  |  | 4                                      | C UPPA   |     |           |   |      |
| Analytical environmental chemistry   |  | 7,5                                    | OP       | 2   | NTNU      |   |      |
| Techniques for detection of organo-chemical pollutants in the Arctic environment |  | 10                                     | OP       |     |           |   |      |
| Advanced instrumental analysis   |  | 4                                      | OP       |     | EHU       |   |      |
| Applied environmental analytical chemistry                                       |  | 4                                      | OP       |     |           |   |      |
| Environmental chemometrics   | 4  | OP                                     |          |     |           |   |      |
| MODULE 4. FUNDAMENTALS IN TOXICOLOGY AND ECOTOXICOLOGY                           | Fundamentals in Aquatic Ecotoxicology  | 6                                      | C UBx    | 1   | UBx       |   |      |
|  | Ecotoxicology and risk quantification  | 6                                      | C ULiège |     | ULiège    |   |      |
|  | Ecotox & biodegradation of marine pollutants   | 6                                      | C ULiège |     | UPPA      |   |      |
|  | Ecotoxicology  | 5                                      | CUPPA    | 2   | UPO       |   |      |
|  | Environmental risk assessment: fundamentals  | 3                                      | OP       |     |           |   |      |
|  | Environment and public health  | 3                                      | OP       |     |           |   |      |
| MODULE 5. ENVIRONMENTAL DATA ANALYSIS  | Data Analysis in Environmental Sciences  | 6                                      | C UBx    | 1   | UBx       |   |      |
|  | Mathematical analysis and modelling methods applied to the environment / Introduction to Marine Ecosystems modelling | 6                                      | OP       |     | ULiège    |   |      |
|  | Univariate & multivariate analysis   | 5                                      | OP       |     | UPPA      |   |      |
| MODULE 6. ADVANCED ENVIRONMENTAL TOXICOLOGY                                      | Genetic toxicology   | 7,5                                    | OP       | 2   | NTNU      |   |      |
|  | Arctic environmental toxicology  | 10                                     | OP       |     |           |   |      |
|  | Arctic environmental pollution, distribution and processes   | 10                                     | OP       |     |           |   |      |
|  | Advanced Ecotoxicology   | 6                                      | C UPO    |     | UPO       |   |      |
|  | Genetic resistance to pollutants   | 3                                      | OP       |     |           |   |      |
|  | Toxicogenomics and toxicoproteomics  | 6                                      | OP       |     | EHU       |   |      |
|  | Envir monit & risk assess in aquatic systems   | 4                                      | C EHU    |     |           |   |      |
|  | Environmental (toxico)genomics   | 4                                      | OP       |     |           |   |      |
|  | Cellular and molecular biomarkers  | 4                                      | OP       |     |           |   |      |
|  | Comparative Endocrinology and Endocrine Disruption   | 4                                      | OP       |     |           |   |      |
|  | Histology and histopathology of aquatic animals  | 4                                      | OP       |     |           |   |      |
|  | Soil & sediment contamination and toxicology   | 4                                      | OP       | 3   |           |   |      |
|  | In vitro toxicity assays   | 4                                      | OP       |     |           |   |      |
| Environmental risk assessment: REACH & CPL                                       | 6  | C                                      |          |     |           |   |      |
| MODULE 7. ENVIRONMENTAL RISK ASSESSMENT OF CHEMICALS                             | Environmental biosafety  | 4                                      | OP       | 3   | EHU       |   |      |
|  | Risk communication (online)  | 4                                      | OP       |     |           |   |      |
|  | Advanced course on Euclid (online)   | 4                                      | OP       |     |           |   |      |
| MODULE 8. RESEARCHER CAREER IN ECT   | Special syllabus for Master Degree   | 7,5                                    | OP       | 2   | NTNU      |   |      |
|  | Free choice: /Practicum / Multicultural integrat in EU/ ...  | 6                                      | OP       |     | UPO / EHU |   |      |
|  | Professional practice - research   | 9                                      | OP       |     | EHU       |   |      |
|  | Professional practice I - research stage /external   | 6                                      | OP       | 3   | EHU       |   |      |
|  | Professional practice II - research stage /external  | 4                                      | OP       |     |           |   |      |
|  | Introduction to research activities  | 4                                      | OP       |     |           |   |      |
|  | Research in environmental contamination & toxicology   | 6                                      | C        |     |           |   |      |
|  | Contamination social awareness & environ ethics  | 6                                      | C        |     |           |   |      |
|  | Master thesis  | 30                                     | C        |     |           | 4 | ALL  |

C UBx, compulsory in UBx-Semester 1; C UPPA, compulsory in UPPA-Semester 1; C ULiège, compulsory in ULiège-Semester 1;  
C UPO, compulsory in UPO-Semester 2; C EHU, compulsory in EHU-Semester 2;  
OP, optional; C, compulsory to all ECT+ EMJMD students;

## Structure and content

The programme runs full-time over 24 months (120 ECTS) and consists of advanced courses (90 ECTS) and a Master Thesis, with a dissertation (30 ECTS).

During Semester 1, students will follow different individually tailored combinations of courses integrated in one of the fundamental modules (1-5) in UBx, ULiège or UPPA.

During Semester 2, they will follow another individually tailored combination of courses integrated into the advanced specialised modules (6-10) in NTNU, UPO or EHU.

During Semester 3 the students must follow the compulsory INCyTA course (6 ECTS) as a part of the Module 10.

Every student will follow a Joint Programme, by combining the different disciplines that can be studied at each of the Partner universities (these are the complementary profiles in which each Partner excels and, as such, recognized internationally):

- Pollutant Biogeochemistry and Integrative Ecotoxicology in UBx;
- Water and Wastewater Pollution in UPPA;

- Marine Ecology and Ecotoxicology in ULiège;
- Arctic Contamination and Toxicology in NTNU;
- Applied and Regulatory Ecotoxicology in UPO;
- Advanced Analytical Chemistry and Translational Ecotoxicology in EHU.

The coursework is arranged in 10 modules:

- MODULE 1: Biogeochemistry of Environmental Pollutants
- MODULE 2: Fundamentals in Toxicology and Ecotoxicology
- MODULE 3: Environmental Analytical Chemistry
- MODULE 4: Advanced Ecology
- MODULE 5: Environmental Data Analysis
- MODULE 6: Advanced Environmental and Analytical Chemistry
- MODULE 7: Applied Ecology and Ecophysiology
- MODULE 8: Advanced and Applied Ecotoxicology
- MODULE 9: Environmental Risk Assessment and Management
- MODULE 10: Researcher's Career

Throughout the coursework, students can make a selection between alternative mobility pathways; choosing one of these pathways is not a requirement and they will not appear as specialisation in the Joint Diploma and EDS.

Through any of the pathways, the students have the opportunity to travel, from chemistry and molecular biology to ecological and management issues and from short-term responses of living systems to chemicals to their long-term; thus achieving a translational science background.

All the students follow advanced courses in UPV/EHU in Semester 3, with a relevant, but not compulsory, imprint in the field of advanced environmental risk assessment and skills for a researcher's career in ECT.

A full list of courses and their associated learning outcomes, credit point values, assessment methods, and pre-requisites is available at the Catalogue of Courses (see website).

The MSc Thesis research is undertaken during Semester 4 (30 ECTS) and consists of a 5-6 month research under the supervision of a PhD holder.

Upon completion of the MSc Thesis the student should demonstrate sufficiency for research in order to undertake the realisation of the PhD Thesis work, or a professional activity as researcher.

## Mobility Pathways

### SEMESTER 1

**30**

| <b>A: FUNDAMENTALS IN INTEGRATIVE ECT</b>    |   | <b>UBx</b> |
|--|---|------------|
| BIOGEOCHEMISTRY OF ENVIRONMENTAL POLLUTANTS  | Biogeochemistry of Environmental Pollutants       | 6          |
| ECOLOGY AND ECOPHYSIOLOGY                    | Terrestrial and Aquatic Ecology and Ecophysiology | 6          |
| ENVIRONMENTAL AND ANALYTICAL CHEMISTRY       | Environmental and Analytical Chemistry            | 6          |
| FUNDAMENTALS IN TOXICOLOGY AND ECOTOXICOLOGY | Fundamentals in Aquatic Ecotoxicology             | 6          |
| ENVIRONMENTAL DATA ANALYSIS                  | Data Analysis in Environmental Sciences           | 6          |
| <b>TOTAL ects OFFERED</b>                    |   | <b>30</b>  |

| <b>B: FUNDAMENTALS IN MARINE ECT</b>         |  | <b>ULiège</b> |
|--|--|---------------|
| BIOGEOCHEMISTRY OF ENVIRONMENTAL POLLUTANTS  | Biogeochemical Cycles in the Ocean   | 6             |
|  | Carbon, Nutrient, Greenhouse gases dynamics in marine ecosystems and geological oceanography                         | 6             |
| ECOLOGY AND ECOPHYSIOLOGY                    | Biology of Marine Mammals  | 6             |
|  | Marine Ecology   | 6             |
| FUNDAMENTALS IN TOXICOLOGY AND ECOTOXICOLOGY | Ecotoxicology and Risk Quantification  | 6             |
|  | Ecotoxicology and Biodegradation of Marine Pollutants  | 6             |
| ENVIRONMENTAL DATA ANALYSIS                  | Mathematical Analysis and Modelling Methods applied to the environment / Introduction to Marine Ecosystems modelling | 6             |
| <b>TOTAL ects OFFERED</b>                    |  | <b>42</b>     |

| <b>C: FUNDAMENTALS IN AQUATIC ECT</b>        |  | <b>UPPA</b> |
|--|--|-------------|
| BIOGEOCHEMISTRY OF ENVIRONMENTAL POLLUTANTS  | Hydrology, Water Cycle and Global Change | 4           |
| ECOLOGY & ECOPHYSIOLOGY                      | Functional Ecology in Aquatic Systems    | 6           |
| ENVIRONMENTAL AND ANALYTICAL CHEMISTRY       | Metrology in Aquatic Environments        | 6           |
|  | Monitoring Networks                      | 4           |
| FUNDAMENTALS IN TOXICOLOGY AND ECOTOXICOLOGY | Ecotoxicology                            | 5           |
| ENVIRONMENTAL DATA ANALYSIS                  | Univariate & multivariate analysis       | 5           |
| <b>TOTAL ects OFFERED</b>                    |  | <b>30</b>   |

## SEMESTER 2

30

| 1: ADVANCED MARINE AND ARCTIC ECT      |  | NTNU        |
|--|--|-------------|
| ENVIRONMENTAL AND ANALYTICAL CHEMISTRY | Techniques for Detection of Organo-chemical Pollutants in the Arctic Environment | 10          |
|  | Analytical Environmental Chemistry   | 7.5         |
| ECOLOGY AND ECOPHYSIOLOGY              | Sustainable Management of Ecosystem Services                                     | 7.5         |
| ADVANCED ENVIRONMENTAL TOXICOLOGY      | Genetic Toxicology   | 7.5         |
|  | Arctic Environmental Toxicology  | 10          |
|  | Arctic Environmental Pollution, Distribution and Processes                       | 10          |
| SKILLS FOR THE RESEARCHER CAREER       | Special Syllabus for Master Degree   | 7.5         |
| <b>TOTAL ects OFFERED</b>              |  | <b>62.5</b> |

| 2: APPLIED ECOTOXICOLOGY                     |   | UPO       |
|--|---|-----------|
| ECOLOGY & ECOPHYSIOLOGY                      | Stress Ecology                                  | 6         |
| FUNDAMENTALS IN TOXICOLOGY AND ECOTOXICOLOGY | Environmental Risk assessment: Fundamentals     | 3         |
|  | Environment and Public Health                   | 3         |
| ADVANCED ENVIRONMENTAL TOXICOLOGY            | Advanced Ecotoxicology                          | 6         |
|  | Genetic Resistance to Pollutants                | 3         |
|  | Toxicogenomics and Toxicoproteomics             | 6         |
| SKILLS FOR THE RESEARCHER CAREER             | Free Option                                     | 3         |
|  | Professional Practice: research /external stage | 9         |
| <b>TOTAL ects OFFERED</b>                    |   | <b>39</b> |

| 3: ENVIRONMENTAL IMPACT ASSESSMENT     |   | EHU       |
|--|---|-----------|
| ENVIRONMENTAL AND ANALYTICAL CHEMISTRY | Advanced Instrumental Analysis                                  | 4         |
|  | Environmental Chemometrics                                      | 4         |
| ECOLOGY AND ECOPHYSIOLOGY              | Ecological Quality Assessment in Coastal Ecosystems             | 4         |
|  | Degradation and Rehabilitation of Estuaries                     | 4         |
|  | Physiological Energetics of Marine Organisms                    | 4         |
|  | Eutrophication and Harmful Algae                                | 4         |
| ADVANCED ENVIRONMENTAL TOXICOLOGY      | Environmental Monitoring and Risk Assessment in Aquatic Systems | 4         |
|  | Cellular and Molecular Biomarkers                               | 4         |
|  | Histology and Histopathology of Aquatic Animals                 | 4         |
|  | Environmental (Toxico)Genomics                                  | 4         |
|  | Comparative Endocrinology and Endocrine Disruption              | 4         |
| SKILLS FOR THE RESEARCHER CAREER       | Free choice: Practicum/Multiculintegrat in EU/ ...              | 6         |
|  | Professional Practice I - research stage /external              | 6         |
| <b>TOTAL ects OFFERED</b>              |   | <b>56</b> |

**SEMESTER 3****30**

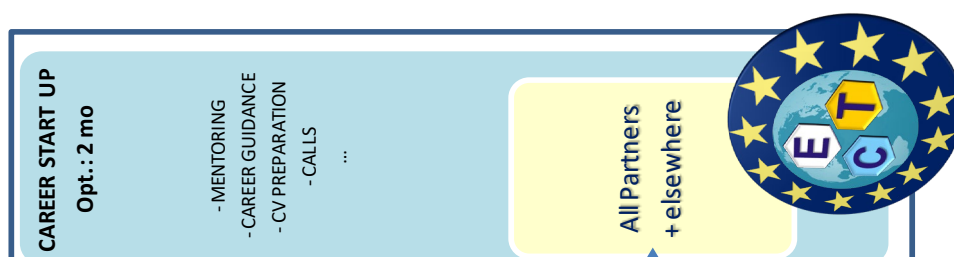
| <b>CAREERS IN ECT: ERA &amp; RESEARCH</b>          |   | <b>EHU</b> |
|--|---|------------|
| <b>BIOGEOCHEMISTRY OF ENVIRONMENTAL POLLUTANTS</b> | Applied Environmental Biogeochemistry                           | 4          |
| <b>ADVANCED ENVIRONMENTAL TOXICOLOGY</b>           | Soiland Sediment Contamination and Toxicology                   | 4          |
|  | In vitro Toxicity Assays  | 4          |
| <b>ENVIRONMENTAL RISK ASSESSEMENT OF CHEMICALS</b> | <b>Envir Risk Assessment: REACH &amp; CPL</b>                   | <b>6</b>   |
|  | Environmental Biosafety   | 4          |
|  | <b>Contamination Social Awareness and Environmental Ethics</b>  | <b>6</b>   |
|  | Risk Communication (online)                                     | 4          |
|  | Advanced Course on Euclid (online)                              | 4          |
| <b>SKILLS FOR THE RESEARCHER CAREER</b>            | Introduction to Research Activities                             | 4          |
|  | <b>INCyTA: research in environ contamination and toxicology</b> | <b>6</b>   |
|  | Profesional Practice -II research stage /external               | 4          |
| <b>TOTAL ects OFFERED</b>                          |   | <b>46</b>  |

**SEMESTER 4****30**

|   |                      |           |
|---|----------------------|-----------|
| <b>RESEARCH IN ECT</b>                  |                      | -         |
| <b>SKILLS FOR THE RESEARCHER CAREER</b> | <b>Master Thesis</b> | <b>30</b> |
|   |                      | <b>30</b> |

**TOTAL ects - ECT+ EMJMD ( 2 yr)****120**

|  |             |
|--|-------------|
| <b>Compulsory for all the students</b>               | <b>ects</b> |
| <b>Compulsory at the corresponding Partner Univ.</b> | <b>ects</b> |









université  
de **BORDEAUX**

## Data Analysis in Environmental Sciences - ECT+ UBx 001

### Synopsis

This teaching re-introduces the fundamentals of statistical analysis applied to environmental sciences. Its five major sections address probability distributions, estimation and hypothesis testing, analysis of variance, Regression and correlation, multivariate analysis methods and time series analysis methods. For most of the statistical techniques, concrete applications are investigated through practical sessions using the free software R.

### Aims

- To a broad and comprehensive overview of the most outstanding statistical methods for data analysis in environmental sciences.

### Objectives

At the end of the Unit, you should be able to choose, implement and interpret data analysis methods based on scientific objectives and sampling/experimental strategies in environmental sciences

### Key Skills Acquired

At the end of the Unit, you should be able to:

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- ç—" ] » « fi » «=fi"«» fi" » ` →⇒ fi"fi" fi" →— : =f1« -«-f"=—

### Syllabus

- Discrete and continuous random variables
- Sample and population: statistical inference
- Regression and correlation
- Multivariate analysis
- Time series analysis

### Learning & Teaching

- Formal Lectures: 26 hr
- Practical work: 20 hr

### Teaching Staff

B Lubac (Coord.)

Semester

1

Timetable slot To be advised

ECTS

6

Level Compulsory (UBx)

### Bibliography

- R.E. Thomson and W.J. Emery 2014. Data Analysis Methods in Physical Oceanography, Third Edition, Elsevier.
- W.W. Daniel and C.L. Cross 2013, Biostatistics: A Foundation for Analysis in the Health Sciences, 10th Edition.

### Assessment

- Written examination (50%)
- Practical examination (50%)

### Course Evaluation

Evaluation Questionnaire by students. Annual assessment by Unit Co-ordinator.

## Biogeochemistry of Environmental Pollutants - ECT+ UBx 002

### Synopsis

In this unit, the basics of biogeochemistry will be provided through the presentation of the water, carbon, nitrogen and phosphorous biogeochemical cycles and the impact of human activities on these cycles. This will be completed by a general introduction about the sources and fate of pollutants in the environment. A comprehensive overview of the main environmental pollutants classes (i.e. organic micro-pollutants and trace metals) and of associated ecodynamics in aquatic ecosystems will be provided. A description of the atmospheric compartment as well as the main associated issues related to air quality and climate change will be described. Finally, the inputs of in silico methodologies to predict the physico-chemical and ecotoxicological properties of a substance as well as the role of the dissolved organic matter on the fate of pollutants in aquatic ecosystems will be emphasized.

### Aims

- To provide fundamental knowledge for the most comprehensive and in-depth understanding of the fate of pollutants in aquatic and atmospheric environments.

### Objectives

At the end of the unit, you should:

- Know the basics of water, C, N and P cycles
- Know the basics of typical organic micro-pollutants and trace metals environmental fate
- Understand the key parameters controlling the environmental fate of pollutants in atmospheric and aquatic environments
- Know the principle of QSAR methods to predict the properties of pollutants

### Key Skills Acquired

At the end of the unit, you should understand:

- Impacts of human activities on the water, C, N and P biogeochemical cycles
- The key parameters controlling the environmental fate of pollutants in atmospheric and aquatic environments

### Syllabus

Topics covered include:

- Water, carbon, nitrogen and phosphorous biogeochemical cycles
- Environmental fate of organic micropollutants in aquatic systems
- Biogeochemistry of trace metals
- Role of dissolved organic matter
- QSAR methods for molecular properties prediction
- Basics on atmospheric chemistry and fate of pollutants in the atmosphere
- Introduction to climate change

### Learning & Teaching

- Formal Lectures: 28
- Seminar: 2

### Teaching Staff

E. Perraudin (Coord.), H. Budzinski, N. Geneste, E. Parlanti, J. Schäfer and E. Villenave

**Semester** 1

**Timetable slot** To be advised

**ECTS** 6

**Level** Compulsory (UBx)

### Bibliography

- Biogeochemistry: An Analysis of Global Change, 3rd Edition by W.H. Schlesinger and E. S. Bernhardt, 2013
- Chemistry of the Upper and Lower Atmosphere: Theory, Experiments, and Applications by B. J. Finlayson-Pitts and J. N. Pitts Jr., 1999

### Assessment

- Written theory examination (100%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

## Environmental and Analytical Chemistry

### ECT+ UBx 0003

#### Synopsis

The most up-to-date instrumental methods for trace analysis (for both organic and trace metal contaminants) in aquatic and atmospheric samples will be presented. The basics of elemental and molecular analysis will be covered with a focus on mass spectrometry and chromatography as well as spectroscopy. Specificities of environmental sampling, sample preparation, quantification and speciation will be emphasized. Case studies will allow the discussion about the applications of these methodologies and strongly support the theoretical understanding of both their interests and limitations in studying water and air pollution.

#### Aims

- To provide exposure to the most up-to-date analytical methodologies for both targeted and non-targeted analysis in environmental samples.

#### Objectives

At the end of the Unit, you should:

1. Understand the basics of the most important analytical techniques for environmental sample (aquatic and atmospheric) analysis
2. Be able to design an appropriate sample preparation and analysis procedure for a given organic micropollutant or trace metal
3. Understand the basics of non-targeted analysis

#### Key Skills Acquired

At the end of the Unit, you should understand:

1. The key steps of a trace analysis procedure
2. The interests and limitations of the most commonly applied or newly developed analytical methods for environmental samples

#### Syllabus

Topics covered include:

- Basics on mass spectrometry and coupling with chromatography
- ICP-MS methods for elemental trace analysis.
- Sample preparation methods for trace analysis in air, water, sediment and biological matrices
- Specific issues about quantification and speciation in environmental samples

#### Learning & Teaching

- Formal Lectures: 24
- Seminar: 1
- Case Studies: 2

#### Teaching Staff

E. Perraudin (Coord.), H. Budzinski, P. Labadie, J. Schäfer, E. Villenave

**Semester** 1

**Timetable slot** To be advised

**ECTS** 6

**Level** Compulsory (UBx)

#### Bibliography

- E. Hoffmann. 2008. Mass spectrometry: principles and applications, John Wiley & Sons, Chichester, UK.
- V.R. Meyer. 2010. Practical high-performance liquid chromatography. John Wiley & Sons, Chichester, UK.
- S. Mitra (Ed.). 2003. Sample preparation techniques in analytical chemistry. Wiley-Interscience, Hoboken, New Jersey
- Introduction to Environmental Analysis, R. N. Reeve, 2002, J. Wiley & Sons

#### Assessment

- Written theory examination (100 %)

#### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

## Fundamentals in Aquatic Ecotoxicology

ECT+ UBx 004

### Synopsis

The latest knowledge on the fundamentals and new developments in aquatic ecotoxicology.

### Aims

- To provide knowledge about mechanisms of action and toxic effects of the main families of organic and metallic pollutants and toxins and new approaches and tools used in aquatic ecotoxicology.

### Objectives

At the end of the unit, you should know and understand:

- The basics of aquatic ecotoxicology
- The deleterious effects of some main pollutants and harmful algae
- The main methodological approach and tools (bioassays and biomarkers) used in ecotoxicology

### Key Skills Acquired

At the end of the Unit, you should be able to:

- Use predictive and retrospective ecotoxicological approaches.
- Design and interpret biomonitoring of aquatic pollutions
- Use ecotoxicological tools (bioassays and biomarkers)

### Syllabus

Topics covered include:

- Ecotoxicity of metals
- Ecotoxicity of organic pollutants. Main focus on PAHs, pesticides and microplastics
- Experimental Aquatic Ecotoxicology and methods
- Main analytical techniques in molecular biology used in ecotoxicology
- Endocrine disruptors
- Genotoxicants
- Effects of harmful algae blooms on physiology and behavior of bivalves

### Learning & Teaching

- Formal Lectures: 30
- Practical study & case study: 15

J Cachot (Coord.), M Baudrimont, B Davail, A Feurtet-Mazel, PGonzalez B Morin, D Tran

**Semester** 1

**Timetable slot** To be advised

**ECTS** 6

**Level** Compulsory (UBx)

### Bibliography

- Aquatic ecotoxicology: fundamental concepts and methodologies, 1989. Ed. Alain Boudou, Francis Ribeyre. CRC press (# 577.5AQU)
- An Introduction to Aquatic Toxicology. Mikko Nikinmaa. 2014. Elsevier Science Publishing Co Inc, Academic Press Inc.
- Aquatic Ecotoxicology. Advancing Tools for Dealing with Emerging Risks, 2015. 1<sup>st</sup> edition. Edited by Claude Amiard-Triquet, Jean-Claude Amiard and Catherine Mouneyrac. Elsevier.

### Assessment

- Written theory examination (50%)
- Laboratory work and report (25%)
- Poster and oral presentations of case studies (25%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Coordinator.

### Teaching Staff

## Terrestrial and Aquatic Ecology and Ecophysiology - ECT+ UBx 005

### Synopsis

The fundamentals and latest knowledge in functional ecology and ecophysiology for an integrative (from the individual to the ecosystem) and comprehensive understanding of terrestrial and freshwater ecosystem functioning in response to natural variations and changes of anthropic origin.

### Aims

- To provide a broad overview of ecosystem functioning for a variety of ecosystem types, and key concepts in ecophysiology, functional ecology and bioindication.

### Objectives

- To understand and be able to carry out a comprehensive assessment of ecosystem functioning built on the inclusion of several ecosystem components and levels of organization, from the individual to the whole ecosystem.

### Key Skills Acquired

At the end of the Unit, you should:

- know the basics and components of ecosystem functioning (ecosystem properties and processes),
- be able to analyze and even predict the effects of environmental and anthropic pressures at the organism (aquatic and terrestrial plants, animals) and ecosystem levels,
- understand how organisms can influence ecosystem functioning,
- understand the principles of bioindication and be able to carry out comprehensive and relevant studies of organisms as bioindicators.

### Syllabus

Topics covered include:

- terrestrial plant hydraulics (basics, regulation, dysfunction and consequences on plant survival in response to environmental variations)
- functional traits and diversity, from the individual level to ecosystem functioning
- structure, functioning and dynamics of freshwater ecosystems
- role of organisms in freshwater ecosystem functioning and their use as bioindicators

### Learning & Teaching

- Formal Lectures: 22
- Case Studies: 8

### Teaching Staff

ML Benot (Coord.), V Bertrin  
S Delzon, A Feurtet-Mazel, C  
Laplace-Treytoure

**Semester** 1

**Timetable slot** To be advised

**ECTS** 6

**Level** Compulsory (UBx)

### Bibliography

- Garnier E., Navas M.L. & Grigulis K. 2016. Plant functional diversity, Organism traits, community structure and ecosystem properties, Oxford University Press.
- Hopkins WG. 2009. Introduction to plant physiology, John Wiley & Sons Inc.
- Lambers H., Chapin III F.S & Pons T.L. 2008. Plant Physiological Ecology, 2<sup>nd</sup> ed, Springer.
- Larcher W. 2003. Physiological Plant Ecology, 4<sup>th</sup> ed, Berlin: Springer.
- Reynolds, C. 2006. Ecology of Phytoplankton. Cambridge University Press, Cambridge, GBR.
- Taiz L. & Zeiger E. 2002. Plant Physiology, 3<sup>rd</sup> ed, Sunderland: Sinauer Associates. (available online).
- Wetzel, 2001. Limnology: Lake and River ecosystems, 3<sup>rd</sup> ed., Academic Press.

### Assessment

- Written theory examination (60 %)
- Case study and oral presentation (40%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.



## Ecology in Aquatic Systems

- ECT+ UPPA 001

### Synopsis

All organisms are not equal when exposed to environmental contamination. Inter- and intra- specific variation in responses to pollutants triggers a cascade of effects, affecting biodiversity and its resilience. These effects will be presented from physiological functions up to populations demography and genetics, through life-history traits and behaviour.

### Aims

- To provide awareness and understanding of organisms response to environmental contamination from individual to meta-populations.

### Objectives

At the end of the Unit, you should:

1. Understand the dynamics of pollutants in the living compartment of ecosystems.
2. Grasp the physiological mode of action of the main types of pollutants and their effect on traits at the level of the whole organism.
3. Project the consequences at the population level, while accounting for evolutionary forces (selection, heredity).

### Key Skills Acquired

At the end of the Unit, you should be able to:

1. Mobilize classical concepts in ecology to interpret the effect of pollutants on populations.
2. Make use of state-of-the-art modelling tools to predict the effects of pollutants on population dynamics and evolution.

### Syllabus

Topics covered include:

- Metabolism and energetic status
- Life-history strategies
- Population dynamics (including metapopulations) and demogenetics

### Learning & Teaching

- Formal Lectures: 15 hr
- Seminar: 5 hr
- Field work: 15hr

C. Recapet (Coord.), M. Vignon, J. Labonne, F. D'Amico

**Semester** 1

**Timetable slot** To be advised

**ECTS** 4

**Level** Compulsory (UPPA)

### Bibliography

- M.C. Newman. 2014. Fundamentals of Ecotoxicology: The Science of Pollution. CRC Press.
- M.C. Molles, A.A. Sher. 2018. Ecology: Concepts and Applications. McGraw-Hill Higher Education.
- T. Jager. 2019. Making Sense of Chemical Stress. Application of Dynamic Energy Budget Theory in Ecotoxicology and Stress Ecology. Version 2.0. Leanpub. [https://leanpub.com/debtox\\_book](https://leanpub.com/debtox_book).

### Assessment

- Written theory examination (40%)
- Laboratory reports and oral presentations (60%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

### Teaching Staff

## Ecotoxicology

- ECT+ UPPA 002

### Synopsis

Ecotoxicology is the study of the effect of environmental contaminants on living organisms - a merger of the study of the environment (ecology) with the study of interactions of chemicals with individual living organisms (toxicology). In this course, we will learn about how toxicants interact with and impact biological organisms, how ecotoxicology is measured in practice, and how to critically analyze ecotoxicological papers through case studies.

### Aims

- To provide the students with an introduction to environmental science and ecotoxicology, and to contribute to the student's knowledge about how pollutant chemicals released in nature may cause adverse effects in organisms, populations and ecosystems.

### Objectives

At the end of the unit, you should:

1. Know the different classes of pollutants, major sources of pollution, the environmental behaviour and fate of pollutants in ecosystems
2. Understand how toxicants interact with and impact biological organisms. We will learn about mechanisms of toxicity, how organisms accumulate and excrete toxic compounds, and the effects of toxicants on individuals, populations, and whole ecosystems.
3. Know how ecotoxicology is measured in practice. We will learn about standardized toxicity tests, alternative testing strategies, and the use of quantitative modeling for Ecological Risk Assessment.
4. Be able to critically analyze primary scientific literature. Students will read ecotoxicology papers and identify important points and summary measurements for comparison within the literature on the same toxicant and between contaminants of interest. More importantly, students will be able to read these papers critically, understanding the limitations of certain measurements or assumptions and identifying potential weaknesses of the methodology or analysis.

### Key Skills Acquired

At the end of the unit, you should be able to:

1. define and interpret effective concentrations (e.g. LC50, EC50)
2. undertake risk and hazard assessments of chemicals, based on physico-chemical parameters and ecotoxicological index
3. estimate the effects of chemical substances on populations of organisms
4. to use characteristics and measured properties to interpret and assess the risks posed by chemicals for organisms, in various work contexts

### Syllabus

Topics covered include:

- Types of pollution, pollutants
- Sources of pollutants
- Reactivity and fate of pollutants in ecosystems

### Learning & Teaching

- Formal Lectures: 18 hr
- Seminar: 12 hr
- Field work: 6 hr

### Teaching Staff

M Monperrus (Coord), S Le Faucheur, L Lanceleur, V Bolliet

**Semester** 1

**Timetable slot** To be advised

**ECTS** 5

**Level** Compulsory (UPPA)

### Bibliography

- Walker, C. H., Sibly, R. M., Hopkin, S. P., Peakall, D. B. (2012). Principles of Ecotoxicology. CRC Press, Boca Raton, USA.
- Hoffman, D. J., Rattner, B. A., Burton, G. A., Cairns, J. (1995). Handbook of Ecotoxicology. Lewis, Boca Raton, USA

### Assessment

- Written theory examination (60%)
- Laboratory reports and oral presentations (40%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

## Hydrology, Water Cycle and Global Change - ECT+ UPPA 003

### Synopsis

The global change due to human activity is increasingly affecting the health of ecosystems and the living conditions for most of living creatures, including human beings. Understanding, predicting and mitigating the response of the global water system in terms of availability, quality and contamination requires to have a bulk knowledge of the water cycle and related hydrological processes.

### Aims

- To review the main cycles of natural waters across water bodies and atmosphere and documents how humans are altering these cycles.

### Objectives

At the end of the Unit, you should:

- be able to understand the temporal and spatial scales involved in the water cycle
- understand the functioning of the main water bodies, their interaction and couplings with atmosphere
- be able to quantify the main fluxes of water, and how they drive the cycles of other basic elements (in particular carbon)
- have a consistent insight on the global change and its consequences on nature and human activities

### Key Skills Acquired

At the end of the Unit, you should understand:

- the connections between human activities and water cycle
- the transformation process in which the global water system is engaged

### Syllabus

Topics covered include:

- Functioning of main water bodies
- Connection with atmosphere: the coupled climate system
- Global cycles: water and carbon
- The Global Change

### Learning & Teaching

- Lectures: 20 hr
- Tutorial classes and seminars for applications: 20 hr

D Sous (Coord.)

**Semester** 1

**Timetable slot** To be advised

**ECTS** 4

**Level** Optional

### Bibliography

- E. K. Berner and R. A. Berner 2012. Global Environment, Water, Air and Geochemical cycles, Princeton University Press.
- Change, I.C., 2007. The physical science basis. Contribution of Working Group 1 to the fourth assessment report of the Intergovernmental Panel on Climate Change, 996.

### Assessment

- Written theory examination (50%)
- Case study and oral presentation (50%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Coordinator.

### Teaching Staff

## Metrology of Aquatic Environments

- ECT+ UPPA 004

### Synopsis

Determining water quality is a key question and legislation aims at achieving an ecological and chemical "good status" of all water bodies. In this module, we focus on superficial water bodies (e.g.: rivers, lakes, estuaries, coastal waters) and the way to assess the status of their physico-chemical status by means of measures, sampling and laboratory analysis.

Field operations are located in the coastal lagoon of Vieux Boucau (SW France). Students are in charge of the monitoring design, the hydrological monitoring and laboratory activities.

### Aims

- The aim of this course is to provide students with a largely comprehensive introduction to aquatic system monitoring by using a wide range of field equipment and lab analyses to investigate the physics and geochemistry of surficial waters.

### Objectives

At the end of the Unit, students should be able:

- to know the basis for defining water quality
- to set up a sampling strategy (types of pollutants, station location, sampling frequency, sampling apparatus)
- to perform basic laboratory activities (concentration measurements), control the quality of the data and process data treatment
- to understand and interpret a water analysis
- to use databases (multi-variables data), statistical analysis and trend determinations to present, interpret and evaluate results in appropriate forms.

### Key Skills Acquired

At the end of this Unit, students should understand:

- the sampling strategy to encompass spatial and temporal variations
- the major parameters used to define water quality and measurement methods
- analytical methods to quantify nutrients and particulate matter parameters

### Syllabus

Topics covered include:

- Sample preparation: sampling, preservation, preparation, extraction, analysis  
Expression of results: studied parameters, units, presentation of results, precision and accuracy  
Chemical substances and pollution criteria
- Major physicochemical characteristics (T, salinity, dissolved oxygen, pH, turbidity), measurement methods
- Particulate material (organic SPM, C, N, P, chlorophyll pigments), measurement methods
- Nutrients (nitrite, nitrate, ammonia, phosphate, silicate), measurement methods
- Application of analytical methods to environmental samples

### Learning & Teaching

- Lectures: 30 hr
- Practical tutorials : 6 hr
- Field and lab analysis 24 hr

### Teaching Staff

M Monperrus, L Lancelleur

**Semester** 1

**Timetable slot** To be advised

**ECTS** 6

**Level** Compulsory (UPPA)

### Bibliography

- Fundamentals of Environmental Sampling and Analysis, by Chunlong Zhang
- Water Quality: An Introduction, by Claude E. Boyd

### Assessment

- Written theory examination (50%)
- Field report presenting details of sampling collection and environmental measurements as well as post-fieldwork analysis (50%)

### Course Evaluation

- By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Coordinator.

## Water quality monitoring networks

- ECT+ UPPA 005

### Synopsis

Water quality monitoring is an important tool for assessing and managing water resources. This multidisciplinary course will present the different types of water quality monitoring networks established within the European regulation.

### Aims

To provide a sound approach of the water quality monitoring cycle: from water management to data analysis and information utilization.

### Objectives

At the end of the Unit, you should:

1. understand and apply the different steps of the monitoring cycle in waterbodies
2. apply common statistical techniques for water quality data evaluation
3. design sound and sustainable water quality monitoring and assessment programmes under specified conditions

### Key Skills Acquired

At the end of this Unit, you should master :

1. the key points for the implementation of a relevant water quality monitoring network
2. the methodology for analyzing data from these networks

### Syllabus

Topics covered include:

- Concepts of monitoring and assessment: basic rules
- Description of different monitoring networks in different matrices : freshwater, groundwaters, littoral waters, biomonitoring
- Case study on different types of water

### Learning & Teaching

- Lectures: 20 hr
- Seminars (for case studies and applications): 20 hr

|                       |               |
|-----------------------|---------------|
| <b>Semester</b>       | 1             |
| <b>Timetable slot</b> | To be advised |
| <b>ECTS</b>           | 4             |
| <b>Level</b>          | Optional      |

### Bibliography

- Bartram, Jamie, Ballance, Richard, World Health Organization & United Nations Environment Programme. (1996). Water quality monitoring : a practical guide to the design and implementation of freshwater quality studies and monitoring programs / edited by Jamie Bartram and Richard Ballance. London : E & FN Spon.
- Daoling Li, Shuangyin Liu, (2018) Water Quality Monitoring and Management , 1st Edition Basis, Technology and Case Studies, Academic press
- Water Quality Monitoring Network Design (1999), Harmancioglu, N.B., Fistikoglu, O., Ozkul, S.D., Singh, V., Alpaslan, M.N., Springer

### Assessment

- Written theory examination (50%)
- Case study and oral presentation (50)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

### Teaching Staff

T Pigot (Coord.)



## Carbon, Nutrient, Greenhouse dynamics in marine ecosystems & Geological oceanography - ECT ULiège OCEA0082-1

|                       |               |
|-----------------------|---------------|
| <b>Semester</b>       | 3             |
| <b>Timetable slot</b> | To be advised |
| <b>ECTS</b>           | 6             |
| <b>Level</b>          | Optional      |

### Synopsis

In the oceans, chemical, biological and physical processes interact in a complex and dependant way. This course specifically aims to give the basis of aquatic chemistry with a particular emphasis on greenhouse gases. The second part deals with the study of basic geochemical concepts requested for the interpretation of the geochemical signature of marine sediment records.

### Aims

- To provide an introduction to biogeochemical and ecological aspects of carbon, greenhouse, nutrients and chemicals in the marine environment, including biogeochemical modelling and particulate and dissolved exchanges.

### Objectives

At the end of the Unit, you should:

- Understand the cycles of organic and inorganic carbon, organic and inorganic nutrients, and greenhouse gases in various marine ecosystems, and their relevance for climate regulation and climate change
- Understand the Chemical processes leading to formation of sedimentary rocks.
- Know how anthropogenic activities and climatic change impact on the sedimentary record.

### Key Skills Acquired

At the end of the Unit, you should be able to:

- Conceptualize, parameterize and implement mathematical models of marine biogeochemical processes.
- Analyse and interpret geochemical signatures of marine sediments and geochemical datasets

### Programme

- Cycles of organic and inorganic carbon, organic and inorganic nutrients, and greenhouse gases in various marine ecosystems.
- Chemical processes leading to formation of sedimentary rocks. Analyses of physical and chemical modifications through early diagenesis. Influence of kinetics and bacterial activity. Interstitial water. Cycle of metallic elements. Paleoceanographical tracers.
- Practicals: Analyses and interpretation of geochemical signatures of marine sediments. Treatment and interpretation of geochemical datasets. Use of excel softawre (a personal computer is requested).

### Learning & Teaching (40 hr Th; 20 hr Pr)

- Lectures: 10x 2 hr = 20 hr (Part 1); 20 hr (Part 2)
- Practicals: 5 hr (Patr 1) 20 hr (Part 2)
- Field work: 1 d (Part 2)

### Teaching Staff

N Fagel (Coord.); A Borges

### Bibliography

There are not published notes of course, but the students will have a copy of transparencies and scientific articles or reference works illustrating the taught theoretical concepts

### Assessment

- Part 1: Written examination: 100%
- Part 2: Theory (70% of final quotation). Written examination on a selection of scientific publications (acces to the reprints and document before the examination). TP - Written report of TP (30%).

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the ULiège Academic Quality & Standards Committee.

## Biogeochemical Cycles in the Ocean

ECT ULiège OCEA0055-5

### Synopsis

Origins and history of the elements during the formation of the Earth. Total cycles of the major and other elements, their role in productivity and food web structure, their importance in climatic changes.

### Aims

- To provide an overview of the biogeochemical cycles in the ocean and how they have governed and govern the Earth system.

### Objectives

At the end of the Unit, you should:

- understand the principal biogeochemical cycles which govern the Earth system and to acquire the basic concepts for their modelling.
- understand the origin and the evolution of the principal biogeochemical phenomena which govern the Earth system

### Key Skills Acquired

At the end of the Unit, you should be able to:

- Undertake basic modelling of biogeochemical cycles

### Programme

- Origins of the elements and their history during the formation of the Earth.
- Description of the large reservoirs and the major biogeochemical phenomena.
- Global cycles of the major elements intervening in the constitution of the organic matter (C, N, O, P) are analyzed. Concepts of characteristic times and the aspects of modeling of these cycles are also approached.
- Biogeochemical cycles of other elements (Fe, S), their role in the productivity and the food web structure, their importance in the context of the climatic changes.
- Importance of the biogeochemical cycles, in the structuring of the ecosystem: case of the Antarctic Ocean
- Disturbance of the carbon cycle: oceanic acidification.
- Two practical work days including 1 day at sea. Practical work will take place according to the availabilities of the R.V. Belgica.

### Learning & Teaching (20 hr Th; 2x10 hr; field work)

- 20 meetings of 2h of theoretical course. Dates to be fixed with the students.

### Teaching Staff

B Delille (Coord.); A Mouchet

**Semester** 3

**Timetable slot** To be advised

**ECTS** 6

**Level** Optional

### Bibliography

Power-point available to the <http://www.co2.ULiège.ac.be/student/address>

### Assessment

- Examination: 75-50%
- Written Report: 25-50%

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the ULiège Academic Quality & Standards Committee.

## Biology of Marine Mammals

ECT ULiège OCEA0063-1

### Synopsis

Introduction to the ecology, ecotoxicology and pathology of the marine mammals

### Aims

- To provide theoretical and practical viewpoint of the human threats to marine mammals.

### Objectives

At the end of the Unit, you should:

1. know about marine mammals and adaptations to aquatic life.
2. understand human threats for marine mammals.
3. familiarize with the principal causes of mortality and threats for the marine mammals
4. acquire concepts on pathology and veterinary surgery (autopsy).

### Key Skills Acquired

At the end of the Unit, you should be able to:

1. identify human threats for marine mammals.
2. perform basic practice in veterinary surgery (autopsy).
3. perform library search and oral presentation of scientific results

### Programme

1. General introduction. Ecology. Ecotoxicology.
2. Tracing pollutants in marine mammals (and other vertebrates).
3. Toxicity and pathologies associated to pollution.
4. Pathologies not related to chemical pollution.
5. Autopsies.

### Learning & Teaching (30 hr Th; 10 hr Pr)

- The theoretical course consists of a general presentation of the causes of mortality, as well as principal threats, of the marine mammals in general and in the North Sea, in particular.
- Seminars presented by invited researchers.
- Written/oral report on a selected topic.
- Practical work: autopsy room (the student individually carries out the autopsy of an cetacean or a seal)

Lectures are organized at the Veterinary Faculty and necropsies are organized at the necropsy room of the same faculty.

### Teaching Staff

K Das (Coord.); T Jauniaux

|                       |               |
|-----------------------|---------------|
| <b>Semester</b>       | 3             |
| <b>Timetable slot</b> | To be advised |
| <b>ECTS</b>           | 6             |
| <b>Level</b>          | Optional      |

### Bibliography

Delivered during the course

### Assessment

- The student will have to prepare a scientific seminar (power-point présentation) (50%).
- Oral examination including theoretical, practical teaching and personal work (50%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the ULiège Academic Quality & Standards Committee.

## Ecotoxicology and Biodegradation of Marine Pollutants - ECT ULiège OCEA0062-1

|                       |               |
|-----------------------|---------------|
| <b>Semester</b>       | 3             |
| <b>Timetable slot</b> | To be advised |
| <b>ECTS</b>           | 6             |
| <b>Level</b>          | Optional      |

### Synopsis

Impact of pollutants. Bioavailability, bioaccumulation, biomagnification and toxicity. Degradation and metabolism of micropollutants. Global change and oceans. Biodeterioration.

### Aims

- To develop critical thinking to study the biological impact and biodegradability of pollutants in the sea

### Objectives

At the end of the Unit, you should:

- Understand the threats of chemical pollution to the marine environment, how to assess them and how then can be combated
- Develop a critical spirit via the study of a fact of topicality, its presentation via the scientific media and its bases.
- Perceive the complexity of the interactions which affect the microbial world and the opportunities it offers to fight against chemical pollution.

### Key Skills Acquired

At the end of the Unit, you should be able to:

- critically review studies on the impact of pollutants in marine organisms
- make an oral presentation of a scientific result.
- identify opportunities offered by marine microbes, to combat against chemical pollution.

### Programme

- Introduction to marine ecotoxicology. How to measure the impact of pollutants. Impact on individuals, populations and ecosystems. Classification of pollutants. Trace metals in marine environment. Organic pollutants in marine environment. Degradation and metabolism of the micropollutants. Global changes and oceans. Case study: Sea of Aral.
- Modes of biodegradation of "natural" organic molecules in the marine environment. Mathematical models to describe the activity of the microorganisms in "natural" conditions.
- Modes of biodegradation of "introduced" organic molecules in the marine environment: domestic (detergent) and industrial (aromatic cycles and halogenous molecules) effluents; hydrocarbons; and plastics.
- Biodeterioration. Case studies: cement, concrete and metallic structures.

### Learning & Teaching (35 hr Th; 15 hr Pr)

- Lectures
- Seminar (oral) prepared by each student and requiring a library search. The set of themes will be imposed by the teacher.
- Practical work combining one day at sea within the framework of a fishing campaign and the corresponding analyses in the laboratory: written report.

### Teaching Staff

K Das (Coord.); M Poulicek

### Bibliography

- Syllabus and collection of copies of all transparencies used distributed at the beginning of the course.
- The biodegradation part of the course was published by the Presses de L'Institut Océanographique à Paris.

### Assessment

- Oral presentation on ecotoxicology (15%)
- Written work on ecotoxicology (15%) within the framework of a seminar
- Training course (20%): Practical work will approach a set of issues of mercury contamination in several species of fish and invertebrates of the North Sea. One day of sampling in the North Sea is envisaged on board R.V. Belgium. The mercury concentrations and the isotopic composition of carbon and nitrogen will be used to connect the trophic ecology of these species, to the level of mercury contamination.
- Oral examination with open book on biodegradation (50%).

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the ULiège Academic Quality & Standards Committee.

## Marine Ecology

ECT ULiège OCEA0057-7

### Synopsis

Foundations of marine ecology. Biodiversity or marine organisms. Sampling techniques in marine ecology. Case studies. Marine ecosystems modelling.

### Aims

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### Objectives

At the end of the Unit, you should:

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### Key Skills Acquired

At the end of the Unit, you should be able to:

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### Programme

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### Teaching Staff

S Gobert (Coord.);

M Poulicek, M Grégoire

Semester 3

Timetable slot To be advised

ECTS 6

Level Compulsory (ULiège)

### Bibliography

- Ppt presentation with lectures available to students.
- Syllabus and CD-Rom with the PowerPoint files and a copy of the software used at the time of the TP (ReefCheck and CoralWatch) available to students

### Assessment

- Marine ecology (60%): Oral examination with open book (two questions) vis-a-vis the two teachers, after preparation (50-75%)  
Written report (25-50%)
- Practical work on modelling (40%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Coordinator. A full external review by the ULiège Academic Quality & Standards Committee.

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### Learning & Teaching (30 hr

Th; 15 hr Pr; 6 d field course)

- Lectures
- Lab sessions (5): devoted primarily to macro and microscopic morphology (1) and systematics (1) of the reef cnidarians, analyses of photographs and films on the structure and the biogeography of the reefs using the software ReefCheck (2) and analyses of quantitative phenomenon of bleaching using the CoralWatch system and software.
- Work practice: carried out during the Training course (STARESO-Calvi-Corsica) at the oceanographic station of the University. Period: October. This includes snorkelling, in scuba diving\* followed by determinations under binocular, photographic documents taken by the student (\*not compulsory).

## Numerical Methods Applied to the Environment - ECT ULiège MECA00551

Mathematical analysis and modelling methods applied to the environment / Introduction to marine ecosystems modelling

### Synopsis

Tools of numerical resolution adapted to the problems encountered in the quantitative study of the environment.

### Aims

- To provide solid mathematical tools to construct and interpret physical and biological models in the marine environment.

### Objectives

At the end of the unit, you should:

- understand the modelling tools useful for the study of the marine environment.

### Key Skills Acquired

At the end of the unit, you should be able to:

- work out tools of numerical resolution adapted to the problems encountered in the quantitative study of the environment.
- work out a digital model for a new problem, while being conscious of the inherent limitations.

### Syllabus

- History of modelling, recalls of the basic mathematical concepts, discretization of oceanographic processes, Coriolis, diffusion, eccentric grids, waves of gravity, diagrams of advection, treatment of the pressure, mode-splitting, Poisson's equations, concepts of nesting, curvilinear coordinates, assimilation of data, adaptive grids

### Learning & Teaching (30 hr Th; 30 hr Pr)

- Lectures: 2 hr/wk
- Making of a tool for simulation for a particular process. This tool will be applied by in particular to analyze the effect of different approaches to the solution of a physical or biological problem. Example: development of a model allowing to study the oscillations of the surface in a lake.

J Beckers (Coord.);

Semester 3

Timetable slot To be advised

ECTS 6

Level Optional

### Bibliography

- The notes of course will be available via WWW in format pdf.
- Electronic copies of interactive "transparencies" are also deposited there under format pdf. <http://modb.oce.ULiège.ac.be/cours/MECA055/accueil.html>

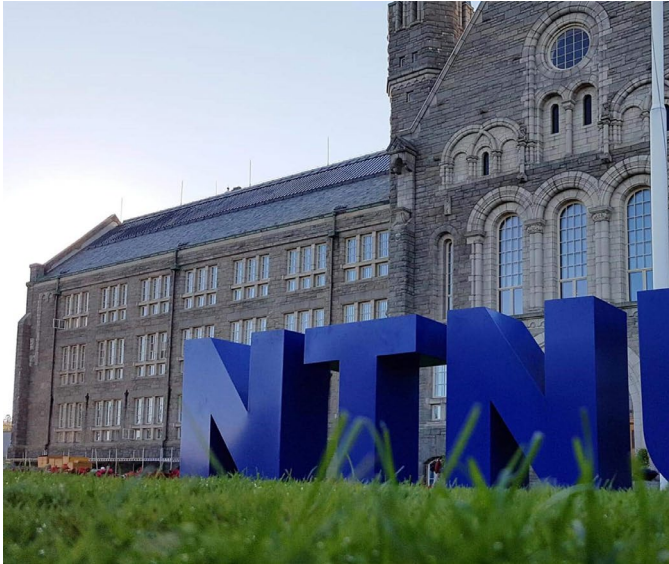
### Assessment

- Written examination (40%)
- Oral examination (40%)
- Practical examination (20%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the ULiège Academic Quality & Standards Committee.

### Teaching Staff



NTNU  
Norwegian University  
of Science and Technology

## Analytical Environmental Chemistry

ECT NTNU KJ3073

### Synopsis

The most outstanding instrumental methods for trace analysis in environmental samples will be provided. Essentially, the basics and the applications of mass spectrometry to the elemental and molecular analysis and liquid chromatography and gas chromatography will be covered, together with the suitable sample preparation procedures.

### Aims

To provide understanding and practice in the most outstanding instrumental methods for analysis of environmental contaminants.

### Objectives

At the end of the Unit, you should:

1. understand and have advanced knowledge in analytical chemistry and specialized insight into analysis of environmental contaminants
2. apply knowledge in new areas through the development of applications and procedures
3. analyze academic issues within analytical chemistry and instrumental methods

### Key Skills Acquired

At the end of this Unit, you should understand:

1. how to plan and use different sampling techniques and chemical analysis methods for key chemicals in environmental samples
2. good analytical practices

### Syllabus

Topics covered include:

- sample preparation methods
- spectroscopy, especially IR and UV/VIS
- high-resolution ICP-MS. Isotopic dilution method.
- chromatography (LC-MS, GC-MS, IC)

### Learning & Teaching

- Lecture, seminars and labwork: 80 hr
- Teamwork: 20 hr

### Teaching Staff

Øyvind Mikkelsen (Coord.)

**Semester** 3

**Timetable slot** To be advised

**ECTS** 7.5

**Level** Optional

### Bibliography

- Fifield F.W., Haines P.J., Environmental Analytical Chemistry 2.ed. ISBN 978-0-632-05383-4.
- Additional course material is given at the lectures and in team work group meetings.
- Theory given at the field and laboratory course

### Assessment

- Oral exam (100%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

## Arctic Environmental Pollution: Distribution and Processes

ECT UNIS AT-331

### Synopsis

The course focuses on how physical conditions affect persistence and distributions of contaminants in the Arctic environment. Important physical factors in the Arctic are atmospheric conditions, extreme variabilities in temperatures and light, and global climate change. How to conduct field work and sample environmental material in Arctic conditions.

### Aims

To provide knowledge distribution of environmental contaminants in the Arctic and how they are affected by physical environmental factors in the Arctic.

### Objectives

At the end of the Unit, you should:

1. have knowledge of local and long-range sources of environmental contaminants in the Arctic
2. have detailed knowledge of how physical-chemical processes work differently in the Arctic than at mid-latitude locations
3. have knowledge on how to conduct field work and obtain relevant environmental samples in the Arctic

### Key Skills Acquired

At the end of this Unit, you should understand:

1. modelling of air mass trajectories
2. how to operate various field devices for collecting and measuring contaminants in different environmental matrices (air, snow, soil)
3. how to make an animation movie as a tool to communicate scientific topics

### Syllabus

Topics covered include:

- operation of field devices for collecting and measuring contaminants in environmental matrices
- using HYSPLIT 4.0 computer model for development of air mass trajectories.
- eulerian and lagrangian atmospheric models.
- atmospheric physical-chemical processes including albedo

### Learning & Teaching

- Lectures: 30 hr
- Seminars (student led): 15 hr
- Modelling exercises: 6 hr
- Field work: 4-5 days
- Laboratory work: 15 hr

### Teaching Staff

Perrine Geraudie (Coord.)

**Semester** 3

**Timetable slot** ca. 14 January  
– 20. February

**ECTS** 10

**Level** Optional

### Bibliography

- Ca. 700 pages of reading from texts, articles and reports. Course material will be delivered during the course.

### Assessment

- Written theory examination (40%)
- Research paper manuscript (20%)
- Animation movie (20%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

## Arctic Environmental Toxicology

ETC UNIS AT-330

### Synopsis

The course provides advanced knowledge on levels, effects and toxicokinetics of environmental contaminants in Arctic wildlife and humans (northerners). The focus is on individual and population effects, and potential ecosystem effects, of particularly persistent organic pollutants, but also other contaminants. Field work in the Arctic, including sampling of biological material.

### Aims

To provide advanced knowledge on exposure and effects of environmental contaminants in Arctic wildlife and humans focusing on effects from effects on the subcellular level to population and ecosystem effects.

### Objectives

At the end of the Unit, you should:

1. have advanced knowledge on the major groups of contaminants that pose a threat to Arctic wildlife, humans and Arctic ecosystems.
2. have good basic knowledge in conducting relevant field work during winter in the Arctic
3. be able to extract available scientific knowledge within the field to produce an up-to-date scientific review essay within the topic of Arctic Environmental Toxicology

### Key Skills Acquired

At the end of this Unit, you should understand:

1. effects of anthropogenic pollutants on the organismal and population level in key Arctic organisms
2. which properties of pollutants that make them potential threats to Arctic wildlife and humans
3. how to produce a written scientific essay based on up-to-date available scientific literature within a self-chosen topic

### Syllabus

Topics covered include:

- Uptake, biotransformation and excretion of pollutants in Arctic organisms
- Effects of pollutants in organisms in relation to the specific Arctic environmental conditions
- How climate change and pollutants may interact in affecting Arctic organisms and ecosystems
- Effects of pollutants on humans in the Arctic

### Learning & Teaching

- Lectures: 24 hr
- Seminars (student led): 27 hr
- Field work and data treatment: 3-5 days

Bjørn Munro Jensen (Coord.)

**Semester** 3

**Timetable slot** Ca. 26.

February – 6. April

**ECTS** 10

**Level** Optional

### Bibliography

- Letcher, R. J., Bustnes, J. O., Dietz, R., Jensen, B. M., et al. 2010. Exposure and effects assessment of persistent organohalogen contaminants in arctic wildlife and fish. *Science of the Total Environment*. 408, 2995-3043.
- Dietz R, Letcher RJ, Desforges J-P, Eulaers I, Sonne C, Wilson S, et al. 2019. Current state of knowledge on biological effects from contaminants on arctic wildlife and fish. *Science of the Total Environment* 696, 133792. doi: 10.1016/j.scitotenv.2019133792
- AMAP Assessment 2018: Biological Effects of Contaminants on Arctic Wildlife and Fish. ISBN 978-82-7971-106-3 (Download for free at [amap.no](http://amap.no)).
- Additional course material provided at the lectures and seminars

### Assessment

- Written theory examination (70%)
- Research paper manuscript (30%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Coordination

### Teaching Staff

## Genetic Toxicology

–ECT NTNU BI3073

### Synopsis

The course provides an introduction to problem solving and to basic methods in genetic toxicological research. A particular emphasis is put on methods suitable for studying the natural environment (Environmental genotoxicology).

### Aims

To provide in-depth knowledge in genetic toxicology and methods related to environmental genotoxicology.

### Objectives

At the end of the Unit, you should:

1. understand the basics of genetic toxicology
2. understand cellular metabolism, such as DNA repair and recombination, replication, transcription, cell cycle regulation and cell death
3. have insight in DNA-damages, DNA-damaging agents and their mechanisms of action

### Key Skills Acquired

At the end of this Unit, you should understand:

1. basic methods in genetic toxicology
2. problem solving in genetic toxicology

### Syllabus

Topics covered include:

- History of genetic toxicology, genetic damages, agents that induce such damage
- The biological mechanisms that respond to the consequences of genetic damage
- Effects on cellular metabolism, such as DNA repair and recombination, replication, transcription, cell cycle regulation and cell death

### Learning & Teaching

- Lectures: 10 hr
- Seminars: 30 hr, mandatory
- Laboratory work: 10 hr

### Teaching Staff

Åse Krøkje (Coord.)

**Semester** 3

**Timetable slot** To be advised

**ECTS** 7.5

**Level** Optional

### Bibliography

- Course material, scientific articles and reports, will be delivered during the course.

### Assessment

- Oral examination (75%)
- Laboratory work and report (25%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

## Special Syllabus for Master Degree – ECT NTNU BI3081

### Synopsis

The course consists of an individual theoretical syllabus in related to the topic of the planned master degree.

### Aims

To provide a broad and advanced background knowledge within the scientific field that the candidate plans to do her/his Master thesis.

### Objectives

At the end of the Unit, you should:

1. understand the basics of the specific scientific field you plan to take your MSc thesis in.
2. be able to design the steps and the requirements of what should be included in your MSc thesis
3. understand the basics of what a MSc project should contain

### Key Skills Acquired

At the end of this Unit, you should understand:

1. how to acquire a broader scientific understanding of the scientific field of choice

### Syllabus

Topics covered include:

- How to acquire scientific literature that is related to a broader scientific understanding of the scientific field of choice
- How to present a synopsis of the relevant scientific literature orally or in a written form

### Learning & Teaching

- Seminars: 10 hr
- Self study
- Laboratory work: 10 hr

Bjørn Munro Jenssen (Coord.)

**Semester** 3

**Timetable slot** To be advised

**ECTS** 7.5

**Level** Optional

### Bibliography

- The syllabus is defined by the student in co-operation with the supervisor.

### Assessment

- Oral presentation and examination, or submission of a written essay and oral presentation (100%).

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Teaching Staff

Sustainable  
Management of

## Ecosystem Services – ECT NTNU RFEL3082

### Synopsis

This interdisciplinary course aims to integrate natural and social sciences including economy, ethics and technological perspectives and show how the ecosystem services framework is relevant for science, policy and practices towards a more sustainable future.

### Aims

To provide in-depth knowledge on status and trends of ecosystem services (provisioning, support, regulating, social and cultural) nature goods and direct and indirect drivers of ecosystem services change.

### Objectives

At the end of the Unit, you should:

1. have an overview of alternative visions for sustainable development and how the ecosystem services framework can promote sustainable socio-ecological systems
2. be able to identify direct and indirect drivers of ecosystem services change at different scales and in different ecosystems
3. understand how governance, institutional arrangements and decision making contribute to sustainable development of ecosystem services

### Key Skills Acquired

At the end of this Unit, you should understand:

1. how to evaluating approaches, methods and techniques needed for sustainable decisions and transitions towards a more sustainable society
2. how to integrate your discipline and education into a wider interdisciplinary context to promote sustainable management of ecosystem services

### Syllabus

Topics covered include:

- Status and trends of ecosystem services and ecosystems, direct and indirect drivers of ecosystem services change at different scales and in different ecosystems
- Scenarios, visions and pathways for sustainable development of ecosystem services
- How governance, institutional arrangements and decision making could contribute to sustainable development of ecosystem services

### Learning & Teaching

- Lectures/seminars: 30 hr
- Project work: 15 hr

### Teaching Staff

Gunnar Austrheim (Coord.)

Semester 3

Timetable slot To be advised

ECTS 7.5

Level Optional

### Bibliography

- Ptschin M, Haines-Young R, Fish R, Turner RK. Routledge Handbook of Ecosystem Services. ISBN 9781138025080. Additional course material, scientific articles and reports will be delivered during the course.

### Assessment

- Oral examination (100%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Techniques for  
Detection of  
Organo-Chemical

## Pollutants in the Arctic Environment

- ETC UNIS AT-324

**ECTS  
Level**

10  
Optional

### Synopsis

Focus is on demonstration and discussion of challenges and pitfalls within modern trace analysis through practical experiences and experiments with Arctic environmental samples collected during field work.

### Aims

To understand the role of analytical chemistry as an integrated environmental research topic for the overall environmental risk assessment in Arctic environments.

### Objectives

At the end of the Unit, you should:

1. understand the role of analytical chemistry as integrated environmental research topic for the overall environmental risk assessment in Arctic environments
2. know the scientific validation principles and requirements underlying modern analytical chemical methods.
3. know the logistical and technological requirements for conducting fieldwork under Arctic conditions

### Key Skills Acquired

At the end of this Unit, you should understand:

1. suitable strategies and technologies for determination and quantification of organic pollutants methods
2. the steps and the requirements of an instrumental method of analysis to fulfill the quality requirements
3. the logistical and technological requirements for conducting fieldwork under Arctic conditions

### Syllabus

Topics covered include:

- strategies and technologies for a sound a reliable determination and quantification of organic pollutants
- principal method validation based upon standard quality control (QC) criteria
- evaluation of the quality of published data based upon QC protocols.
- method uncertainty and statistical evaluations

### Learning & Teaching

- Lectures: 30 hr
- Field excursions: 3 days
- Laboratory work: 80 hr

### Bibliography

- AMAP Assessment 2015: Temporal Trends in Persistent Organic Pollutants in the Arctic (Download for free at [amap.no](http://amap.no))
- AMAP Assessment 2016: Chemicals of emerging Arctic concern. ISBN 978-82-7971-104-9 (Download for free at [amap.no](http://amap.no))
- -Additional course material provided at the lectures and seminars

### Assessment

- Written theory examination (40%)
- Laboratory work and report (20%)
- Case study and oral presentation (40)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

### Teaching Staff

Roland Kallenborn (Coord.)

**Semester** 3

**Timetable slot** Ca. 15. April – 22. May



**U. PORTO**

## Advanced Ecotoxicology

### ECT UPO 2019/001

#### Synopsis

The human society faces global environmental challenges, such as human population in accelerated growth, pollution, climate changes. Human resources with advanced training in Ecotoxicology are needed to address and overcome such challenges contributing to societal development and sustainability of life on earth.

#### Aims

To get knowledge and practical training on Ecotoxicology.

#### Objectives

At the end of the Unit, you should have:

1. Advanced and applied ecotoxicological concepts, and training on methods and techniques commonly used in ecotoxicity assessments, as well as in new approaches necessary to address and overcome major environmental problems (e.g. pollution and other problems resulting from human population growth, climate changes).
2. Increased interest for scientific research and skills to continuously update your knowledge and training and to apply them in problem solving in the scope of ecotoxicology in different regions (temperate, tropical and subtropical, cold).
3. The capability of working in a team, in an integrated and multidisciplinary way in the scope of Ecotoxicology.
4. Developed autonomy and skills to promote consensual choices, analyse and discuss results, make decisions and communicate results, risks and decisions to different types of audience in distinct contexts in the scope of ecotoxicology.

#### Syllabus

Topics covered include:

- Ecotoxicology; environment and societal development; sustainability.
- Classic problems and Emerging paradigms.
- Toxicity of environmental contaminants.
- Mixtures and toxicological interactions.
- Assessment of the ecotoxicity of individual agents and mixtures in terrestrial, freshwater and marine ecosystems: laboratory assays; micro-, meso- and macro-cosmos assessments; monitoring and other methods to assess the environmental quality and the effects of environmental contaminants in real scenarios.
- Interactions between physical (e.g. temperature) and chemical stressors; effects of multi-stressors.
- Climate changes, biotoxins and pollution.
- New challenges and opportunities.

#### Learning & Teaching

- Lectures: 18 hr
- Practical and laboratory work: 24 hr
- Seminary: group autonomous work with oral presentation

#### Teaching Staff

L. Guilhermino (Coord.)

#### Semester 2

**Timetable slot** To be advised

**ECTS** 6

**Level** Compulsory

#### Bibliography

- Araújo, C.M.V.; Shinn, C. (Eds.). 2017. *Ecotoxicology in Latin America*. Nova Publishers, New York, 591 p. ISBN: 978-1-53610-609-1.
- Duarte, B.; Caçador, M.I. 2019. *Ecotoxicology of Marine Organisms*. CRC Press.
- Kim, Y.J.; Platt, U. (Eds.). 2008. *Advanced Environmental Monitoring*. Springer, Dordrecht.
- Van Gestel, C.A.M.; Jonker, M.J.; Kammenga, J.E.; Laskowski, R.; Svendsen, C. 2010. *Mixture Toxicity – Linking Approaches from Ecological and Human Toxicology*. SETAC & CRC Press, Taylor & Francis Group, Boca Raton.
- \* Vethaak, D.; Schrap, M.; de Voogt, P. 2006 (Eds.). *Estrogens and Xenoestrogens in the Aquatic Environment: an Integrated Approach for Field Monitoring and Effect Assessment*. Society of Toxicology and Environmental Chemistry (SETAC) Press, Pensacola.
- Walker, C.H.; Hopkin, S.P.; Sibly, R.M.; Peakall, D.B. (Eds.) 2006. *Principles of Ecotoxicology*. 3rd ed., CRC Taylor & Francis, London.
- Recent articles and several websites

#### Assessment

- Written examination (50%)
- Continuous evaluation (10%)
- Seminary and oral presentation (40%)

#### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

## Environment and Public Health ECT UPO 2019/003

### Synopsis

The environment plays a fundamental role on human health. The main global environmental challenges and their consequences To public health will be addressed according the 'One health' concept and approach (animal, human and environmental health).

### Aims

To get knowledge on global environmental challenges and their consequences to public health, applying the 'One health' approach.

### Objectives

At the end of the Unit, you should have:

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### Syllabus

Topics covered include:

1. Environment and Public Health: introduction to the subject through interactive discussion with the students. One Health.
2. Exposure to environmental stressors and effects on human health: from scientific research to clinical practice. General population and groups at special risk. Environment and development. Environment and aging.
3. Main environmental stressors and human health: assessment of effects; risk assessment and management; global problems and methods to address/overcome them; regulation; institutions involved in prevention and control.
  - 3.1. Global changes.
  - 3.2. Pollution. Emerging problems.
  - 3.3. Bioinvasions and zoonosis. Emerging and re-emerging diseases.
  - 3.4. Combined effects of multi-stressors.
  - 3.5. Resistance to therapeutic agents.
  - 3.7. Terrorism (biological and chemical).
  - 3.8. Other environmental effects.

### Learning & Teaching

- Lectures: 8 hr
- Theoretical-practical: 11 hr

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### Teaching Staff

L. Guilhermino (Coord.);

E. Rocha

**Semester** 2

**Timetable slot** To be advised

**ECTS** 3

**Level** Optional

### Bibliography

- Barboza, L.G.A., Vethaak, A.D., Lavorante, B.R.B.O., Lundebye, A.-K., Guilhermino, L. 2018. Marine microplastic debris: an emerging issue for food security, food safety and human health. *Marine Pollution Bulletin* 133, 336-348.
- Herrmann, J.A., Johnson-Walker, Y.J. (EDs) 2019. *Beyond One Health: From Recognition to Results*. Wiley-Blackwell.
- Frumkin, H. (ED.) 2010. *Environmental Health. From Global to Local*. 2nd edition. John Wiley & Sons, Inc.
- Lueddeke, G. 2019. *Survival: One Health, One Planet, One Future*. Routledge, Taylor and Francis Group.
- Woods, A., Bresalier, M., Cassidy, A., Dentinger, R. M. 2018. *Animals and the Shaping of Modern Medicine. One Health and its Histories*. Cham: Springer International Publishing.
- Recent articles and several websites

### Assessment

- Written examination (50%)
- Continuous evaluation (10%)
- Seminary and oral presentation (40%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Coordinator.

## Environmental Risk Assessment ECT UPO 2019/004

### Objectives

At the end of the Unit, you should have:

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### Syllabus

Topics covered include:

1. Introduction to the course.
2. Introduction to environmental risk assessment. Prospective and retrospective environmental risk assessment. Problems and contexts. General frameworks.
3. European and national regulations, institutions/agencies and technical guidance documents in the scope of REACH and CLP. Emerging environmental contaminants.
4. Other regulation, institutions in charge and procedures (e.g. risk assessment of oil and other chemical spills in the marine environment). Risk management and communication.
5. Simulations in diverse contexts and situations

### Learning & Teaching

- Lectures and practical: 21 hr
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Level

Optional

### Assessment

- Written examination (50%)
- Continuous evaluation (10%)
- Seminary and oral presentation (40%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

### Teaching Staff

L. Guillermino (Coord.)

Semester 2

Timetable slot To be advised

ECTS 3

**Free Option  
ECT UPO 2019/005**

Synopsis

The student can select any course of the University of Porto (Master level) available for the academic year with the appropriate number of ECTS. The syllabus depends of the specific UC selected by the student.

#### Learning & Teaching

- Lectures and practical: 21 hr

**Level** Optional

#### Assessment

- Written examination (50%)
- Continuous evaluation (10%)
- Seminary and oral presentation (40%)

#### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

#### Teaching Staff

L. Teles (Coord.)

**Semester** 2

**Timetable slot** To be advised

**ECTS** 3

**Genetic resistance  
to pollutants  
ECT UPO 2019/006**

#### Synopsis

Genetic material and genetic variability. Mutation and repair

of DNA. Genetic recombination. Methodology of analysis and genes' manipulation. Laboratorial works. Analysis, presentation and report of a scientific article.

### Learning & Teaching

- Lectures and practical: 21 hr
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### Assessment

- Written examination (50%)
- Continuous evaluation (10%)
- Seminary and oral presentation (40%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

### Teaching Staff

A. Videira (Coord.)

Semester 2

Timetable slot To be advised

ECTS 3

Level Optional

**Toxicogenomics  
and  
toxicoproteomics  
ECT UPO 2019/007**

### Syllabus

Topics covered include:

1. Definition and objectives of genomics and proteomics applied to toxicology
2. Presentation of the main study strategies of the genome and proteome
3. Databases and Data Research Tools
4. Presentation of the principles of mass spectrometry and identification of proteins
5. Experimental design and analysis of genomic and proteomic data
6. DNA Sequencing, Gene Identification, and Gene / Protein Phylogenetics
7. Theoretical and practical training on the identification of proteins using bioinformatics tools, extraction of proteins from biological samples and their separation in polyacrylamide gel

- Written examination (50%)
- Continuous evaluation (10%)
- Seminary and oral presentation (40%)

#### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Coordinator.

#### Learning & Teaching

- Lectures and practical: 42 hr
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#### Teaching Staff

A. Antunes Perira (Coord.)

Semester 2

Timetable slot To be advised

ECTS 6

Level Optional

#### Assessment

## Stress Ecology

### ECT UPO 2019/002

#### Synopsis

The human society faces global environmental challenges, such as human population in accelerated growth, pollution, climate changes. Human resources with advanced training in Stress Ecology are needed to address and overcome such challenges contributing to societal development and sustainability of life on earth.

#### Aims

To get knowledge and practical training on Stress Ecology.

#### Objectives

At the end of the Unit, you should:

1. Have fundamental and applied concepts in the scope of Stress Ecology, and training on methods and techniques commonly used in stress ecology and on new approaches necessary to address and overcome major environmental problems (e.g. climate changes, bioinvasions, pollution, biodiversity lost).
2. Have the stimulus and skills to get continuous upgrade of knowledge and training and to apply them in problem solving in the scope of Stress Ecology.
3. Have the capability of working in a team, in an integrated and multidisciplinary way in the scope of Stress Ecology.
4. Have developed autonomy and skills to promote consensual choices, to analyse and discuss results, make decisions and communicate results, risks and decisions to different types of audience in distinct contexts.

#### Syllabus

Topics covered include:

- Main ecological paradigms and challenges.
- Development, biodiversity and conservation, sustainability.
- Main regulation and conventions.
- Environmental stressors. Global pollutants and environmental contaminants of special concern (e.g. microplastics, nanomaterials).
- Methods and techniques commonly used in Ecology and ecotoxicology to assess the effects of stressors on populations, communities and ecosystems.
- Effects of environmental stressors (physical, chemical, biological) on interspecific relationships; adaptations, resistance and differences among species.
- Effects of individual environmental stressors on communities and ecosystems (terrestrial, freshwater, marine).
- Combined effects of climate changes, pollution and bioinvasions in ecosystems of different regions (temperate, cold, tropical, extreme environments).
- Implications to biodiversity conservation, environmental and human health, and ecosystem services.

#### Learning & Teaching

- Lectures: 18 hr
- Practical and laboratory work: 24 hr

- Seminar: group work with oral presentation

#### Teaching Staff

L. Guilhermino (Coord.),  
M.J. Rocha

**Semester** 2

**Timetable slot** To be advised

**ECTS** 6

**Level** Compulsory

#### Bibliography

- Araújo, C.M.V.; Shinn, C. (Eds.). 2017. Ecotoxicology in Latin America. Nova Publishers, New York, 591 p. ISBN: 978-1-53610-609-1.
- Barnthouse LW; Munn Jr WR; Sorensen MT 2007. Population-level Ecological Risk Assessment. SETAC & CRC – Taylor & Francis Group.
- Begon M; Townsend CR; Harper JL 2009. Ecology: From Individuals to Ecosystems. Blackwell Publishing.
- Sheppard, C.R.C. (Ed.) 2019. World Seas: An Environmental Evaluation. 2nd Edition, Vol. III: Ecological Issues and Environmental Impacts. Academic Press.
- Steinberg CEW 2012. Environmental Stress as Ecological Driving Force and Key Player in Evolution. Springer.
- recent articles and several websites

#### Assessment

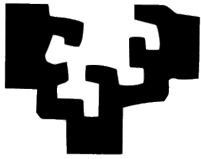
- Written examination (50%)
- Continuous evaluation (10%)
- Seminary and oral presentation (40%)

#### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Coordinator.



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Universidad  
del País Vasco

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## Advanced Instrumental Analysis

ECT+ EHU 501323

### Synopsis

The most outstanding instrumental methods for trace analysis in environmental samples will be provided. Essentially, the basics and the applications of mass spectrometry to the elemental and molecular analysis and liquid chromatography and gas chromatography will be covered, together with the suitable sample preparation procedures.

### Aims

To provide exposure to the most outstanding instrumental methods for trace analysis in environmental samples.

### Objectives

At the end of the Unit, you should:

1. understand the basics of mass spectrometry
2. be able to design the steps and the requirements of an instrumental method of analysis to fulfill the quality requirements
3. understand the basics of advanced chromatographic methods

### Key Skills Acquired

At the end of this Unit, you should understand:

1. the key points of an instrumental trace analysis method
2. good analytical practices

### Syllabus

Topics covered include:

- Sample preparation methods for trace analysis
- Basics on mass spectrometry
- ICP-MS methods for elemental trace analysis. Isotopic dilution method.
- Analysis of micro-organic contaminants by liquid or gas chromatography

### Learning & Teaching

- Lectures: 20 hr
- Seminars (for case studies and applications): 10 hr
- Laboratory work: 10 hr

O Zuloaga (Coord.) G Arana

**Semester** 2

**Timetable slot** To be advised

**ECTS** 4

**Level** Optional

### Bibliography

- E. Hoffmann. 2008. Mass spectrometry: principles and applications, John Wiley & Sons, Chichester, UK.
- V.R. Meyer. 2010. Practical high-performance liquid chromatography. John Wiley & Sons, Chichester, UK.
- D. Rood. 2007. The troubleshooting and maintenance guide for gas chromatographers. Wiley-VCH, Weinheim, Germany
- S. Mitra (Ed.). 2003. Sample preparation techniques in analytical chemistry. Wiley-Interscience, Hoboken, New Jersey

### Assessment

- Written theory examination (40%)
- Laboratory work and report (20%)
- Case study and oral presentation (40)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Teaching Staff

Applied  
Environmental  
Biogeochemistry

## ECT+ EHU 501323

**Synopsis**

The topics covered will allow getting knowledge in main aspects of biogeochemistry and dynamics of contaminants in natural matrices.

**Aims**

To provide exposure to the most outstanding instrumental methods for trace analysis in environmental samples.

**Objectives**

At the end of the Unit, you should:

1. Understand the current topics in soil chemistry
2. Understand the current topics in principles of contaminant transport and distribution
3. Understand the current topics contaminant behaviour in different matrices.

**Key Skills Acquired**

At the end of this Unit, you should understand:

1. the key points of an instrumental trace analysis method
2. good analytical practices

**Syllabus**

1. Chemical balance in natural systems
2. Alkalinity and acidity: the CO<sub>2</sub> system
3. Solubility and precipitation: complexity of natural polymers
4. Natural redox systems
5. Control of chemical composition in natural water bodies
6. Case studies: atmosphere, water bodies and soil matrices

**Learning & Teaching**

- Lectures: 20 hr
- Seminars (for case studies and applications): 5 hr
- Laboratory work: 15 hr

**Teaching Staff**

A Usobiaga (Coord.)

**Semester** 2

**Timetable slot** To be advised

**ECTS** 4

**Level** Optional

**Bibliography**

- Schlesinger, W.H., Bernhardt, E. 2013. Biogeochemistry: An analysis of Global Change (3rd Edition). Academic Press. ISBN: 9780123858740
- Likens, G.E. 2010. Biogeochemistry of inland waters. Academic Press. ISBN: 9780123819970
- Prasad, M.N.V., Sajwan, K.S., Naidu, R. 2019. Trace elements in the environment. CRC Press. ISBN 9780367391966

**Assessment**

- Written theory examination (50%)
- Oral presentation (50)

**Course Evaluation**

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Coordinator.

**Cellular and  
Molecular  
Biomarkers**

ECT+ EHU 501316

**Synopsis**

Directed at students aiming to specialize in environmental toxicology, with a focus on cell and molecular biology. Global/updated view of environmental problems and the use of cell/molecular responses as early warning signals (biomarkers) of ecosystem health in pollution assessment.

**Aims**

- To provide a global/updated view of environmental toxicology and the use of cell/molecular responses as early warning signals (biomarkers) of ecosystem health in pollution assessment.

**Objectives**

At the end of the Unit, you should:

- Understand the mechanisms of action incorporation into cells, as well as the cellular strategies to detoxify and/or sequester physiological metals at toxic concentrations and xenobiotic metals, depending on the characteristics and speciation of metals.
- Understand the cellular and molecular responses to pollution by organic xenobiotics, including their biotransformation, involvement in oxyradical generation, and mechanisms and strategies of cellular and molecular adaptation.
- Understand the cellular and molecular pathways that lead to toxicant-caused genotoxic and non-genotoxic DNA and chromosomal damage, including repair mechanisms, and further development of preneoplastic and neoplastic diseases.
- Understand the importance of pollutant effects on cell signalling and homeostasis of the endocrine system, with emphasis in ecologically-relevant effects on reproduction.
- Understand the implications of the changes at cellular and molecular level, in the general health condition of the individuals and the natural populations, with the aim of achieving a reasonable and sustainable exploitation of natural resources.
- Understand the rationale for the use of cellular and molecular responses to pollutants in environmental monitoring and in environmental risk assessment, including the limitations and challenges of the approach. Role of emerging toxico-genomics and proteomics in new biomarker discovery.

**Teaching Staff**

MP Cajaraville, A Orbea (Coord.)

**Semester** 2

**Timetable slot** To be advised

**ECTS**

4

**Level**

Optional

**Bibliography**

Delivered during the course

**Assessment**

- Attendance is compulsory. All absences must be justified documentally. Active participation in the activities of the course is required; particular attention will be paid to the participation in open discussions in lectures, seminars and practicals.
- Personal report: Based on one research article, presenting a case study on biomarker use. It will be presented in a seminar by each student (15 min).
- Notebook of practicals, where the student has made his/her own observations, must be presented in order to assess the progress achieved in practicals.

**Course Evaluation**

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

**Key Skills Acquired**

At the end of the Unit, you should be aware of the relevance of the cellular and molecular mechanisms of accumulation/detoxification

of metal and organic xenobiotics, in relation to the diagnosis of toxic levels relevant to Human Health (Environmental Health, Public Health, ...) and in Environmental Health Sciences (biomonitoring, biological effects assessment, ecosystem health, environmental risk assessment..)

### Programme

1. Introduction to cellular and molecular biomarkers of pollution: examples and applications in monitoring programmes.
2. Biomarkers and bioassays for endocrine disrupting environmental pollutants.
3. Techniques to measure cell and molecular biomarkers.
4. Toxicity of metallic pollutants, in relation to cellular accumulation and storage processes.
5. In vitro alternative methods in biomarker development: potential of mussel cells primary cultures for toxicity testing of environmental pollutants.
6. Generation of oxyradicals and oxidative stress in marine organisms.
7. Mechanisms of pollutant-induced peroxisome proliferation and rationale, for use as a biomarker in environmental pollution assessment.
8. Biotransformation of organic xenobiotics.
9. Lysosomal perturbations as indicators for toxically-induced cell damage.
10. Biomarkers for assessment of toxicant-caused DNA damage.
11. Challenges for use of biomarkers in environmental monitoring and risk assessment.

PRACTICALS: Biomarkers of exposure to metals. Assessment of peroxisome proliferation. Lysosomal biomarkers. Genotoxicity assessment. SEMINARS: Application of biomarkers to case studies.

### Learning & Teaching

- Lectures: 20 hr
- Seminars: 4,5 hr
- Lab practicals: 13 hr
- Computer practicals: 2 hr

## Disruption - ECT+ EHU 501327

### Synopsis

Fish reproduction, sex determination and differentiation. Endocrinology of marine fish and shellfish. Endocrine and reproductive effects of pollutants. Applications to fisheries, aquaculture and environmental pollution assessment.

### Aims

- To introduce the students to the wide diversity and variability existing in fish reproduction and sexual determination and differentiation processes.
- To offer to the students basic knowledge on endocrinology of marine fish and shellfish.
- To show the students the effects of environmental pollutants on endocrine system and reproduction of fish and shellfish
- To develop skills to estimate reproductive stages in fish and shellfish and understand modern tools on aquaculture of fish and shellfish species.

### Objectives

At the end of the Unit, you should:

1. Understand reproduction strategies in fish
2. Identify reproduction strategies and reproductive gonad stages in fish and shellfish
3. Have gained a knowledge of impact of environmental pollutants on fish and shellfish reproduction and endocrine system, as well as of hormonal regulation in aquaculture.

### Key Skills Acquired

At the end of the Unit, you should be able to:

1. Identify sex and gonad development in fish and shellfish
2. Identify effects of pollutants in reproductive and endocrine system in fish and shellfish

### Programme

1. Reproduction in the marine environment: Fish and shellfish
2. Reproduction strategies and cycles in fish
3. Sex determination and differentiation in fish
4. Endocrinology of fish
5. Hormones and their function in fish
6. Impact of environmental pollutants on fish reproduction and endocrine system
7. Aquaculture strategies in fish: tools to improve fish reproduction
8. Endocrinology of main marine shellfish groups (crustaceans, molluscs and echinoderms)
9. Hormones in shellfish: participation on reproduction
10. Endocrine disruption on marine invertebrates
11. Shellfish aquaculture: modern tools and techniques

### Learning & Teaching

- Lectures: 20 hr
- Seminars: 6 hr
- Practical sessions (lab): 6 hr
- Computer practicals: 4 hr
- Tutorials: 4 hr

### Teaching Staff

M Ortiz-Zarragoitia (Coord.), U Izagirre, (AZTI)

Semester 2

Timetable slot To be advised

ECTS 4

Level Optional

### Bibliography

Delivered during the course

### Assessment

Written examination (100%)

## Contamination Social Awareness and Environmental Ethics

ECT+ EHU 501323

### Synopsis

The topics covered will allow getting knowledge in main aspects of bioethics and social perception of the contamination. Students will critically evaluate how communication media transmit information to the society in environmental issues.

### Aims

To provide exposure to the most outstanding instrumental methods for trace analysis in environmental samples.

### Objectives

At the end of the Unit, you should:

1. Understand the environmental impact and risk of genetically modified organisms (GMOs).
2. Understand the concepts of contamination, toxicity, remediation and recovery associated to sustained development.
3. Understand the interaction between humans and contaminated environments from the perspectives of communication media and society.
4. Understand the science and technology from a social perspective

### Key Skills Acquired

At the end of this Unit, you should understand:

1. Bioethic aptitudes and attitudes in teaching, research and management activities.

### Syllabus

Part I: Contamination and Society

1. Contamination and industry
2. Global effects of contamination
3. Contamination and politics
4. Industrial revolution/Ecologism/Nuclear powered facilities/Future perspectives
5. Contamination: Literature, cinema and communication media
6. Science, technology and society

Part II: Environmental Ethics

1. Environmental education
2. Biodiversity and management
3. Environment and anthropogenic effects
4. Bioethics

### Learning & Teaching

- Lectures: 20 hr
- Seminars (for case studies and applications): 30 hr
- Practical/Team work: 10 hr

### Teaching Staff

B Zaldibar (Coord.)  
M Saloña, E Angulo, T Heyd, C Marin

**Semester** 2

**Timetable slot** To be advised

**ECTS** 6

**Level** Optional

### Bibliography

- Edelstein, M.R., Tysiachniouk, M., Smirnova, L.V. (Eds.). 2007. Cultures of Contamination. Emerald Publishing. ISBN 978-0-7623-1371-6.
- Wagner, M., Lambert, S. (Eds.). 2018. Freshwater Microplastics: Emerging environmental contaminants? SpringerLink. ISBN 978-3-319-61615-5

### Assessment

- Written theory examination (50%)
- Oral presentation (50)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Coordinator.

## Degradation and Rehabilitation of Estuarine Ecosystems - ECT+ EHU 501319

### Synopsis

Introduction to estuaries. Uses of estuaries. Human impact assessment: physical perturbation and pollution, and their effects. Management: status assessment and monitoring.

### Aims

- To provide an introduction to the chemistry of sea-water through qualitative and quantitative approaches and presentation of the chemical interactions between the lithosphere, the biosphere, the atmosphere and the ocean.

### Objectives

At the end of the Unit, you should:

- understand the basic concepts of estuarine ecology, and the main differences between estuaries
- identify the important functions of estuaries, including benefits to humans, the factors that affect estuarine health and the actions that can be taken to improve the health of estuaries
- have gained knowledge of the procedures and tools to assess the health of estuaries, and monitoring changes in abiotic and biotic conditions.

### Key Skills Acquired

At the end of the Unit, you should be able to:

- access scientific and institutional information (paper and online literature)
- achieve written reporting, oral presentation and discussion
- achieve in situ recording of environmental data in water and sediments
- apply data treatment methods

### Programme

- The estuarine ecosystem: Definition. Limits. Geomorphologic types. Classifications based on salinity, tides and energy. Functional components. Circulation of materials. Biodiversity.
- Habitats and communities: Pelagic habitats and plankton communities. Benthic habitats and communities. Associated subsystems. Nekton. Birds.
- Socioeconomic values and uses: Natural resources. Urbanization, industry and commerce. Tourism and recreation. Other activities.
- Human impact: Physical changes and habitat loss. Pollution: enrichment, unhealthiness and toxins. Overharvest and overfishing. Introduction of exotic species.
- Bases for estuarine management: Definition and goals. Social and scientific visions. Status assessment. Conservation. Recovery: cleaning, restoration and rehabilitation. Monitoring.

F Villate (Coord.), A Iriarte, I Uriarte

**Semester** 2

**Timetable slot** To be advised

**ECTS** 4

**Level** Optional

### Bibliography

Delivered during the course

### Assessment

- Oral presentation and written report (60%)
- Fieldwork 1 (20%)
- Fieldwork 2: (20%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Practical works:

### Teaching Staff

1. Technical report: Sessions of literature review and oral presentation, reporting environmental and biological characteristics, main resources and uses, major problems and possible solutions for a particular estuary.
2. Field studies: Boat work recording environmental data, to identify particular environmental problems in a humanised system: the estuary of Bilbao
3. Fieldwork to recognize natural and recreational values in a well conserved system: the estuary of Urdaibai
4. Seminar 1: Oral presentation.
5. Computer data treatment
6. Seminar 2: Discussion of field results, and conclusions.

#### **Learning & Teaching**

- Formal Lectures: 16 hr
- Sessions (literature data search and reporting): 10 hr
- Boat work (recording environmental data): 10 hr
- Computer session (field data treatment and interpretation): 4 hr

## Ecological Quality Assessment in Coastal Ecosystems - ECT+ EHU 501318

### Synopsis

Marine diversity as a tool in environmental quality assessment and its value for protection of endangered ecosystems and for environmental monitoring and assessment programs in the framework of regulatory directives (EU Water Framework Directive, etc.).

### Aims

- To be aware that marine diversity is a precious treasure to preserve in conservation programmes and a key variable to assess environmental quality in endangered ecosystems.
- To introduce the basic concepts used in marine ecological quality assessment.
- To provide a basic knowledge on the Water Framework Directive and other legislative references and their implications for the marine quality assessment
- To provide the methods for the integrative ecological assessment of marine quality
- To present some practical cases dealing with the integrative ecological assessment of marine quality

### Objectives

At the end of the Unit, you should:

1. recognize characteristic taxa of algae, invertebrates and fishes from coastal ecosystems.
2. assess environmental quality, by using different diversity measures.
3. design and analyse monitoring programmes for algae and animals
4. have a good knowledge of the main legislative references in relation to the assessment of the quality of the marine environment, especially the Water Framework Directive.
5. interpret the data from monitoring programs
6. design monitoring programs for the assessment of the quality of the marine environment

### Key Skills Acquired

1. Generic skills: report writing, scientific writing, working in teams, oral presentations, library information retrieval and critical analysis of literature, presentation and manipulation of data (e.g. water quality data interpretation biological data interpretation), ability in integrative interpretation of data.

### Teaching Staff

I Saiz-Salinas & J Franco (AZTI)  
(Coord.)

JM Gorostiasga, A Martinez de Murgia (OFG), A Borja (AZTI)

**Semester** 2

**Timetable slot** To be advised

**ECTS** 4

**Level** Optional

### Bibliography

Delivered during the course

### Assessment

- Written report (70%)
- Lecture attendance (15%)
- Field trips assessment (15%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

### Programme

PART 1. BIODIVERSITY  
ASSESSMENT & MONITORING

1. Richness of diversity based on algae, invertebrates and fishes from coastal ecosystems.
2. How to sample, undertake surveys and perform floristic and faunistic analyses to: (a) measure diversity; (b) select appropriate bioindicators of environmental state; and (c) assess environmental quality in many endangered habitats.
3. Temporal dimension in the design and analysis of efficient monitoring programmes, to evaluate ecological recovery, once correction measures have been implemented by environmental managers.
4. Role of Aquaria in education programmes and conservation of target species.

Field trip 1. Floristic and faunistic survey

Field trip 2. Visit to Aquarium Donostia

## PART 2. INTEGRATIVE ASSESMENT OF MARINE ENVIRONMENTAL QUALITY

1. Theoretical and practical basis for an integrative assessment of the marine quality.
2. Basic conceptual issues on the marine quality assessment and its relationship with the general features and some peculiarities of the marine environment will be presented.
3. The Water Framework Directive (WFD) and its implications for the marine quality assessment in EU will be presented. Framework for Community action in the field of water policy. Concepts, objectives, requirements and implementation phases of the WFD. Other important legislative references e.g., European Marine Strategy Directive.
4. Relevant aspects of general marine monitoring programs: ongoing projects and case studies.

Practical: Marine environmental quality indices

Field trip: Visit to AZTI, Pasaia

### Learning & Teaching

- Formal & Audiovisual Lectures: 18 hr; 6 (Part 1) & 12 (Part 2)
- Computer practicals: 7 hr
- Part 1 Field trip (½ day): 4 hr
- Part 2 Field trip (1 day): 8 hr
- Visit to Aquarium (OFG): 3 hr

## Environmental Analytical Chemistry

ECT+ EHU 501321

### Synopsis

Integrative view of the analytical methodologies in environmental issues. We will emphasize the sampling strategies, both active and passive methodologies, and the interpretation of analytical data. The concepts of bioaccumulation and bioavailability will be introduced.

### Aims

To provide an integrative view of the analytical methodologies, in environmental issues.

### Objectives

At the end of this Unit, you should:

1. understand the basic processes of an analytical method
2. be able to design efficiently a sampling procedure
3. understand the chemical outputs of the analytical results
4. understand the bioaccumulation and bioavailability of contaminants in the trophic chain.

### Key skills acquired

At the end of this Unit, you should understand:

1. the analytical approach to environmental issues
2. good analytical practices

### Syllabus

Topics covered include:

- Basics on environmental analytical chemistry
- The analytical procedure
- Sampling techniques
- The fate and the distribution of contaminants
- Bioaccumulation and bioavailability

### Learning & Teaching

- Lectures: 20 hr
- Seminars (for case studies) : 6 hr
- Laboratory work: 8 hr
- Tutorials (exercises and presentations): 6 hr

A Vallejo

Semester 2

Timetable slot To be advised

ECTS 4

Level Optional

### Bibliography

- C. Zhang. 2007. Fundamentals of environmental sampling and analysis, John Wiley & Sons, New Jersey, USA.
- M. Radojevic, V. N. Bashkin. 2006. Practical environmental analysis. RSC Publ. Cambridge, UK
- J.R. Dean. 2007. Bioavailability, bioaccessibility and mobility of environmental contaminants, John Wiley & Sons, Chichester, UK.

### Assessment

- Written theory examination (40%)
- Laboratory work and report (20%)
- Case study and oral presentation (40%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator

### Teaching Staff

N Etxebarria (Coord.),

## Environmental Biosafety

ECT+ EHU 501321

### Synopsis

The topics covered will allow getting knowledge in main aspects of biosafety and the risks posed by GMOs and chemicals when working in experimental labs. The student will be able to classify laboratories according to the facility design and protocols.

### Aims

To provide an integrative view of the analytical methodologies, in environmental issues.

### Objectives

At the end of this Unit, you should:

1. Understand pathologies related to environmental alterations.
2. Understand the environmental impact and risk of genetically modified organisms (GMOs).
3. Understand the principles of environmental epidemiology and its applications to the study of chemical and biological contamination.
4. Understand the concepts and procedures of Experimental Biosafety facilities.
5. Understand the concepts and procedures for the manipulation and isolation of high risk substances.

### Key skills acquired

At the end of this Unit, you should understand:

1. the analytical approach to environmental issues
2. good analytical practices

### Syllabus

Topics covered include:

- o Introduction to Environmental Risk Assessment
- o Pathologies and environment
- o Environmental epidemiology
- o Biosafety Experimental facilities
- o Safety cells facilities

### Learning & Teaching

- Lectures: 20 hr
- Seminars (for case studies) : 5hr
- Laboratory work: 15 hrç

M Ortiz-Zarragoitia, M Barral

**Semester** 2

**Timetable slot** To be advised

**ECTS** 4

**Level** Optional

### Bibliography

- o Sateesh, M.K. 2008. Bioethics and Biosafety. IK International. ISBN 978-8190675703
- o Wooley, D.P., Byers, K. B. (Eds.). 2017. Biological Safety: Principles and Practices (5th Edition). ASM Press. ISBN 9781555816209
- o Frumkin, E. (Ed.). 2016. Environmental Health: From Global to Local (3rd Edition). Wiley Publisher. ISBN: 978-1-118-98476-5

### Assessment

- Written theory examination (40%)
- Laboratory work and report (20%)
- Case study and oral presentation (40%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Coordinator

### Teaching Staff

I Cancio (Coord.),

**Environmental  
Chemometrics**

**ECT+ EHU 501352****Synopsis**

The statistical procedures to interpret large environmental data sets will be provided. First of all, environmental data sets will be considered and data pre-treatment and data display methods will be explained. Multivariate data analysis will be covered, including discriminant techniques, classification methods and regression analysis. Finally, time series analysis will be outlined.

**Aims**

- To understand and apply multivariate approach to interpret the environmental data

**Objectives**

At the end of this Unit, you should:

1. use and apply multivariate data analysis methods; and
2. interpret the environmental outcomes from large data sets

**Key skills acquired**

At the end of this Unit, you should be able:

1. to apply a multivariate approach to interpret the environmental data

**Syllabus**

Topics covered include:

- Basic statistics
- Principal component analysis and partial least squares methods
- Discriminant analysis and classification methods.
- Analysis of time series

**Learning & Teaching**

- Lectures: 20 hr
- Computer work: 15 hr
- Seminars and tutorials: 5 hr

M Olivares

**Semester** 2

**Timetable slot** To be advised

**ECTS** 4

**Level** Optional

**Bibliography**

- G. Hanrahan. 2009. Environmental chemometrics : principles and modern applications. CRC Press, Boca Ratón, USA
- J. Einax. 1997. Chemometrics in environmental chemistry: statistical methods. Springer-Verlag, Berlin, Al.

**Assessment**

- Written theory examination (40%)
- Computer work and report (30%)
- Case study and oral presentation (30%)

**Course Evaluation**

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

**Teaching Staff**

A De Diego (Coord.),

## Environmental Risk Assessment: REACH and CPL - ECT+ EHU 501352

### Synopsis

The topics covered will allow getting knowledge in main aspects European regulations for the control and risk classification of chemicals substances. The students will be able to understand technical and legislative documents and produce reports for chemical substances.

### Aims

- To understand and apply multivariate approach to interpret the environmental data

### Objectives

At the end of this Unit, you should:

1. Understand concepts, criteris and modalities of the evaluation process in risk assessment associated to contaminant chemicals.
2. Understand the processes for evaluation and actualization of ERA within the European legislation.
3. Understand the protocols to classify contaminants according to their risk for the enviromen

### Key skills acquired

At the end of this Unit, you should be able:

1. to apply a multivariate approach to interpret the environmental data

### Syllabus

Topics covered include:

- Introduction to environmental risk assessment
- Applications of environmental risk assessment procedures
- Scientific and technical fundaments for the use of chemical substances in the EU
- European policy on chemical substances: REACH and CLP

### Learning & Teaching

- Lectures: 30 hr
- Computer work: 10 hr
- Seminars and tutorials: 20 hr

JV Tarazona (EFSA), A Rodriguez (EChA), MM Vega & U Otila (Envir Agency)

**Semester** 2  
**Timetable slot** To be advised  
**ECTS** 6  
**Level** Optional

### Bibliography

- Rausan, M. 2010. Risk Assessment. Theory, Methods and Applications. Wiley Publisher. ISBN 978-0470637647
- Simon, T. 2016. Environmental Risk Assessment. A toxicological approach. CRC Press. ISBN 978-1138033832
- Fisk, P. (2013). Chemical Risk Assessment: A manual for REACH. Wiley Publisher. ISBN 9781119953685

### Assessment

- Written theory examination (50%)
- Seminar and oral presentation (50%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

### Teaching Staff

MP Cajaraville (Coord.)

## Environmental Toxicogenomics

ECT+ EHU 501347

### Synopsis

Environmental genomics, with emphasis on transcriptomic studies in environmentally-relevant non-model organisms. Application of genomic technology to environmental resources management or ecosystem health assessment.

### Aims

- To provide basic notions, with the use of practical examples, that will explain the principal techniques used in environmental genomics, in ecotoxicogenomics and in clinic toxicogenomics.

### Objectives

At the end of the Unit, you should:

1. detect/interpret molecularly and mechanistically the adaptation events that living organisms trigger to obtain homeostasis in disease; reproduction; toxicity, feeding regimes and in a changing environment.
2. determine the action mechanisms of different chemical compounds, on different cell functional pathways and structures.
3. understand the usefulness of using transcriptional profiles in the evaluation of the quality of the environment and its application in pollution biomonitoring programs.
4. learn the diagnostic usefulness of the ecotoxicogenomic approach in the determination of the ethiology of diverse pathologies and toxicopathies, in animals.

### Key Skills Acquired

At the end of the Unit, you should be able to:

1. master the technology, tools and information required for the planning, development and interpretation of high-throughput genomic and transcriptomic studies.
2. know how to design a research project based upon the study of gene transcription profiles diagnostic of exposure to and/or effect of chemical compounds in laboratory and real field/environmental conditions: selection of sentinel species, sequence information retrieval; traditional and massively parallel sequencing techniques; gene expression analysis techniques; and analysis of gene pathways.

### Teaching Staff

I Cancio (Coord.), EBilbao

**Semester** 2

**Timetable slot** To be advised

**ECTS** 4

**Level** Optional

### Bibliography

- Relevant papers delivered during the course
- Web resources delivered during the course

### Assessment

- Attendance is compulsory. Proactive participation in the activities, practical and oral sessions, will be considered.
- Individual report (seminar) including a questionnaire about the course. 3 page abstract (specific subject) that will be made available to lecturers and to all students participating in the course. All students will have to formulate a critical question to each abstract, that will be also sent to the lecturer. Questions must be answered by all the students/lecturers. Assessment criteria: written report quality, abstract understanding by other students, and rationale at answering the questions raised.

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

### Programme

1. Environmental genomics and gene sources in the seas, soils, rivers, inside metazoa
2. Environmental metagenomics and gene discovery
3. Genomic services for aquaculture, fisheries research, study of fish stock dynamics, agriculture, food supply, comparative physiology...
4. Genomics and environmental model organisms.
5. Marine genomics and patents.
6. Basic concepts in toxicogenomics: ecotoxicogenomics, functional genomics, transcriptomics, proteomics, metabolomics, analysis of gene expression, and gene ontology.
7. Molecular mechanisms in cell toxicity: effects on gene transcription levels. Gene families with predictive capacity in toxicology: inflammation; peroxisome proliferation; mutagenesis; carcinogenesis; teratogenesis; agonists of AhR and other nuclear receptors; metal scavengers; detoxification metabolism; cytotoxicity; apoptosis; and immunosuppression...
8. How to address the lack of basic gene sequence information about the species of interest. Cloning, "expressed sequence tags" (ESTs). "Suppression subtractive hybridisation-PCR". Gene sequencing, Genome vs transcriptome sequencing. Massively parallel sequencing techniques. Sequence/Gene annotation (Gene ontology).
9. Basic techniques for the qualitative and quantitative study of differential gene expression (effects of chemical compounds). Toxicological fingerprinting. RT-PCR, Q-RT-PCR. Northern-blot, dot-blot, in situ hybridisation. Differential display PCR. Suppression subtractive hybridisation-PCR. Microarrays (microchips) and transcriptomics
10. Toxicogenomics vs proteomics vs metabolomics. Systems biology.
11. Knock-down and transgenic technology and the gene dissection of relevant molecular pathways.
12. Practicals: Navigating through the web in search of gene/genome/metagenome data bases. Gene sequence repositories, Genome sequence repositories (NCBI, ENSEMBL, GOLD). Gene expression repositories (GEO, Arrayexpress). Pathway analysis based on Gene ontology (GoFact, KEGG pathways). Microarray data interpretation and analysis tools.

### Learning & Teaching

- Lectures: 24 hr
- Seminars: 12 hr personal work
- Lab Practicals: 2 hr
- Computer Practicals: 8 hr
- Tutorials: 4 hr

## Environmental Monitoring and Risk Assessment in Aquatic Systems

ECT+ EHU 501317B

### Synopsis

Regulatory policies for the protection of the aquatic environment. Environmental Risk Assessment (ERA). Ecotoxicological bioassays in ERA. Marine pollution biomonitoring. Biological effects assessment through biomarkers and biomarker indices. Environmental Specimen Banks.

### Aims

- To develop the abilities that enable suitable study design of ecotoxicology in environmental risk assessment
- To provide the criteria useful for analysing and interpretation of toxicity and bioaccumulation data
- To develop the abilities that enable suitable study design of pollution biomonitoring programmes
- To provide the criteria useful for analysing and interpretation of ecologically relevant environmental levels of pollutants and their biological effects

### Objectives

At the end of the Unit, you should:

1. identify the main questions that can be addressed by the use of bioassays and biomarkers
2. know the advanced methods for the determination of ecotoxicity of contaminated water and sediments
3. understand the role of toxicity testing into an integrative risk assessment of the aquatic ecosystems
4. know the advanced methods for biomonitoring pollution and its biological effects
5. understand the role of biological endpoints into an integrative assessment of aquatic pollution, its biological effects and their ecological consequences.

### Key Skills Acquired

At the end of the Unit, you should be able to:

1. face problem analysis in an aquatic environment related to risk assessment
2. face problem analysis in an aquatic environment related to pollution biomonitoring
3. achieve clear expression (oral or written) of conclusions from results derived from bioassays

### Teaching Staff

I Marigomez (Coord.),  
U Izagirre

**Semester** 2

**Timetable slot** To be advised

**ECTS** 4

**Level** Optional

### Bibliography

Delivered during the course

### Assessment

- Written examination: 30 %
- Oral presentation: 20 %
- Practical examination : 50%

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.



## Eutrophication and Harmful Algae

ECT+ EHU 501320

### Synopsis

Overview of the effects of harmful algae on marine ecosystems and human health. Factors contributing to harmful algal blooms development. Eutrophication and its control.

### Aims

- To provide an introduction to the biology of harmful algae, the methods for their detection and identification and to their relevance for environmental and human health.

### Objectives

At the end of the Unit, you should:

- understand the biology of harmful algae.
- be familiar with methods to detect and identify marine phytoplankton.
- understand the foundations of eutrophication and its consequences for environment and human health.
- be aware of the factors enhancing eutrophication

### Key Skills Acquired

At the end of the Unit, you should be able to:

- identify the main groups of harmful algae
- apply methods to detect and identify harmful algae
- be conversant on eutrophication and harmful algae

### Syllabus

Topics covered include:

- Presentation of the different types of harmful microalgae
- Methods of detection and identification of harmful algae
- Impact of harmful algal blooms (HABs) on humans, wild fauna and aquaculture
- Factors triggering harmful algal blooms
- Eutrophication of estuaries and coastal waters
- Factors enhancing eutrophication
- Restoration of eutrophized habitats: case studies

### Learning & Teaching

- Lectures: 12 hr
- Seminars (oral presentations): 5 hr
- Practical sessions: 12 hr
- Field trip ( 1 day): 6 hr
- Tutorials (writing reports): 5 hr

**Semester** 2

**Timetable slot** To be advised

**ECTS** 4

**Level** Optional

### Bibliography

- Grant, Pitcher & Pillar. 2010. Harmful Algal Blooms in Upwelling Systems. Progress in Oceanography. 85: 1-136.
- Glibert, Burkholder, Graneli & Anderson. 2008. HABs and Eutrophication. Harmful Algae. 8: 1-188.
- Karlson, Cusack & Bresnan. 2010. Microscopic and Molecular Methods for Quantitative Phytoplankton Analysis. IOC (Intergovernmental Oceanographic Commission of UNESCO). Paris, 110pp.
- Suthers & Rissik. 2009. Plankton. A guide to their Ecology and Monitoring for Water Quality.

### Assessment

- Written report on a case study of eutrophication control (20%)
- Oral presentation of the ecology and toxic effects of a toxic algae (40%)
- Written theory examination: a 1 hour written examination paper based on the lectures (40%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

### Teaching Staff

S Seoane (Coord.), A Laza-Martinez,

## Histology and Histopathology of Aquatic Animals - ECT+ EHU 501324

### Synopsis

Topics covered will include the description of the normal and pathological histology of marine invertebrates and fish, with special emphasis on the effects of chemical pollutants and other sources of environmental stress.

### Aims

- To describe the normal and pathological histology of marine animal species: mainly fishes, molluscs and crustaceans.
- To identify histopathological alterations of viral, bacterial, parasitic and toxic (due to pollutant exposure) ethiology
- To characterise the cellular and molecular mechanisms involved in pathological damage and organismal defence.

### Objectives

At the end of the unit, you should:

1. be familiar with the form and function of organs and tissues in aquatic animals (comparative histology)
2. understand the normal histological organisation of target tissues in molluscs (integument, kidney, blood, digestive gland)
3. understand the normal histological organisation of target tissues in marine fishes (integument, kidney, spleen, blood, liver)
4. recognise major parasites and pathological lesions in molluscs and fish
5. know the value of histopathology in ecosystem health monitoring and marine pollution assessment

### Key Skills Acquired

At the end of the unit, you should be able to:

1. conduct histological processing of marine animal tissues
2. identify normal tissues and cell types at the light microscope in marine molluscs and fish
3. identify major parasites and histopathological lesions in marine molluscs and fish
4. search in the web and literature the relevant information concerning molluscs and fish disease, with emphasis in environmentally relevant syndromes

**Teaching Staff**  
M Soto (Coord.),

I Marigomez, U Izagirre, B Zaldibar, S Feist, A Villalba

**Semester** 2

**Timetable slot** To be advised

**ECTS** 4

**Level** Optional

### Bibliography

- Pathobiology of marine and estuarine organisms. Couch, JA; Fournie, JW. CRC Press, Boca Raton, Florida, USA, 1993.
- Fish and shellfish pathology. Ellis, AE. Academic Press. London, UK, 1985.
- Systemic fish pathology. Ferguson, HW. Iowa State Univ. Press, 1989.
- Fish diseases and disorders. Vol 2. Non-infectious disorders. Leatherland, JF; Woo PTK. CABI Publ., Oxon, UK, 1995.
- Fish as sentinels of environmental health. Murchelano, RA. NOAA, US Dept, Commerce, Woods Hole MA, USA, 1988.
- Histopathology atlas of the registry of marine pathology. Murchelano, RA; MacLean, SA. NOAA, US Dept. Commerce, Osford MD, USA, 1990.
- Fish Pathology. Roberts, RJ. WB Saunders, London, 2001.
- Fish disease and marine pollution. Vethaak, AD. National Institute for Coastal and Marine Management/RIZK, Amsterdam, 1993.
- Fish diseases and disorders. Vol 1. Protozoan and metazoan infections. Woo, PTK. CABI Publ., Oxon, UK, 1995.

### Assessment

- Attendance is compulsory. Proactive participation in the activities, practical and oral sessions, will be considered.
- Written report (70%)
- Practical examination (30%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

### Syllabus

1. Lectures: Comparative histology of marine invertebrates. Normal histology of molluscs. Normal histology of fishes. Basic principles in biopathology,

histopathology and parasitology. Molluscs: general histopathology, toxicopathology, neoplastic lesions, natural variability and temporal trends in histopathological lesions. Fish: general histopathology, mechanisms of chemical carcinogenesis, carcinogenic lesions. Histopathology in ecosystem health assessment: quantitative histopathology, quality assurance, monitoring programmes

2. Practicals: Histotechnology preparation of samples. Microscopical examination of molluscan tissues. Microscopical examination of fish tissues. Histopathological examination of marine molluscs. Histopathological examination in fishes. Navigating through the web in search of data bases and images of aquatic animal histopathology
3. Workshop on toxicological pathology (mini-symposium)

### **Learning & Teaching**

- Lectures: 20 hr
- Practical sessions (laboratory): 8 hr
- Practical sessions (microscopy): 10 hr
- Practical sessions (computer): 2 hr

## Introduction to Research Activities

ECT+ EHU-501330

### Synopsis

The topics covered will allow getting knowledge in main aspects the scientific method applied to the study of environmental contamination. Students will develop critical thinking and will be aware of the main mistakes produced in scientific research.

### Aims

- to introduce the students to the wide range of sampling techniques applicable to operational oceanography

### Objectives

At the end of the Unit, you should:

1. Understand the current topics in environmental contamination and toxicology research.
2. Identify most active research groups in environmental pollution research
3. Identify the main research groups working in applied environmental research
4. Science communication Critical way of thinking Wide perspective of research issues.

### Key Skills Acquired

At the end of the Unit, you should be able to:

1. Apply fundamental techniques for the culture of animal tissues
2. Produce functional analysis in cell cultures.

### Syllabus

The following issues are addressed:

1. The Theory of Knowledge
2. Research, Ethics and Society
3. Basic Research Methods
4. Scientific Documentation
5. Communication: Oral and Written
6. Creativity and Problem Solving
7. Research Funding
8. Research Outside the Academic World

### Learning & Teaching

- Lectures: 24 hr
- Tutorials: 11 hr
- Seminars: 5 hr

### Teaching Staff

LA Fernández (Coord.),

|                       |               |
|-----------------------|---------------|
| <b>Semester</b>       | 2             |
| <b>Timetable slot</b> | To be advised |
| <b>ECTS</b>           | 4             |
| <b>Level</b>          | Optional      |

### Bibliography

- Montello, D.R., Sutton, P. 2012. An Introduction to Scientific Research Methods in Geography and Environmental Studies (2nd edition). SAGE Publishing. ISBN 9781446200742
- Valiela, I. 2009. Doing Science: Design, Analysis and Communication of Scientific Research. Oxford University Press. ISBN 978-0195385731
- Staddon, J. 2017. Scientific Method: How science works, fails to work, and pretends to work. CRC Press. ISBN 9781138295360

### Assessment

- Written theory examination (50%)
- Seminar and oral presentation (50%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Coordinator.



## Physiological Energetics of Marine Organisms - ECT+ EHU 501322

|                       |               |
|-----------------------|---------------|
| <b>Semester</b>       | 2             |
| <b>Timetable slot</b> | To be advised |
| <b>ECTS</b>           | 4             |
| <b>Level</b>          | Optional      |

### Synopsis

Physiological basis of energetic exchanges between marine animals and environment are analysed.

### Aims

To present the tools that Physiological Energetics provides to understand the basis of energy exchanges and constrains to attain high rates of growth.

To present the tools that Physiological Energetics provides to evaluate sublethal effects of pollutants on individual growth and reproductive potential.

### Objectives

At the end of the Unit, you should be able to:

1. handle information Scope For Growth provides as regards to understanding actual growth and factors that may potentially affect growth rate.
2. design simple experiments to measure the scope for growth in marine animals

### Key Skills Acquired

At the end of the Unit, you should be able to:

1. perform critical Analysis of literature data on Scope For Growth.
2. express (write and analyse) experimental results obtained in the laboratory.
3. design experiments.

### Syllabus

1. The course is organized into two sections: discussion of general principles of physiological energetics; and two independent and complementary modules developing concepts and methods within the framework of production and toxic effects of pollutant agents.
2. Lectures and laboratory experiments deal with the physiological parameters of the energy balance, such as: rates of food ingestion and absorption; absorption efficiency; metabolic rate; excretion rate; and the resulting scope for growth.
3. Modules on production and pollution follow the pattern of a case study where experimental results are thoroughly discussed.

### Learning & Teaching

- Lectures: 20 hr
- Seminars: 6 hr
- Practical sessions (laboratory): 10 hr
- Tutorials: 4 hr

### Teaching Staff

E Navarro (Coord.), MB Urrutia, I Ibarrola

### Bibliography

- Galloway, T.S., Sanger, R.C., Smith, K.L., Fillmann, G., Readman, J.W., Ford, T.E., Depledge, M.H. Rapid assessment of marine pollution using multiple biomarkers and chemical immunoassays ,(2002) Environmental Science and Technology, 36 10, 2219-2226.
- Widdows, J., Donkin, P., Staff, F.J., Matthiessen, P., Law, R.J., Allen, Y.T., Thain, J.E., (...), Jones, B.R. Measurement of stress effects (scope for growth) and contaminant levels in mussels (*Mytilus edulis*) collected from the Irish Sea ,(2002) Marine Environmental Research, 53 4, 327-356.
- Webb, N.A., Shaw, J.R., Morgan, J., Hogstrand, C., Wood, C.M. Acute and chronic physiological effects of silver exposure in three marine teleosts ,(2001) Aquatic Toxicology, 54 3-4, 161-178.
- Niemi, Gerald J., Bradbury, Steven P., McKim, James M. Use of fish physiology literature for predicting fish acute toxicity syndromes ,(1991) ASTM Special Technical Publication, 1124, 245-260.
- Willmer P, Johnston I, (2000) Environmental Physiology of Animals. Blackwell Publishing.

### Assessment

- Written examination (60%)
- Written assay on lab experiments (40%)

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Coordinator.

## Research in Environmental Contamination and Toxicology (INCyTA)

ECT+ EHU 501315

### Synopsis

Annually, a general workshop is held in the facilities of the PiE-UPV/EHU, where students have experiences for 2 weeks. Teaching staff from all the institutions in the ECT Consortium and world-wide renowned environmental scientists participating as guest lecturers are present. PhD candidates of the local CTA PhD programme present their PhD outputs to ECT EMJMD students.

The topics covered will allow getting knowledge in main aspects of research in the field of environmental toxicology and chemical contaminants, including on the main global problems and challenges, mainly related with pollution and global changes, and the acquisition of skills and training on methods and approaches expected to contribute to the mitigation of their effects (through prevention, assessment and management).

### Aims

- to provide an updated point of view of the main problems in applied marine research;
- to provide a cross-section viewpoint of hot spots in RIMER; and
- to facilitate contacting with renowned scientists/research groups.

### Objectives

At the end of the Unit, you should:

1. understand the current topics in environmental contamination and toxicology research
2. identify most active research groups in environmental contamination and toxicology
3. have gained a knowledge of the main problems that concern applied environmental research

### Key Skills Acquired

At the end of the Unit, you should be able to:

1. be familiar with science communication skills;
2. develop a critical way of thinking; and
3. acquire a transversal, multidisciplinary perspective of ECT research

### Syllabus

Lectures and Round Tables on the following topics:

- Ecosystem health assessment in water and soil ecosystems
- Environmental Risk Assessment and Regulatory Toxicology
- Emerging and persistent pollutants
- Pollution effects in cultural heritage
- Environmental specimen banking
- Nanotoxicity
- Human risk assessment and Public health

### Learning & Teaching

- Lectures: 36 hr
- Workshops: 24 hr

### Teaching Staff

M Ortiz\_Zarragoitia (Coord.)

I Cancio, M Soto, MP

Cajaraville

**Semester** 2

**Timetable slot** To be advised

**ECTS** 6

**Level** Compulsory

### Bibliography

- Kesari, K.K. (Ed.). 2017. Perspectives in Environmental Toxicology. Springer. ISBN 978-3-319-46248-6
- Newman, M.C. (Ed.). 2014. Fundamentals in Environmental Toxicology (4th edition). CRC Press. ISBN 9781466582293
- D'Mello, J.P.F. (Ed.). 2019. A handbook of Environmental Toxicology: Human disorders and ecotoxicology. CABI. 978-1786394675

### Assessment

- Attendance is compulsory. All absences must be justified documentally. Active participation in the activities of the course is required; particular attention will be paid to the participation in open discussions in lectures, seminars and practicals.
  - Written examination (up to 50%)
- Written reports (at least 50%):
  - List of 2 questions per lecture
  - One 5 page journalistic summary of the INCyTA Course
  - One 5 page summary of the student's choice Round Table

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

## Soil and Sediment Contamination and Toxicology - ECT+ EHU 501346

### Synopsis

The topics covered will allow getting knowledge in main aspects of soil exotoxicology and bioremediation techniques.

### Aims

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### Objectives

At the end of the Unit, you should:

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### Key Skills Acquired

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### Programme

1. Soil physicochemical features
2. Organic and inorganic contaminants in soils and underground waters
3. Bioavailability and bioaccumulation of contaminants
4. Toxicity and tolerance of soil organisms to contaminants
5. Bioassays for soil toxicity assessment
6. Toxicity and tolerance biomarkers
7. Phytoremediation and bioremediation
8. Soil health assessment
9. Management of contaminated soils

### Learning & Teaching

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B Zaldibar, C Garbisu

Semester 2

Timetable slot To be advised

ECTS 4

Level Optional

### Bibliography

- Duarte, A., Cachada, A., Rocha-Santos, T. (Eds.). 2017. Soil pollution. Academic Press. ISBN: 9780128498736
- Coleman, D.C., Callaham Jr, Mac. A., Crossley Jr, D. A. (Eds.). 2017. Fundamentals of Soil Ecology (3rd edition). Academic Press. ISBN 9780128052518
- Tarazona, J.V., Fernandez, M.D., 2008. Complementary Approaches for Using Ecotoxicity Data in Soil Pollution Evaluation. Nova Science Pub. Inc. ISBN 978-1606921050

### Assessment

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### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Coordinator.

Teaching Staff  
M Soto (Coord.)

## Master Thesis

ECT+ EHU 501000

### Synopsis

6 month research on environmental contamination and Toxicology within the framework of a research group active in the field

### Aims

- To provide an introduction to the chemistry of sea-water through qualitative and quantitative approaches and presentation of the chemical interactions between the lithosphere, the biosphere, the atmosphere and the ocean.

### Objectives

At the end of the Unit, you should:

- demonstrate sufficiency for research in order to undertake the realisation of the PhD Thesis work, or a professional activity as researcher.

### Key Skills Acquired

At the end of the Unit, you should be able to:

- be integrated in the research group where the MTP has been carried out.
- demonstrate basic skilfulness achieved regarding the methods employed in the MTP
- design and plan and carry out a research work, under the consideration that the MTP must be undertaken during a period of 6 months
- show quality in written scientific reporting
- show quality in oral presentation and ability to discuss and defend each postulates concerning the MTP.

### Syllabus

- 6 month research under the supervision of a PhD holder.
- Written report in English, French, Portuguese, Spanish or Basque language (+ 2nd language summary), according to the standard structure/extension of a scientific paper.
- Dissertation will consist of a 20 min oral presentation plus a questions/discussion session for an additional 20 min.
- Oral presentation will be made in English and a simultaneous translation service will not be available.

### Learning & Teaching

- A list of available MSc Research projects is available every July
- The ECT JPB may also accept a proposal made individually by a student, provided the proposed supervisor and host institution accept and always in compliance with the academic requirements of the ECT EMJMD programme.

### Teaching Staff

M Ortiz Zarragoitia & I Marigómez (Coord.); Other JPB Members

|                       |               |
|-----------------------|---------------|
| <b>Semester</b>       | 4             |
| <b>Timetable slot</b> | To be advised |
| <b>ECTS</b>           | 30            |
| <b>Level</b>          | Compulsory    |

### Requisites

"pass" in 90 ECTS in the ECT EMJMD Programme

### Course Evaluation

By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

- ECT EMJMD students can follow their MSc research programme in any Partner institution or in Associated Partners or other collaborating institutions,

which will host a student considering the field of his/her MSc Thesis, according to the subject a student chooses. The ECT Secretariat provides administrative support to formalize the required agreements with host institutions when the supervisors are from institutions other than the ECT Consortium.

### Assessment

1) A complete pdf file (including signatures) of the written MSc Thesis report must be sent by email to ECT Secretariat before the published deadline. Likewise, the original and 3 paper copies must be sent by mail (with postmark date before deadline). Besides, in order to incorporate the abstracts into the ECT EMJMD web page, a pdf file including the cover and back pages, the tutor certificate form and two summaries (see below) is also required. One copy of the report will be deposited in the ECT Secretariat repository and will be available for those who request it conveniently.

2) Written reports can be presented in English, French, Portuguese, Spanish or Basque upon but in any case a second language summary must be also included.

3) The written report must be undertaken according to the standard structure and extension of a scientific paper, in which an extended Introduction is included in order to help in evaluating the candidate's skills and basic knowledge in the study field.

- As a whole, the extension should correspond to a (numbered) 35-50 pages manuscript plus Tables, Legends and Figures written in a common text processor (Word, ), with a letter type similar to Times New Roman 10-12, with 1.5 space between lines and at least 2.5 cm margins at both sides. The candidate can decide to present it edited and formatted or without editing and formatting with Tables and Figures after the text.
- Use the cover front page, back page and tutor agreement form provided by the ECT Secretariat.

4) The report structure will be as follows:

- ✓ Cover page: title, affiliations, and indication, if it proceeds, of whether the work has been published or submitted for publication in the form of an article or contribution to a congress, etc.
- ✓ Tutor agreement form and if different, also scientific supervisor signature
- ✓ Summary (max. 1 page)
- ✓ Second language summary (max. 2 pages)
- ✓ Introduction (scientific paper style -context, objectives, hypothesis, justification of the research interest-, plus an additional preamble where the basic concepts of the research field are presented)
- ✓ Material and Methods
- ✓ Results
- ✓ Discussion: including a list of conclusions.
- ✓ (Results & Discussion section may be accepted as a single section)
- ✓ References

(up to here 50 pages, at most)

- ✓ Annexes: Tables, Legends of figures, Figures, etc.

5) The public dissertation and the discussion will be held in the Plentzia Marine station (PiE-UPV/EHU) in mid July.

6) Dissertation will consist of a 20 min oral presentation, plus a questions/discussion session for an additional 20 min. Oral presentation will be made in English.

The following aspects will be considered for evaluation, according to the Academic Assessment Form:

- Integration of the student in the research group where the MSc Thesis research has been carried out.
- Basic skills achieved regarding the methods employed.
- Ability to design and plan and carry out a research work, under the consideration that the MSc Thesis must be undertaken within a period of 6 months.
- Quality of the written scientific report.
- Quality of the oral presentation and ability to discuss and defend each one's postulates concerning the MSc thesis.
- Overall, it will be evaluated on whether the candidate has achieved sufficiency for research in order to undertake in a next step the realisation of the PhD Thesis work or a professional activity, as a researcher in the field of marine environment and resources.
- After the public session, students will be requested to complete questionnaires to assess the quality of the MSc Thesis research programme and the ECT EMJMD programme overall.
- A Graduation ceremony takes place after the vivas, with participation of students of at least two consecutive cohorts
- Any change, correction or amendment in the terms and requirements of this official call will be timely and transmitted to candidates.





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