Erasmus Mundus Joint Master Degree
in Marine EnviRonment

MER2030 EMJMD
CATALOGUE OF COURSES

2021-2026

www.mer2030.eu

With the support of the Erasmus+ Programme of the European Union

A Erasmus+ EMJMD (120 ECTS)

MER2030 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 MER MSc programme provides students with competences and skills to develop their marine career in the following fields:

Integrated coastal zone management
Protection of marine and estuarine environments
Adaptation to global climate change
Assessment of marine ecosystem health
Conservation of biodiversity and natural heritage
Ecosystem approach for marine resources management

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 Multiple MSc degree (120 ECTS) awarded by the three Partner Universities through which the studies have been undertaken.

MER Consortium Secretariat

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

UNIVERSIDAD DEL PAIS VASCO
/EUSKAL HERRIKO UNIBERTSITATEA

AREATZA Z/G, E-48620 PLENTZIA-BIZKAIA
BASQUE COUNTRY (SPAIN)

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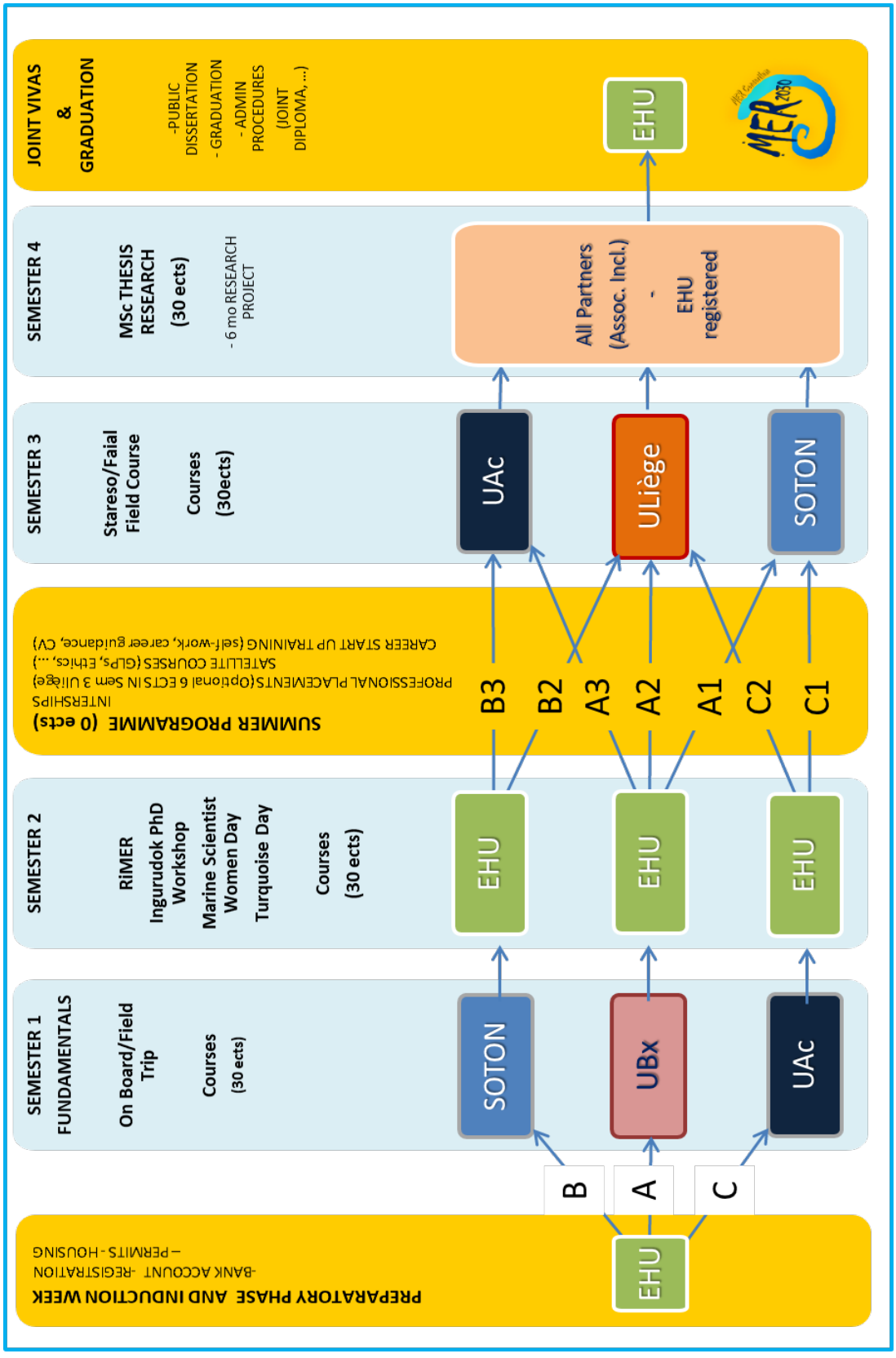
www.merconsortium.eu

MODULE	COURSE	TYPE	ECTS	UNIV
FUNDAMENTALS IN OCEAN SCIENCE	**Introduction to Biological Oceanography**	CSS1	3,75	SOTON
	Introduction to Chemical Oceanography			
	Introduction to Marine Geology			
	Introduction to Physical Oceanography			
	Biological Oceanography	CBS1 CAS1	6	UBx UAc
	Chemical Oceanography			
	Dynamic Oceanography			
	Seafloor Geology			
	Marine Ecology	CLS3 CAS3	6	ULiège UAc
CLEAN OCEAN	Advanced Instrumental Analysis	OP	4	EHU
	Cellular and Molecular Biomarkers			
	Ecological Quality Assessment in Coastal Ecosystems			
	Environmental (toxico) Genomics			
	Environmental Analytical Chemistry			
	Environmental Chemometrics			
	Environmental Monitoring and Risk Assessment ...			
	Biology of Marine Mammals	OP	6	ULiège UAc
	Ecotoxicology and Risk Quantification of Marine Pollutants	OP	6	ULiège
HEALTHY AND RESILIENT OCEAN	Degradation and Rehabilitation of Estuarine Ecosystems	OP	4	EHU
	Eutrophication and Harmful Algae			
	Ocean Global Change Biology			
	Marine Microbial Ecology			
	Marine Resource Genomics			
	Socio-economic Aspects of Climate Change			
	Large Scale Ocean Processes	OP	7,5	SOTON
	Marine GeoArchaelogy			
	Biogeochemical Cycles in the Earth system			
	Coastal Sediment Dynamics			
	Biogeochemical Cycles in the Ocean	OP	6	ULiège
	Carbon, Nutrient, Greenhouse ... and Geological Oceanography			
	Marine Plant Biology and Ecology			
	Oceans and Health	OP	6	UAc
PREDICTABLE AND SAFE OCEAN	Applied and Marine Geophysics	OP	7,5	SOTON
	Computational Data Analysis for Geophysicists and Ocean			
	Geodynamics and Solid Earth Geophysics			
	Introductory Remote Sensing of the Oceans			
	Microfossils, Environment and Time			
	Analysis of Environmental Data and Modelling	CBS1 CAS1	6	UBx UAc
	Instrumentation ... in Operational Oceanography	OP	4	EHU
	Satellite Oceanography and Meteorology			
	Mathematical Analysis and Modelling Methods Applied to the Environment	OP	6	ULiège
	Remote Sensing of the Oceans	OP	6	ULiège UAc
	Geographical Information Systems	OP	6	UAc
	Maritime and Coastal Spatial Planning and Law			
SUSTAINABLY HARVESTED OCEAN	Comparative Endocrinology and Endocrine Disruption...	OP	4	EHU
	Ecosystem-based Fisheries Management			
	Environment and Fisheries/Aquaculture Interactions			
	Histology and Histopathology of Aquatic Animals			
	Marine Resources Genomics			
	Physiological Energetics of Marine Organisms			
	Deep Sea Ecology	OP	7,5	SOTON
	Marine Conservation and Policy			
	Zooplancton Ecology and Processes			
	Biochemistry and Physiology of Marine Animals	OP	6	ULiège
	Functional and Molecular Marine Microbiology			
	Aquaculture and Blue Biotechnology	OP	6	UAc
	Fisheries and Fish Biology			
OCEAN SCIENTIST CAREER	Contemporary Topics in Ocean and Earth Sciences	CSS1	7,5	SOTON
	Research in Marine Environment and Resources	C	6	EHU
	Multicultural Integration in EU	OP	4	
	Marine Entrepreneurship			
	Professional Practice in marine/envir. sectors	OP	6	ULiège
	Master Thesis	C	30	EHU

MOBILITY PATHWAYS



LINK TO UBx MER WEBSITE

SEMESTER 1		
COURSE	ECTS	TYPE
Analyses of Environmental Data and Modelling	6	CBS1
Biological Oceography	6	CBS1
Chemical Oceanography	6	CBS1
Dynamic Oceanography	6	CBS1
Seafloor Geology	6	CBS1

CBS1: Compulsory at UBx Semester 1

Course/Unit	Analyses of Environmental Data and Modelling
MER Code	MER UBx 0703
ECTS	6
Level	Compulsory (UBx)
Semester	1
Timetable slot	To be advised
Teaching Staff	B Lubac (Coord.)
Synopsis	Basic methods for the representation, analysis and modelling of environmentally-relevant data.
Aims	To provide an introduction to the analysis of environmental data and modelling
Objectives At the end of the Unit, the student should:	1. understand the principles and methods of descriptive statistics, applied to environmental data. 2. understand the concepts of the principles and methods of variability and trend analyses, applied to environmental data. 3. understand data modelling in environmental sciences.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. solve problems of descriptive statistics and its application to environmental sciences 2. solve problems of analytical statistics and its application to environmental sciences 3. interpret deterministic and statistical models 4. be familiar with the use of representation basic methods in environmental sciences.

Programme/Syllabus	1. Statistics (random variables and probability, data sampling, descriptive statistics, parametric and non-parametric hypotheses, confidence intervals, etc.) 2. Data analysis (Factor Analyses, automatic classification) 3. Modelling (deterministic modelling, statistical modelling)
Learning & Teaching	• Formal Lectures: 20 hr • Seminars 16 hr • Field work: 18 hr
Bibliography	Delivered during the course
Assessment	• Written examination (50 %) • Oral examination (50 %)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the UBx Academic Quality & Standards Committee.

Course/Unit	Biological Oceography
MER Code	MER UBx 0001
ECTS	6
Level	Compulsory (UBx)
Semester	1
Timetable slot	To be advised
Teaching Staff	X de Mountaduoin (Coord.)
Synopsis	Biological community structures in marine environment, as a function of control variables and forcing parameters.
Aims	To provide an introduction to biological oceanography and the methods and procedures employed in marine biological exploration.
Objectives At the end of the Unit, the student should:	1. understand the different options of community structures in marine environment, as a function of control variables and forcing parameters.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. apply tools for the description and comparison of marine populations, diversity measurements and ecosystem functioning, as a response to environmental conditions. 2. become familiar with basic laboratory and fieldwork in biological oceanography

Programme/Syllabus	1. Introduction to tools for the description and comparison of marine populations, diversity measurements and ecosystem functioning, as a response to environmental conditions. 2. Darkness-chemotrophic systems 3. Heterogeneous systems-observation scales 4. Interaction between species and environment 5. Research stage at the Arcachon Marine Station 6. Oligothrophic systems 7. Interactions between plankton and benthic communities 8. Turbid and brackish water systems.
Learning & Teaching	• Formal Lectures: 34 • Seminar: 6 • Field work: 4 • Laboratory practicals: 10
Bibliography	Delivered during the course
Assessment	• Written examination (50 %) • Oral examination (50 %)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the UBx Academic Quality & Standards Committee.

Course/Unit	Chemical Oceanography
MER Code	MER UBx 0002
ECTS	6
Level	Compulsory (UBx)
Semester	1
Timetable slot	To be advised
Teaching Staff	P Martínez (Coord.); P Anschutz; J Schafer, N Savoye
Synopsis	Topics covered will include: the description of the chemistry of sea-water; marine biogeochemistry; chemical fluxes from the continent to the ocean; ocean-atmosphere interactions; and oceanic crust-sea-water interactions.
Aims	To provide an understanding of: the chemical composition of the sea and learn quantitative approaches to element reactivity at various interfaces and interactions with marine biosphere, (bio)geochemical transfer processes, at different scales (time and space).
Objectives At the end of the Unit, the student should:	1. understand the chemistry of seawater; 2. understand the concepts of the biogeochemistry and their principal chemical processes; and 3. understand the fluxes between the continent and the ocean.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. understand through an interdisciplinary approach the chemical composition of the sea 2. become familiar with quantitative approaches to element reactivity at various interfaces, interactions with the marine biosphere, (bio)geochemical transfer processes at different scales of time and space.

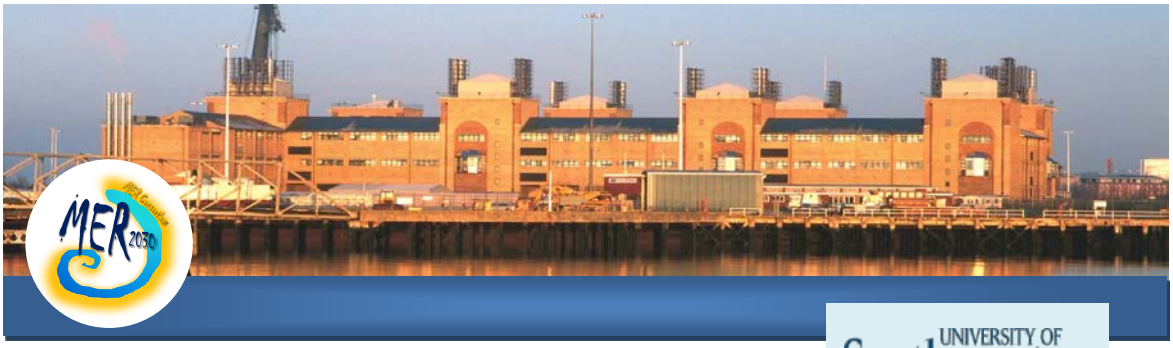
Programme/Syllabus	1.- Introduction to chemical composition of the seas. 2.- Biogeochemical processes. 3.- Marine carbon cycle 4.- Radionuclides 5.- Continent-ocean interactions 6.- Estuaries 7.- Mass transfers, from the photic zones to deep water 8.- Water-rock interactions 9.- Analytical instruments and techniques in water geochemistry 10.- Research stage at the Arcachon Marine Station. 11.- Research stages at the national coastal Research Vessel 'Côte de la Manche'.
Learning & Teaching	• Formal Lectures: 30 • Seminar: 11 • Field work: 10
Bibliography	Delivered during the course
Assessment	• Written examination (60 %) • Practical examination and report (40%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the UBx Academic Quality & Standards Committee.

Course/Unit	Dynamic Oceanography
MER Code	MER UBx 0003
ECTS	6
Level	Compulsory (UBx)
Semester	1
Timetable slot	To be advised
Teaching Staff	N Senechal (Coord.); A Sottolichio, B Lubac, T Corrège
Synopsis	Fundamental knowledge on Ocean dynamics (fluid mechanics, physical properties, global circulation)
Aims	To provide an introduction to Ocean Dynamics (fluid mechanics, physical properties, global circulation)
Objectives At the end of the Unit, the student should:	1. understand fluid dynamics; 2. understand the physical seawater properties and global circulation; and 3. understand atmospheric and meteorological physical parameters.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. solve problems of fluid dynamics 2. interpret data of descriptive physical oceanography 3. interpret meteorology data

Programme/Syllabus	1.- Introduction to fluid dynamics (e.g. Navier Stokes equations, geostrophic equilibrium, Ekman transport, vorticity) 2.- Descriptive Oceanography (physical seawater properties, global circulation, regional Oceanography, ocean-atmosphere interactions) 3.- Meteorology (physical parameters, global atmospheric circulation, thermodynamics, visit to Meteo France)
Learning & Teaching	• Formal Lectures: 25 • Seminar: 30 • Field work: 6 All more or less mixed to into «integrated courses»
Bibliography	• Introductory Dynamical Oceanography. 2nd Edition. Authors: Stephen Pond George L. Pickard. eBook ISBN: 9780080570549. Paperback ISBN: 9780750624961. Imprint: Butterworth-Heinemann. Published Date: 22nd October 2013
Assessment	• Written examination (30 %) • Oral examination (20 %) • Practical examination (50%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the UBx Academic Quality & Standards Committee.

Course/Unit	Seafloor Geology
MER Code	MER UBx 0004
ECTS	6
Level	Compulsory (UBx)
Semester	1
Timetable slot	To be advised
Teaching Staff	JL Schneider (Coord.); J Bonnin, T Corrège, V Hanquiez
Synopsis	General characteristics of marine environments, with respect to geology and oceanography, as a basis for further studies in different domains of marine sciences, (e;g. paleoclimatology, sedimentology, hydrography, etc.).
Aims	To provide an introduction to the chemistry of seawater, through qualitative and quantitative approaches and presentation of the chemical interactions between the lithosphere, biosphere, and the atmosphere and the ocean
Objectives At the end of the Unit, the student should:	1. Understand the general characteristics of marine environments, with respect to geology and oceanography, as a basis for further studies in different domains of marine sciences (e;g. paleoclimatology, sedimentology, hydrography, etc.).
Key Skills Acquired At the end of the Unit, the student should be able to:	1. interpret basic data in marine geology (Imaging, seismic, magnetic anomalies); and 2. become familiar with sampling techniques

Programme/Syllabus	1. Introduction to the main physiographic domains 2. Methodological approaches and tools in Marine Geology (imaging, seismic, magnetic anomalies, etc.). 3. Sampling techniques (e.g. coring). 4. Composition, structure and evolution of marine ground. 5. Interactions between oceans and inner planetary dynamics. 6. Marine sediments, as archives of geodynamics and paleoclimate. 7. Field trip and core sampling on-board a research vessel on the Gironde Estuary. 8. Field trips and core sampling on-board a research vessel around the Arcachon Lagoon.
Learning & Teaching	• Formal Lectures: 18 • Seminar: 14 • Field work: 12
Bibliography	Delivered during the course
Assessment	• Written examination (50 %) • Oral examination (50 %)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the UBx Academic Quality & Standards Committee.



LINK TO SOTON MER WEBSITE

SEMESTERS 1 & 3

COURSE	ECTS	TYPE
Introduction to Biological Oceanography	3.75	CSS1
Introduction to Chemical Oceanography	3.75	CSS1
Introduction to Marine Geology	3.75	CSS1
Introductory Physical Oceanography	3.75	CSS1
Applied and Marine Geophysics	7.5	OPT
Biogeochemical Cycles in the Earth System	7.5	OPT
Coastal Sediment Dynamics	7.5	OPT
Computational Data Analysis for Geophysicists and Ocean Scientists	7.5	OPT
Contemporary Topics in Ocean and Earth Sciences	7.5	OPT
Deep Sea Ecology	7.5	OPT
Geodynamics and Solid Earth Geophysics	7.5	OPT
Introductory Remote Sensing of the Oceans	7.5	OPT
Large-scale Ocean Processes	7.5	OPT
Marine Conservation and Policy	7.5	OPT
Marine GeoArchaeology	7.5	OPT
Microfossils, Environment and Time	7.5	OPT
Zooplankton Ecology and Processes	7.5	OPT

CSS1: Compulsory at Soton Semester 1
OPT: Optional at SOTON in both Semester 1 and Semester 3
NOTE: Some courses may be not offered every academic year

Course/Unit	Introduction to Biological Oceanography
MER Code	MER SOES 6013
ECTS	3.75
Level	Compulsory (Soton) - Semester 1
Semester	1
Timetable slot	To be advised
Teaching Staff	T Bibby (Coord.)
Synopsis	Introduction to general ecological principles relating to the ocean and description of the ocean environment.
Aims	• To provide a basic understanding of the biological processes in the water and how these are affected by the ambient physicochemical conditions.
Objectives At the end of the Unit, the student should:	• At the end of the unit you should be able to understand the biological oceanography of the pelagic ecosystem.
Key Skills Acquired At the end of the Unit, the student should be able to:	Know the biological processes in the pelagic environment of the world ocean to include: o Primary and secondary production o Recycling process o Open ocean, shelf and upwelling production

Programme/Syllabus	1. General ecological principles relating to the ocean and description of the ocean environment. 2. Physical factors influencing primary productivity. 3. Primary production. 4. Breakdown of organic material, and regeneration of nutrients. 5. Oxygen relationships and anoxic conditions. 6. Pelagic secondary production. 7. Food webs. 8. Importance of vertical flux of organics in water column, implications of vertical migration to such movement. 9. Behavioural and physiological problems associated with vertical migration in the water column. 10. Fisheries and upwelling, the biology of subtropical gyres and the Southern Ocean and long-term ocean time-series together with an introduction to modelling in biological oceanography.
Learning & Teaching	(18 hr; 52 hr personal work) • Lectures • Boat work
Bibliography	• The lecture material is summarised at blackboard.soton.ac.uk. Instructions for accessing this material will be given during the course. • Core text: Miller, C.B., 2004. Biological Oceanography, Blackwell Science Ltd. ISBN 0-632-05536-7.
Assessment	• Written examination (80%) • Short Boat Work Report (20%): A 2 page report based on biological measurements made during MSc boat work in Southampton Water.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Introduction to Chemical Oceanography
MER Code	MER SOES 6015
ECTS	
Level	Compulsory (Soton) - Semester 1
Semester	1
Timetable slot	To be advised
Teaching Staff	MJ Cooper (Coord.); B Dickie
Synopsis	The Unit is designed for graduates in any science discipline, embarking on postgraduate studies in Ocean and Earth Science.
Aims	• To introduce the basic concepts used in chemical oceanography. • To provide basic knowledge of chemical processes in the ocean. • To provide a framework to undertake more advanced units, within SOES. • To introduce techniques and practical skills needed for oceanographic chemical sampling/analyses.
Objectives At the end of the Unit, the student should:	1. able to convert between the different units used in chemical oceanography; 2. familiar with the hydrological cycle and erosion processes 3. aware of the differences between river water and seawater and the reasons for the differences; 4. able to discuss the impact of mid-ocean ridge hydrothermal activity on ocean chemistry; 5. familiar with (non-)conservative elements and their behaviour in the oceans (e.g.: nutrients, major/minor elements, trace metals); 6. able to construct 2 box models; 7. aware of the behaviour of elements within estuaries; 8. familiar with the behaviour of dissolved gases in the ocean and their impact on ocean anoxia and carbonate chemistry; 9. able to describe the distribution of major sediment types in ocean basins and chemical controls of the observed distributions; 10. aware of the behaviour and importance of trace metals dissolved in seawater; 11. aware of some of the different chemical tracers used in oceanography; and 12. able to interpret an estuarine nutrient data set.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Ability to access chemical oceanography literature 2. Data handling and interpretation skills 3. Chemical oceanographic sampling techniques 4. Chemical laboratory techniques and safety

Programme/Syllabus	Chemical oceanography covers many facets of marine environmental science and a multitude of different spatial and temporal scales. Topics covered in this unit span from evolution of the ocean, to controls on chemical speciation in sea water and molecular diffusion processes. Chemical processes are essential in biological systems; they control the geology of the planet and they are key tracers utilised in understanding the physics of the ocean.
Learning & Teaching	• Lectures 18 hr • Boat work (half day) • Problem Sheets & Online tests (52 hr personal work)
Bibliography	• The lecture material is summarised at blackboard.soton.ac.uk. Instructions for accessing this material will be given during the course. • Online test: A test with multiple choice and single word answer questions will be available on the Blackboard site for students to give feedback on their knowledge and understanding of the first half of the course.
Assessment	• Written examination (80%):To test the understanding of the theoretical part of the course, through essay-type questions and also numerical problems. Learning Outcomes 1-11 • Short Practical Write Up (20%):A short data analysis exercise based on the practical work carried out during the boat work week. Learning Outcomes 1,3,7 & 12
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Introduction to Marine Geology
MER Code	MER SOES 6016
ECTS	3.75
Level	Compulsory (Soton) - Semester 1
Semester	1
Timetable slot	To be advised
Teaching Staff	L McNeill (Coord.) & J Davis
Synopsis	The module is designed for graduates in any science discipline embarking on postgraduate studies in Ocean and Earth Science.
Aims	• To give a broad outline of the geological evolution of the ocean basins. • To give a broad outline of the methods used presently to investigate the superficial and deep structural features of the sea bed.
Objectives At the end of the Unit, the student should:	1. have a solid grounding in marine geology; 2. understand the framework provided by Plate Tectonics; 3. describe sediments found in different water depths and settings, and understand the sedimentary processes leading to their deposition; 4. describe the main geological and geophysical techniques for observing the seabed and sub-seabed; and 5. understand the driving forces behind, consequences, and importance of sea-level changes in the geological record.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Generic skills: report writing, scientific writing 2. Subject specific skills: presentation and manipulation of data, e.g. seismic interpretation, use of sea-level curves.

Programme/Syllabus	• This module will cover: the inception of ocean basins; the role of mid-ocean ridges in basin-scale processes; structure and geological processes at continental margins; and sedimentary processes within the basins. • Methodologies covered will include: the principles and design considerations behind echo-sounder and side-scan sonar systems; seismic methods; gravity and magnetic measurements; and dating methods. • Emphasis will be placed on the present utilisation of these techniques, in both research led and economically led environments.
Learning & Teaching	• Lectures 24 hr • Boat practical • Practicals (2): seismic interpretation, sea-level change and sedimentology (48 hr perdosnalñ work)
Bibliography	Much of the material is summarised at blackboard.soton.ac.uk. Instructions for accessing this material will be given during the course.
Assessment	• Written examination (80%) To test the understanding of the theoretical part of the course, through essay-type questions and also numerical problems. Learning Outcomes 1-11 Learning outcomes 1-5 • Short Practical Write Up (20%):A short data analysis exercise based on the practical work carried out during the boat work week. Learning Outcomes 1,3,7 & 12
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Introductory Physical Oceanography
MER Code	R SOES 6014
ECTS	3.75
Level	Compulsory (Soton) - Semester 1
Semester	1
Timetable slot	To be advised
Teaching Staff	A Naveira Garabato (Coord.)
Synopsis	Topics covered will include: the physical properties of sea water; the dynamics of wind-driven ocean circulation; description of the thermohaline circulation; and the role of the ocean in climate variability.
Aims	• To provide an introduction to the physics of the ocean, including descriptive and dynamical oceanography; • To give an understanding of the processes that control the movement of water, heat and other properties.
Objectives At the end of the Unit, the student should:	1. understand the physical processes that control the distribution of water properties and the movement of those properties in the ocean. 2. understand the range of time- and space-scales that exist from small-scale mixing processes (sec, cm) to the global ocean circulation (1000 years, 10000 km).
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Generic skills: team working at sea; report writing on fieldwork; time management; and problem solving. 2. Subject-specific skills: knowledge of ocean waves; practical skills in oceanographic data acquisition; presentation of raw data.

Programme/Syllabus	
Learning & Teaching	• Lectures: 18 • Practical sessions: 2 • Tutorials: 6 ; Personal work: 116 hr
Bibliography	• The lecture material is summarised at blackboard.soton.ac.uk. Instructions for accessing this material will be given during the course. • Recommended books: Pond, S. and G. L. Pickard: Introductory Dynamic Oceanography. Open University: Ocean Circulation - fewer equations, more illustrations; Stewart, R. H. Introduction to Physical Oceanography (available on Web, http://oceanworld.tamu.edu/home/course_book.htm) • Further Reading: Gill, A. E.: Atmosphere-Ocean Dynamics; Lacombe, H.: Cours D'Oceanographie Physique (for French readers)
Assessment	• Written examination (80%). To test the understanding of the theoretical part of the course, through essay-type questions and also numerical problems. Tests Learning Outcomes 1 & 2 • Boat work report (20%) Tests Learning Outcome 1 (and generic and subject key skills).
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Applied and Marine Geophysics
MER Code	MER SOES 6004
ECTS	7.5
Level	Optional
Semester	1 or 3
Timetable slot	To be advised
Teaching Staff	N. Harmon (Coord)
Synopsis	Topics central to applied geophysics in the marine environment: seismology; potential field methods; marine electromagnetic surveying; application of potential field theory to geophysical exploration; and controlled-source electromagnetic methods.
Aims	• To develop the principles of geophysical exploration, from a basic level to that of current practice in exploration industry, together with research applications.
Objectives At the end of the Unit, the student should:	1. explain the main techniques used in multi-channel seismic reflection data processing; 2. interpret and report on seismic reflection profiles; 3. describe limits to the resolution of seismic and potential field data and design a data acquisition and processing strategy for a given target; 4. explain aspects of how seismic reflection methods and electromagnetic methods are used to identify and optimise hydrocarbon; 5. understand the core theory and practice underlying electromagnetic exploration methods; and 6. process, analyze and interpret potential field and electromagnetic data, to infer subsurface structure
Key Skills Acquired At the end of the Unit, the student should be able to:	1. use computer programs to model gravity, magnetic and electromagnetic data; 2. report writing to summarise scientific findings; 3. interprete seismic reflection profiles; 4. use of ProMAX software, for the processing and analysis of seismic reflection data.

Programme/Syllabus	The module covers, at an advanced level, three topics that are central to applied geophysics in the marine environment. The first is reflection seismology; the second is potential field methods; and the third is marine electromagnetic surveying. • Seismology : basic seismic processing operations (including correlation, convolution, deconvolution, frequency filtering and migration). Applications of spectral analysis, using Fourier-based methods. Examples from hydrocarbon exploration and continental margin studies (seismic stratigraphy, methods of reservoir identification and 3D surveying). Practicals exercises: seismic processing and interpretation. • Application of potential field theory to geophysical studies with a particular emphasis on gravity and magnetic surveying. Advanced methods for anomaly separation and filtering, based upon spectral analysis and spatial derivatives. Computer modeling and analysis exercises. Marine and airborne surveying and data processing. • Controlled source electromagnetic methods, as applied in marine survey operations (theory and the fundamentals of data acquisition and processing). Computer-based practical exercises: modeling marine controlled source electromagnetic datasets, and examining the sensitivity of this type of data to resistivity anomalies in the sub-surface.
Learning & Teaching	(51 hr + 99 hr personal work) • Lectures • Laboratory classes
Bibliography	• Much of the lecture material is summarised at blackboard.soton.ac.uk. Instructions for accessing this material will be given during the course. • Core text: W. M. Telford, L. P. Geldart & R. E. Sheriff, Applied Geophysics, 2nd Edition (1990), Cambridge University Press • Background reading: P. Kearey, M. Brooks & I. Hill, An Introduction to Geophysical Exploration, 3rd Edition (2002), Blackwell; E. J. W. Jones, Marine Geophysics, 1999, Wiley
Assessment	• Theory examination (60%): The questions normally will require the integration of information from more than one part of the course. Tests Learning Outcomes 1,3,4,5 • Practical (20%): Seismic processing and interpretation exercises. Tests Learning Outcomes 1 & 2 • Practical (20%): Potential field or EM data exercises. Tests Learning Outcomes 5 and 6.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Biogeochemical Cycles in the Earth System
MER Code	MER SOES 6007
ECTS	7.5
Level	Optional
Semester	1 or 3
Timetable slot	To be advised
Teaching Staff	T Tyrrell (Coord.)
Synopsis	This module examines at the operation of the Ocean as a biogeochemical entity within the larger Earth System. There is a strong focus on how the Earth System will respond to anthropogenic impacts and global change.
Aims	• To provide at an advanced level, an overview of the Earth System; in particular biogeochemical processes, feedbacks and fluxes. • To examine how this knowledge contributes to understanding the global cycles of important elements, including carbon. • To cover examples from the modern ocean and the geological record, considering timescales from seconds to millions of years.
Objectives At the end of the Unit, the student should:	1. Have the ability to critically read the primary literature, understand the techniques used, their assumptions and limitations; 2. Be able to assimilate and to synthesise and discuss Earth System processes and biogeochemical cycles; 3. Be able to understand how they may be regulated via negative feedbacks; 4. Be able to devise, construct and solve geochemical mass balances; 5. Be able to estimate residence times; 6. Be able to solve quantitative problems; 7. Be able to understand anthropogenic effects on ocean carbonate chemistry
Key Skills Acquired At the end of the Unit, the student should be able to:	1. address numeracy and Problem Solving; 2. acquire literature access skills and critical reading; and 3. obtain laboratory analysis of dissolved gases and data interpretation.

Programme/Syllabus	This module examines in greater depth the sources, sinks and cycles of chemical constituents in the Earth System, particularly the Ocean, with particular reference to: processes at the ocean boundaries; the role of particle fluxes and scavenging in removing and redistributing material; and the interactions of biological, geological, chemical and physical oceanographic phenomena (geochemical cycles of trace elements and major biogeochemical elements; major nutrient cycles and their homeostatic regulation). Particular focus is placed upon the ocean carbon cycle and ocean acidification. Processes at the ocean boundaries: coupling of the ocean and atmosphere as geochemical systems, fluxes of aerosols and gases; and the chemistry of hydrothermal systems. Practical sessions include computer modeling of nutrient and carbon cycles in the ocean , together with manipulation of spreadsheets to determine impact of fluxes on the ocean. On-line quizzes are used to permit consolidation of acquired skills
Learning & Teaching	(40 hr + 110 hr personal work) • Lectures and Laboratory classes • Reading assignments and Tutorial support A wide range of support can be provided for those students who have further or specific learning and teaching needs.
Bibliography	• The lecture material is summarised at blackboard.soton.ac.uk. Instructions for accessing this material will be given during the course.
Assessment	• Theory Examination (70%) Tests Learning Outcomes 1-7 • Computing Assignment (30%) Tests Learning Outcomes 2-7
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Coastal Sediment Dynamics
MER Code	MER SOES 3014
ECTS	7.5
Level	Optional
Semester	1 or 3
Timetable slot	To be advised
Teaching Staff	J. Dix (Coord.)
Synopsis	Principles of coastal sediment dynamics, in a quantitative manner. Flow properties, benthic boundary layer and resulting sediment responses, under waves and steady currents. Sediment transport algorithms and the resulting evolution of the bed.
Aims	• To define the basic concepts of sediment movement within coastal and inner continental shelf waters, and the processes that control this movement. • To define the methods, techniques and equipment used in the study and measurement of sediment transport within a coastal setting.
Objectives At the end of the Unit, the student should:	1. Define and describe flow structures under unidirectional and wave tidal induced currents, alone and in combination. 2. Have an understanding of the prediction of sediment transport rates and directions. 3. Have a broad knowledge of the terminology and expressions used in coastal sediment dynamics and, in some cases, their derivation. 4. Distinguish between non-cohesive and cohesive sediment dynamics and what technologies and theories would be appropriate to use to evaluate issues, in each case.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Problem Analysis and numerical computation 2. Written Communication 3. Ability to learn 4. Critical Analysis

Programme/Syllabus	• Fundamental principles of coastal sediment dynamics in a quantitative manner. • Flow properties, the benthic boundary layer, and resulting sediment responses under waves and steady tidal currents are summarised. • Sediment transport algorithms are described, and the resulting evolution of the bed defined.
Learning & Teaching	(26 hr + 124 hr personal work) • Lectures • Tests: Four, 1-hour tests will be given at regular intervals through the course. The results will be evaluated in class and feedback given rapidly for misconceptions and deficiencies in learning
Bibliography	• Blackboard: Much of the lecture material is summarized at blackboard.soton.ac.uk. Instructions for accessing this material will be given during the course.
Assessment	• Written Examination (50%) Tests Learning Outcomes 1-2. • In-class Tests (50%) Tests Learning Outcomes 3- 4.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	**Computational Data Analysis** for Geophysicists and Ocean Scientists
MER Code	MER SOES6025
ECTS	7.5
Level	Optional
Semester	1 or 3
Timetable slot	To be advised
Teaching Staff	T. Tyrrell (Coord.)
Synopsis	This module will present a variety of different types of geophysical, oceanographic and remote sensing data and will explore methods for processing, analysing and modelling using MATLAB
Aims	• To provide students with a basic understanding of the mathematical methods used in the processing, analysis and modelling of a diverse range of geophysical and oceanographic data. • To provide the skills required to implement analysis methods in your own computer programs, including statistical analysis, spectral analysis and filtering.
Objectives At the end of the Unit, the student should:	1. Programming skills; 2. Report writing. 3. Data manipulation including the identification of noise and filtering
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Analyse data using a variety of statistical and processing techniques, with an understanding of the relative merits of each technique, when and where to apply them, and any potential pitfalls in their use. 2. Implement mathematical algorithms in MATLAB programs. 3. Produce a quantifiable interpretation of data and present it in an informative manner.

Programme/Syllabus	The module will introduce statistical analysis, curve fitting and the interpolation of data. The analysis of data in the frequency domain using the Fourier Transform will be covered with applications to filtering in 1-D and 2-D. The fundamentals of computer programming will be taught in practical sessions using MATLAB and will involve implementing the techniques covered in the lectures. The course will include optimal methods for the display of data. Practical sessions: will exemplify the theory. Practical sessions will be computer-based exercises used to illustrate the concepts covered in the formal lectures. Computer practical sessions will use the software package MATLAB.
Learning & Teaching	• Lectures: 22 • Practical sessions: 2 • Personal work: 46 hr (A wide range of support can be provided for those students who have further or specific learning and teaching needs.)
Bibliography	Blackboard: The lecture material is summarized at blackboard.soton.ac.uk. Instructions for accessing this material will be given during the course. Illustrated handout materials will complement most lectures. Where relevant, lecturers' own research experience in the appropriate fields is brought into the lecturing sessions. References to the applicable chapter of course text and/or relevant journal articles are provided to complement some of the lectures.
Assessment	• Computing exercises 1&2 (2 x 30%): Write simple MATLAB programs to analyse and plot oceanographic and geophysical datasets. Tests Learning Outcomes (TLOs): 1, 2 and 3. • Mini project (40%): Write a substantial MATLAB program, or a number of smaller programs, to process and analyse one or more datasets. Interpret the results and present these in a written report including the analysis methods applied. TLOs: 1, 2, and 3.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Contemporary Topics in Ocean and Earth Sciences
MER Code	MER SOES 6001
ECTS	7.5
Level	Optional
Semester	1 or 3
Timetable slot	To be advised
Teaching Staff	C. Hauton/ A. Naveria Garabato (Coords.)
Synopsis	An opportunity to be guided into the key literature on a variety of important contemporary topics at the forefront of Earth Science, Oceanography, Marine Biology, Marine Science Policy and Law and Marine Environmental and Resource Management.
Aims	• To provide an opportunity for you to be guided into the key literature on a variety of important contemporary topics at the forefront of Earth Science, Oceanography, Marine Biology, Marine Science Policy and Law and Marine Environmental and Resource Management.
Objectives At the end of the Unit, the student should:	1. synthesise a body of knowledge on a given subject 2. critically assess the scientific literature on a wide range of topics 3. make public oral presentations on the findings of current research 4. write critical syntheses of knowledge for a given subject in a scientifically-cogent style
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Write scientific texts 2. Present scientific results 3. Understand scientific research

Programme/Syllabus	• The student will select three key topics from a list of options in his/her specialist area. • The student will be required to write a critical review and make a short oral presentation on each of your selected topics at weekly or fortnightly seminars. • Much of the learning will be through independent reading. The breadth of subject coverage is intended to broaden and deepen the student's knowledge of topical issues in his/her specialist area, as well as to develop scientific writing and presentation skills.
Learning & Teaching	• Seminars will be led by a variety of staff members with expertise in a range of important contemporary topics. • Reading will be guided by staff members, but much of the learning will be through independent reading and study by students, who will also give oral presentations at seminar-style classes. • The programme will consist of 12 two-hour seminars. • Supplementary material: Geophysics Seminar, NOCS Seminar programmes and WUN Seminars.
Bibliography	• Blackboard: the lecture material is summarized at blackboard.soton.ac.uk. Instructions for accessing this material will be given during the course.
Assessment	• Written reports (70%): Two reports on a topic which you will be expected to review, identify key scientific issues at stake and summarise arguments on both sides. You will be expected to form your own opinion on the matter. Each report should not be more than 5000 words. Tests Learning Outcomes 1,2,4 • Oral presentations (30%): Two x 10 minute presentations at seminar style gatherings, on a key-note topic. Tests Learning Outcomes 1,2,3
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Deep Sea Ecology
MER Code	MER SOES 6008
ECTS	7.5
Level	Optional
Semester	1 or 3
Timetable slot	To be advised
Teaching Staff	J. Copley (Coord.)
Synopsis	The course explores all aspects of the physical environment of the deep sea, including vents, considering the fauna of the deep sea within this framework.
Aims	• To give a detailed knowledge of the oceanography of the deep sea, the largest single ecosystem on Earth. • To introduce students to a variety of aspects of the physical and chemical environment. • To examine the distributions of fauna in different types of deep sea environments.
Objectives At the end of the Unit, the student should:	1. Determine those factors that are of physico-chemical significance in the deep sea; 2. Understand how these factors affect process in the animal communities; 3. Recognise a variety of ecological variables and their consequences in the deep sea including species diversity, biomass and zonation; and 4. Appreciate the latest research in deep-sea oceanography.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. get aacquinted with nowledge of the largest environment on Earth.

Programme/Syllabus	The deep-sea occupies at least 50% of the surface of the globe. The original concept was that the deep sea was a tranquil environment, with little variation in its dominant physico-chemical and biological variables. In the last 20 years this paradigm has been challenged and we now know that the deep sea can be a highly dynamic environment, in which there are benthic storms and seasonal processes. There is also high species diversity. The original concept was that the system was heterotrophic but, with the discovery of hydrothermal vents and cold seeps, we have environments in which the basis of life is chemical energy, rather than sunlight.
Learning & Teaching	(26 hr + 124 hr personal work) 1. Lectures 2. Seminar series: a series of seminars will be delivered by guest speakers covering topics at the forefront of deep sea ecology. 3. Tutorial support
Bibliography	• Blackboard: the lecture material is summarized at blackboard.soton.ac.uk. Instructions for accessing this material will be given during the course.
Assessment	• Written Examination (75%) . Tests Learning Outcomes 1-4 • Coursework (25%) An analysis of a video of the East Pacific hydrothermal vents. Tests Learning Outcomes 2 and 3.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Geodynamics and Solid Earth Geophysics
MER Code	MER SOES6037
ECTS	7.5
Level	Optional
Semester	1 or 3
Timetable slot	To be advised
Teaching Staff	N Harmon (Coord)

Synopsis

Topics include seismology, heat flow, geomagnetism and paleomagnetism, with a particular focus on the geometry, kinematics and dynamics of plate motion. Simple models of lithosphere rheology are developed and applied to case studies.

Aims

Objectives

At the end of the Unit, the student should:

.1. Understand the quantitative aspects of plate tectonics.
2. Understand the geomagnetic field and the principles of palaeomagnetism as they apply to plate tectonics.
3. Achieve practical experience of the application of elastic plate bending theory and heat conduction equations.
4. Be aware of the research methods in use in various aspects of solid Earth geophysics.
5. Describe the limitations and simplifications of plate tectonic theory.
6. Demonstrate an advanced understanding of the concept of the lithosphere.
7. Appreciate the principles of terrestrial heat flow.
8. Understand and know how to apply elastic plate bending theory.
9. Comprehend the characteristics of active plate boundaries.
10. Understand the importance of seismology in determining the interior structure of the Earth.
11. Understand the constraints on features around the core-mantle boundary

Key Skills Acquired

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

1. To determine earthquake parameters from teleseismic data.
2. To interpret first motion from seismograms and determine focal mechanisms.
3. To interpret palaeomagnetic data in terms of large-scale plate motions.

Programme/Syllabus	Formal lectures: will provide the underlying theory to kinematics, dynamics, seismology, crustal seismics and heatflow. An outline of each lecture is provided prior to start of a lecture or on website/in manual. Each lecture systematically covers the main concepts and topics. Where relevant, lecturers' own research experience in the appropriate fields is brought into the lecturing sessions. References to the applicable chapter of course text and/or other relevant journal articles are provided as essential reading for each lecture. Practical classes: will exemplify the theory and develop your practical skills in the analysis of plate kinematic and geodynamic data.
Learning & Teaching	Teaching (55 hr + 95 hr personal work) • Lectures • Practical sessions • Tutorial support A wide range of support can be provided for those students who have further or specific learning and teaching needs.
Bibliography	• Blackboard: the lecture material is summarized at blackboard.soton.ac.uk. Instructions for accessing this material will be given during the course.
Assessment	• Summative Assessment (100%) .
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Introductory Remote Sensing of the Oceans
MER Code	MER SOES 6017
ECTS	7.5
Level	Optional
Semester	1 or 3
Timetable slot	To be advised
Teaching Staff	S. Henson (Coord.)
Synopsis	Introduction at Masters level to the ways in which remote sensing from satellites is used in oceanography.
Aims	• To provide an overview of how the ocean can be observed and measured remotely using sensors on Earth orbiting satellites. • To provide an understanding of the role of remotely-sensed data in the study of the oceans
Objectives At the end of the Unit, the student should:	1. Acquire a new Perspective: grasp what is special about the view of the ocean provided from satellites, to enhance your knowledge of the ocean; 2. Methodology: understand the main methods of ocean remote sensing and the ocean properties that can be measured; 3. Importance in Ocean Science: discover some of the specific ways in which satellite ocean data make unique contributions to ocean science; 4. Wider Applications: find out how satellite ocean data are being applied for the benefit of human activity in the ocean; and 5. Acquire image handling skills: learn how to acquire, enhance, present and apply satellite image data in scientific and educational contexts.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Communication: scientific writing. 2. Information technology: image processing; manipulation and evaluation of satellite datasets acquired from the Internet. 3. Working in teams.

Programme/Syllabus	Topics to be covered include: • Basic principles: Introductory lectures on remote sensing methods, coupled with a practical introduction to image processing self paced on-line introductory tutorials. • Sea surface temperature: Method of infra-red and passive microwave remote sensing, detection of clouds and removal of atmospheric contamination, studies of ocean eddies and fronts, monitoring of global temperature patterns. • Ocean colour: Measuring chlorophyll and suspended sediment concentration from water colour as detected from aircraft and satellites. • Imaging Radar: How satellite synthetic aperture radars "see" the ocean and ocean information in radar images. Methods include, altimeters plus: Ocean topography winds and waves measured globally from satellites. • Earth observation systems: Global programmes, synergy between different types of data. • Lecture material is reinforced by computer practicals using remote sensing data.
Learning & Teaching	(47 hr: 103 hr personal work) • Lectures • Practicals: interactive computer-based practical work with image data, contained in a modular programme. (A wide range of support can be provided for those students who have further or specific learning and teaching needs)
Bibliography	• Blackboard: The lecture material is summarized at blackboard.soton.ac.uk. Instructions for accessing this material will be given during the course.
Assessment	• Group Presentation (10%) . Tests Learning Outcomes 1-5 • In class test (30%) Tests Learning Outcomes 1, 2, 3, 4 • Practial assignment (60%). Tests Learning Outcomes 1-5
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Large-scale Ocean Processes
MER Code	MER SOES 6005
ECTS	7.5
Level	Optional
Semester	1 or 3
Timetable slot	To be advised
Teaching Staff	B. Marsh (Coord.)
Synopsis	Introduction to the physical processes, both deep ocean and ocean margins. Processes which give rise to ocean circulation. Global processes (tides, wind, buoyancy forcing) and their influence on deep ocean and ocean margins.
Aims	• To provide an introduction to the dynamics of the deep ocean and ocean margins. • To explore and quantify the processes which give rise to ocean circulation. • To explore and quantify the links between ocean circulation and climate.
Objectives At the end of the Unit, the student should:	1. understand the dynamical approach to physical oceanography. 2. understand the mathematical formalism of dynamical ocean models. 3. interpret the mathematical results from dynamical ocean models. 4. quantify these results for the ocean circulation. 5. have an appreciation of the physical interactions between the deep ocean, the atmosphere and the shelf seas and their relation to global processes.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Develop numerical and mathematical skills. 2. Have a working knowledge of mathematical models and techniques. 3. Application of mathematical methods to ocean circulation. 4. Use of MATLAB, to analyse and interpret ocean data.

Programme/Syllabus	• The module will explore the processes which give rise to ocean circulation and how recent observations (e.g. World Ocean Circulation Experiment) are providing new insights into how the system works. • The module will include global processes (tides, wind, buoyancy forcing) and how these processes have markedly different influences on the deep ocean and on ocean margins. For example, the deep ocean is governed mainly by geostrophic flow, whilst the shelf seas are influenced strongly by frictional processes. • The global ocean circulation: its causes, its measurement and its role in the climate system will be explored.
Learning & Teaching	Teaching (41 hr + 109 hr personal work) • Lectures • MATLAB sessions • Practical sessions • Tutorial support
Bibliography	• Blackboard: The lecture material is summarized at blackboard.soton.ac.uk. Instructions for accessing this material will be given during the course.
Assessment	• Written examination (60%)Tests Learning Outcomes 1-5 • Course work (20%) Two computer based assessments: one Hydrographic practical • Data analysis practical (20%) Tests Learning Outcomes 1-5
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Marine Conservation and Policy
MER Code	MER SOES 6076
ECTS	7.5
Level	Optional
Semester	1 or 3
Timetable slot	To be advised
Teaching Staff	J. Godbold (Coord)
Synopsis	This module will cover a range of issues surrounding marine conservation and policy, split into three sections We will initially focus on the causes and consequences of the current biodiversity concerns, and concentrate on the socio-economic aspects and monitoring of marine exploitation, tracking of animal products and illegal trade.
Aims	
Objectives At the end of the Unit, the student should:	1. Summarise the main issues affecting global biodiversity and its socio-economic value. 2. Explain the main techniques and their effectiveness involved in biodiversity monitoring and tracking. 3. Describe contemporary UK and international conservation issues and have an understanding of the development of both conservation policy and biodiversity policies. 4. Understand and discuss potential conflicts of interest in management approaches between people, species and habitats.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. To describe and apply population models for projections of biodiversity futures to improve conservation outcomes. 2. To develop, write and present a policy brief to inform non-specialists on research that may be important for the development of UK marine conservation strategies and policies.

Programme/Syllabus	Introduction and analysis of the central aspects of marine biodiversity conservation, the importance of population models for predicting and improving conservation outcomes and will investigate and discuss the main techniques and their effectiveness involved in biodiversity monitoring and tracking, including issues surrounding illegal wildlife trade, harvesting and invasive species. Understanding of the scientific processes which underpinning conservation and management, focussing in particular on marine biodiversity, threats to biodiversity and how it can be preserved. Threats for marine biodiversity: habitat loss and fragmentation, climate change, invasive species, over-exploitation, and pollution. Socio-economic trade-offs and potential conflicts between conservation, habitat use and exploitation of marine resources. Socio-economic facets of marine exploitation, including national and international legislative frameworks associated with marine exploitation, management and conservation. Case Studies: Research led examples, presentations from guest speakers e.g. local conservation trusts and the Southern IFCA will provide a wide breadth of perspectives, allowing discussion and debate on issues surrounding conservation, human use of habitats and exploitation of marine resources. Practical sessions: 1) Communicating science to decision makers and managers I: developing a policy brief. 2) Projecting population futures: use of population models for predicting conservation outcomes. 3) Communicating science to decision makers and managers II: presentation of policy brief, implications for conservation and management. Fieldtrips: 1) Studland: MPA under development - management and policy issues. 2) Poole Harbour: fisheries management and conservation designations
Learning & Teaching	Lectures 22 Fieldwork 12 Practical classes and workshops 6 Independent Study 110
Bibliography	• Blackboard: The lecture material is summarised at blackboard.soton.ac.uk. Instructions for accessing this material will be given during the course.
Assessment	• Policy brief (100%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Marine GeoArchaeology
MER Code	MER SOES 6061
ECTS	7.5
Level	Optional
Semester	1 or 3
Timetable slot	To be advised
Teaching Staff	J Dix (Coord.)
Synopsis	The module covers aspects of the marine environment, formation processes and marine geophysical prospection techniques. It includes a short (three day maximum) field programme is to provide the acquisition from inter-tidal and/or marine locations.
Aims	• To provide an understanding of what approaches are used by academia and the commercial sector to investigate the geoarchaeological record. • To provide the students with the skills set to be able to undertake a full geoarchaeological assessment of a marine or coastal site (from desk based analysis to field based data – acquisition, processing and interpretation. • To provide an understanding of how marine and coastal environments impact and/or enhance the archaeological record.
Objectives At the end of the Unit, the student should:	1. Plan and execute a geoarchaeological assessment of coastal or full marine archaeological site; 2. Be able to acquire, analyse and evaluate a wide range of archaeological, geological and oceanographic data including (heritage records; in situ and remotely (Lidar) acquired topographic data; bathymetric and some sub-surface seismic data; hydrodynamic data; hand auger sediment and faunal samples; 3. Place local site studies in both regional and global contexts; 4. Have a full appreciation of the key issues in marine geoarchaeology in terms of both submerged landscape studies and archaeologically specific site dynamics; 5. Have confidence in orally presenting in extended format integrated archaeological and earth science material; and 6. Write a full geoarchaeological report of a field site to English Heritage standards.
Key Skills Acquired At the end of the Unit, the student should be able to:	• Carry out team working; report writing; oral presentations; time management (generic skills) • get acquitance of the knowldge of all of the key topics covered (subject-specific skills).

Programme/Syllabus	
Learning & Teaching	(47 hr: 103 hr personal work) • Lectures • Practicals: 6 x 3 h (4 on GIS, one on particle size analysis and one on core data interpretation using Rockworks. • Field sessions: 3 sessions in the field or on boat. Support: is provided by staff and/or postgraduate demonstrators where appropriate. Including one surgery session where questions to facilitate the field report can be answered.
Bibliography	• Blackboard: The lecture material is summarised at blackboard.soton.ac.uk. Instructions for accessing this material will be given during the course.
Assessment	• Presentations (25%) A 20 minute oral presentation, assessed by academic staff. Tests All Learning Outcomes • 5000 Word Geoarchaeological Field Report (75%) Tests All Learning Outcomes.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Microfossils, Environment and Time
MER Code	MER SOES 6022
ECTS	7.5
Level	Optional
Semester	1 or 3
Timetable slot	To be advised
Teaching Staff	S. Bohaty (Coord.)
Synopsis	General introduction to the various groups of microfossils. Alongside their morphology and taxonomy, you will learn how certain groups can be used for the solution of geological problems, or for hydrocarbon exploration.
Aims	• To give a general introduction to the various groups of microfossils, detailing their morphology, taxonomy, biology, and ecology. • To show how certain microfossil groups can be used in an applied manner for the solution of geological problems (such as biostratigraphy, palaeoecology, palaeoceanographic interpretation, proxies for climatic change, etc.). • To detail some of the industrial applications of microfossils, particularly those related to hydrocarbon exploration. • To provide a basic introduction to microfossil extraction/preparation methods. • To demonstrate the utility of various microfossil groups in hydrocarbon exploration (source rock analyses, thermal maturity studies, etc.). • To undertake an investigative exercise based on a hydrocarbon exploration borehole core.
Objectives At the end of the Unit, the student should:	1. assign a microfossil to its major taxonomic group (e.g. foram, ostracod, dinoflagellate, spore, pollen, etc.). 2. be aware of, and to recognise, the main morphological and compositional features which allow assignation of an individual fossil to each group. 3. draw basic stratigraphic conclusions about microfossil assemblages (e.g. age of rock unit, correlations, etc.). 4. deduce palaeoecological and/or palaeoceanographic interpretations from different assemblages of microfossils. 5. understand the applicability of particular microfossil groups to particular lithologies and particular geological time periods. 6. determine which microfossil groups are most applicable to the solution of a variety of particular geological problems.
Key Skills Acquired At the end of the Unit, the student should be able to:	• Utilise stereo binocular, transmitted and reflected light microscopes; use of scanning electron microscope; and report writing (generic skills). • acquire practical experience of microfossil identification to species level; compilation, utilisation and interpretation of biostratigraphic and palaeoenvironmental information; an appreciation of how to prepare and mount micropalaeontological samples for observation, and the safety precautions necessary to observe during such preparations; to have developed a background knowledge of micropalaeontological literature sources (subject-specific skills).

Programme/Syllabus

• Introduction to the various microfossils groups and detail their utility as important indicators of past environments, by examining the ecology of living microplankton taxa and extrapolating this to the fossil record (palaeoecology, palaeoceanography).
• Applicability of different microfossil groups in providing both relative time-scales (through zonal schemes) and biostratigraphic correlation will be detailed, as will the role of certain microfossils in understanding evolutionary processes (particularly in groups such as land plants).
• Microplankton as agents of global environmental change will also be investigated, especially with regard to fluxes of $CaCO_3$ and C and, hence, to CO_2 in the atmosphere.
• Microfossil groups which form mineralised skeletons (calcareous, siliceous, phosphatic) and the organic-walled microfossils (known as palynomorphs).

• Web based assessments: 2 web-based assessments will be run at specified times in NOCS Computer Cluster (dates in the timetable). These will be based on the Geodata Unit's WebQuiz programme, and guidance in answering the form of the questions will be provided. Tests learning outcomes 1-6
• Practical exercises & demonstrations: A series of practical exercises and demonstrations of material will be set during the course. Tests learning outcomes 1-6. Attendance at practical classes is expected, as some of these may form the basis of questions in the web assessments, the written exam and the practical exam.
• A guided tour of the micropalaeontological laboratory facilities will be conducted, in addition to the opportunity to have hands-on experience of using the Scanning Electron Microscope for observation of microfossils. Tests learning outcomes 1-2

Learning & Teaching

(35 hr + 115 hr personal work)
• Lectures, • Tutorial support and Seminar Guest Lectures

Bibliography

• Blackboard: The lecture material is summarized at blackboard.soton.ac.uk. Instructions for accessing this material will be given during the course.

Assessment

• Theory Examination (40%) Tests Learning Outcomes 3-6
• Practical Examination (60%) Two in class practical examinations. Tests learning outcomes 1-6.

Course Evaluation

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

Course/Unit	Zooplankton Ecology and Processes
MER Code	MER SOES 6009
ECTS	7.5
Level	Optional
Semester	1 or 3
Timetable slot	To be advised
Teaching Staff	C. Lucas (Coord.)
Synopsis	The module will assess the role of zooplankton in the global marine ecosystem.
Aims	• To establish the role of zooplankton in the pelagic and global marine community and to introduce holo- and meroplankton biodiversity. • To introduce the biological and non-biological factors which regulate community structure from the meso- to microscale. • To review the technologies available to sample the community in the field and to introduce procedures of laboratory analysis of abundance and biomass. • To establish the impact of zooplankton in the 'economy' of pelagic trophic web; introducing the impact of zooplankton grazing, zooplankton as predators, 'alternative' food resources; to review the methods available the assess feeding; zooplankton metabolic responses. • To review zooplankton reproduction and life cycle strategies and the methods available to estimate zooplankton production; to review zooplankton 'models'. • To introduce the responses of zooplankton to water mass movements; tidal advection and behavioural/physiological methods to avoid displacement; meroplankton settlement behaviour; diurnal vertical migration and its impact on the individual and the community. • To review the use of zooplankton as indicators of water mass movement; global climate change and pollution. • To assess the commercial importance of zooplankton.
Objectives At the end of the Unit, the student should:	1. appreciate the role of zooplankton in marine ecosystems and recognise the diversity of mero- and holplankton, and be able to identify the common species of temperate water zooplankton; 2. appreciate the factors that regulate the distribution patterns of zooplankton and be able the assess the methodologies available to design an effective field sampling programme; 3. understand the role of zooplankton in the pelagic trophic web and be able to appreciate the constraints in measuring zooplankton feeding in the laboratory and the field and structuring the energetic budget of individual zooplankters; 4. appreciate the methods available to estimate zooplankton secondary production, and the nature of the raw data required for the calculations; 5. appreciate the behavioural and physiological response employed by zooplankton to counter tidal advection/population dispersal and to undertake 24hr diurnal vertical migration; 6. assess the role of zooplankton as indicators of a range of environmental change; 7. design and conduct experiments on live zooplankton; 8. use a range of library information services, to aid production of well structured written reports.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Generic: Small groups ~ boatwork and laboratory practical programme. Individual assessment of data quality, presentation of written reports, library information retrieval and critical analysis of literature. 2. Subject-based: Boatwork and practical laboratory skills in zooplankton taxonomy and experimentation. Interrogation, analysis and presentation of raw data. Knowledge of zooplankton subject area.

Programme/Syllabus	Biological and non-biological forcing-factors structuring biodiversity, community and population patterns from the meso- to the microscale. Methods of conducting and analysing field sampling programmes. The position of zooplankton in the 'economy' of the pelagic ecosystem: (a) feeding and reproductive strategies of a range of zooplankton types; (b) make-up of zooplankton energy budgets; and (c) methods for the estimation and modelling of zooplankton secondary production. Responses of individual zooplankters to their environment (factors regulating tidal advection, larval settlement and the implications of diurnal vertical migration). The zooplankton as biological indicators of water mass movement, global climate change and pollution. The potential of zooplankton as a commercial resource. Practical classes: the diversity of mero- and holoplankton forms and formal taxonomic identification of temperate water species. Measure and analyze the impact of zooplankton grazing pressure, in relation to the quantity, quality and species composition of available diet.
Learning & Teaching	(28 hr + 122 hr personal work) • Lectures: 22 • Student reportk • Practical sessions • Boatwork • Revision support
Bibliography	• Blackboard: The lecture material is summarized at blackboard.soton.ac.uk. Instructions for accessing this material will be given during the course.
Assessment	• Theory Examination (75%) A 2½ hour written examination paper, choice of three questions from six to be answered. Tests learning outcomes 1-6 & 8 • Two online tests (25%) Tests learning outcomes 1, 3, 7 & 8.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

LINK TO EHU MER WEBSITE

Universidad del País Vasco Euskal Herriko Unibertsitatea

SEMESTERS 2

COURSE	ECTS	TYPE
Research in Marine Environment and Resources	6	C
Advanced Instrumental Analysis	4	OPT
Cellular and Molecular Biomarkers	4	OPT
Comparative Endocrinology and Endocrine Disruption	4	OPT
Degradation and Rehabilitation of Estuarine Ecosystems	4	OPT
Ecological Quality Assessment in Coastal Ecosystems	4	OPT
Ecosystem-based Fisheries Management	4	OPT
Environment and Fisheries/Aquaculture Interactions	4	OPT
Environmental Analytical Chemistry	4	OPT
Environmental Chemometrics - Formerly Environmental Data Analysis	4	OPT
Environmental (Toxico)Genomics	4	OPT
Environmental Monitoring and Risk Assessment in Aquatic Systems	4	OPT
Eutrophication and Harmful Algae	4	OPT
Histology and Histopathology of Aquatic Animals	4	OPT
Instrumentation and Measurements in Operational Oceanography	4	OPT
Marine Enterpreneurship	4	OPT
Marine Microbial Ecology	4	OPT
Marine Resources Genomics	4	OPT
Multicultural integration in EU	4	OPT
Ocean Global Change Biology	4	OPT
Physiological Energetics of Marine Organisms	4	OPT
Satellite Oceanography and Meteorology	4	OPT
Socio-Economic Aspects of Climate Change	4	OPT

SEMESTERS 4

	ECTS	TYPE
Master Thesis	30	C

C: Compulsory

OPT: Optional at EHU in Semester 2

Course/Unit	Research in Marine Environment and Resources
MER Code	MER EHU 501315
ECTS	6
Level	Compulsory
Semester	2
Timetable slot	To be advised
Teaching Staff	I Marigómez, Jon Saenz & A Uriarte (AZTI) (Coord.); guest lecturers
Synopsis	Annually, a general workshop is held in the facilities of the Aquarium in San Sebastian (OFG) for 1 week and at the PiE-UPV/EHU for a second week at the PiE-UPV/EHU. Teaching staff from all the institutions in the MER Consortium and world-wide renowned marine scientists participate as guest lecturers.
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, the student should:	1. understand the current topics in marine environment and resources research; 2. identify the most active research groups in marine research; and 3. know the main problems that concern applied marine research
Key Skills Acquired At the end of the Unit, the student 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 RiMER

Programme/Syllabus	1. Lectures on developments and hot spots in RiMER; 2. Round Table: developments in research in marine environment and resources 3. Lectures on coastal management 4. Round Table: sustainable coastal management 5. Lectures on marine ecosystem health 6. Round Table: threats to marine ecosystem health 7. Round Table: prospects in marine ecosystem health 8. Lectures on global climate crisis 9. Round Table: fossil records of climate change 10. Round Table: challenges of global climate change to marine life and biological resources 11. Lectures on marine resources and fisheries 12. Round Table: future of fisheries in European regions 13. Lectures on challenges for biodiversity conservation 14. Round Table: challenges for biodiversity conservation 15. Practical workshop: an approach to modelling in system biology 16. Round Table: towards regional strategies for marine science 17. Open workshop (cinema): marine environment and resources revisited
Learning & Teaching	• Lectures: 44 hr • Workshops: 16 hr • Personal work: 90 hr (In situ teaching activities might be replaced -at least partially- by remote teaching in case of need for sanitary or other reasons)
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. • Written reports (4): (1) list of 2 questions per lecture; (2) one 5-page or miniclip journalistic summary of the RiMER Course; (3) one 5-page summary or miniclip of the student's choice Round Table; and one report (10-page or MOOC or simlar) on one topic selected among the ones treated during the course (100%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Master Thesis
MER Code	MER EHU 501000
ECTS	30
Level	Compulsory
Semester	4
Timetable slot	To be advised
Teaching Staff	M Soto & I Marigómez (Coord.); J Schafer, J Etorneau, C D'Angelo, S Gobert, K Das, PV Garcia, A Rodrigues
Synopsis	5-6 month research on marine environment and resources within the framework of a research group active, under the supervision of a PhD holder
Aims	• To provide an introduction to research in ocean sciences ocean.
Objectives At the end of the Unit, the student should:	1. 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, the student should be able to:	1. be integrated in the research group where the MTP has been carried out. 2. demonstrate basic skilfulness achieved regarding the methods employed in the MTP 3. design and plan and carry out a research work, under the consideration that the MTP must be undertaken during a period of 6 months 4. show quality in written scientific reporting 5. show quality in oral presentation and ability to discuss and defend each postulates concerning the MTP.

Programme/Syllabus	1. 5-6 month research under the supervision of a PhD holder. • A list of available MSc Research projects is available every year • The MER JPB may accept a proposal made individually by a student, provided the proposed supervisor and host institution accept the academic requirements of the MER programme. • MER MSc students can follow their MSc research programme in any Partner institution or in Associated Partners or other collaborating institutions, which will host a student. The MER Secretariat provides administrative support to formalize agreements with host institutions. ---------- 1) A complete pdf file (including signatures) of the written MSc Thesis report must be sent by email to MER Secretariat before the deadline. Likewise, the original must be sent by mail (with postmark date before deadline). Besides, in order to incorporate the abstracts into the MER MSc web page, a CD with a PDF file including the cover and back pages, the tutor certificate form and two summaries (see below) is also required. 2) Written reports can be in English, French, Portuguese, Spanish or Basque 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. 4) The public dissertation and the discussion will be held in the Plentzia Marine station (PIE-UPV/EHU) in September.Dissertation will consist of a 20 min oral presentation + discussion session for an additional 15 min. Oral presentation in English.a simultaneous translation service will not be available.
Learning & Teaching	WRITTEN REPORT: 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 MER Secretariat.
Bibliography	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.
Assessment	• 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. 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.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Advanced Instrumental Analysis
MER Code	MER EHU 501323
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	O Zuloaga (Coord.) G Arana
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, the student 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 the Unit, the student should be able to:	1. undersatnd the key points of an instrumental trace analysis method 2. be skill in good analytical practices

Programme/Syllabus	• 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 • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
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%) • Case studies and exercises in seminars (60 %)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Cellular and Molecular Biomarkers
MER Code	MER EHU 501316
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	MP Cajaraville, A Orbea (Coord.)
Synopsis	Specialization in environmental toxicology with focus on cell/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, the student should:	1. Understand the mechanisms of cation 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. 2. 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. 3. 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. 4. Understand the importance of pollutant effects on cell signalling and homeostasis of the endocrine system, with emphasis in ecologically-relevant effects on reproduction. 5. 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. 6. 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.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. understand the effects that metal and organic pollutants as well as other environmental stressors cause at cell and molecular levels. 2. understand the advantages and limitations of the biomarker-based approach to assess ecosystem health status.

Programme/Syllabus

1.- Introduction to cellular and molecular biomarkers of pollution: examples and applications in monitoring programmes.
2.- Techniques to measure cell and molecular biomarkers.
3.- Biomarkers and bioassays for endocrine disrupting environmental pollutants.
4.- Toxicity of metallic pollutants in relation with cellular accumulation and storage processes.
5.- In vitro alternative methods in biomarker development.
6.- Generation of oxyradicals and oxidative stress in marine organisms.
7.- Mechanisms of pollutant-induced peroxisome proliferation and rationale for use as 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.

LAB PRACTICALS:
1.- Measurement of catalase activity.
2.- Lysosomal biomarkers.
3.- Genotoxicity assessment.
4.- Microscopical observation on cytochemical biomarkers.

SEMINARS:
1.- Application of biomarkers to case studies.

Learning & Teaching

- Lectures: 23,5 hr
- Seminars: 4,5 hr
- Lab practicals: 12 hr
- Personal work: 60 hr

(In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)

Bibliography

• Braunbeck T, Hinton DE, Streit D (Eds.) (1998) Fish ecotoxicology. Birkhäuser Verlag, Basel.
• Cajaraville, M.P. (ed.) (1995) Cell Biology in Environmental Toxicology. UBCPress Service, Bilbo.
• ICES (2004) Biological monitoring: General guidelines for quality assurance. In: Rees H (Ed.). ICES TMES, No. 32. 44 pp.
• ICES (2005) Report of the Working Group on Biological Effects of Contaminants (WGBEC), 18-22 April 2005, Reykjavik, Iceland. ICES CM 2005/E: 08. 94 pp.
• Lawrence AJ, Hemingway KL (2003) Effects of pollution on fish. Blacwell Science Ltd., Oxford.
• Stanley L (2014) Molecular and Cellular Toxicology: An Introduction. John Wiley & Sons, Inc.
• UNEP/RAMOGE (1999) Manual on the biomarkers recommended for the MED POL biomonitoring programme. UNEP, Athens. 39 pp.

Additional more specialised 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. (15%)
• Written questionaire about basic concepts (30%)
• 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) (30%)
• Practical tasks (notebook of practicals) (25%)

Course Evaluation

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

Course/Unit	Comparative Endocrinology and Endocrine Disruption - Formerly Fish and Shellfish Reproduction and Endocrinology
MER Code	MER EHU 501327
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	M Ortiz-Zarragoitia (Coord.), U Izagirre,
Synopsis	Fish reproduction, sex determination and differentiation. Endocrinology of marine fish and invertebrates. 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 invertebrates. • To show the students the effects of environmental pollutants on endocrine system and reproduction of fish and marine invertebrates • To develop skills to estimate reproductive stages in fish and marine invertebrates and understand modern tools on aquaculture of marine fish and invertebrates species.
Objectives At the end of the Unit, the student should:	1. Understand reproduction strategies in fish 2. Identify reproduction strategies and reproductive gonad stages in fish and marine invertebrates 3. Have gained a knowledge of impact of environmental pollutants on fish and marine invertebrates reproduction and endocrine system, as well as of hormonal regulation in aquaculture.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Identify sex and gonad development in fish and marine invertebrates 2. Identify effects of pollutants in reproductive and endocrine system in fish and marine invertebrates

Programme/Syllabus	1. Reproduction in the marine environment: Fish and invertebrates 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 invertebrate groups (crustaceans, molluscs and echinoderms) 9. Hormones in marine invertebrates: 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): 10 hr • Tutorials: 4 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	• Textbook of Fish Endocrinology. Papoutsoglou SE. Nova Science Publishers Inc. 2012. • Fish Endocrinology Vol 1 and 2. Reinecke M, Zaccone G,Kapoor BG. CRC Press. • Advances in Marine and Brackishwater Aquaculture. Perumal S, Thirunavukkarasu AR, Perumal P. Springer. 2015. • Offshore Marine Aquaculture (Fish, Fishing and Fisheries). Nolan JT. Nova Science Publishers, Inc. 2012. • Additional information delivered during the course
Assessment	o Written examination (40%) o Seminar presentation and report 60%
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Degradation and Rehabilitation of Estuarine Ecosystems
MER Code	MER EHU 501319
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	F Villate (Coord.), A Iriarte, I Uriarte
Synopsis	The course offers basic knowledge on estuarine ecosystems, such as the main physicochemical and biological characteristics, the resources and services they offer, the human uses and impacts, the estuarine health assessment, and scientifically-based management.
Aims	To know the structure and function of estuaries: main patterns of environmental variability, life variety and physical and biological processes interacting in such systems. To introduce the student in the historic and current problems of the use of estuaries by man, the human impact on them and the causes of estuarine ecosystems degradation. To adquire basic knowledge about estuarine management for the conservation of biodiversity and ecosystem services, and the improvement of estuarine health, including estuarine rehabilitation and clean-up methods.
Objectives At the end of the Unit, the student should:	• Know the peculiarities of estuarine environments and organisms, and those of the main biotic and abiotic processes they are involved in. • Be able to identify the main estuarine habitats and communities, and associated subsystems. • Understand the function of estuarine ecosystems. • Be aware of estuarine ecosystem services, mainly in relation to the living resources • Be able to identify and assess main environmental problems in estuarine systems, as well as the causes. • Have gained knowledge on the measures that should be implemented to prevent, correct or minimize the impacts.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Access scientific and institutional information (paper and online literature) 2. Discuss results, write reports and perform oral presentations 3. Obtain environmental data in water and sediments 4. Apply data treatment methods

Programme/Syllabus

Theoretical programme (Lectures):
1. The estuarine ecosystem.-Definition. Limits. Geomorphologic types. Classifications based on salinity, tides and energy. Functional components. Circulation of materials.
2. Ecological values. Productivity and biodiversity. Pelagic habitats and plankton communities. Benthic habitats and communities. Associated subsystems. Nekton. Birds. Other vertebrates.
3. Socioeconomic values and anthropogenic uses: Natural resources. Urbanization, industry and commerce. Tourism and recreation. Other activities.
4. Human impact.Physical changes and habitat loss. Pollution: enrichment, unhealthiness and toxins. Overharvest and overfishing. Introduction of exotic species.
5. Estuarine management: basic knowledge. Definition and goals. Status assessment. Conservation. Recovery: cleaning, restoration and rehabilitation. Monitoring.
Practical programme:
1. Boat survey to obtain environmental data in order to identify environmental problems in a humanised system: the estuary of Bilbao.
2. Field trip for visual assessment of the status of conservation and the human impact of a protected system: the estuary of Urdaibai.
3. Computer session.Treatment of the data obtained during the environmental survey of the estuary of Bilbao.
4. Seminar 1 to share information, discuss results and draw conclusions from the field works in groups.
5. Seminar 2 for the oral presentation of the report on environmental and biological characteristics, main resources and uses, major problems and possible solutions of a estuary chosen by students. The work is the result of a literature rewiew performed in groups.

Learning & Teaching

• Formal Lectures: 9 hr
• Field works: 16 hr (Boat survey: 8 hr; Field trip: 8 hr)
• Computer session (field data treatment): 4 hr
• Seminar sessions: 9 hr (Seminar 1: 4 hr; Seminar 2: 5 hr)
• Personal work: 60 hr
(In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)

Bibliography

Delivered during the course

Assessment

1. Attendance to lectures and practical activities (25%)
To pass the practicals it is compulsory to attend field and seminar sessions.
2. Oral presentation of the report on the selected estuary and answering to questions about the work presented (25%).
3. Written report on the environmental study of the estuary of Bilbao (25%).
4. Written report on the visual assessment of the estuary of Urdaibai (25%).

Course Evaluation

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

Course/Unit	Ecosystem-based Fisheries Management
MER Code	MER SOES 6007
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	I del Valle (Coord.) & L Motos (AZTI)
Synopsis	EBFM provides the students the key biological and socioeconomic concepts in the framework of the triple bottom line of sustainable fisheries. In particular, students will know a) how the scientific advice is generated, from data collection to data integration and stock assessment, in order to make diagnostics of the stock and ecosystem status and to give scientific advice on exploitation and conservation of ecosystem resources and services; b) the main determinants of the behaviour of fishermen, institutions and stakeholders; and the pros and con of alternative governance options and frameworks. It is not required a profound mathematical background.
Aims	• To know the scientific basis for a sustainable use of living resources (fleet and fishery technology; population dynamics; assessment methods; sustainable fishing and management tools; and management institutions). • To understand the problems concerning the management of fish populations, pelagic and demersal. • To provide an introduction to the basic research techniques in fisheries socio-economy: data gathering and interpretation.
Objectives At the end of the Unit, the student should:	1. Be acquainted with the scientific basis for a sustainable use of living resources, including population dynamics; assessment methods; sustainable fishing and management tools; and management institutions and procedures. 2. Understand the problems concerning the management of fish populations as exploited by European fleets 3. Become familiar with the basic research techniques in socio-economy, data gathering and interpretation. 4. Understand the fundamentals of socioeconomic analysis and develop critical analysis in socio-economy.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Be familiar with sampling, experimental design, computer skills and research writing. 2. Learn and link interdisciplinary subjects. 3. Written and oral communication.

Programme/Syllabus	1. Marine ecosystem services, components and interactions. 2. EBFM1: Ecosystem-based Fisheries Management: the Socio-economic Perspective 2.1. From economics to fisheries socioeconomics: The basic bio-economic models and tools. 2.2. On alternative fisheries governance options. 2.3. Right based governance systems: theoretical and empirical approaches. 2.4. The complex social-ecological ecosystems (SES) and the multilevel nested framework. Practical issues: Exploring economics with Mathematica; Estimating production elasticities with R. EBFM and portfolio theory; Socioeconomic data collection; Top journals in the field (WoK). 3. EBFM2: Ecosystem-based Fisheries Management: the Biological Perspective 3.1. From single stock assessment and management to ecosystem-based management. 3.2. The basics of Fisheries Science. 3.3. Single stock assessment and management. 3.4. Towards ecosystem-based management. Practical issues: Role games on fisheries managemen; visit to a Fisheries Assessment and Management Lab. Students will meet and learn from Fisheries Research Professionals.
Learning & Teaching	• Lectures: 12 hr (PART 1); 12 (PART 2) • Practicum: 4 hr (PART 1); 8 h (PART 2) • Seminars: 4 hr (PART 1); 4 h (PART 2) • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	Delivered during the course
Assessment	EBFM 1: Written (take home) exam (50%) + Individual report. Students have two options: (a) Socioeconomic report of a marine framework; or (b) State of the art of a specific topic related to fisheries socio-economics. Format: Video (40%). Participation: 10% EBFM 2: Mixed system of continuous and final assessment: Written examination (50%) + Oral presentation of Coursework (40%). Participation(10%) Final mark: 50% EBFM1 + 50% EBFM2
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Ecological Quality Assessment in Coastal Ecosystems
MER Code	MER EHU 501318
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	M Bustamante, I Saiz & J Franco (AZTI) (Coords.) JM Gorostiasga, E Quintano, A Martinez de Murgia (OFG), A Borja (AZTI), I Zorita (AZTI)
Synopsis	Coastal ecosystems are globally threatened by anthropogenic impacts (pollution, physical alterations, climate change). In order to protect those environments, several directives (e.g. EU Water Framework Directive) have been developed. The main objective of this unit is to acquire knowledge on the different tools to evaluate the ecological status and the impacts on coastal ecosystems, as well as the criteria for an appropriate management.
Aims	• To be aware that marine diversity is a precious treasure to preserve in conservation programmes and a key component to assess environmental quality in coastal ecosystems. • To introduce the basic concepts used in marine ecological 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. • 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 main concepts and approaches regarding the management of human activities in the marine environment according to ecological criteria.
Objectives At the end of the Unit, the student should:	1. Recognize characteristic taxa of algae, invertebrates and fishes from coastal ecosystems 2. Assess environmental quality, by using different diversity measures from different biological communities and physico-chemical components 3. Design and analyse monitoring programmes for algae and animals 4. Design monitoring programmes for the assessment of the quality of the marine environment 5. Interpret the data from monitoring programmes 6. 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
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Perform report writing, scientific writing, working in teams, oral presentations, library information retrieval and critical analysis of literature, and presentation and manipulation of data (e.g. water quality data interpretation biological data interpretation) 2. complete an integrative interpretation of data

Programme/Syllabus	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 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 and monitoring programmes in the Basque coastal environments. 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 Fild trip (½ day): 4 hr • Part 2 Fild trip (1 day): 8 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
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.

Course/Unit	Environmental Analytical Chemistry
MER Code	MER EHU 501321
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	N Etxebarria (Coord.), A Vallejo
Synopsis	Integrative view of the analytical methodologies in environmental issues. We will emphasize the sampling strategies, both active and passive methodologies, the development of target and nontarget analysis workflows, 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. • To offer the criteria to design a suitable analytical procedure • To give the clues to understand analytical procedures and results
Objectives At the end of the Unit, the student should:	1. Understand the basic processes of an analytical method and procedure. 2. Be able to design efficiently a sampling and analysis procedures 3. Understand the differences between targeted and nontargeted requirements 4. Understand the bioaccumulation and bioavailability of contaminants in dynamic scenarios
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Apply the analytical approach to environmental issues 2. Perform good analytical practices

Programme/Syllabus	Topics covered include: • Basics on environmental analytical chemistry • The analytical procedure • Active and Passive Sampling techniques • Bioaccumulation and bioavailability • Targeted and non-targeted analytical methods
Learning & Teaching	• Lectures: 20 hr • Seminars (for case studies) : 12 hr • Tutorials (exercises and presentations):8 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
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. • Roger Reeve, 2002. Introduction to Environmental Analysis, John Wiley & Sons Ltd. • Miroslav Radojevic, 2006. Practical Environmental Analysis: Edition 2, Vladimir Bashkin, The Royal Society of Chemistry. • AR Conklin,2004. Field Sampling, Principles and Practices in Environmental Analysis, ,Marcel Dekker. • D. Harvery, Analytical Chemistry 2.1 (http://dpuadweb.depauw.edu/harvey_web/eTextProject/version_2.1.html http://www.epa.gov/nerlesd1/chemistry/anal-env-chem.htm
Assessment	• Written theory examination (25%) • Practical activities (35%) • Case studies and reports (40%) By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Environmental Chemometrics - Formerly Environmental Data Analysis
MER Code	MER SOES 6001
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	A De Diego (Coord.), M Olivares, JM Madariaga
Synopsis	This course is an introduction to the application of statistic and chemometric tools to the analysis of data obtained mainly, but not only, after chemical analysis of a large variety of environmental samples. Descriptive and inference statistics are briefly reviewed, and the most important multivariate techniques for pattern recognition, classification and regression are also deeply investigated. Rather than on the mathematical detail, the course focuses on understanding the basic concepts behind each technique, and on selecting the most appropriate tool in each specific situation. The theoretical basis of the techniques considered will be illustrated by the resolution of exercises and case studies.
Aims	• To understand and apply multivariate approach to interpret the environmental data
Objectives At the end of the Unit, the student 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 the Unit, the student should be able to:	1. Apply a multivariate approach to interpret the environmental data

Programme/Syllabus	1.- Introduction: statistics, chemometrics, environmental analysis, multivariate data analysis 2.- Basic statistics: descriptive and inference statistics 3.- Exploratory analysis 4.- Pattern recognition 5.- Classification 6.- Calibration and regression
Learning & Teaching	• Lectures: 20 hr • Computer work: 15 hr • Seminars and tutorials: 5 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	1.- M. Otto, Chemometrics, Statistics and Computer Application in Analytical Chemistry, Wiley, Weinheim, 1999 2.- D. A. Skoog, D. M. West, F. J. Holler, S. R. Crouch, Fundamentals of Analytical Chemistry, 8th edition, Thomson Brooks-Cole, Belmont, 2004 3.- J. N. Miller, J. C. Miller, Estatistics and Chemometrics for Analytical Chemistry, 4th edition, Pearson Education, Essex, 2000 4.- G. Ramis, M. C. García, Quimiometría, Síntesis, Madrid, 2001 5.- K. H. Esbensen, Multivariate Data Analysis – in Practice, 5th edition, CAMO Process AS, 2004 6.- B. Kendall, C. Costello, Data Analysis for Environmental Science and Management, (http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.115.4159&rep=rep1&type=pdf) 7.- G. Hanrahan, Environmental Chemometrics: Principles and Modern Applications, CRC Press, Boca Ratón, 2009 8.- J. W. Einax, H. W. Zwanziger, S. Geiss, Chemometrics in Environmental Analysis, VCH, Hamburg, 1997
Assessment	The evaluation of this course will be of a mixed type. The final score will be obtained as the weighted average of the following sections: i) Lecture attendance (10%), bibliographic survey (20%), iii) practical tasks (30%) and iv) written examination (40%). A minimum score of 5.0 in each section will be required to pass the course. If the student waives the call, she/he will be graded as not presented.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Environment and Fisheries/Aquaculture Interactions
MER Code	MER EHU 501349
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	I Martínez (Coord.)
Synopsis	The students will get a general overview on the interactions between environmental and breeding conditions on the safety/quality of seafood, both in fisheries and in aquaculture
Aims	• To provide a general view of the impact of environmental conditions, pollutants, climate change and breeding conditions on the safety, quality and biochemical composition of seafood • To provide knowledge suitable to be applied to farming practices and to seafood safety. • To provide a general view of the impact of fisheries and aquaculture on environmental quality status and ecosystem health.
Objectives At the end of the Unit, the student should:	1. Know the foundations of seafood safety and authenticity. 2. Understand how diverse factors affect fish wellbeing and seafood safety/quality. 3. Know procedures to ensure seafood safety/quality and human health. 4. Be familiar with analytical methods to identify fraud and the relationship between fraud and seafood safety
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Find relevant information including updates in laws and regulations and Rapid Alert System for Food and Feed (RASFF); 2. Actively participate in seminars and discussions; 3. Become familiar with the production system and the introduction, control and elimination of undesirable substances from the production chain. 4. Understand the relationship between environmental conditions and seafood safety

Programme/Syllabus	1. The environment and seafood safety: introductory remarks 2. Seafood safety hazards:anthropogenic contaminants, toxins, virus, bacteria, allergen, parasites 3. Emerging risks and climate change 4. Ensuring seafood safety: Hazard analysis and critical control points (HACCP) 5. Seafood quality: fish nutrition, harvesting methods, post-mortem changes 6. Seafood authenticity and how to fight fraud on species identification, geographic origin, production and processing. 7. Environmental impact of fisheries and aquaculture 8. Intelligenty aquaculture systems
Learning & Teaching	• Lectures and Seminars: 40 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	The students will have to find and use relevant published material complementing the one provided during the classes
Assessment	• Attendance is compulsory. Proactive participation in the activities, practical and oral sessions, will be considered. • Written examination (50%) • Oral presentation of a subject to be selected (50%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Environmental (Toxico)Genomics
MER Code	MER EHU 501347
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	I Cancio (Coord.), E Bilbao
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, the student 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, metagenomics and environmental DNA, 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, the student 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 for diagnosing exposure to and/or effect of chemical compounds in laboratory and field conditions: selection of sentinel species, sequence information retrieval; traditional and massively parallel sequencing techniques; gene expression analysis techniques; and analysis of gene pathways.

Programme/Syllabus

1. Environmental genomics and gene sources in the seas, soils, rivers, inside metazoa
2. Environmental metagenomics and gene discovery
3. Environmental DNA (eDNA) and biodiversity analysis.
4. Genomic services for aquaculture, fisheries research, study of fish stock dynamics, agriculture, food supply, comparative physiology...
5. Genomics and environmental model organisms.
6. Marine genomics and patents.
7. Basic concepts in toxicogenomics: ecotoxicogenomics, functional genomics, transcriptomics, proteomics, metabolomics, analysis of gene expression, and gene ontology.
8. 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…
9. 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).
10. 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), RNA-Seq and transcriptomics
11. Toxicogenomics vs proteomics vs metabolomics. Systems biology.
12. Knock-down and transgenic technology and the gene dissection of relevant molecular pathways.
13. 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

Learning & Teaching

- Lectures: 24 hr
- Lab Practicals: 2 hr
- Computer Practicals: 8 hr
- Tutorials: 4 hr
- Personal work: 60 hr (including 12 specific on the seminars)

(In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)

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.
- Students will prepare in couples a very short ppt presentation (10 min) to explain one gene, group of genes or genome of environmental interest (in the framework of pollution monitoring, climate change, disease outbreaks, resistance to environmental changes, predation, symbiosis…) in front of all the class. From the discussion, we shall agree on two questions that may remain without answer and the students will have 2 weeks to find answer to such questions and present them in a written report to be sent to kecturers and all classmates. Assessment criteria: ppt, presentation in public, capacity to answer in public, written report quality.

Course Evaluation

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

Course/Unit	Environmental Monitoring and Risk Assessment in Aquatic Systems
MER Code	MER EHU 501317B
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	I Marigomez (Coord.), U Izagirre
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 for 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 for pollution biominotirng programmes • To provide the criteria useful for analysing and interpreting ecologically relevant environmental levels of pollutants and their biological effects
Objectives At the end of the Unit, the student 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 in aquatic risk assessment 4. Know the advanced methods for biomonitoring pollution and its biological effects 5. Understand the role of biological endpoints in the integrative assessment of aquatic pollution, its biological effects and their ecological consequences
Key Skills Acquired At the end of the Unit, the student 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

Programme/Syllabus	1. Introduction: scope and basic concepts * 2. Ecotoxicity bioassays in aquatic systems * 3. Environmental Risk Approaches (ERA): EDS, TIE and WoE * 4. Chemical biomonitoring: baselines, Long-Term Trends * 5. Mussel Watch and other chemical biomonitoring programmes * 6. Pollution indices in the aquatic environment * 7. Biological effects assessment: biological endpoints * 8. Marine ecosystem health indices * 9. Integrative biomonitoring programmes: design and case studies * 10. Environmental specimen banks (ESBs) * 11. Ecotoxicity bioassays and ERA I: standard BE assays; TIE; Toxicity profiling 12. Ecotoxicity bioassays and ERA II: non-standard assays; WoE Case studies Practical sessions: P1. Coastal biomonitoring: design and sampling * P2. Pollution Indices and Ecosystem Health Indices * P3. Acute toxicity testing & ERA calculations (PNEC, WoE) * P4. Team work mini-projects on toxicity assays or biomonitoring P5. Poster corner workshop on mini-projects ** Priority will be given to remote learning combined with individual/small group tutorials*
Learning & Teaching	Lectures:18 hr Computer practicals (3x3): 9 hr Lab/Field practical work: 9 hr Workshop: 4 hr Personal work: 60 hr *(In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)*
Bibliography	• European Commision. 2014. Technical report on aquatic effect-based monitoring tools. EC Technical Report - 2014 - 077. EU Luxemburng, ISBN 978-92-79-35787-9, 242 pp. • Potters G. 2013. Marine Pollution, Bookboon, ISBN-13: 9788740305401, 231 pp. • Goh, B.P.L., Lai, C.H., Tan, L.T., Yap, N.W.L. & Dissanayake, A. (2014) Handbook of Marine Ecotoxicology Techniques. National Institute of Education, Nanyang Technological University. National Parks Board, Singapore, 110 pp. • OSPAR. 2013. Background document and technical annexes for biological effects monitoring, Update 2013. Monitoring and Assessment Series. 239 pp.
Assessment	• Attendance (compulsory) • Written examination (definitions): 20-30% • Report on computer practicals: 30-40% • Mini-project Workshop (poster and poster corner): 30-40%
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Eutrophication and Harmful Algae
MER Code	MER EHU 501320
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	S Seoane (Coord.), A Laza-Martinez
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, the student should:	1. Understand the biology of harmful algae. 2. Be familiar with methods to detect and identify marine phytoplankton. 3. Understand the foundations of eutrophication and its consequences for environment and human health. 4. Be aware of the factors enhancing eutrophication
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Identify the main groups of harmful algae 2. Apply methods to detect and identify harmful algae 3. Be conversant on eutrophication and harmful algae

Programme/Syllabus	1. Presentation of the different types of harmful microalgae 2. Methods of detection and identification of harmful algae 3. Impact of harmful algal blooms (HABs) on humans, wild fauna and aquaculture 4. Factors triggering harmful algal blooms 5. Eutrophication of estuaries and coastal waters 6. Factors enhancing eutrophication 7. Restoration of eutrophized habitats: case studies
Learning & Teaching	• Lectures: 12 hr • Seminars (oral presentations): 5 hr • Practical sessions: 14 hr • Field trip (1 day): 6 hr • Tutorials (on writing reports): 3 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
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 (60%) • Written theory examination: a written examination paper based on the lectures (20%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Histology and Histopathology of Aquatic Animals
MER Code	ER EHU 501324
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	M Soto (Coord.), U Izagirre, B Zaldibar, S Feist, A Villalba
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, the student 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, the student 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

Programme/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 programmess 2. Practicals: Histotechnology preparation of samples. Microscopical examination of molluscan tisúes. Microscopical examination of fish tissues. Histopathological examination of marine molluscs. Histopathological examination in fishes. Navigating trough the web in search of data bases and images of aquatic animal histopathology 3. Report: Review of cutting edge themes on toxicological pathology in aquatic animals
Learning & Teaching	• Lectures: 20 hr • Practical sessions (laboratory): 8 hr • Practical sessions (microscopy): 10 hr • Practical sessions (questionaire on line) 2 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary
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. • Sistemic 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 deseases and disorders. Vol 1. Protozoan and metazoan infections. Woo, PTK. CABI Publ., Oxon, UK, 1995.
Assessment	• Attendance is compulsory. Proactive participation in activities, practical and on-line questionaire (follow up of objective fulfilling). • Written report (review) at the end of the module (70%) • Practical examination (daily fulfilling and feedback) (30%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Instrumentation and Measurements in Operational Oceanography
MER Code	MER EHU AZTI-501330
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	A Uriarte (AZTI) (Coord.), M González (AZTI)
Synopsis	A practical introduction to the wide range of sampling techniques and procedures applicable to operational oceanographic studies.
Aims	• To introduce the students to the wide range of sampling techniques applicable to operational oceanography
Objectives At the end of the Unit, the student should:	1. Have gained knowledge in the different sampling techniques and data analysis
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Perform individual assessment of data quality, presentation of written reports, library information retrieval and critical analysis of literature. 2. Perform boatwork and practical laboratory work in operational oceanography

Programme/Syllabus	The following issues are addressed: • Oceanographic instrumentation and sampling techniques (CTD, Sediment grabs and cores, etc.) • State of the art instrumentation in fish biology surveys (acoustic surveys, plankton samplers, etc.) • Physical instrumentation and data analysis (currents, tides and waves) • Geophysical sampling tools and data analysis (multibeam, side scan sonar, etc.)
Learning & Teaching	• Lectures and Seminars: 14 hr • Laboratory practicals: 8 hr • Computer practicals: 8 hr • Field trip: 6 hr • Tutorials: 4 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	Delivered during the course
Assessment	Practicals notebook will be marked
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Marine Enterpreneurship
MER Code	MER EHU 20180001
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	I Del Valle (Coord.) & Torger Edvardsen (consultant)
Synopsis	The course is addressed to marine science students who may consider the option to developing a marine career as entrepreneur. Topics include introduction to business management and entrepreneurship, as well as an integrated overview of ocean economy and some practical cases of ocean economy
Aims	• To awake vocations and prepare students to work with or to become entrepreneurs in the maritime and marine sectors or leaders of marine organizations.
Objectives At the end of the Unit, the student should:	1. Understand the basic principles of bussiness management 2. Know the basic processes and the prospects and hurdles relative to the world of innovation and entrepreneurship 3. Identify the main drivers of ocean economy and the needs and opportunities associated to entrepreneur's endeavours in the marine and maritime sectors
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Increase his/her entrepreneurship skills 2. Improve confidence and increase international business ambition 3. Understand and get insights to practical tools and approaches in business management 4. Know how to support to accelerate the growth of business organizations

Programme/Syllabus	PART 1. Entrepreneurship and business management 1. Introduction to business management: accounting, microeconomics, marketing, small business management, human resources management, operations management 2. Introduction to entrepreneurship: financing and fund raising, markets and sales strategies, new product development, sustainable entrepreneurship, circular economy, entrepreneurial leadership, SMEs, social relations and communication. PART 2. Ocean economy 3. Overview of the ocean economy: the marine and maritime sector, global trends and macro-factors influencing the ocean economy; science, technology and innovation in tomorrow's ocean economy; international maritime regulation and emerging ocean-based industries; perspectives on and projections of the future of the ocean economy; integrated ocean management 4. Workshops on exemplary practical cases:
Learning & Teaching	• Lectures and Seminars: 24 hr • Computer or In place practicals: 8 hr • Field trips: 8 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	• OECD (2016), The Ocean Economy in 2030, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264251724-en • More references delivered during the course
Assessment	Mixed system of continuous and final assessment, where class attendance is compulsory. • Written examination (50%) • Oral presentation of Coursework (50%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Marine Microbial Ecology
MER Code	MER EHU 20180002
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	B Ayo (Coord:), JM Arrieta (IEO)
Synopsis	Marine microbes are the most abundant organisms in the ocean, and they mediate many essential biogeochemical processes. In this course, we will convey the basic information on marine microbes by addressing their biodiversity and functioning, together with the analysis of currently topical research questions.
Aims	• To provide the students a global view of the abundance, physiology and biodiversity of marine microbes. • To offer to the students a microbial perspective of the functioning of the ocean system. • To develop skills to estimate microbial standing stocks and microbial activities.
Objectives At the end of the Unit, the student should:	1. Recognise the main groups of microbes living in the ocean. 2. Understand the basic processes and activities carried out by the microbial communities in the ocean. 3. Identify the main microbial drivers in the global cycles of carbon, nitrogen and phosphorous.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Identify the main microbial processes taking place in the ocean. 2. Obtain quantitative results about microbial standing stocks. 3. Critically analyse scientific research on marine microbial ecology.

Programme/Syllabus	1. Overview of diversity of marine prokaryotes, eukaryotes and viruses. 2. Ecophysiology of marine microbes: adaptations to oligotrophic conditions, response to different regimes of temperature, hydrostatic pressure, oxygen concentrations. 3. Microbial primary production and phototrophy by eukaryotic and prokaryotic microbes. 4. Degradation of organic material. Bacterial growth efficiency in marine systems. 5. Heterotrophic marine eukaryotic microbes. Overview of protists and grazing activities. 6. Diversity of marine viruses. Impact in microbial processes. 7. Influence of the microbial activities on ocean processes. Cycles of elements. 8. Microbial community structures in the ocean. Genomics and metagenomics of marine microbes. 9. Symbiotic associations. Practicals/Case studies: 1. Estimation of microbial densities in seawater. 2. Estimation of microbial activity rates in seawater.
Learning & Teaching	• Lectures: 20 h • Seminars: 5 h • Lab practicals/Case studies: 15 h • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	• Kirchman, D.L. (2008) Microbial ecology of the oceans, 2nd Ed. Wiley-Blackwell. • Kirchman, D.L. (2012) Processes in microbial ecology. Oxford University Press, New York. • Munn, C. (2011) Marine microbiology. Ecology and applications, 2nd Ed. Garland Science, Taylor & Francis Group. New York. Specific bibliography: Relevant papers delivered during the course
Assessment	• Attendance is compulsory. All absences must be justified. Active participation in the activities of the course will be considered. • Written report and oral presentation: based on the analysis of research articles about a selected topic on microbial ecology.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Marine Resources Genomics - Formerly Molecular Population Genetics of Fish and Shellfish
MER Code	MER EHU 501351
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	A Estonba (Coord.), I Zarraonaindia, A. Fullaondo, T.Pérez
Synopsis	Molecular population genetics for fisheries and aquaculture species, and metagenomics for the study of whole biological communities. Conservation management and ecosystem health protection.
Aims	• To initiate students into genomic research in the marine world by exploring current research cases, understanding of cutting-edge lab technologies, building bioinformatics/computational skills, and shaping knowledge base
Objectives At the end of the Unit, the student should:	1. Know the foundations of population genomics and metagenomics 2. Understand principles of bioinformatics and statistics methods to make use of DNA sequence data. 3. Be aware of the potential application of molecular population genetics in the field of marine environment and resources
Key Skills Acquired At the end of the Unit, the student should be able to:	• Apply population genomic approaches to survey patterns of variation within and among marine fish and shellfish populations. • Apply metagenomic/metabarcoding approaches to study of complete communities directly in their natural environments.

Programme/Syllabus	A. ESSENTIALS OF GENOMICS B. METAGENOMICS -Microbial ecology: metagenomics -Metagenomics applications -Quiz test metagenomics -Linux tutorial -Analysis pipeline -Computer practice: tutorial using QIIME C. MARINE POPULATION GENOMICS -Basic principles of fish population genetics -Molecular markers and application in fisheries and aquaculture -Computer practice: tutorial
Learning & Teaching	• Lectures: 16 hr • Computer based exercises: 18 hr • Computer practices report tutorials: 8 hr (following completion of the practices, each student will do an independent report. For computer practices raw sequence data coming from an experiment designed to meet a specific goal will be provided) • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	Delivered during the course
Assessment	Attendance is compulsory. Proactive participation in the activities and practical sessions, will be considered. Each student should write a lab report following completion of the two computer practices of population genomics and metagenomics: •The two reports should explain what you did in your computer practices what you learned, and what the results meant. •Argument, research problem statement, methodology, and presentation and expression will be evaluated. "The assessment method included in this guide may be subject to change if health authority guidelines so state. The modifications to be adopted would be announced in a timely manner, with the necessary strategies and tools to guarantee the right of students to be evaluated with equity and justice".
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Multicultural integration in EU
MER Code	MER EHU 501351
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	M Soto (Coord.), N Etxebarria
Synopsis	Academic recognition of certified activities in learning languages, participating in cultural/sport/social or science dissemination activities, cooperation with NGO's, etc.
Aims	• To promote and enhance multicultural integration among students or in the host institutions/countries or at EU level
Objectives At the end of the Unit, the student should:	1. Improve the level of language or cultural/social integration at either local scale in the host institution, or an European scale
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Gain knowledge of any MER MSc Consortium or host country official language, other than mother's language 2. Gain integration as regards different cultural, sport, social or organizational aspects of the host institution/country 3. Perceive intercultural, organizational or cooperation (e.g. with NGO's) links among different European countries in the fields of marine and environmental science and technology or in the areas of education, environmental awareness or research career

Programme/Syllabus	N/A
Learning & Teaching	• Personal work: 100 hr (4 ECTS correspond to approximately 100 hr personal work, provided the activity or activities have been previously recognized by the MER UAB in UPV/EHU and approved by the MER JPB, as stated in the MER Student Agreement, and provided it has been successfully achieved and so certified) • Tutorials
Bibliography	N/A
Assessment	A certificate of achievement is needed • Written report: 60% • Questionnaire: 40%
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Ocean Global Change Biology
MER Code	MER EHU 20180003
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	I Marigómez & J Saenz (Coord.); guest lecturers
Synopsis	Global change is conceived as any consistent environmental change and trend (past, present or projected) that affects a substantial part of the global environment and can be caused by a diversity of processes including those guided by biological drivers. The main topics include basic techniques used in the generation of high quality datasets for the stydu of climate change, how marine organisms and ecosystems respond to change drivers and vice versa, and how the biota acclimate and adapt to the major environmental stressors driven by global change and its environmental and evolutionary consequences.
Aims	• To integrate diverse approaches to understand how marine organisms respond to complex, multiple stressors in the global ocean, in past, present and tentative future scenarios.
Objectives At the end of the Unit, the student should:	1. Know which are the different drivers of global change and the possible interactions between them and with marine biota and ecosystems 2. Acquire a basic understanding of how marine organisms respond to changes in environmental factors environment, from alterations in gene expression patterns, through metabolic, cellular and physiological level to ecophysiological adaptation and alterations in phenology; 3. Understand the mechanisms by which marine organisms cope with specific stressors in their environments, including e.g. extreme temperatures and acidification;
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Analyse the causal chain leading from human activities to global change processes and their impact on ecosystems, based on discussions of case studies. 2. Demonstrate a critical, analytical approach to scientific research and have developed skills in literatuire reading and in writing scientific reports.

Programme/Syllabus

1. Introduction: ocean global environmental trends, threats and challenges
PART 1. GLOBAL OBSERVATORIES
2. Global meteorology and climate
3. High-quality datasets for monitoring global change and oceanic processes
4. Atmospheric data reanalysis
5. Ocean data assimilation and modelling
PART 2. BIOLOGICAL IMPACT OF GLOBAL OCEANIC TRENDS
6. Ocean acidification I: trends and effects on marine life
7. Ocean acidification II: mitigation of CO_2
8. Thermal stress in marine ectotherms I: biological responses to gradual warming
9. Thermal stress in marine ectotherms II: biological responses to heat waves
10. Global long-term trends in chemical pollution
11. Global plastic threat
12. The One Ocean - One Health approach
PART 3. GLOBAL MARINE BIODIVERSITY TRENDS
13. Introduction: the 5 w's of global marine biodiversity
14. Climate change and the decline of coral reefs
15. Global shipping and allien species
16. Global marine diversity and MAPs
17. Biosphere's life history: a recapitulation
ROUND TABLES (team work and open discussion) & WORKSHOP
1. Round Table on Global Observatories
2. Round Table on Adaptations, Trends and Evolution
3. Workwhop (Poster corner style) on Ocean Global Change Biology

Learning & Teaching

• Lectures: 24 hr
• Workshops: 16 hr
• Personal work: 60 hr
(In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)

Bibliography

• IPCC 2019 Special Report on the Ocean and Cryosphere in a Changing Climate: https://www.ipcc.ch/srocc/

• Other bibliography to be delivered during the course

Assessment

• Attendance is compulsory. All absences must be justified documentally.
• Active participation; questions in roundtables + question list report (30-50%)
• Poster Corner Workshop (50-70%)

Course Evaluation

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

Course/Unit	Physiological Energetics of Marine Organisms
MER Code	MER EHU 501322
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	E Navarro (Coord.), MB Urrutia, I Ibarrola
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, the student should:	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, the student 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.

Programme/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: 16hr • Seminars: 12 hr • Practical sessions (laboratory): 8 hr • Tutorials: 4 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
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 of theoretical and practical issues (40%) • Continuous evaluation of assigned tasks (30%) . Written/oral presentation of selected case studies (30%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Satellite Oceanography and Meteorology
MER Code	MER EHU 501346
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	J Sáenz & C García-Soto (IEO) (Coord.); G Ibarra-Berastegi, G Esnaola
Synopsis	Satellite oceanography: sea surface temperature, altimetry , imaging radars. Meteorology: radiation propagation through the atmosphere, atmosphere-ocean coupling, satellite data analysis applied to oceanography, meteorology and climate
Aims	• To understand the present developments in the fields of Satellite Oceanography and Meteorology
Objectives At the end of the Unit, the student should:	1. Analyze data from satellite oceanography and meteorology for different applications with emphasis on oceanography and climate
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Critical analysis and interpretation 2. Use of numerical tools (R and other languages) for data analysis 3. Use of web resources 4. Working in groups 5. Presentation of written and oral scientific reports

Programme/Syllabus	PART 1 SATELLITE OCEANOGRAPHY 1. Sea Surface Temperature: Application to global warming, ENSO and SST variability. Reconstructions of missing satellite data. 2. Altimetry: Sea level rise, currents and eddies. 3. Other applications: Chlorophyll, waves, wind.. PART 2 METEOROLOGY 1. Introduction to satellites and satellite based data 2. Propagation of radiation through the atmosphere for satellite applications 3. Atmosphere-ocean coupling 4. Satellite meteorology and climate (variability and change)
Learning & Teaching	• Lectures: 16 hr • Exercises: 8 hr • Computer sessions: 16 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	Delivered during the course
Assessment	• Completion of practicals (50 %) • Oral presentation of coursework (50%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Socio-Economic Aspects of Climate Change
MER Code	MER EHU 20180004
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	IGalarraga & E Sainz de Murieta (BC3) (Coord.), A Ansuategi, M Escapa (UPV-EHU), Itziar Ruiz de Gauna (Metroeconomica)
Synopsis	This course will illustrate, from a socio-economic standpoint, the dimension of this problem, its causes, its impacts and the potential solutions which are being planned in order to confront the problem on a world scale. It will summarize existing knowledge regarding the potential impacts over all systems, the difficulties to manage the topic, the costs associated to the problem and the magnitude of effort required to confront the situation. It will explain why climate change can be considered as a market failure and what this means in terms of the importance of public policies to correct the problem and its impact on international trade and negotiations. The course will also cover the advances in the United Nations conferences, the Kyoto Protocol and the Paris Agreement that entered into force on the 4th November 2016.
Aims	• To offer a good understanding of the ongoing trends in Climate Change research in the field of economics and policy. • To cover the main challenges to accelerate the transition towards a low carbon economy. • To fully comprehend the impacts, policies and instruments that can be applied in mitigation and adaptation to climate change.
Objectives At the end of the Unit, the student should:	1. Be able to comprehend the complexities and uncertainties surrounding climate change impacts. 2. Understand the enormous effort needed in terms of emissions reduction. 3. Have a good knowledge of what mitigation policies are like in different sectors: industry, energy, transport, housing and others. 4. Be familiar with adaptation policies and policies to enhance resilience. 5. Have an updated comprehension of the international climate policy and the difficulties to reach agreements.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Have good written and oral communicating abilities in the field. 2. Understand the basic concepts of a mitigation policy. 3. Understand the basic concepts of an adaptation policy. 4. Understand, follow and assess the climate summits. 5. Identify the main sources of policy and research literature.

Programme/Syllabus	1. Introduction to Climate Change 2. Basic socio-economic concepts. 3. Mitigation policies: a transition to a low carbon economy. 4. Adaptation policies: building resilience to climate impacts. 5. International climate policy: Kyoto Protocol, Paris Agreement and the United
Learning & Teaching	• Lectures: 26 hr • Seminars: 6 hr • Role playing games: 8 hr (i) UN Climate Summit, (ii) Designing adaptation plans. • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	Fankhauser, S., 2017. Adaptation to Climate Change. Annual Review of Resource Economics 9, 209–230. https://doi.org/10.1146/annurev-resource-100516-033554 IPCC, 2019. IPCC Special Report on the Ocean and Cryosphere in a Changing Climate. In press. Roman De Lara, M.V. and Galarraga, I. 2016. The Paris Summit: The Beginning of the End of the Carbon Economy. Dyna Energía y Sostenibilidad. 5. (1) 41-44. DOI (10.6036/ES7954). Roman De Lara, M.V. and Galarraga, I. 2016. The summit in Paris, a historic result? DYNA Ingeniería e Industria. 91. (2) 131. DOI (10.6036/7958). Stern, N. (2006): The Stern Review: the Economics of Climate Change, HM treasury, UK Government.
Assessment	• Written assignments (50%) • Oral presentation of coursework (30%) • Participation in role playing games (20%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

LINK TO ULIEGE MER WEBSITE

SEMESTER 3

COURSE	ECTS	TYPE
Marine Ecology	6	CLS3
Biochemistry, Physiology of Marine Animals	6	CSS1
Biogeochemical Cycles in the Ocean	6	CSS1
Biology of Marine Mammals	6	CSS1
Carbon, Nutrient, Greenhouse Gases Dynamics ... and Geological Oceanography	6	OPT
Ecotoxicology of Marine Pollutants	6	OPT
Functional and Molecular Marine Microbiology	6	OPT
Marine Plant Biology and Ecology	6	OPT
Numerical Methods Applied to the Environment	6	OPT
Professional Placement in Marine /Environmental Sectors	6	OPT
Remote Sensing of the Oceans	6	OPT

CLS3: Compulsory at ULiège Semester 3
OPT: Optional at ULIège in Semester 1

Course/Unit	Marine Ecology
MER Code	MER ULiège OCEA0057-7
ECTS	6
Level	Compulsory (ULiège)
Semester	3
Timetable slot	To be advised
Teaching Staff	S Gobert (Coord.) ML Grégoire K Das
Synopsis	Foundations of marine ecology. Biodiversity or marine organisms. Sampling techniques in marine ecology. Case studies. Marine ecosystems modelling.
Aims	• To provide an introduction to ecology focuses on specific marine ecological concept, covering interactions between marine organisms and the environment at scales of populations, communities, and ecosystems. • To give a basic knowledge of ecological characteristics and processes in the marine environment. • To show the importance, complexity and fragile aspects of different types of marine habitats. • To conceptualize, parameterize and implement mathematical
Objectives At the end of the Unit, the student should:	1. Acquire stable foundations in ecology and to form with the ecological reasoning applied in marine environment. 2. Be able to explain the factors that determine the spatial and temporal distributions and abundance populations and communities of marine organisms in relation with biotic and abiotic factors. 3. Be able to apply ecological principles 4. Be familiar with the tools and procedures to conduct ecological surveys in particular ecosystems
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Perform sampling in marine ecology and identify target taxa in marine communities 2. Collect, analyse and interpret marine ecological data. 3. Work constructively both independently and collaboratively and communicate effectively about Marine Ecology (issues and ideas) using language that can be understood by the public and scientists.

Programme/Syllabus	1. Foundations of marine ecology 2. Description of the biodiversity or marine organisms, 3. Sampling techniques in marine ecology 4. Detailed description of three particular ecosystems: the posidonia meadow in the Mediterranean Sea, coral reefs and abyssal environments (more particularly, hydrothermal vents). 5. Introduction to marine ecosystems modelling. 6. Model formulation. Spatial components. Parameterisation. Model solution. testing and Validating the model. Taxonomy of ecological models. Differential equations. 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. 7.Training course (STARESO-Calvi-Corsica) at the oceanographic station of the University. Period: Septembre-October. This includes snorkelling, in scuba diving* followed by determinations under binocular, photographic documents taken by the student (*not compulsory).(1-4: Gobert-Das; 5-6: Grégoire; 7: Gobert-Das).
Learning & Teaching	• Lectures: 30 hr • Practicals: 5 sessions = 15 hr • Field work: 6 d: Training course (STARESO-Calvi-Corsica)
Bibliography	• Ppt presentation with lectures available to students (S Gobert-K Das) • PowerPoint files and a copy of the software used at the time of the TP (ReefCheck and CoralWatch) available to students (ML Grégoire)
Assessment	• Marine ecology (25%): Oral examination with open book (two questions) vis-a-vis the two teachers, Marine ecology fieldtrip (35%): oral presentation and the end of the fieltrip, Practical work on modelling (35%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Carbon, Nutrient, Greenhouse Gases Dynamics ... and Geological Oceanography
MER Code	MER ULiège OCEA0082-1
ECTS	6
Level	Optional (Formerly: Aadvanced Marine Geochemistry)
Semester	3
Timetable slot	To be advised
Teaching Staff	N Fagel (Coord.); A Borges
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, the student should:	1. 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 2. Understand the Chemical processes leading to formation of sedimentary rocks. 3. Know how anthropogenic activities and climatic change impact on the sedimentary record.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Interpret CO2, CH4 and N2O data in broad physical and biological frame of aquatic systems 2. Analyse and interpret geochemical signatures of marine sediments and geochemical datasets

Programme/Syllabus	1. Concepts of chemical and biological oceanography necessary to the understanding of GHGs dynamics (2 Lecture), in-depth description of CO2, CH4, N2O dynamics in aquatic systems, including air-sea exchange (5 Lectures). 2. 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. 3. 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	• Lectures: 10x 2 hr = 20 hr (Part 1); 20 hr (Part 2) • Practicals: 5 hr (Patrt 1) 20 hr (Part 2)
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.

Course/Unit	Biochemistry, Physiology of Marine Animals
MER Code	MER ULiège OCEA0080-1
ECTS	6
Level	Optional
Semester	3
Timetable slot	To be advised
Teaching Staff	P Compére (Coord.)
Synopsis	Cellular and molecular aspects of the mechanisms of perception and the adaptations to physical and chemical factors in the marine environment.
Aims	• To provide a basic knowledge of the cellular and molecular aspects of perception and environmental adaptations in marine animals and its relevance in the marine environment.
Objectives At the end of the Unit, the student should:	1. Acquire, by a cellular and molecular approach, concepts on the mechanisms of perception and adaptations to some physical and chemical factors of the marine environment. 2. Understand the ecological integration of the animal species in the marine environment.
Key Skills Acquired At the end of the Unit, the student should be able to:	

Programme/Syllabus	1. Introduction to the biochemistry and physiology of marine animals: constraints imposed by life in the marine environment, physiological and biochemical compensations to the variations in marine environmental factors (conformity, regulation). 2. Physical constraints: temperature, hydrostatic pressure 3. Chemical constraints: salinity, homeostasis, oxygen availability, pollutants. 4. Perception: chemical, physical, photo-receptors (including bioluminescence).
Learning & Teaching	• Learning by personnal experience under guidance • Lectures and practical illustrations. (15 hr Th; 15 hr Pr)
Bibliography	• Various booklets as well as articles copies are offered to the students. • A copy of letures ppts and a syllabus are provided to the students.
Assessment	• Written report (10-15 pages) and Public presentation (project): 50%. Literature search on adaptation of marine animals to environmental physico-chemical and/or biological constraints.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Biogeochemical Cycles in the Ocean
MER Code	MER ULiège OCEA0055-5
ECTS	6
Level	Optional
Semester	3
Timetable slot	To be advised
Teaching Staff	B Delille (Coord.); A Mouchet
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, the student should:	1. understand the principal biogeochemical cycles which govern the Earth system and to acquire the basic concepts for their modelling. 2. 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, the student should be able to:	1. Undertake basic modelling of biogeochemical cycles

Programme/Syllabus	1. Origins of the elements and their history during the formation of the Earth. 2. Description of the large reservoirs and the major biogeochemical phenomena. 3. 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. 4. 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. 5. Importance of the biogeochemical cycles, in the structuring of the ecosystem: case of the Antarctic Ocean 6. Disturbance of the carbon cycle: oceanic acidification. 7. 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.
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.

Course/Unit	Biology of Marine Mammals
MER Code	ULiège OCEA0063-1
ECTS	6
Level	Optional
Semester	3
Timetable slot	To be advised
Teaching Staff	K Das (Coord.); T Jauniaux
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, the student 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, the student 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/Syllabus	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. 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. 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.
Learning & Teaching	(30 hr Th; 10 hr Pr) • Seminars presented by invited researchers. • Written/oral report on a selected topic.
Bibliography	PowerPoint presentation and reference publication will be available on eCampus.
Assessment	Oral presentation on a topic chose by the student in the field of Marine Ecotoxicology. The topic has to be approved by the Professor.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Ecotoxicology of Marine Pollutants
MER Code	MER ULiège OCEA0062-1
ECTS	6
Level	Optional
Semester	3
Timetable slot	To be advised
Teaching Staff	K Das (Coord.)
Synopsis	Impact of pollutants. Bioavailability, bioaccumulation, biomagnification and toxicity. Degradation and metabolisation of micropollutants. Global change and oceans.
Aims	To develop critical thinking to study the biological impact of pollutants in the sea
Objectives At the end of the Unit, the student should:	1. Understand the threats of chemical pollution to the marine environment, how to assess them and how then can be combated 2. Develop a critical spirit via the study of a fact of topicality, its presentation via the scientific media and its bases.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. critically review studies on the impact of pollutants in marine organisms 2. perform library search and make an oral presentation of a scientific result.

Programme/Syllabus	1. 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 metabolisation of the micropollutants. Global changes and oceans.
Learning & Teaching	(35 hr Th; 15 hr Pr) • Seminar (oral) prepared by each student and requiring a library search.
Bibliography	PowerPoint presentation and reference publication will be available on eCampus.
Assessment	Oral presentation on a topic chose by the student in the field of Marine Ecotoxicology. The topic has to be approved by the Professor.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Functional and Molecular Marine Microbiology
MER Code	MER ULiège OCEA0064-1
ECTS	6
Level	Optional
Semester	3
Timetable slot	To be advised
Teaching Staff	A Wilmotte (Coord)
Synopsis	Biodiversity, ecology and evolution of marine microbes. Molecular techniques to study diversity and ecology of marine microorganisms.
Aims	To provide the basic knowledge on the importance and biodiversity of microorganisms in marine biotopes, on the genetic processes responsible for their diversification, and on the molecular methods used to characterize their biodiversity and functions
Objectives At the end of the Unit, the student should:	1. Have an integrated picture of the impact of bacteria in oceanic systems. 2. Critically understand the literature related to the diversity of the marine microorganisms.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Use molecular techniques to study diversity and ecology in marine microorganisms.

Programme/Syllabus	1. Introductory remarks on bacteriology. 2. Biodiversity of the marine microorganisms. 3. Molecular approaches to the diversity of marine microorganisms. 4. Molecular markers to study diversity at the genetic level and ecological implications (geographical distribution, endemism). 5. Mechanisms of microbial evolution 6. Phylogenetic analyses of molecular sequences Practicals: 1. Laboratory exercise : DNA extraction, amplification by Polymerase Chain Reaction of the 16S rRNA gene of strains of marine cyanobacteria, electrophoresis on agarose gel 2. Bioinformatic exercise: phylogenetic analyses of the obtained 16S rRNA sequences.
Learning & Teaching	• Lectures: 25 hr • Seminars and Practicals: 25 hr
Bibliography	• Powerpoint presentations available to the students. • Reference work: “Microbial Ecology of the oceans”, D.L. Kirchman, ED. Wiley-read Inc.
Assessment	• Oral examination on the theory (75%) • Presentation of an article and answer to questions (25%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Marine Plant Biology and Ecology
MER Code	MER ULiège OCEA0056-1
ECTS	6
Level	Optional
Semester	3
Timetable slot	To be advised
Teaching Staff	S Gobert (Coord)
Synopsis	Seagrasses (marine Magnoliophyta) live in the coastal waters of most of the worlds' continents. After a brief introduction (definition, distribution, adaptation, taxonomy...), the course presents a broad spectrum of researches and techniques of samplings focused on the marine magnoliophyta.
Aims	To provide an overview of the diversity and ecology of marine plants, the human impact they are subjected to, and the most relevant remedial actions that can be advised to coastal managers.
Objectives At the end of the Unit, the student should:	1. understand the diversity of the marine primary producers, at a global scale 2. identify the great production systems 3. understand how environmental factors control marine primary production 4. know the human impact on the dynamics of phytoplankton and macroalgae 5. know concepts relevant to advise in coastal water management (emphasis in Mediterranean species and ecosystems).
Key Skills Acquired At the end of the Unit, the student should be able to:	1. identify major marine plants taxa 2. design an ecological study of marine plant communities 3. provide basic advice to coastal managers

Programme/Syllabus	1. Diversity and ecology of the marine primary producers (phytoplankton and macroalgae) 2. Ecology of marine magnioliophytes (formerly named marine phanerogames) which form coastal ecosystems: reproduction, dynamics of carbon, the nutrients, reproduction, protection… 1. Laboratory practicas: measurement of the pigments phytoplanktonic (chemotaxonomy). 2. Seminars: presentation of a recent publication, a congress communication, for discussion.
	1
Learning & Teaching	• Lectures: 30 hr • Seminar and Practicals: 20 hr
Bibliography	• Ppt presentations are available to students. • Reference scientific articles.
Assessment	• Oral examination. • Preparation of a research project on a given topic. (Overall rating modulated by appreciation on the work carried out during Staresso training course
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Numerical Methods Applied to the Environment
MER Code	MER ULiège MECA00551
ECTS	6
Level	Optional
Semester	3
Timetable slot	To be advised
Teaching Staff	J Beckers (Coord.);
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, the student should:	1. understand the modelling tools useful for the study of the marine environment.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. work out tools of numerical resolution adapted to the problems encountered in the quantitative study of the environment. 2. work out a digital model for a new problem, while being conscious of the inherent limitations.

Programme/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. 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.
Learning & Teaching	(30 hr Th; 30 hr Pr) • Lectures: 30 hr (2 hr/wk) • Practical simulation : 30 hr
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.

Course/Unit	Professional Placement in Marine /Environmental Sectors
MER Code	MER ULiège PLUS0001
ECTS	6
Level	Optional
Semester	3
Timetable slot	N/A
Teaching Staff	S Gobert and A Alvera (Coord.)
Synopsis	Before starting Semester 3, students follow a Professional Placement of around 150 hours (4 weeks maximum) within an associated partner of the MER+ EMJMD Consortium. Students work under the guidance of a mentor in this host organisation and an academic supervisor from the partner universities. Through the Professional Practice the student will be immersed in the working environment and will get acquainted with real-life job world.
Aims	• to become familiar with different workplace functions and roles expected for a particular profession. • to facilitate a period of professional practice to assist students in making an informed decision concerning their career path.
Objectives At the end of the Unit, the student should:	1. develop professional competence, increase self awareness and career development prospects. 2. understand how knowledge acquired during schooling may be applied to solving problems in real world situations.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. understand the process of thinking, reflecting and critically evaluation. 2. communicate and work effectively with others; 3. show initiative and work independently; 4. organise their workload and set priorities; 5. respond to new challenges and changing situations

Programme/Syllabus	Professional placements are offered by MER Consortium partners along Year 1 of the programme; especially, but not only, as summer internships. They consist of internships carried out in compliance of the ECTS recognition requirements approved by the JPB for the Professional Placement module; say, it should be an internship in a MER Consortium partner carried out under the supervision of a professional mentor and an academic supervisor, and must be recognised as eligible for Professional Placement in the individual student agreement. Documentation including the assessment and its approval by the MER+ must be submitted before Semester 3 to the ULiège UAB to be recognised as an optional 6 ECTS module in place of one of the optional courses. A Professional Placement agreement will arrange the rights and duties of both the student and Professional Placement provider.
Learning & Teaching	• 125 hr in situ • 25 hr homework
Bibliography	N/A
Assessment	The student will submit an activity report. The Professional mentor will submit independently an assessment report. The academic supervisor will consider both reports and might have interviews with both the student and the mentor, and will propose a mark that will be ratified by the JPB.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Remote Sensing of the Oceans
MER Code	MER ULiège OCEA00031-00041
ECTS	6
Level	Optional
Semester	3
Timetable slot	To be advised
Teaching Staff	A. Alvera (Coord.)
Synopsis	Information given by the remote sensing images. Treatments of remote sensing images. Image processing software. Data processing of complete sequences of satellite images. Bio-geo-physical parameters given by remote sensing images.
Aims	To provide advanced knowledge and training in remote sensing of the oceans.
Objectives At the end of the Unit, the student should:	1. Understand the process of acquisition and the nature of information of the remote sensing images 2. Know the principal types of treatments applied to remote sensing images. 3. Acquire expertise in the functionalities of image processing, by means of typical software tools.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Process, analyze and interpret satellite data by applying specific software

Programme/Syllabus	Introduction Electromagnetic Spectrum Types of satellite sensors Orbits, geolocation Atmospheric effects, atmospheric transmission of the signal, Radiative Transfer Visible waveband radiometers - Ocean Colour Infrared waveband radiometers - Sea Surface Temperature (SST) Microwave waveband radiometers - SST, salinity, wind, sea ice, rain Satellite data processing Applications of ocean remote sensing data: - Large scale to submesoscale applications - Synergy applications using multiple satellite sources - Satellite data analysis exercises
Learning & Teaching	• Formal Lectures: 30 hr • Practical work: 30 hr
Bibliography	• Selected bibliography: - Measuring the Oceans from Space: The principles and methods of satellite oceanography, Ian Robinson, 2004 - Discovering the Ocean from Space: The Unique Applications of Satellite Oceanography, Ian Robinson, 2010. - An Introduction to Ocean Remote Sensing. Seelye Martin. (2nd edition, 2014). Cambridge University Press. doi:10.1017/CBO9781139094368. • Slides available as pdf and downloadable on the Uliege e-campus website
Assessment	• Theoretical exam 75% (writen) • Practical exercise 25% (written report)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

LINK TO UAc MER WEBSITE

SEMESTER 1		
COURSE	ECTS	TYPE
Analyses of Environmental Data and Modelling	6	CAS1
Biological Oceography	6	CAS1
Chemical Oceanography	6	CAS1
Dynamic Oceanography	6	CAS1
Seafloor Geology	6	CAS1

SEMESTER 3		
COURSE	ECTS	TYPE
Marine Ecology	6	CAS3
Aquaculture and Blue Biotechnology	6	OPT
Biology of Marine Mammals	6	OPT
Fisheries and Fish Biology	6	OPT
Geographical Information Systems	6	OPT
Maritime and Coastal Spatial Planning and Law	6	OPT
Oceans and Health	6	OPT
Remote Sensing of the Oceans	6	OPT

CAS1: Compulsory at UAc Semester 1
CAS3: Compulsory at UAc Semester 3

Course/Unit	Analyses of Environmental Data and Modelling
MER Code	MER UAc 0001 (eq. MER UBx 0703)
ECTS	6
Level	Compulsory (UAc)
Semester	1
Timetable slot	To be advised
Teaching Staff	Luís Filipe Dias e Silva (coord.)
Synopsis	Basic methods for the representation, analysis and modelling of environmentally-relevant data.
Aims	1. solve problems of descriptive statistics and its application to environmental sciences 2. solve problems of analytical statistics and its application to environmental sciences 3. interpret deterministic and statistical models 4. be familiar with the use of representation basic methods in environmental sciences.
Objectives At the end of the Unit, the student should:	1. understand the principles and methods of descriptive statistics, applied to environmental data. 2. understand the concepts of the principles and methods of variability and trend analyses, applied to environmental data. 3. understand data modelling in environmental sciences.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. solve problems of descriptive statistics and its application to environmental sciences 2. solve problems of analytical statistics and its application to environmental sciences 3. interpret deterministic and statistical models 4. be familiar with the use of representation basic methods in environmental sciences.

Programme/Syllabus	I. Tools for the description of environmental parameters. II. Tools for the description of biological and ecological parameters. III. Development of Numerical Ecology from an historical perspective. IV. Analysis of species distribution patterns and their relationship with abiotic, biotic, and anthropogenic parameters V. Tools for describing ecological communities and species richness patterns. VI. Similarity indexes, distances, and biological diversity indices. VII. Ordering of species, communities, and environmental factors. VIII. Models applied to environmental and ecological parameters without spatialization. IX. Models applied to environmental and ecological parameters with spatialization. X. Procedures for training, validation, selection, and projection of ecological and environmental models. XI. Some cutting-edge methods in numerical ecology: machine learning, Bayesian models. XII. Modeling methods available in freeware applications.
Learning & Teaching	• Formal Lectures and pratical sessions : 45 hr
Bibliography	Borcard D, Gillet F, P Legendre (2011). Numerical Ecology with R. Springer, New York, 306 pp. Danilson, Romeiras Maria M, Silva Luís. Implications of climate change on the distribution and conservation of Cabo Verde endemic trees. Global Ecology and Conservation 34 (2022): e02025. Dutra Silva L, Elias RB, Silva L (2021). Modelling invasive alien plant distribution: A literature review of concepts and bibliometric analysis. Environmental Modelling and Software, 145: 105203. Humphries G, Magness DR, Huettmann Falk (Eds.) (2018) Machine learning for ecology and sustainable natural resource management. Springer International Publishing, 441 pp. Pavão D, Elias R, Silva L (2019) Comparison of discrete and continuum community models: Insights from numerical ecology and Bayesian methods applied to Azorean plant communities. Ecological Modelling, 402: 93-106. Scutari M, Denis J-B (2015) Bayesian networks with examples in R. CRC Press, Taylor & Francis Group, Boca Raton, 221 pp.
Assessment	The evaluation will be based on the response to an individual questionnaire, qualitative and quantitative participation in the discussion forum, and on the preparation of a group report on a modeling exercise that integrates the topics taught.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the UAc Academic Quality & Standards Committee.

Course/Unit	Biological Oceography
MER Code	MER UAc 0002 (eq. MER UBx 0001)
ECTS	6
Level	Compulsory (UAc)
Semester	1
Timetable slot	To be advised
Teaching Staff	Ana C. Costa (Coord.)
Synopsis	Introduction to general ecological principles relating to the ocean and description of the ocean environment and interaction with biological communities in marine environment.
Aims	To provide an introduction to biological oceanography and the methods and procedures employed in marine biological exploration. Introduction to general ecological principles relating to the ocean and description of the ocean environment and interaction with biological communities in marine environment.
Objectives At the end of the Unit, the student should:	1. Understand, describe and interpret the interactions of organisms within the oceanic ecosystem, including the relations with physical, chemical and climatic processes. 2. Know the biological processes in the pelagic environment of the world ocean, including: a) Primary and secondary production b) Recycling process c) Open Ocean, shelf and upwelling production
Key Skills Acquired At the end of the Unit, the student should be able to:	1. apply tools for the description and comparison of marine populations, diversity measurements and ecosystem functioning, as a response to environmental conditions. 2. become familiar with basic laboratory and fieldwork in biological oceanography and be able to perform basic laboratory and fieldwork in biological oceanography; 3. understand and interpret scientific literature on biological oceanography

Programme/Syllabus	1. General ecological principles relating to the ocean and description of the ocean environment. 2. Physical factors influencing primary productivity. 3. Primary production and productivity. 3.1 Phytoplankton. Diversity and Ecology. HABs. 3.2 Oxygen relationships and anoxic conditions. 3.3 Nutrients and productivity, breakdown of organic material, and regeneration of nutrients; Microbial loop. 3.4 Biogeochemical cycles: C, N, P, Fe and Si and primary production. 3.5 Carbon sink and Climatic regulation. 4. Pelagic secondary production (zooplankton) 5. Food webs. Herbivory and vertical migrations. Nekton; Diversity, organisation, and interaction. Importance of vertical flux of organics in the water column, implications of vertical migration. Food web dynamics and ecosystem functioning.
Learning & Teaching	• Formal Lectures: 30hr • Field and pratical work: 30hr
Bibliography	Garrison, T. & R. Ellis 2016 Oceanography. An invitation to Marine Science. Cengage Learning. 604pp Lalli, C., & Parsons, T. R. 1997. Biological oceanography: an introduction. Elsevier. Levington, J 2010 Marine Biology: International Edition: Function, Biodiversity, Ecology Miller, C. B., & Wheeler, P. A. 2012. Biological oceanography. John Wiley & Sons. Townsend, D. W. 2012. Oceanography and marine biology: an introduction to marine science. Sunderland: Sinauer Associates. Trujillo, A. & H. Thurman, 2005. Essentials of Oceanography. 8th edition. Pearson Prentice Hall 532pp Webb, P. (2021). Introduction to oceanography. Roger Williams University.
Assessment	• Written examination (50 %) • Written Practical Reports and Assignments (50 %)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the UAc Academic Quality & Standards Committee.

Course/Unit	Chemical Oceanography
MER Code	MER UAc 0003 (eq. MER UBx 0002)
ECTS	6
Level	Compulsory (UAc)
Semester	1
Timetable slot	To be advised
Teaching Staff	António Trota (Coord.)
Synopsis	Topics covered will include: the description of the chemistry of sea-water; marine biogeochemistry; chemical fluxes from the continent to the ocean.
Aims	To provide an understanding of: the chemical composition of the sea and learn quantitative approaches to element reactivity at various interfaces and interactions with marine biosphere, (bio)geochemical transfer processes, at different scales (time and space).
Objectives At the end of the Unit, the student should:	a) Characterize the chemical composition of seawater, both in terms of dissolved solids (main, secondary and trace elements) and in terms of particulate matter. b) Understand spatial and in depth compositional variability. c) Associate the chemical composition of sea water with ocean circulation. d) Understand the mechanisms that modify the chemical composition of seawater. e) Understand the anthropogenic influence on the chemical composition of sea water, particularly on acidification. f) Characterize the main mechanisms of mass transport to the oceans. g) Establish geochemical balances for the main species in solution in seawater. h) Conceptualize models of chemical composition of sea water. i) Characterize the main geochemical cycles and understand the role of seawater on them. j) Characterize the chemical composition of marine sediments. k) Understand the importance of marine sediments as geochemical sinks.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. understand through an interdisciplinary approach the chemical composition of the sea 2. become familiar with quantitative approaches to element reactivity at various interfaces, interactions with the marine biosphere, (bio)geochemical transfer processes at different scales of time and space.

Programme/Syllabus	1: Salinity/temperature/density/CO2/alkalinity. Main elements of sea water. Minor and trace elements of sea water. Particulate matter. 2: Processes that modify the composition of seawater. Biological processes. Interaction with volcanic activity. Interaction with marine sediments. Anthropogenic influence: pH and ocean acidification. 3: Mass transport to the oceans: the water, the atmospheric and the hydrothermal vias 4: Geochemical balances. The concept of residence time. Geochemical balances: Cl, Na, S, Mg, K, Ca, HCO3, Si, P and N. Modeling the chemical composition of sea water. 5: The geochemical cycles and the oceans: the carbon cycle, the phosphorus cycle and the nitrogen cycle. 6: Geochemistry of marine sediments. Classification and composition. Marine sediments as geochemical sinks.
Learning & Teaching	• Formal Lecture and Practicals: 60 hr
Bibliography	Berner, E.K. & Berner R.A. (2012) Global environment. Water, air and geochemical cycles. Princeton University Press, Princeton, 444 p. Chester R. & Jickells, T. (2012) Marine geochemistry. Wiley-Blackwell, Chichester, 411 p. Kump, L.R., Kasting, J.E. & Crane R.G. (2010) The earth system. Prentice-Hall, San Francisco. Ryan, P. (2014) Environmental and low temperature geochemistry. Wiley-Blackwell, Chichester, 402 p. Schlesinger, W.H. (1997) Biogeochemistry. An analysis of global change. Academic Press, San Diego, 588 p. Thurman, H.V. & Trujillo, A.P. (2002) Essentials of oceanography. Prentice-Hall, Upper Saddle River, 524 p.
Assessment	• Theoretical part (50%): Test the understanding of the theoretical part of the course, through essay questions and numerical problems. • Practical part (50%): A data analysis exercise based on practical work carried out during the boat work week and laboratory practices.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the UAc Academic Quality & Standards Committee.

Course/Unit	Dynamic Oceanography
MER Code	MER UAc 0004 (eq. MER UBx 0003)
ECTS	6
Level	Compulsory (UAc)
Semester	1
Timetable slot	To be advised
Teaching Staff	Ana Maria Martins
Synopsis	Introduction to Ocean dynamics. Topcis covered shall include: the physical properties of sea water; fluid mechanics and basic principles of physics applied to ocean waters, the dynamics of wind-driven ocean circulation, thermohaline circulation, the role of the ocean in climate variability.
Aims	This course provides an introduction to Ocean Dynamics at a level suitable for graduate students entering oceanography. Students are introduced to the field of dynamic physical oceanography and its relation to the material of descriptive (synoptic) oceanography. The main aim is that students with different backgrounds realize the importance of obtaining quantitative information from the Ocean to understand observational aspects of physical oceanography as well as, to understand how physical-biological-chemical or geological interactions/ processes occur in the Ocean.
Objectives At the end of the Unit, the student should:	1. understand basic principles of fluid dynamics. 2. understand the physical seawater properties and the movement of those properties in the ocean. 3. understand ocean range of time- and space-scales (i.e. from small-scale mixing processes to global ocean circulation; 4. understand atmospheric and meteorological physical parameters;
Key Skills Acquired At the end of the Unit, the student should be able to:	1. solve problems of fluid dynamics 2. interpret data of descriptive physical oceanography 3. interpret meteorology data

Programme/Syllabus	1.- Introduction to fluid dynamics (e.g. the physical properties of fluids, equation of motion, Navier Stokes equations, geostrophic equilibrium, Ekman transport and layer, Reynolds number, vorticity) 2.- Descriptive Oceanography (e.g. physical seawater properties, instrumentation, mesoscale and large scale circulations, regional Oceanography, ocean-atmosphere interactions) 3.- Meteorology (e.g. physical parameters, structure and composition of the atmosphere, high and low pressure systems, cloud formation and types, geostrophic winds and surface wind flows, global atmospheric circulation)
Learning & Teaching	• Formal Lectures: 24 • Seminar: 30 • Field work: 6
Bibliography	The lecture material shall be provided to students. The access to this will be provided during the course. Recommended books: Introductory Dynamical Oceanography. 2nd Edition. Authors: Stephen Pond George L. Pickard. eBook ISBN: 9780080570549. Paperback ISBN: 9780750624961. Imprint: Butterworth-Heinemann. Published Date: 22nd October 2013.
Assessment	• Written examination (50 %) • Oral examination (20 %) • Practical examination (30%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the UAc Academic Quality & Standards Committee.

Course/Unit	Seafloor Geology
MER Code	MER UAc 0005 (eq. MER UBx 0004)
ECTS	6
Level	Compulsory (UAc)
Semester	1
Timetable slot	To be advised
Teaching Staff	José Virgílio Cruz (Coord.), Paulo Amaral Borges
Synopsis	General characterization of the of marine and coastal environments, with respect to geology, geochemistry and oceanography, as a common ground for further studies in different domains of marine sciences (e.g. paleoclimatology, sedimentology, hydrography, coastal management).
Aims	To integrate knowledge within the Earth Sciences in order to characterize the active geological processes in the ocean floor and coastal areas, and the resulting geodiversity.
Objectives At the end of the Unit, the student should:	1. Understand the main mechanisms of the Earth internal dynamics and their implications for the marine and coastal geology; 2. Understand geodiversity and identify the different materials in the marine branch of the geological cycle; 3. Understand the ocean floor and coastal areas morphology with respect to the processes that led to their genesis and their evolution over time; 4. Describe sediments found in different water depths and settings, and understand the sedimentary processes leading to their deposition; 5. Describe the main geological and geophysical techniques for observing the seabed and coastal areas; 6. Describe the main geochemical cycles and their relationship to marine and coastal processes. 7. Identify key geological resources in the marine environment.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Handling and interpretation of marine geology and water geochemistry data (Imaging, seismic, magnetic anomalies, water analyses); 2. Comprehensive domain of the main sampling and analytical techniques; 3. Generic skills: report writing, scientific writing.

Programme/Syllabus	1. THE EARTH AS A DYNAMIC SYSTEM: 1.1. Evolution, evaluation, internal structure and composition.1.2. Formation of the atmosphere and oceans 2. PLATE TECTONICS: 2.1. Continental Drift. 2.2. Plate Tectonics Theory. 2.3. hot spots 3. THE GEOLOGICAL CYCLE: 3.1. Magmatism and Volcanism. 3.2. metamorphism. 3.3. Sedimentation. 3.4. Minerals and Rocks 4. OCEANIC BED MORPHOLOGY: 4.1. Determining factors of relief in oceanic areas. 4.2. Shapes and structures of the ocean floor. 4.3. Origin and morphology of ocean basins and margins. 4.4. Origin and composition of marine sediments 5. COASTAL GEOLOGY: 5.1 Sedimentation. 5.2 Wave impacts. 5.3 Storm surges. 5.4 Coastal erosion. 5.5 Marine transgression and regression 6. STUDY METHODS IN MARINE GEOLOGY: 6.1. Direct methods. 6.2. Indirect methods 7. GEOCHEMICAL CYCLES AND THE OCEANS: 7.1. Cycles of carbon, phosphorus and nitrogen 8. GEOLOGICAL RESOURCES OF THE OCEANIC FLOOR: 8.1. Energy resources. 8.2. Metallic and non-metallic resources
Learning & Teaching	• Formal Lectures: 30 • Seminar: 20 • Field work: 10
Bibliography	Berner, E.K., Berner R.A. (2012) Global environment. Water, air and geochemical cycles. Princeton University Press, Princeton, 444 p. Bird, E. (2000) - Coastal geomorphology, an introduction. Wiley, Chichester, 332 p. Chester R., Jickells, T. (2012) Marine geochemistry. Wiley-Blackwell, Chichester, 411 p. Davis, R.A. Jr., Fitzgerald, D.M. (2004) - Beaches and coasts. Blackwelf, Oxford, 419 p. Kump, L.R., Kasting, J.E., Crane R.G. (2010) The earth system. Prentice-Hall, San Francisco. Seibold, E., Berger, W. (2017) - The Sea Floor. An Introduction to Marine Geology. Springer, 4th Ed., 272 pp. Thurman, H.V., Trujillo, A.P. (2002) Essentials of oceanography. Prentice-Hall, Upper Saddle River, 524 p.
Assessment	• Theoretical exam 75% (writen) • Presentation of a practical exercise 25%
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the UAc Academic Quality & Standards Committee.

Course/Unit	Marine Ecology
MER Code	MER UAc 0006 (eq. MER ULiège OCEA0057-7)
ECTS	6
Level	Compulsory (ULiège)
Semester	3
Timetable slot	To be advised
Teaching Staff	Ana Costa (Coord.), José Azevedo
Synopsis	Foundations of marine ecology. Biodiversity or marine organisms. Sampling techniques Case studies, by applying marine ecology sampling techniques in coastal areas (field tript to St, Cristo lagoon - S. Jorge island) and/or open ocean (boat survey on neustonic biodiversity). It includes a Field Course in Faial.
Aims	• To provide an introduction to ecology focuses on specific marine ecological concept, covering interactions between marine organisms and the environment at scales of populations, communities, and ecosystems. • To give a basic knowledge of ecological characteristics and processes in the marine environment. • To show the importance, complexity and fragile aspects of different types of marine habitats. • To conceptualize, parameterize and implement mathematical • To allow the use several, non-destructive, sampling methods on coastal/intertidal/shallow underwater zones of the Azorean shores (Atlantic islands).
Objectives At the end of the Unit, the student should:	1. Have familiarity with the tools and procedures to conduct ecological non destructive surveys in selected marine ecosystems. 2. Be able to explain the factors that determine the spatial distributions and abundance populations of marine neustonic species in relation with biotic and abiotic factors. 3. Understand the importance of the selected marine ecossystems.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Carry out monitoring surveys in the selected marine ecosystems and identify the majority of the species collected 2. Analyse and interpret the data collected during the monitoring surveys. 3. Work collaboratively and communicate the results of the surveys to the society.

Programme/Syllabus	1. Introduction to the selected marine ecosystems of the Azores: - Coastal lagoons (St. Cristo – São Jorge island); - Submarine sand banks: - Neuston - high sea surface ecosystem. 2. Biodiversity of the selected ecosystems (species): - Algae and plants; - Invertebrates; - Vertebrates. 3. Application of marine ecology sampling techniques to the field course surveys in coastal areas (St. Cristo lagoon - S. Jorge island) and/or in open ocean campaigns (boat survey on neustonic biodiversity). 4. Data analysis 5. Writing of the final report and presentation
Learning & Teaching	• Lectures: 5 h • Field surveys: 26 h • Data analysis: 24 h • Oral presentations: 5h
Bibliography	Cunliffe, M. & Wurl, O. (2014). Guide to best practices to study the ocean's surface. Plymouth, UK, MBA, U.K. for SCOR, 118pp. (Occasional Publications of the MBA-UK. https://doi.org/10.25607/OBP-1512 Morton, B., J.C. Britton & A.M.F. Martins (1998). Coastal Ecology of the Azores. Sociedade Afonso Chaves, Ponta Delgada. 249 pp.; Segar D.A. (2018). - Introduction to Ocean Sciences. 4rd ed. Author Edition. (https://www.reefimages.com/oceans/SegarOcean4Book.pdf) • PowerPoint presentations available online on course website
Assessment	• Final individual writen test: 55%; • Working group with oral presentation and discussion: 45%.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the UAc Academic Quality & Standards Committee.

Course/Unit	Aquaculture and Blue Biotechnology
MER Code	UAc 0007
ECTS	6
Level	Optional
Semester	3
Timetable slot	To be advised
Teaching Staff	Ana C. Costa (Coord.), Andrea Zita Botelho, Raul Bettencourt, Mª do Carmo Barreto
Synopsis	The syllabus was designed to provide students with knowledge and concepts to recognize the main marine production systems and their biotechnological applications in the pharmaceutical, food and cosmetics industries. (points 1, e 2 of the program contribute to this objective). Points 2 and 3 of the program make it possible to introduce the process from bioprospecting to production and related research (objective 2). Point 1 of the program will contribute to the acquisition of knowledge about the main techniques of cultivation and production of organisms.
Aims	1. to provide an introduction to main concepts of aquaculture and bluebiotecnologies
Objectives At the end of the Unit, the student should:	1. To recognize the main production systems of marine organisms and their economic relevance and biotechnological applications within the medicine, pharmaceutical, food and cosmetic industries, 2. To understand the process from bioprospection to production and related research. 3. To understand main cultivation and organism production techniques 4. To become familiar with some biotech lab techniques as extraction procedures and activity testing 5. To perform analytic thinking in collecting, interpreting, and communicating experimental data
Key Skills Acquired At the end of the Unit, the student should be able to:	1. understand main cultivation and organism production tecniques 2. be familiar with some biotec lab techniques as extraction procedures and activity testing 3. pocess analytic thinking in collecting, intepreting and comunicating experimental data

Programme/Syllabus	1. Marine organisms and resources: 1.1 Selection, Bioprospecting and production. 1.2 Aquaculture of marine organisms - main production systems and objectives of production. 2. Applications of Blue Biotechnology: 2.1. Biotechnological potential of Marine microbes. Why do marine microbes matter in Biotechnology? 2.2 Food production and added value to fisheries' products. 2.3 Pharmaceutical, Medical biomaterials and Nano-Biotechnology, 2.4 Nutraceuticals and cosmeceuticals, 2.5 Industrial Biotechnology.2.6 Bioremediation 3. Molecules from Aquatic Origin: 3.1 Biodiversity and chemical ecology and chemical diversity: Marine natural products as drugs and leads from the Ocean through Biotechnology; Marine Microbial Enzymes. 3.2 Bioprospecting, processes, and ethical issues. 3.3 From prospection to production: Definição de "Omics". Revisão dos conceitos de metagenómica e proteómica na Biotecnologia Marinha. Microbiologia ambiental nos ecosistemas marinhos. Metagenomics, Bio screening, Bioassays and clinical trials. 3.4 Nagoya protocol, intellectual property rights and their implications in biological research and product development. 4. Production of biofuels from marine biomass: Sustainable Biofuel Technology from microalgae 5. Impact of blue biotechnology in marine bioeconomy
Learning & Teaching	• Lectures: 30 hr • Practicals: 30hr
Bibliography	Felix,S, H19(2010) Handbook of Marine and Aquaculture Biotechnology AGROBIOS INDIA -Gavrilescu M.(2010) Environmental Biotecnology: Achievements, Opportunities and Challenges. Dynamic Biochemistry, Process Biotechnology and molecular Biology; 4(1):1-26. -Le Gal, Y., Ulber, R., & Antranikian, G. (2005). Marine Biotechnology (Vol. 96). -Nabti, E. (2017). Biotechnological Applications of Seaweeds. -Naik, M., Dubey, S. (2017). Marine pollution and microbial bioremediation -Pereira H, Amaro H, Katkam NG, Barreira L, Guedes AC, Varela J, Malcata FX (2013) Microalgal biodiesel. In Kennes C, Veiga MC (eds.) Air Pollution Prevention and Control: Bioreactors and Bioenergy, J. Wiley & Sons, ISBN: 9781119943310. -Se-Kwon Kim (Ed.) (2015) Handbook of Marine Microalgae - Biotechnology Advances, Elsevier Inc. 2015. ISBN: 978-0-12-800776-1. -Se-Kwon Kim (Ed.) (2015) Springer Handbook of Marine Biotechnology, Springer-Verlag Berlin Heidelberg. DOI 10.1007/978-3-642-53971-8 -Tidwell JH, 2012. Aquaculture Production Systems. Wiley-Blackwell. 440 pp. H26
Assessment	Evaluation will be based on Written examination (50 %) and Written Practical Reports and Assignments (50 %)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the UAc Academic Quality & Standards Committee.

Course/Unit	Biology of Marine Mammals
MER Code	UAc 0008 (eq. ULiège OCEA0063-1)
ECTS	6
Level	Optional
Semester	3
Timetable slot	To be advised
Teaching Staff	José Azevedo (Coord.)
Synopsis	Introduction to the biology and conservation of marine mammals, using an evolutionary approach
Aims	To provide the context, and tools of analysis, to study the role of marine mammals in the ocean ecosystem and the past and present human impacts.
Objectives At the end of the Unit, the student should:	1. List the main taxonomic groups of marine mammals, and discuss the evolutionary pressures which led to the main features of each 2. Explain the main biological adaptations of marine mammals to the ocean environment 3. Discuss the ecological roles of marine mammals 4. Criticize human interventions in the ocean environment given its impact on marine mammals
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Apply and evolutionary framework to the analysis of biological or ecological issues 2. Write an argumentative essay 3. Use information resources to update its knowledge of the human impact on marine mammals

Programme/Syllabus	The theoretical course consists of lectures and seminars on the following topics 1. evolution of marine mammals- taxonomy and biogeography of cetaceans, pinnipeds and sirenians 2. biological adaptations to life in the ocean- termoregulation, respiration, swimming, feeding, reproduction. 3. conservation of marine mammals- status and trends
Learning & Teaching	(30 hr Th; 10 hr Pr) • Seminars presented by invited researchers. • Written/oral report on a selected topic.
Bibliography	Berta, A. (2020). Return to the sea: the life and evolutionary times of marine mammals. University of California Press. Additional scientific papers, to be selected during the course of the seminars.
Assessment	Beyond participation in the seminars, each student will be required to write an argumentative essay on a theme on the conservation of marine mammals. The production of this essay will follow a process mimicking the production of a scientific paper: an oral presentation, a peer review, and an editorial review before the final submission.The assessment will take into consideration the contributions of each student to the seminars, as well as the grade obtained in the essay.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the UAc Academic Quality & Standards Committee.

Course/Unit	Fisheries and Fish Biology
MER Code	MER UAc 0009
ECTS	6
Level	Optional
Semester	3
Timetable slot	To be advised
Teaching Staff	Régis Santos (Coord.)
Synopsis	Fundamental knowledge on fisheries and fish biology
Aims	To provide an introduction to fisheries and fish biology and the methods and procedures employed in stock assessment.
Objectives At the end of the Unit, the student should:	1. Understand and identify the main living marine resources and the fishing gears used to their capture 2. Understand the sensitivity of the living resources in relation to human interventions such as fishing, pollution and habitat destruction and know the effects of exploitation on different components of the marine ecosystem 3. Study the influence of environmental conditions in the availability and fluctuations in the abundance of marine resources 4. Study various types of emblematic fisheries worldwide (small pelagic, tuna, demersal species, cephalopods)
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Interpret basic data on fisheries and fish biology 2. Become familiar with stock assessment concepts

Programme/Syllabus	1. Main concepts in fisheries biology. Population and stock unit, catches and fishing effort. Main biological parameters (reproduction, growth, mortality). Data collection frameworks. 2. Main exploited living resources: fish, crustaceans, molluscs and algae. Fishing gears and techniques and main types of fishing vessels. 3. The exploitation of living resources: historical evolution and current situation in the world. Fishing in the European Union and Portugal. The fishing industry, economic, political and social considerations. 4. Basic knowledge of theoretical concepts used in stock assessment of commercially exploited marine living resources. 5. Ecological problems of fisheries. Multispecies aspect of fisheries. Bycatches. Interactions between fisheries.
Learning & Teaching	• Formal Lectures: 30 hr • Practical work: 30 hr
Bibliography	• Practical work: 30 hr Cadima, E. L. 2000. Manual de avaliação de recursos pesqueiros. FAO Documento Técnico sobre as Pescas, Nº393. Roma. FAO, 162. Caddy, J.F., Mahon, R. 1995. Reference points for fisheries management.FAO Fisheries Technical Paper. No. 347. Rome, FAO. 83p. King, M. 1995. Fishery biology, assessment and management. Fishing News Books. 341p. Sparre, P.;Venema, S. C. 1997. Introdução à avaliação de mananciais de peixes tropicais. Parte 1:Manual. FAO Documento Técnico sobra as Pescas. No. 306/1, Rev. 2. Roma, FAO.. 404p.
Assessment	• Written examination (60 %) • Practical work and report (40%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the UAc Academic Quality & Standards Committee.

Course/Unit	Geographical Information Systems
MER Code	MER UAc 0010
ECTS	6
Level	Optional
Semester	3
Timetable slot	To be advised
Teaching Staff	Artur Gil (Coord.), Rui Marques
Synopsis	Fundamentals of GIS Science and Technologies. Introduction to GIS software. Acquisition, production and management of GIS data. GIS data processing. Geospatial analysis and modeling. GIS for coastal/marine studies.
Aims	This course aims at providing an introduction to collecting, organizing, processing and analysing GIS data for coastal/marine studies.
Objectives At the end of the Unit, the student should:	1. Understand the processes of coastal/marine GIS data acquisition, production and management. 2. Understand the basic techniques of coastal/marine GIS data processing, modelling and analysis . 3. Identify the potential uses of GIS-based approaches for supporting the development of coastal/marine studies.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Acquire, produce and managing coastal/marine GIS data using GIS software. 2. Processing, modelling and analysing coastal/marine GIS data using GIS software. 3. Conceiving and developing GIS-based approaches for supporting coastal/marine studies.

Programme/Syllabus	1. Fundamentals of GIS Science and Technologies. 2. Design, conception, development and management of a GIS project. 3. Prospection, acquisition, production and management of coastal/marine geospatial data. 4. Geospatial analysis and modelling of coastal/marine GIS data. 5. GIS-based case-studies for supporting coastal/marine studies. 6. Conception and development of students' individual projects.
Learning & Teaching	Working Hours: 160h - Include 70h of Contact (Formal lectures: 20h ; Practical Classes: 50h)
Bibliography	Bartlett, D., & Smith, J. (Eds.). (2004). GIS for Coastal Zone Management (1st ed.). CRC Press. https://doi.org/10.1201/9781420023428 - De Smith, M. J., Goodchild, M. F., & Longley, P. (2007). Geospatial analysis: a comprehensive guide to principles, techniques and software tools. Troubador publishing ltd. Online available at https://spatialanalysisonline.com/HTML/index.html - Hamylton, S. (2017). Spatial Analysis of Coastal Environments. Cambridge: Cambridge University Press. doi:10.1017/9781107707412 - Parthasarathy, K.S.S., & Deka, P.C. (2021). Remote sensing and GIS application in assessment of coastal vulnerability and shoreline changes: a review, ISH J Hydr Eng, 27:sup1, 588-600 - Zeng, T., Zhou, Q., Cowell, P., & Huang, H. (2002). Coastal GIS: Functionality versus applications. J Geospat Eng. 3. 109-126.
Assessment	Theoretical exam (20% of the final grade) Development (in the form of a scientific article, equivalent to 60% of the final grade) and respective oral presentation (equivalent to 20% of the final grade) of an individual project simulating the use of GIS for decision support in a “real world” coastal/marine issue at the local, national or regional level.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the UAc Academic Quality & Standards Committee.

Course/Unit	Maritime and Coastal Spatial Planning and Law
MER Code	MER UAc 0011
ECTS	6
Level	Optional
Semester	3
Timetable slot	To be advised
Teaching Staff	Helena Calado (Coord.)
Synopsis	This module outlines the main International and European maritime law and policies, legal systems, legal instruments and initiatives, and legal issues.
Aims	Familiarization with Maritime and Coastal Planning Concepts such as: Maritime Spatial Planning (MSP), Integrated Coastal Zone Management (ICZM) and with European and international legal framework on MSP and ICZM
Objectives At the end of the Unit, the student should:	Acquire knowledge on European and international legal framework on MSP and ICZM Acquire knowledge on maritime policies for ICZM and maritime spaces; Understand the different legal levels and framework for the regulation of maritime spaces and uses.
Key Skills Acquired At the end of the Unit, the student should be able to:	Familiarization with Maritime and Coastal Planning Concepts such as: Maritime Spatial Planning (MSP), Integrated Coastal Zone Management (ICZM)); - Acquire knowledge on European and international legal framework on MSP and ICZM - Acquire knowledge on maritime policies for ICZM and maritime spaces; - understand the different legal levels and framework for the regulation of maritime spaces and uses.

Programme/Syllabus	I-Concepts and Framework 1.1 -State of Art:: 1.1.1. from terrestrial to Coastal Zone Planning. 1.1.2. from MPAs to MSP. 1.2 Principles: Ecosystem Based Management; Adaptive Management; Stakeholder Involvement; Cross Border Cooperation 1.3 Worldwide Experiences II Tools and Instruments 2.1. Legal Instruments: 2.1.1. MSP International Legal Framework: UNCLOS; ABNJ Saebed Authority; The EU Directives. 2.1.2. The EU Directives and regulation, the Integrated Maritime Policy. 2.1.3. The ICZM Recommendation and the Coastal Zone Management Plans. 2.1.4. The ICZM Mediterranean experience 2.2. Planning Instruments: 2.2.1. Planning Theory. 2.2.2. CZMP specific features. 2.2.3. MSP specific features. 2.2.4. Monitoring and Evaluation
Learning & Teaching	• Formal Lectures: 30 hr • Practical work: 30 hr
Bibliography	CALADO, H. & BENTZ, J. (2013). Mar Policy J 42: 325-333. CALADO, H., et al (2010). Mar Policy 34: 1341 - 1349. CALADO, H.et al (2022). “Maritime Spatial Planning and Sustainable Development”. In Walter Leal Filho,et al (Eds.). Encyclopedia UN SDGs. Life Below Water. 644-655. CEC (2008). Roadmap for Maritime Spatial Planning: Achieving Common Principles in the EU. 791 GUERREIRO J. et al. (2021). Mar Policy. 123. 104294 IOC (2009). Marine Spatial Planning ? A Step-by-Step Approach toward Ecosystem-based Management. Manual and Guides No. 53 ICAM Dossier 6 MONWAR, M.,et al. (2017). GPSAZORES -ACORES-01-0145-FEDER-00002, 41pp. CALADO, H., et al. (2021). The Futures of (Atlantic) MSP. Açoreana 11, 439-445
Assessment	Continuous evaluation.Students assessment is 100% on practical assignments and individual or group reports
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the UAc Academic Quality & Standards Committee.

Course/Unit	Oceans and Health
MER Code	MER UAc 0012
ECTS	6
Level	Optional
Semester	3
Timetable slot	To be advised
Teaching Staff	Patricia V Garcia (coord.), Armindo S Rodrigues
Synopsis	Main classes of pollutants in the ocean, their main sources and impacts on human health. Maritime traffic as potential vias for the spread of disease vectors and as sources of air pollutants - impacts on human health.
Aims	1- Recognize the main groups of pollutants present in the ocean and associate them to their sources; 2- Identify the main impacts of ocean pollutants living organisms and marine communities; 3- Understand the main impacts of ocean pollutants on human health 4- Recognize the relevance of the need for a more holistic approach (OneHealth approach) to understand the complex links between the ocean and human health.
Objectives At the end of the Unit, the student should:	1. be able to understand the process of interaction between pollutants and biological systems; 2. be able to recognize the existence of negative effects on human health as a reflection of the desregulation of the ocean environment by pollutants; 3. be able to develop analytical and critical thinking regarding the effects of pollutants on marine organisms and, ultimately, on human health; 4. be able to use the knowledge and skills acquired for the development of an integrated thinking of the One Health concept.
Key Skills Acquired At the end of the Unit, the student should be able to:	-

Programme/Syllabus	1- Introduction to the main classes of pollutants present in the ocean: a. Anthropogenic (e.g. industrial, domestic and agricultural land-based sources). b. Natural (e.g. volcanism) sources of pollutants. 2- Medical and veterinary pharmaceuticals residues present in the ocean: a. Antibiotic resistance b. Endocrine disruptors. c. Other pharmaceutical residues and their impact in human health 3- Natural biogenic toxins (e.g. cyanobacterial blooms) and human health 4- Traffic of cruise ships and cargo ships as potential routes for the spread of disease vectors 5- Heavy metals in trophic chains and human health 6- Microplastics in trophic chains and human health 7- Radionuclides (naturally occurring in the environment or man-made) in trophic chains and human health 8- Ocean and air quality : a. The ocean as the main source of oxygen breathed by the human population. b. Maritime transport and air pollution and its impact on human health 9- Sessions of analysis and tutored discussion of scientific papers, in groups, on topics related to pollutants of the marine environment and its effects on human health. 10- Study visits to organizations (e.g. Ponta Delgada WWTP, LOTAÇOR; Portos dos Açores,...) with clarification sessions (lectures and conferences) and debate on the role of monitoring and controlling the impacts on human health and ecosystems.
Learning & Teaching	• Formal lectures: 22 hr • Pratical sessions: 10 hr • Seminars: 8 hr
Bibliography	European Marine Board (2013). Linking Oceans and Human Health: A Strategic Research Priority for Europe. Position paper 19 of the European Marine Board, Ostend, Belgium. H2020 SOPHIE Consortium (2020) A Strategic Research Agenda for Oceans and Human Health in Europe. H2020 SOPHIE Project. Ostend, Belgium. ISBN: 9789492043894 DOI: 10.5281/zenodo.3696561 Short, R. E., Cox, D. T., Tan, Y. L., Bethel, A., Eales, J. F., & Garside, R. (2021). Review of the evidence for oceans and human health relationships in Europe: a systematic map. Environment International, 146, 106275. Walsh, P. J., Smith, S., Fleming, L., Solo-Gabriele, H., & Gerwick, W. H. (Eds.). (2011). Oceans and human health: risks and remedies from the seas. Academic Press.
Assessment	• Written test exam: 50 % • Team Work with oral communication: 50 %
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the UAc Academic Quality & Standards Committee.

Course/Unit	Remote Sensing of the Oceans
MER Code	MER UAc 0013 (eq. MER ULiège OCEA00031-00041)
ECTS	6
Level	Optional
Semester	3
Timetable slot	To be advised
Teaching Staff	Ana Maria Martins (coord.)
Synopsis	Definition of remote sensing (applied). Main Earth Observation (EO) fields. Types of ocean remote sensors (Satellite Oceanography). Main information obtained from satellite-derived imagery. Satellite data treatment levels and imagery processing software. Space and time variability of satellite imagery. Satellite derived bio-geo-physical parameters.
Aims	To provide introductory to advanced knowledge and training in satellite oceanography.
Objectives At the end of the Unit, the student should:	1. Understand the process of acquisition and the nature of information of the remote sensing images 2. Know the principal types of treatments applied to remote sensing images. 3. Acquire expertise in the functionalities of image processing, by means of typical software tools.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Understand how sensors on board satellites can provide important information for ocean studies. 2. Recognize levels of satellite data processing. 3. Be able to acquire, process, analyze and interpret satellite data by applying specific software. 4. Understand satellite data advantages and limitations. 5. Recognise major institutions and websites that collect, process, calibrate, validate, archive and distribute ocean-related products from operational satellite remote-sensing missions at different resolutions. 6. Be able to apply and present this field of expertise in scientific and educational contexts.

Programme/Syllabus	Introduction to Ocean Remote Sensing; Physics of Radiation; Electromagnetic Spectrum; Types of satellite sensors; Types of orbits, geolocation; Atmospheric effects, atmospheric transmission of the signal, Radiative Transfer, Signal-to-Noise ratio; Visible waveband radiometers - Ocean Colour; Infrared waveband radiometers - Sea Surface Temperature (SST); Microwave waveband radiometers - SST, salinity, wind, sea ice, rain; Satellite data processing; Applications of ocean remote sensing data: - Large scale to submesoscale applications - Synergy applications using multiple satellite sources - Satellite data analysis exercises
Learning & Teaching	• Formal Lectures: 30 hr • Practical work: 30 hr
Bibliography	• Selected bibliography: - Measuring the Oceans from Space: The principles and methods of satellite oceanography, Ian Robinson, 2004 - Discovering the Ocean from Space: The Unique Applications of Satellite Oceanography, Ian Robinson, 2010. - An Introduction to Ocean Remote Sensing. Seelye Martin. (2nd edition, 2014). Cambridge University Press. doi:10.1017/CBO9781139094368. • Slides available as pdf and downloadable on the Uliege e-campus website
Assessment	• Theoretical exam 75% (writen) • Practical exercise 25% (written report)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator. A full external review by the UAc Academic Quality & Standards Committee.