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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.
Learning & Teaching	1 • 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.