# LINK TO UAc MER WEBSITE

| SEMESTER 1 | | |
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| 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 | | |
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| 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***

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| 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<br>2. solve problems of analytical statistics and its application to environmental sciences<br>3. interpret deterministic and statistical models<br>4. be familiar with the use of representation basic methods in environmental sciences. |
| Objectives<br><br>At the end of the Unit, the student should: | 1. understand the principles and methods of descriptive statistics, applied to environmental data.<br>2. understand the concepts of the principles and methods of variability and trend analyses, applied to environmental data.<br>3. understand data modelling in environmental sciences. |
| Key Skills Acquired<br><br>At the end of the Unit, the student should be able to: | 1. solve problems of descriptive statistics and its application to environmental sciences<br>2. solve problems of analytical statistics and its application to environmental sciences<br>3. interpret deterministic and statistical models<br>4. be familiar with the use of representation basic methods in environmental sciences. |

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| Programme/Syllabus | I. Tools for the description of environmental parameters.<br>II. Tools for the description of biological and ecological parameters.<br>III. Development of Numerical Ecology from an historical perspective.<br>IV. Analysis of species distribution patterns and their relationship with abiotic, biotic, and anthropogenic parameters<br>V. Tools for describing ecological communities and species richness patterns.<br>VI. Similarity indexes, distances, and biological diversity indices.<br>VII. Ordering of species, communities, and environmental factors.<br>VIII. Models applied to environmental and ecological parameters without spatialization.<br>IX. Models applied to environmental and ecological parameters with spatialization.<br>X. Procedures for training, validation, selection, and projection of ecological and environmental models.<br>XI. Some cutting-edge methods in numerical ecology: machine learning, Bayesian models.<br>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.<br>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.<br>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.<br>Humphries G, Magness DR, Huettmann Falk (Eds.) (2018) Machine learning for ecology and sustainable natural resource management. Springer International Publishing, 441 pp.<br>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.<br>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. |

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| 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<br><br>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.<br>2. Know the biological processes in the pelagic environment of the world ocean, including:<br>a) Primary and secondary production<br>b) Recycling process<br>c) Open Ocean, shelf and upwelling production |
| Key Skills Acquired<br><br>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.<br>2. become familiar with basic laboratory and fieldwork in biological oceanography and be able to perform basic laboratory and fieldwork in biological oceanography;<br>3. understand and interpret scientific literature on biological oceanography |

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| Programme/Syllabus | 1. General ecological principles relating to the ocean and description of the ocean environment.<br>2. Physical factors influencing primary productivity.<br>3. Primary production and productivity.<br>3.1 Phytoplankton. Diversity and Ecology. HABs.<br>3.2 Oxygen relationships and anoxic conditions.<br>3.3 Nutrients and productivity, breakdown of organic material, and regeneration of nutrients; Microbial loop.<br>3.4 Biogeochemical cycles: C, N, P, Fe and Si and primary production.<br>3.5 Carbon sink and Climatic regulation.<br>4. Pelagic secondary production (zooplankton)<br>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<br>• Field and pratical work: 30hr |
| Bibliography | Garrison, T. & R. Ellis 2016 Oceanography. An invitation to Marine Science. Cengage Learning. 604pp<br>Lalli, C., & Parsons, T. R. 1997. Biological oceanography: an introduction. Elsevier.<br>Levington, J 2010 Marine Biology: International Edition: Function, Biodiversity, Ecology<br>Miller, C. B., & Wheeler, P. A. 2012. Biological oceanography. John Wiley & Sons.<br>Townsend, D. W. 2012. Oceanography and marine biology: an introduction to marine science. Sunderland: Sinauer Associates.<br>Trujillo, A. & H. Thurman, 2005. Essentials of Oceanography. 8th edition. Pearson Prentice Hall 532pp<br>Webb, P. (2021). Introduction to oceanography. Roger Williams University. |
| Assessment | • Written examination (50 %)<br>• 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. |

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| 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<br><br>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.<br>b) Understand spatial and in depth compositional variability.<br>c) Associate the chemical composition of sea water with ocean circulation.<br>d) Understand the mechanisms that modify the chemical composition of seawater.<br>e) Understand the anthropogenic influence on the chemical composition of sea water, particularly on acidification.<br>f) Characterize the main mechanisms of mass transport to the oceans.<br>g) Establish geochemical balances for the main species in solution in seawater.<br>h) Conceptualize models of chemical composition of sea water.<br>i) Characterize the main geochemical cycles and understand the role of seawater on them.<br>j) Characterize the chemical composition of marine sediments.<br>k) Understand the importance of marine sediments as geochemical sinks. |
| Key Skills Acquired<br><br>At the end of the Unit, the student should be able to: | 1. understand through an interdisciplinary approach the chemical composition of the sea<br>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. |

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| Programme/Syllabus | 1: Salinity/temperature/density/CO2/alkalinity. Main elements of sea water. Minor and trace elements of sea water. Particulate matter.<br>2: Processes that modify the composition of seawater. Biological processes. Interaction with volcanic activity. Interaction with marine sediments. Anthropogenic influence: pH and ocean acidification.<br>3: Mass transport to the oceans: the water, the atmospheric and the hydrothermal vias<br>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.<br>5: The geochemical cycles and the oceans: the carbon cycle, the phosphorus cycle and the nitrogen cycle.<br>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.<br>Chester R. & Jickells, T. (2012) Marine geochemistry. Wiley-Blackwell, Chichester, 411 p.<br>Kump, L.R., Kasting, J.E. & Crane R.G. (2010) The earth system. Prentice-Hall, San Francisco.<br>Ryan, P. (2014) Environmental and low temperature geochemistry. Wiley-Blackwell, Chichester, 402 p.<br>Schlesinger, W.H. (1997) Biogeochemistry. An analysis of global change. Academic Press, San Diego, 588 p.<br>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.<br>• 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. |

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| 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.<br>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<br><br>At the end of the Unit, the student should: | 1. understand basic principles of fluid dynamics.<br>2. understand the physical seawater properties and the movement of those properties in the ocean.<br>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<br><br>At the end of the Unit, the student should be able to: | 1. solve problems of fluid dynamics<br>2. interpret data of descriptive physical oceanography<br>3. interpret meteorology data |

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| 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)<br>2.- Descriptive Oceanography (e.g. physical seawater properties, instrumentation, mesoscale and large scale circulations, regional Oceanography, ocean-atmosphere interactions)<br>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<br>• Seminar: 30<br>• 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 %)<br>• Oral examination (20 %)<br>• 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. |

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| 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<br><br>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;<br>2. Understand geodiversity and identify the different materials in the marine branch of the geological cycle;<br>3. Understand the ocean floor and coastal areas morphology with respect to the processes that led to their genesis and their evolution over time;<br>4. Describe sediments found in different water depths and settings, and understand the sedimentary processes leading to their deposition;<br>5. Describe the main geological and geophysical techniques for observing the seabed and coastal areas;<br>6. Describe the main geochemical cycles and their relationship to marine and coastal processes.<br>7. Identify key geological resources in the marine environment. |
| Key Skills Acquired<br><br>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);<br>2. Comprehensive domain of the main sampling and analytical techniques;<br>3. Generic skills: report writing, scientific writing. |

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| 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<br>2. PLATE TECTONICS: 2.1. Continental Drift. 2.2. Plate Tectonics Theory. 2.3. hot spots<br>3. THE GEOLOGICAL CYCLE: 3.1. Magmatism and Volcanism. 3.2. metamorphism. 3.3. Sedimentation. 3.4. Minerals and Rocks<br>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<br>5. COASTAL GEOLOGY: 5.1 Sedimentation. 5.2 Wave impacts. 5.3 Storm surges. 5.4 Coastal erosion. 5.5 Marine transgression and regression<br>6. STUDY METHODS IN MARINE GEOLOGY: 6.1. Direct methods. 6.2. Indirect methods<br>7. GEOCHEMICAL CYCLES AND THE OCEANS: 7.1. Cycles of carbon, phosphorus and nitrogen<br>8. GEOLOGICAL RESOURCES OF THE OCEANIC FLOOR: 8.1. Energy resources. 8.2. Metallic and non-metallic resources |
| Learning & Teaching | • Formal Lectures: 30<br>• Seminar: 20<br>• Field work: 10 |
| Bibliography | Berner, E.K., Berner R.A. (2012) Global environment. Water, air and geochemical cycles. Princeton University Press, Princeton, 444 p.<br>Bird, E. (2000) - Coastal geomorphology, an introduction. Wiley, Chichester, 332 p.<br>Chester R., Jickells, T. (2012) Marine geochemistry. Wiley-Blackwell, Chichester, 411 p.<br>Davis, R.A. Jr., Fitzgerald, D.M. (2004) - Beaches and coasts. Blackwelf, Oxford, 419 p.<br>Kump, L.R., Kasting, J.E., Crane R.G. (2010) The earth system. Prentice-Hall, San Francisco.<br>Seibold, E., Berger, W. (2017) - The Sea Floor. An Introduction to Marine Geology. Springer, 4th Ed., 272 pp.<br>Thurman, H.V., Trujillo, A.P. (2002) Essentials of oceanography. Prentice-Hall, Upper Saddle River, 524 p. |
| Assessment | • Theoretical exam 75% (writen)<br>• 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. |

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| 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.<br>• To give a basic knowledge of ecological characteristics and processes in the marine environment.<br>• To show the importance, complexity and fragile aspects of different types of marine habitats.<br>• To conceptualize, parameterize and implement mathematical<br>• To allow the use several, non-destructive, sampling methods on coastal/intertidal/shallow underwater zones of the Azorean shores (Atlantic islands). |
| Objectives<br><br>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.<br>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.<br>3. Understand the importance of the selected marine ecossystems. |
| Key Skills Acquired<br><br>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<br>2. Analyse and interpret the data collected during the monitoring surveys.<br>3. Work collaboratively and communicate the results of the surveys to the society. |

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| Programme/Syllabus | 1. Introduction to the selected marine ecosystems of the Azores:<br>- Coastal lagoons (St. Cristo – São Jorge island);<br>- Submarine sand banks:<br>- Neuston - high sea surface ecosystem.<br>2. Biodiversity of the selected ecosystems (species):<br>- Algae and plants;<br>- Invertebrates;<br>- Vertebrates.<br>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).<br>4. Data analysis<br>5. Writing of the final report and presentation |
| Learning & Teaching | • Lectures: 5 h<br>• Field surveys: 26 h<br>• Data analysis: 24 h<br>• 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<br>Morton, B., J.C. Britton & A.M.F. Martins (1998). Coastal Ecology of the Azores. Sociedade Afonso Chaves, Ponta Delgada. 249 pp.;<br>Segar D.A. (2018). - Introduction to Ocean Sciences. 4rd ed. Author Edition. (https://www.reefimages.com/oceans/SegarOcean4Book.pdf)<br><br>• PowerPoint presentations available online on course website |
| Assessment | • Final individual writen test: 55%;<br>• 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. |

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|---|---|
| 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<br><br>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,<br>2. To understand the process from bioprospection to production and related research.<br>3. To understand main cultivation and organism production techniques<br>4. To become familiar with some biotech lab techniques as extraction procedures and activity testing<br>5. To perform analytic thinking in collecting, interpreting, and communicating experimental data |
| Key Skills Acquired<br><br>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 |

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| Programme/Syllabus | 1. Marine organisms and resources:<br>1.1 Selection, Bioprospecting and production. 1.2 Aquaculture of marine organisms - main production systems and objectives of production.<br><br>2. Applications of Blue Biotechnology:<br>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<br><br>3. Molecules from Aquatic Origin:<br>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.<br><br>4. Production of biofuels from marine biomass: Sustainable Biofuel Technology from microalgae<br><br>5. Impact of blue biotechnology in marine bioeconomy |
| Learning & Teaching | • Lectures: 30 hr<br>• Practicals: 30hr |
| Bibliography | Felix,S, H19(2010) Handbook of Marine and Aquaculture Biotechnology AGROBIOS INDIA<br>-Gavrilescu M.(2010) Environmental Biotecnology: Achievements, Opportunities and Challenges. Dynamic Biochemistry, Process Biotechnology and molecular Biology; 4(1):1-26.<br>-Le Gal, Y., Ulber, R., & Antranikian, G. (2005). Marine Biotechnology (Vol. 96).<br>-Nabti, E. (2017). Biotechnological Applications of Seaweeds.<br>-Naik, M., Dubey, S. (2017). Marine pollution and microbial bioremediation<br>-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.<br>-Se-Kwon Kim (Ed.) (2015) Handbook of Marine Microalgae - Biotechnology Advances, Elsevier Inc. 2015. ISBN: 978-0-12-800776-1.<br>-Se-Kwon Kim (Ed.) (2015) Springer Handbook of Marine Biotechnology, Springer-Verlag Berlin Heidelberg. DOI 10.1007/978-3-642-53971-8<br>-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. |

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| 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<br><br>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<br>2. Explain the main biological adaptations of marine mammals to the ocean environment<br>3. Discuss the ecological roles of marine mammals<br>4. Criticize human interventions in the ocean environment given its impact on marine mammals |
| Key Skills Acquired<br><br>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<br>2. Write an argumentative essay<br>3. Use information resources to update its knowledge of the human impact on marine mammals |

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| Programme/Syllabus | The theoretical course consists of lectures and seminars on the following topics<br>1. evolution of marine mammals- taxonomy and biogeography of cetaceans, pinnipeds and sirenians<br>2. biological adaptations to life in the ocean- termoregulation, respiration, swimming, feeding, reproduction.<br>3. conservation of marine mammals- status and trends |
| Learning & Teaching | (30 hr Th; 10 hr Pr)<br>• Seminars presented by invited researchers.<br>• 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.<br>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. |

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|---|---|
| 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<br><br>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<br>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<br>3. Study the influence of environmental conditions in the availability and fluctuations in the abundance of marine resources<br>4. Study various types of emblematic fisheries worldwide (small pelagic, tuna, demersal species, cephalopods) |
| Key Skills Acquired<br><br>At the end of the Unit, the student should be able to: | 1. Interpret basic data on fisheries and fish biology<br>2. Become familiar with stock assessment concepts |

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| 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.<br>2. Main exploited living resources: fish, crustaceans, molluscs and algae. Fishing gears and techniques and main types of fishing vessels.<br>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.<br>4. Basic knowledge of theoretical concepts used in stock assessment of commercially exploited marine living resources.<br>5. Ecological problems of fisheries. Multispecies aspect of fisheries. Bycatches. Interactions between fisheries. |
| Learning & Teaching | • Formal Lectures: 30 hr<br>• Practical work: 30 hr |
| Bibliography | • Practical work: 30 hr<br>Cadima, E. L. 2000. Manual de avaliação de recursos pesqueiros. FAO Documento Técnico sobre as Pescas, Nº393. Roma. FAO, 162.<br>Caddy, J.F., Mahon, R. 1995. Reference points for fisheries management.FAO Fisheries Technical Paper. No. 347. Rome, FAO. 83p.<br>King, M. 1995. Fishery biology, assessment and management. Fishing News Books. 341p.<br>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 %)<br>• 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. |

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| 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<br><br>At the end of the Unit, the student should: | 1. Understand the processes of coastal/marine GIS data acquisition, production and management.<br>2. Understand the basic techniques of coastal/marine GIS data processing, modelling and analysis .<br>3. Identify the potential uses of GIS-based approaches for supporting the development of coastal/marine studies. |
| Key Skills Acquired<br><br>At the end of the Unit, the student should be able to: | 1. Acquire, produce and managing coastal/marine GIS data using GIS software.<br>2. Processing, modelling and analysing coastal/marine GIS data using GIS software.<br>3. Conceiving and developing GIS-based approaches for supporting coastal/marine studies. |

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| Programme/Syllabus | 1. Fundamentals of GIS Science and Technologies.<br>2. Design, conception, development and management of a GIS project.<br>3. Prospection, acquisition, production and management of coastal/marine geospatial data.<br>4. Geospatial analysis and modelling of coastal/marine GIS data.<br>5. GIS-based case-studies for supporting coastal/marine studies.<br>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<br>- 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<br>- 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)<br>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. |

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| 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<br><br>At the end of the Unit, the student should: | Acquire knowledge on European and international legal framework on MSP and ICZM<br>Acquire knowledge on maritime policies for ICZM and maritime spaces;<br>Understand the different legal levels and framework for the regulation of maritime spaces and uses. |
| Key Skills Acquired<br><br>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));<br>- Acquire knowledge on European and international legal framework on MSP and ICZM<br>- Acquire knowledge on maritime policies for ICZM and maritime spaces;<br>- understand the different legal levels and framework for the regulation of maritime spaces and uses. |

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| Programme/Syllabus | I-Concepts and Framework<br><br>1.1 -State of Art::<br>1.1.1. from terrestrial to Coastal Zone Planning. 1.1.2. from MPAs to MSP.<br><br>1.2 Principles: Ecosystem Based Management; Adaptive Management; Stakeholder Involvement; Cross Border Cooperation<br><br>1.3 Worldwide Experiences<br><br>II Tools and Instruments<br><br>2.1. Legal Instruments:<br>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<br><br>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<br>• Practical work: 30 hr |
| Bibliography | CALADO, H. & BENTZ, J. (2013). Mar Policy J 42: 325-333.<br>CALADO, H., et al (2010). Mar Policy 34: 1341 - 1349.<br>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.<br>CEC (2008). Roadmap for Maritime Spatial Planning: Achieving Common Principles in the EU. 791<br>GUERREIRO J. et al. (2021). Mar Policy. 123. 104294<br>IOC (2009). Marine Spatial Planning ? A Step-by-Step Approach toward Ecosystem-based Management. Manual and Guides No. 53 ICAM Dossier 6<br>MONWAR, M.,et al. (2017). GPSAZORES -ACORES-01-0145-FEDER-00002, 41pp.<br>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. |

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| 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;<br>2- Identify the main impacts of ocean pollutants living organisms and marine communities;<br>3- Understand the main impacts of ocean pollutants on human health<br>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<br><br>At the end of the Unit, the student should: | 1. be able to understand the process of interaction between pollutants and biological systems;<br>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;<br>3. be able to develop analytical and critical thinking regarding the effects of pollutants on marine organisms and, ultimately, on human health;<br>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<br><br>At the end of the Unit, the student should be able to: | - |

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| 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.<br>2- Medical and veterinary pharmaceuticals residues present in the ocean: a. Antibiotic resistance<br>b. Endocrine disruptors. c. Other pharmaceutical residues and their impact in human health<br>3- Natural biogenic toxins (e.g. cyanobacterial blooms) and human health<br>4- Traffic of cruise ships and cargo ships as potential routes for the spread of disease vectors<br>5- Heavy metals in trophic chains and human health<br>6- Microplastics in trophic chains and human health<br>7- Radionuclides (naturally occurring in the environment or man-made) in trophic chains and human health<br>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<br>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.<br>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<br>• Pratical sessions: 10 hr<br>• 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.<br>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<br>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.<br>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 %<br>• 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. |

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| 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<br><br>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<br>2. Know the principal types of treatments applied to remote sensing images.<br>3. Acquire expertise in the functionalities of image processing, by means of typical software tools. |
| Key Skills Acquired<br><br>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. |

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