MASTER THESIS GRANT

The Institute of Marine Research offers 10 Master thesis grants to promote scholarly research in marine sciences by students already enrolled in a Master programme at any European University.

These scholarships are focused to master students interested in starting a research career, making possible the realization of a period of fellowship in one of the research groups that develop their work in the Institute of Marine Research (IIM) of the Spanish National Research council (CSIC), according to the thesis topics described below.

Master's students are invited to apply under the following conditions:

Deadline: The first collection date is fixed at 30 September 2019. However, if not suitable candidates are selected a second collection date is fixed at 30 November 2019.

Location: the successful candidates will be based at Instituto de Investigaciones Marinas (Institute of Marine Research) in Vigo, Spain.

Host institution: The IIM is part of the Spanish Council of Scientific Research (CSIC). The CSIC is the largest public research institution in Spain and the third largest in Europe, hosting over 4000 doctoral and post-doctoral researchers across 138 institutes. Its mission is to foster, coordinate, develop and promote scientific and technological research, of a multidisciplinary nature, in order to contribute to advancing knowledge and economic, social and cultural development, as well as to train staff and advise public and private entities on this matter.

The institute is a multidisciplinary research center aimed at contributing to the sustainable development objectives from different research lines: ocean status in regards to climate change, fisheries and aquaculture as means of food supply and food science and technology towards human health.

Funding: Each fellowship will be funded with a monthly stipend of 800€ up to a total of 4,800 € (6 months). The scholarship will not be considered salary or remuneration, but scholarship training.

Period and duration: The intended duration of each fellowship is 6 months, ideally between January and June 2020, although eventually the research stay may be started earlier and finished not later than August 31 2020. It is compulsory to stay from January to March 2020.

Requirements: Applicants must hold a first degree in relevant subjects (see below) and should not have initiated the Master Thesis, but should be already enrolled in a master

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programme. A minimum grade point average is established for each thesis topic (see below).

Training: IIM offers during the research stay a range of short training courses, as i) code of good scientific practice; ii) data management and open science; iii) public outreach and media communication. Regular scientific seminars are also hosted at IIM. The fellows must give a seminar about their thesis results.

Application procedure: Applicants should prepare a single PDF document with

1. A letter of motivation (no more than 1 page)
2. A CV (no more than 4 pages). The CV must include:
   - Basic personal data (date and place of birth, citizenship, language proficiency)
   - Education and work experience,
   - Grade point average (GPA) over all courses, excluding the thesis grade for each diploma. GPA must be provided in the original scale (provided by the corresponding University) plus in 0 -10.00 scales.

The document should be submitted to Fran Saborido-Rey, jaeintro@iim.csic.es

Applicants may contact with the PIs to obtain further information about each thesis theme (details are provided below).

Thesis topics:

IIM offers to conduct Master thesis in the following topics:

1. Applicability of hyperspectral imaging (HPI) technology in the food sector
2. New molecular and remote control technologies for the evaluation of cetacean populations
3. Determining the optimal nutritional requirements for the common octopus (*Octopus vulgaris)* using computational modelling
4. Evaluation of mytilids as bio-indicator of emerging contaminants
5. A high throughput sequencing-based approach for the identification of sex-specific markers in hake (*Merluccius merluccius*)
6. Dynamic genome-scale metabolic modelling for food biotechnology applications
7. Control and monitorization of *Listeria monocytogenes* in the food environment
8. Mechanistic ecological modelling for food biotechnology applications
9. Molecular basis of the inflammatory response using zebrafish as a model
10. Environmental drivers of behaviour and movement patterns of coastal fish species

Details for each topic are found in the table below, including the requirements regarding degree subjects and the GPA.

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#1 Applicability of hyperspectral imaging (HPI) technology in the food sector

Different applications of HPI for improving food control processes and products of high interest for the Food Technology Department will be explored:
-Food analysis. Quick determination of fat content in fish products.
-Food Quality Analysis. Monitoring food quality control parameters.
-Food waste managing. Improving food waste managing and classification.

Supervisor	Marta López Cabo (marta@iim.csic.es)
Degree Subject	Applicants must hold a first degree in biology, chemistry, biotechnology or engineering. Background in mathematical modelling and programming will be valuable.
GPA	Ideally, the minimum must be 8 for sciences degrees or 7 for engineering and in any case GPA below 7.5 and 6.5 respectively will be assessed

#2 New molecular and remote control technologies for the evaluation of cetacean populations

The Marine Strategy Framework Directive requires EU Member States to carry out monitoring and assessment of the environmental status of their marine waters. To do this, various functional groups are monitored and evaluated, in relation to 11 descriptors, including D1 Biodiversity. These functional groups include the cetaceans. In relation to descriptor 1, the main method for evaluating cetacean status is the study of trends in their abundance. Traditional methods, based on sightings from research vessels, are expensive and logistically complex, so they are widely spaced in time (in practice, every 11 years), making difficult to evaluate population trends over the 6-year cycle of MSFD assessment. Thus there is a need to look for new methods which could compliment or even replace large-scale sightings surveys . This JAE ICUS project aims to contribute to the improvement of monitoring programs by developing two innovative methodologies: the detection of DNA from these organisms in water (environmental DNA, eDNA) and the use unmanned aerial vehicles (UAVs) also known as DRONES, to estimate its presence and abundance

Supervisor	Josep Rotllant (rotllant@iim.csic.es) / Graham Pierce (g.j.pierce@iim.csic.es)
Degree Subject	Applicants must hold a first degree in relevant subjects (for example, biology, marine biology, environmental science, biochemistry etc.),
GPA	The minimum required is 8

#3 Determining the optimal nutritional requirements for the common octopus (*Octopus vulgaris)* using computational modelling

Octopus vulgaris is an outstanding candidate for aquaculture productions due to its high market demand and biomass generation rate. Nevertheless, aquaculture of *O. vulgaris* is currently not possible as most reared individuals die at early stages. This premature death in culturing conditions is believed to be caused by a combination of different factors, among them, poor diet and infectious diseases are tightly related. Recent advances in aquaculture techniques are increasing the survival rate of individuals and a pilot culture has been successfully achieved. However, current diets are prohibitively expensive or difficult to obtain calling for the application of systematic methods for the design of feeds.
Flux balance analysis is modelling tools that is widely used in optimization of bio processes that combines the knowledge of reaction stoichiometry (a metabolic network) with the

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biomass composition of organisms to simulate growth. The usage of these tools is currently not possible as no model for *O. vulgaris* exists. The first step in the generation of an *O. vulgaris* metabolic model is the determination of its biomass composition. In this work, the selected candidate will:
1) Explore the literature and recent data to generate a biomass equation of *O. vulgaris* in terms of lipids, amino acids, carbohydrates, RNA, DNA.
2) Once the previous information has been compiled, temptative simulations with the metabolic network of *C. elegans* (the closest organism for which a metabolic network exists) taking in consideration transcriptomic data of healthy and diseased individuals.

Supervisor	David Henriques (davidh@iim.csic.es), Camino Gestal (cgestal@iim.csic.es), Eva Balsa-Canto (ebalsa@iim.csic.es)
Degree	Applicants must hold a first degree in relevant subjects (Biotechnology,
Subject	Bioengineering, Bioinformatics, Computational Biology or similar)
GPA	Ideally the minimum must be 8 for sciences degrees or 7 for engineering and in any case GPA below 7.5 and 6.5 respectively will be assessed

#4 Evaluation of mytilids as bio-indicator of emerging contaminants

In order to understand the spatial patterns and temporal trends of contaminants in coastal areas and estuaries characterized by highly heterogeneity in water and sediments and varying anthropogenic impact, different mytilid species will be used resembling distinct ecological niches that naturally occur in Galician Rías. *Mytilus galloprovincialis* and *Xenostrobus securis* are two mytilids from the same family Mytilidae but compiting for food and space in the inner waters of the Vigo Ria. At the present, *X. securis* corresponds to an exotic species with significant ecological impact on the native communities so far but with potential economical consequences for the near future with regard to the successful cultivation of the other mytilid species *M. galloprovincialis*. The bioaccumulation of common (e.g. Cu, Cd, Pb, Ag) and emerging (e.g. Pt, Gd, Ga, Tl, Nb) metallic contaminants will be evaluated and compared for both mytilid species in order to assess their use as bio-indicators for emerging contaminants in estuarine and coastal areas.

Supervisor	José Manuel Fernández Babarro and Antonio Cobelo-García
Degree	Applicants must hold a first degree in relevant subjects (for example, biology,
Subject	marine biology, environmental science, chemistry, etc.),
GPA	The minimum required is 8

#5 A high throughput sequencing-based approach for the identification of sex-specific markers in hake (*Merluccius merluccius*)

Among the animals that reproduce sexually, teleosts show the widest array of reproductive systems, including all known reproductive styles found in vertebrates. The mechanism of sex determination in fish has attracted a lot of attention from biologist due to the astonishing variety of systems they have evolved, however very little is known about the mechanism of sex determination in the vast majority of fish species.
Understanding the plasticity and the genetic basis of sex determination is of major importance in the evolution of fish. At a more applied level, our ability to identify sex is pivotal for conservation purposes, to assess fish abundance in natural populations and in the design of breeding programs. The genetic sex of many species cannot be deduced from external morphology - a problem usually exacerbated when dealing with embryonic or juvenile forms, or when only small tissue samples are available.

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One effective solution is to exploit DNA markers to diagnose sex. Such sex-specific markers inform as well about the mechanisms underlying sex determination and they have proven useful to determine whether a species has genetic sex determination with either male or female heterogamety.
High throughput sequencing (HTS) offers a unique opportunity for screening genes or sex-associated DNA fragments in non-model species. We propose to use Restriction site Associated DNA Sequencing (Rad-Seq) to identify and isolate sex-specific markers in hake (*Merluccius merluccius*), one of the most important commercially exploited fish species that has been heavily fished for centuries, to aid fisheries assessments and elucidate its sex determination mechanism.

Supervisor	Laura Casas Castaño (lauracasas@iim.csic.es), Fran Saborido-Rey (fran@iim.csic.es)
Degree Subject	Applicants must hold a first degree in biology, marine biology, environmental science, or similar. Background in genomics will be valuable.
GPA	The minimum required is 8

#6 Dynamic genome-scale metabolic modelling for food biotechnology applications

Dynamic genome-scale metabolic models (GEMs) allow for the study of the metabolic response and flux simulation in a system of interest (bacteria, yeasts, algae, etc.) under given environmental conditions. In a GEM, metabolites link to each other through reactions which are associated with enzymes encoded by genes. The stoichiometric matrix represents reactions and is used to define balance equations describing the dynamics of metabolic concentrations as a function of reaction rates (or fluxes). Metabolic fluxes can be then obtained by, for example, Flux Balance Analyses (FBA); which accounts for a specific cellular objective (e.g. maximum growth rate) plus specific constraints on internal and external fluxes. FBA can be solved iteratively to handle dynamic systems.
Recently we have obtained GEMs to explain the metabolism of various yeasts strains from the Saccharomyces genus in fermentation. Models were able to explain the experimental data satisfactorily and provided an ideal tool to identify metabolic differences among species.
The proposed work lies on these previous results and its aims include:

1) Learning how to implement and solve DFBA models following the pipeline we have developed.
2) Applying the DFBA approach to model the behaviour of a particular Saccharomyces strain of industrial interest under two different environmental conditions.
3) To decipher metabolic differences for the different environmental conditions.

Supervisor	Eva Balsa-Canto (ebalsa@iim.csic.es), David Henriques (davidh@iim.csic.es)
Degree Subject	Applicants must hold a first degree in relevant subjects (for example, physics, mathematics, chemistry, chemical, biological or industrial engineering, biotechnology, etc.),
GPA	Ideally, the minimum must be 8 for sciences degrees or 7 for engineering and in any case GPA below 7.5 and 6.5 respectively will be assessed

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#7 Control and monitorization of *Listeria monocytogenes* in the food environment

Preventing *L. monocytogenes* from food is a major objective for food safety. Several measures have been implemented to achieve it, but results are not satisfactory yet. Listeriosis has significantly increased between 2008-2017 in the EU and Spain.

The proposal aims to integrate the student into some on-going projects that the MICROTEC Group is executing on this pathogen, and thus lead him/her to understand the problem of *L. monocytogenes* in the food industry.

1.- *L. monocytogenes* is usually living in biofilms. Biofilms are highly resistant to adverse conditions, which makes removal highly difficult. Modulating molecules are being explored in the medical field to reduce the use of antibiotics, but not in the food environment yet. Among them, quorum sensing inhibitors seems a promising alternative. This is one of the aims of SOLISTA.

2.- Consumers increasingly demand for more natural, fresher and convenience food, such as minimally-processed or ready-to-eat (RTE) food. The prevalence of *L. monocytogenes* was highest in RTE seafood in the UE in 2017. Producing RTE food requires to demonstrate there is no unacceptable risk of *L. monocytogenes*, particularly if a high-risk group is a targeted consumer. This is an aim of SEAFOOD-AGE.

3.- Traditional microbial counting methods are slow and invasive. Detecting *L. monocytogenes* requiees 2-5 days, and only a small number of samples can be analyzed, which drastically reduces representation. There is a need to develop point-of-care sensors for pathogens in the food industry, which would allow a rapid response. This is an aim of FOODSENS.

Supervisor	Juan José Rodríguez Herrera (juanherrera@iim.csic.es), Marta López Cabo (marta@iim.csic.es)
Degree Subject	Applicants must hold a first degree in biology, marine biology, environmental science, or similar.
GPA	The minimum required is 8

#8 Mechanistic ecological modelling for food biotechnology applications

Currently, many biotechnological products such as amino acids, organic acids, antibiotics, vitamins, or enzymes, wine or beer, are almost exclusively produced by single cultures of microorganisms. However, it has been recognised that the interactions among microorganisms in the so-called mixed-culture bioprocesses have the potential to produce new market tailored products and may contribute to improving the sustainability of biotechnological processes. Such interactions include cooperation and competence and depend on the selected species, plus the selected environment (e.g., medium, temperature, etc.). Therefore, the design of successful microbial consortia requires investigating their ecological interactions under different environmental regimes.

In this work, we will focus on yeast fermentation. Currently, *Saccharomyces cerevisiae* strains rule most of the industrial fermentations. However, the use of other species is of the highest interest to obtain novel products while reducing energy consumption.

In this regard, we propose a model-based approach for the design of mixed fermentations that can guarantee the coexistence of the desired species. With this aim, we have recently proposed a mechanistic model to account for the specific cooperation and competence mechanisms (role of nutrients uptake or production of toxic products, etc.) between S. cerevisiae and a non-cerevisiae yeast species.

The primary objectives of this work are:

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1.) To generalise the mechanistic model to account for the role of the temperature
2.) To reconcile the model with experimental data through data fitting
3.) To explore how the temperature shapes the ecology of fermentation.

Supervisor	Eva Balsa-Canto (ebalsa@iim.csic.es), David Henriques (davidh@iim.csic.es)
Degree Subject	Applicants must hold a first degree in relevant subjects (for example, physics, mathematics, chemistry, chemical, biological or industrial engineering, biotechnology, etc.),
GPA	Ideally, the minimum must be 8 for sciences degrees or 7 for engineering and in any case GPA below 7.5 and 6.5 respectively will be assessed

#9 Molecular basis of the inflammatory response using zebrafish as a model

The student will use transcriptomic studies (RNA seq) and several bioinformatic tools to analyze the modulation of the inflammatory response of macrophages and neutrophils against infections. Using zebrafish (*Danio rerio*) we can study the role of different genes in the innate immune response, mainly those with relevance in human inflammatory diseases.

Supervisor	Antonio Figueras (antoniofigueras@iim.csic.es), Beatriz Novoa (Beatriz Novoa (beatriznovoa@iim.csic.es)
Degree Subject	Applicants must hold a first degree in biology, biotechnology, veterinary sciences, or similar
GPA	The minimum required is 8

#10 Environmental drivers of behavior and movement patterns of coastal fish species

This project aims to elucidate how environmental variability affects movement and behavioral patterns in coastal species and hence affecting their vulnerability. The student will use acoustic telemetry techniques to monitor the movement of individual fish within a restricted coastal area. At the same time, the oceanographic conditions in the study (temperature, wind, wave height, etc.) will be registered using data loggers and other sources of environmental data. Finally, the student will use advanced statistical techniques to study correlation among movement/behavior and environmental variability. The student will have the opportunity to work within current research projects of the host lab. Student's tasks wild include fieldwork, data treatment and data analysis.

Supervisor	Alexandre Alonso Fernández (alex@iim.csic.es) and Miguel Gil Coto (migil@iim.csic.es)
Degree Subject	Applicants must hold a first degree in relevant subjects (for example, biology, biotechnology, marine biology, environmental science, oceanography, physics or similar).
GPA	The minimum required is 8

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