



UNIVERSITÀ  
DEGLI STUDI DI MILANO-BICOCCA

**PhD Course in Chemical, Geological and  
Environmental Sciences  
XXXVIII cycle, a.y. 2022/2023**

**Scholarships**

**N. 1 linked to research project:** *"Biomaterials for the healing of corals and conservation of reefs biodiversity"*

**Company:** Fondazione Istituto Italiano di Tecnologia

**Curriculum:** Terrestrial and Marine Environmental Sciences

**Abstract:**

Coral diseases and bleaching are threatening the existence of the corals and of the ecosystems that depend on them. The affected corals need immediate treatments, but so far, no efficient and scalable therapies have been found, highlighting the necessity for an immediate action before the reefs' disappearance. The PhD project will be focused on the design and development of sustainable, biocompatible, biodegradable and easily scalable polymeric biocomposites, for the underwater controlled delivery of therapeutic agents directly onto the corals to tackle the various coral diseases. The project will combine the most recent advances in sustainability, material science, and pharmaceuticals in order to give a chance of survival to the coral ecosystems.

***Intellectual property clauses agreed with the Company apply to this scholarship.***

**N. 1 linked to research project:** *"Derivatization and characterization of polysaccharides to be used for the functionalization of biomaterials"*

**Company:** Istituto di Ricerche Chimiche e Biochimiche G. Ronzoni

**Curriculum:** Chemical Sciences

**Abstract:**

The aim of the project will be the production of biomaterials functionalized with polysaccharides. Polysaccharides are a heterogeneous class of biopolymers extracted by plants, algae, animals, and bacteria sources and a study of their properties, such as molecular distribution, viscosity, size, and surface charge, is of essential to determine and predict their biological functions or applications.

Natural polysaccharides have a high degree of biodegradability, biocompatibility, bio-adhesive capacity and able to mimic the natural extracellular matrix (ECM) microenvironment. Furthermore, they present a low toxicity and are availability on a large scale in a relative low cost. Natural or chemically modified

polysaccharides can be used in pharmaceuticals, food and cosmetical field, due to their interaction with several proteins.

In this contest the PhD project will be focused on the research and development of new class of functionalized biomaterials.

## **High level training apprenticeship contracts**

**N. 1 linked to research project:** *"Advanced mineralogical analysis of quartz-rich sands used for the industrial production of glass".*

**Company:** VERALLIA ITALIA S.p.A.

**Curriculum:** Geological Sciences

**Salary for apprentice:** Apprenticeship contract, initial graduation level E1, final graduation level D1, indication of net monthly salary € 1400 (for 14 months)

### **Abstract:**

Glass is an infinitely recyclable material that is at the heart of the circular economy, has exceptional qualities and can play an essential role in building a sustainable future, for example by significantly reducing CO2 emissions in the different phases of the business production and accelerating innovation along the entire value chain. Collaboration with a Centre of Excellence for the study of quartz sands will allow for sustainable industrial exploitation for the environment that is at the forefront for the production of very high-quality glass. The future availability of raw materials for glass production represents a crucial challenge, as the resources available on the planet are limited and a sustainable approach is required in the use of geo-resources to achieve the high standards required and to ensure continuity of production over time. The technologies in use today, albeit consolidated, require a modern quantitative approach in the analysis of sediments that gives advantages both in economic terms (e.g.: choice of the best performing products) and environmental (e.g.: use of recyclable substances such as glass). The need to apply quality control protocols of the sand introduced into the production process therefore requires a new quantitative approach for the identification and removal of accessory minerals other than quartz, which are dangerous during the glass preparation phase. DISAT and the research centre called Provenance, has many years of experience in the analysis of trace minerals in sediments and has developed a protocol for the gravimetric separation of heavy minerals (Andò 2020) and for their identification (Andò and Garzanti 2013) which, when suitably adapted, could be exported to the industrial sector to improve the process in the various stages of production. This research is part of the rapidly developing sector that belongs to the actions of the green transition, in a world that wants to progressively replace the use of plastic, highly polluting and persistent in the environment with a product that can be recycled indefinitely. To achieve this objective, it is necessary to develop and apply advanced techniques of mineralogical analysis of quartz sands to be used to produce glass in the industrial plants of Verallia Italia.

Primary objectives of the doctoral project:

1. Mineralogical analysis of the material in the quarries currently in activity.
2. Control of the mineralogy of the sands entering the industrial plants scattered throughout the territory.
3. Development of a rapid emergency intervention protocol to recognize and isolate any contaminants before they enter the production process.
4. Creation of fixed and mobile laboratories equipped with a kit for preparing and validating the quality of incoming raw materials for the Verallia Italia plants.
5. Staff training through knowledge transfer and dissemination and sharing actions.
6. Identification of new primary reservoirs, in different geological contexts, to assess the availability and presence of potential new quartz sand reservoirs.

Part of the training will take place directly at the Verallia production plants and the research and development of the protocols required for mineralogical analyses will take place at the University of Milan-Bicocca, DISAT, mainly in the Sedimentology, Microscopy and Spectroscopy laboratories of the Provenance Centre, under the supervision of Prof. Sergio Andò. The doctoral project is part of the so-called "Green transition" sector, in which the proposing company is the protagonist in Italy, with particular attention to the involvement of young researchers who transfer university skills in the industrial field, relying on the PhD Course in Chemical, Geological and Environmental Sciences, for the Curriculum in Geological Sciences, with the formula of high training and research apprenticeship.

References cited

Andò S., 2020. Gravimetric Separation of Heavy Minerals in Sediments and Rocks. *Minerals*, 10, 273.

Andò S. and Garzanti E., 2013. Raman spectroscopy in heavy-mineral studies. From: Scott, R. A., Smyth, H. R., Morton, A. C. & Richardson, N. (eds) *Sediment Provenance Studies in Hydrocarbon Exploration and Production*. Geological Society, London, Special Publications, 386.

**N. 1 linked to research project:** *"Nanoplastics: environmental impact and possible neurotoxicity"*

**Company:** ETT S.p.A.

**Curriculum:** Terrestrial and Marine Environmental Sciences

**Salary for apprentice:** Apprenticeship, level IV incoming and level II outgoing - € 1,700 monthly initial gross and thereafter as per the CCNL applied, 36 months, 40 hours per week

**Abstract:**

Plastics are one of the materials most commonly used by humans, both in industry and everyday life because of its physical and chemical versatility and the low cost of production. For these reasons, it is present in all spheres of daily life and its production is increased by 660% between 1976 and 2016, when it reached 300 million tons. It has been estimated that around 25 million tons of plastic waste will be produced by 2050 if this trend continues.

The biogeochemical cycle of plastics includes all environmental compartments and thus it should be considered a ubiquitous problem. Given the fact that synthetic materials, by definition, are of human origin, the contamination directly involves fresh waters and soils. Marine ecosystems are particularly vulnerable, as nearly 10% of the plastic produced annually is transported to seas and oceans, mostly via rivers. Moreover, especially small particles can also be easily spread by wind, making atmospheric air an important vehicle for micro- and nanoplastics distribution.

Primary micro- (MPs) and nanoplastics (NPs) are deliberately produced in ultra-small sizes. Breakdown of these fragments contributes to the continuously increasing amount of so-called secondary MPs (defined as particles with a diameter 0.1 µm to 5 mm) and secondary NPs (defined as particles with a diameter below 100 nm). Majorly MPs are mainly destructed and deformed into NPs with the exposure to various conditions in the ambient atmosphere.

MPs have been detected, for example in processed foods, beer, seafood, and sugary drinks, among others. MPs and NPs are of special relevance from a public health perspective, because the smaller polymer size facilitates their dispersal and contamination of our ecosystems, favouring the exposure and entry into the human organism. Moreover, inhalation exposure results from MPs and NPs released from textiles, synthetic rubber tires and plastic covers. Therefore, besides the dietary pathway, MPs in the environment can also gain access via the respiratory pathway.

Besides the potential adverse effects induced by the physical presence of MPs and NPs, they can act as carrier for various (chemical) contaminants, including metals, persistent organic pollutants, antibiotics and

(pathogenic) micro-organisms. NPs enhance the co-transport of heavy metals such as Co, Al, Cr, Pb, Ni, Zn, Co, Cd and Hg due to high surface charge density.

For more than decades, the study of marine plastic litter shows that the ingestion of seafood containing NPs represents a source of toxicity to humans. NPs can easily cross the biological membranes and barriers (e.g., the gut- and blood-brain-barrier), thus causing adverse effects to humans. In this context, several studies reported the accumulation of MPs and NPs in brain tissues of fish and indications that MPs and NPs can cross the blood-brain barrier. Overall, these findings highlight that (human) exposure to MPs and NPs can result in systemic uptake and/or accumulation in the brain.

Given the limited data on the neurotoxic effects of NPs available, the project aims to assess the neurotoxic hazard of plastic particles and metals more frequently discovered in organisms and found in environmental matrices (e.g., soil, and sea water).

To this purpose, this project aims also to develop technical procedures for environmental sample characterization.

In addition, aim of the project will be to fine-tune the experimental procedure to automatically recognize and evaluate the presence of NPs in water samples, and possibly in samples from contaminated soils.

The investigation of the effect of NPs on nervous system will be performed by using both in vitro and in vivo models. Furthermore, since NPs may adsorb environmental chemicals, such as metals, it will be also evaluated the eventual synergistic effect of NPs and metals co-exposure.

The ETT company will contribute to this project providing its knowledge and skills in the field of in vitro neurotoxicology and make available the technical equipment and platforms for NPs characterization for reaching the project's goals.

The project will be developed in collaboration with the Interuniversity Research Centre MISTRAL, of which University of Milano-Bicocca is part.

**N. 1 linked to research project:** *"Synthesis, optimization and formulation studies of novel TLR4 receptor agonists"*

**Company:** CP2 BIOTECH S.r.l.

**Curriculum:** Chemical Sciences

**Salary for apprentice:** Part-time fixed-term contract of 30 hours per week (75% part-time) with net salary of approximately 1000 euros for 14 months with initial 4th level and final 3rd level

**Abstract:**

The project aims to develop new TLR4 receptor agonists, derivatives of already patented molecules, as vaccine adjuvants. These new molecules will be tested in parallel for their biological properties by pharmacology group of CP2 BIOTECH. The project will be characterized as follows (three points each corresponding to one year work):

1) Computer assisted drug design. Starting from the already developed TLR4 agonists, the aim will be to extend the variety of agonists with improved affinity for TRR4 receptor, The interaction of ligands with TLR4 will be optimized through a QSAR analysis and allows us to define different pharmacophores reflecting in turns different biological properties.

2) Synthesis and optimization. The synthesis will be performed starting from the already developed panel of TLR4 agonists and will be optimized until a small scale up. All new compounds will be characterized by NMR (mono- and multidimensional) and mass spectrometry. The purity of compounds to be used in cellular and in vivo studies will be assessed by quantitative NMR and HPLC analyses. The thermodynamic and kinetic parameters of the agonist/receptor binding will be determined

3) Formulation studies. Starting from the data obtained in parallel by pharmacology group, lead compounds will be submitted to formulation studies in order to obtain molecules with a good pharmacokinetic profile to be used in vivo. Objective of this part of the project is to generate lead compounds for the subsequent in vivo pharmacodynamic and pharmacokinetic pre-clinical studies.

## **PhD Executive Positions**

### **N. 2 linked to research project:**

- 1) *Development and application of innovative bioremediation methodologies*
- 2) *Development and application of innovative phytoremediation methodologies*

**Company:** HPC ITALIA S.r.l.

**Curriculum:** Terrestrial and Marine Environmental Sciences

#### Project 1:

Bioremediation technologies provide solutions to clean up contaminated sites using the natural biological activity of organisms, thus representing an environmentally and economically sustainable approach. Bioremediation technologies rely on human intervention to overcome the limiting factors that negatively affect the natural biodegradation / biotransformation rate of organic and inorganic contaminating molecules present in a given environment. The limiting factors can be lack of inorganic nutrients (N, P, microelements), low bioavailability of the contaminant, lack of suitable electron donors / acceptors, lack of specialized microbial populations. This research project has the general objective of defining a characterization and intervention strategy for superficial and deep soils contaminated by hydrocarbons through innovative methods of microbiological analysis and bioremediation. In particular, molecular microbiology techniques will be used to integrate the information of the chemical characterization. Laboratory-scale activities will be conducted to define the best biological treatment alternatives based on the conceptual model of the site. In particular, in this project, treatments will be evaluated to stimulate bacterial activity by adding soil amendments as a source of nutrients, oxygen and bacterial strains. The chosen strategy will be tested on a model site through pilot trials and full-scale implementation.

#### Project 2:

Bioremediation technologies provide solutions to clean up contaminated sites using the natural biological activity of organisms, thus representing an environmentally and economically sustainable approach. Bioremediation technologies rely on human intervention to overcome the limiting factors that negatively affect the natural biodegradation / biotransformation rate of organic and inorganic contaminating molecules present in a given environment. The limiting factors can be lack of inorganic nutrients (N, P, microelements), low bioavailability of the contaminant, lack of suitable electron donors / acceptors, lack of specialized microbial populations. This research project has the general objective of defining a characterization and intervention strategy for surface soils contaminated by hydrocarbons through innovative methods of microbiological analysis and bioremediation. In particular, molecular microbiology techniques will be used to integrate the information of the chemical characterization. Laboratory-scale activities will be conducted to define the best biological treatment alternatives based on the conceptual model of the site. In particular, in this project, treatments aimed at stimulating the interaction of plants and rhizospheric microorganisms will be evaluated. Different plant species and clones will be tested and their impact on soil and root associated microbial communities will be determined. The chosen strategy will be tested on a model site through pilot trials and full-scale implementation

**N. 1 linked to research project:** *"Submarine Landscape Evolution and Late Quaternary heavy minerals distribution of the south-western African coast and implications for seabed mining practices"*

**Company:** International Mining and Dredging South Africa (PTY) - LTD

**Curriculum:** Geological Sciences

**Abstract:**

Focus on the reconstruction of a landscape evolution of the passive margin along the coasts of Namibia and South Africa, using mainly seismic, acoustic and direct sampling data. Analyse samples from the offshore area of the southwest African coast and reproduce maps of the distribution and concentration of heavy minerals for mining purposes. Particular attention will be paid to the characterization of coastal and submarine landforms, with the creation of representative seabed submarine geomorphological maps. The data used for the research will come directly from vessel sailing offshore Namibian and South African coast, during oceanographic surveys in which the candidate will take part in conjunction with university commitments. The data obtained will be processed by dedicated software with the aim of reconstructing and produce an ultra-high-resolution map of the seabed as much accurate as possible, enclosed in the designated area with a licence. The cores will be analysed to provide ground-truthing, which will support the subsequent seismic interpretation produced by software such as Delph, Geosuite or Petrel. From the high resolution multibeam bathymetry and backscattering data, all significant acoustic morpho-bathymetric facies will be detected and segmented applying geomorphometric techniques and using ecoGnition Developer software. The coupling of morphometric and seafloor backscattering analysis and ground-truthing will allow the quantitative characterization of representative submarine landforms that will be validated through appropriate accuracy assessment procedures. All maps will be further implemented in ArcGis to produce a comprehensive geomorphological map of the surveyed area.

**N. 2 linked to research project:**

- 1) *Animal well-being of allochthonous mammals living in the Maldives. Benessere animale di mammiferi terrestri alloctoni presenti alle Maldive*
- 2) *Search for potentially pathogenic viruses for maldivian marine turtles/ ricerca di virus potenzialmente patogeni per le tartarughe marine maldiviane*

**Company:** Clinica Veterinaria Modena Sud STP S.r.l.

**Curriculum:** Terrestrial and Marine Environmental Sciences

**La Candidata/il Candidato deve avere competenze nel campo delle malattie di animali che conducono vita libera o di interesse ricreativo.**

**Project 1:**

In some Island of Maldives lives rabbits belonging to the species *Oryctolagus cuniculus*. This species includes the European rabbit and its descendants, the world's 305 breeds of domestic rabbits. With their widespread effect on ecologies and cultures, rabbits are, in many areas of the world, part of people's daily life as companions. Project will be conducted in the Maldives (Baa Atoll) where there is an island with a population of *Oryctolagus cuniculus* conducting free living. During the 3 years of the PhD Program the following research will be conducted: rabbit diet by fecal analysis, rabbit social structure, pathologies potentially transmittable to humans, eco-parasitological investigation, investigation of level of antibiotic resistance.

## **Project 2:**

Fibropapillomatosis (FP) is a tumor-causing neoplastic disease affecting sea turtles worldwide. In the last few decades, FP has been spreading to new species and new areas, gradually reaching wider proportions. Together with hunting, habitat degradation, poaching, invasive species and pollution, FP can be a major threat to sea turtle conservation and requires careful monitoring and intervention. FP has shown a positive cause-effect relationship with a herpesvirus infection from Chelonian Herpesvirus 5 (ChHV5). However, ChHV5 is not the only agent responsible and the entire etiology of the disease is still unknown. ChHV5 has been evolving with its sea turtle host for millions of years, but only now we see consistent outbreaks in the wild. Recent human-driven environmental changes are often indicated in the scientific literature to explain FP emergence and devastating impact. Prevalence of FP has already been associated with regions linked to agricultural and domestic runoff, industries conglomeration and urban development.

Sea turtles are affected by a variety of health problems. The environment sea turtles occupy predisposes them to some of the disease processes with which they must contend.

Turtles are affected by a variety of non-infectious diseases occurring either as a direct result of natural or man-made threats, or they may act as multifactorial influences on disease outcome. In some cases, it is not easy to determine if clinical signs are caused by an infectious or non-infectious agent.

Previously undetected bacteria, viruses, parasites and fungi are frequently described in sea turtles and in new regions, but the health implications to sea turtles are not commonly addressed in the literature

Disease is likely a contributing or primary factor in sea turtle deaths and poses challenges to conservation programs, but due to a number of factors, including the challenges of sampling wild marine animals in remote areas, incidences are generally under-reported

A higher rate of disease in immunocompromised individuals was repeatedly reported and a possible link between immunosuppression and environmental contaminants as a result of anthropogenic influences was suggested.

Disease affects not only a population, but also the habitat, the other animals and humans that share it and vice versa.

Aim of this project is to investigate the influence of these environmental variables on the presence of Fibropapillomatosis and other disease.

**N. 1 linked to research project:** *"Analysis of sharks aggregations and ecology in the Maldives. Assessing a protocol for the survey of the species by the use of non-invasive methods."*

**Company:** WHITE WAVE MALDIVES PVT - LTD

**Curriculum:** Terrestrial and Marine Environmental Sciences

The Candidate must have expertise in the field of diving and marine ecology.

## **Abstract**

The project aims to develop an efficient method to be used via citizen sciences projects for the survey of Grey Reef Shark aggregations in the Maldives, focusing on the identification of potential nurseries and assessing reef fidelity amongst the different groups. Having few data published and short period surveys we aim to locate potential hotspots that can be useful also for future conservation strategies adopted by competent authorities. During 3 years of the PhD program the following research will be conducted by using: visual census observations, laser photogrammetry to establish size, age and sex-ratio of individuals, Baited Remote Underwater Video Stations to assess the presence of elasmobranchs species without divers disturbances and eDNA analysis for the mosaic of the megafauna in channels, atolls and open sea.