TERRA-MED PhD PROGRAM - Marie Skłodowska-Curie Actions

Context on the program

TERRA-MED is an interregional doctoral program funded under the Marie Skłodowska-Curie COFUND Actions that will recruit and train a new generation of researchers to address the sustainability and resource stress (Water–Land–Energy nexus) in Mediterranean territories.



The Euroregion Pyrenees–Mediterranean, coordinator of the program, brings together the Regions of Occitanie (France), Catalonia and the Balearic Islands (Spain) forming a cross-border research ecosystem. Through this collaboration, TERRA-MED connects world-class universities, research centres and socio-economic actors committed to advancing resilience in the face of climate change. With more than 22,000 scientists across 10 universities and 2 research centers, encompassing 1000 research units, TERRA-MED provides a rich, interdisciplinary environment where doctoral candidates can excel and launch their research careers.

33 PhD positions will be offered to early-stage researchers with a unique interregional, interdisciplinary and intersectoral environment.

Fellows will benefit from having two supervisors (a principal supervisor and a co-supervisor) from two different regions and having a non-academic mentor. The fellows will undertake mandatory cross-border or international stays to the co-institution, as well as a secondment in a non-academic entity.
Moreover, doctoral candidates will receive a specifically designed training program related to their research topics, alongside modules on innovation, entrepreneurship, project management, ethics, open science, etc.

Benefits of TERRA-MED PhD program

- Top-tier PhD education and research training
- Access to world-class laboratories
- Interregional Dual supervision
- Dual PhD degree (France / Spain) where applicable
- Interdisciplinary and cross-sector research experience
- Unique TERRA-MED's excellence training program on resources stress and climate change. See here
- Attractive salary in the frame of MSCA standards
- Extensive network of academic and non-academic partners
- 2 secondments: 1 in the co-supervisor's institution (9 to 12 months); 1 in a non-academic organization to gain extra academic experience and skills (3 to 6 months)

Reference of the thesis project: **CRG2**	**Title of the thesis project** **Pyrenean sentinel lakes genomics observatory: using environmental DNA to track ecosystem pressures**
Host institution: Centre for Genomic Regulation (CRG, Barcelona)	**Co-supervision / co-host institution:** Station d'Écologie Théorique et Expérimentale (SETE), CNRS, Moulis
Country Spain	**Country** France
Host Research Unit: Computational Biology and Health Genomics programme CRG. Environmental DNA (eDNA) provides a minimally invasive way to monitor biodiversity across habitats. This approach is especially well suited to mountain systems because they concentrate strong environmental gradients over short distances, allowing biodiversity to be compared across high-altitude pristine ecosystems, ecologically singular habitats, and human-influenced valleys. The group leads PyriSentinel, an international project on Pyrenean high-mountain lakes. It has already generated an extensive resource across 302 lakes (more than 1000 eDNA samples, over 600 eukaryotic and prokaryotic metabarcoding profiles, metagenomic data from 30 lakes, and environmental chemistry metadata for 291 lakes), together with an established cross-border collaboration network of natural parks and partners in Occitanie. The incoming candidate will build on this and extend it to a set of Pyrenean thermal springs. www.crg.eu; www.pyrisentinel.eu	**Co-host Research Unit:** SETE is a CNRS research station dedicated to theoretical and experimental ecology, located at the foot of the Pyrenees and directly connected to the study sites. It combines experimental infrastructures, molecular ecology and eDNA capacity, and long-term field networks with strong links to protected-area managers. The team's research addresses biodiversity–environment relationships, freshwater and stream ecology, eDNA-based biodiversity assessment, and ecological modelling. www.sete.cnrs.fr
Name of the first co-supervisor Roderic Guigó –& Hannah Benisty – roderic.guigo@crg.eu hannah.benisty@crg.eu	**Name of the second co-supervisor** Dr. Simon Blanchet simon.blanchet@sete.cnrs.fr
Doctoral School: Universitat Pompeu Fabra (PhD Programme in Biomedicine)	**Doctoral School:** Université de Toulouse
Research field(s) Environmental DNA (eDNA), Microbial ecology, Computational biology, Biodiversity monitoring, Long-read sequencing Genomic sequence-composition analysis	
Keywords Environmental DNA (eDNA), metabarcoding, shotgun metagenomics, long-read sequencing, high-mountain lakes, sentinel ecosystems, bioindicators, freshwater monitoring, Pyrenees	

Description of the research project

Scientific context

Environmental DNA (eDNA) offers a minimally invasive way to monitor biodiversity and is particularly useful in mountain ecosystems, where strong environmental gradients occur over short distances. High-mountain lakes are sensitive sentinel systems whose microbial communities respond rapidly to environmental change, which is particularly important in the contect of global warming, seasonality and glacial melting shifts in elevated regions. This project will combine metabarcoding, shotgun metagenomics and – where feasible – metatranscriptomics with physicochemical data to identify genomic indicators of ecosystem state. It builds on the PyriSentinel initiative (https://pyrisentinel.eu/), which has already established sampling protocols, baseline datasets and an experienced cross-border collaboration network across the Pyrenees.

Research gap

Most studies of Pyrenean lakes are based on individual sampling campaigns. Therefore, it is difficult to distinguish changes related to environmental pressures from seasonal, daily or genuine lake-to-lake variation. In our experience, taxonomy can vary considerably between lakes and is biased by incomplete reference databases. This led us to ask whether functional and taxonomy-independent genomic signals may provide more robust and transferable indicators across freshwater systems, and we will be powered to address quantitative hypotheses by relying on a highly standardised experimental and computational genomics-based monitoring framework.

Relevance to resource stress and climate change (Water–Land nexus)

WATER is the main pillar, as high-mountain lakes are part of headwater systems that support downstream freshwater resources and can provide early warning of ecological change. LAND is the secondary pillar because catchment processes such as erosion, nutrient inputs, grazing and tourism directly affect the lake ecosystems. Climate change and governance connect both dimensions, with the project aiming to develop indicators that are useful not only scientifically but also for national park authorities, water agencies and environmental managers.

Objectives:

Characterize seasonal and environmental variation in Pyrenean high-mountain lakes using metabarcoding, shotgun metagenomics and physicochemical data.

Identify quantitative statistical signals associated with environmental pressures, including genomic signatures as GC content, taxa, genes and pathways that change consistently across lakes and sampling periods.

Test whether DNA syntax, functional profiles and, where feasible, gene expression profiles provide more consistent indicators than taxonomy alone.

Develop candidate indicators of ecosystem state that can be compared across lakes, years and monitoring contexts, and assess their potential use by environmental managers and non-expert citizens.

Expected Results:
The integration of genomic and environmental data will provide a reliable set of candidate indicators that can be implemented across lakes together with natural park authorities, water agencies and other monitoring actors.

Work plan:
Sampling and environmental gradients. Select sentinel lakes representing different environmental conditions and pressure gradients. Seasonal sampling will be combined with limnological data (pH, key chemical trace elements, surface temperature, turbidity, etc.) and existing PyriSentinel genomics datasets to define the main sources of natural and pressure-related variation.

Identification of genomic signatures. Metagenomic data will be used to identify 'DNA syntax', genes, pathways and reconstructed genomes significantly associated with environmental gradients. These statistical signals will be compared with baseline models of purely taxonomic changes, to assess whether genomic signatures provide consistent indicator improvements across lakes. Key reference: Antman et al., *Nature Microbiology* 2026 (https://www.nature.com/articles/s41564-026-02451-y)

Validation and application. Candidate genomic signatures will be refined across sites, seasons and years and integrated with environmental variables to derive the most reliable indicators of ecosystem state. In collaboration with Andorra Recerca + Innovació (AR+I), Andorra will serve as a 'Living Lab' (https://andorralivinglab.ad/) for validation exercises as its small territory concentrates strong altitudinal and environmental gradients over short distances – this provides an ideal setting to test whether the indicators remain consistent across contrasting ecosystems and can be connected to existing local monitoring and management needs.

Candidates' co-supervision will rely on the complementary expertise of both research groups: the CRG team will mainly contribute knowledge in genomics, metagenomics, bioinformatics and other large-scale data integration exercises, while the SETE-CNRS partner will contribute their leading experience in freshwater ecology, ecosystem modelling, field networks and collaborative links with protected-area stakeholders. The PhD candidate will spend research periods in both institutions. Regular joint group meetings will serve to coordinate the work.

References of both supervisors: **Roderic Guigó** - **Hannah Benisty** - **Simon Blanchet**

Required Skills and Competences:

Candidates may come from experimental or computational/theoretical backgrounds; training will be provided in accordance with the candidates' specific needs and goals.

- Background in molecular ecology, genomics, bioinformatics or computational biology.
- Programming in Python and/or R and basic Linux skills.
- Willingness to participate in high-mountain fieldwork and public science communication/outreach.
- Motivation to work independently and integrate into a highly collaborative international team.

Beneficial, but not essential:

- Experience with eDNA, metabarcoding and metagenomics workflows.
- Experience with reproducible bioinformatics workflows and high-performance computing clusters.
- Experience with statistical genetics approaches, evolutionary theory, population genetics and/or ecosystem modelling.
- (Apart from English), fluency in French, Spanish and/or Catalan.

Master's degree(s) required or equivalent(s):
Biology; Biotechnology; Molecular biology; Genomics; Statistical Genetics; Microbiology; Ecology; Evolutionary biology; Environmental sciences; Bioinformatics; Computational Biology; Bioinformatics; Systems biology.

Co-supervision partnership framework

Co-supervision (2 supervisors): Yes

Dual degree PhD (France / Spain) where applicable and approved by the relevant institutions : Yes
To be confirmed by the administrations of the two institutions (UPF and Université de Toulouse).

Indicative mobility arrangements:
Hosting institution: 24 to 36 months
Co-hosting institution secondment: 9 to 12 months
Non-Academic secondment: 3 months in a water agency or a public innovation agency in Andorra.

Work conditions
Duration: 48 months
Indicative start date : September/ October 2027

Indicative gross salary:
~ €2,450/month + Statutory end-of-contract compensation in accordance with Spanish legislation estimated at ~ €80/months accrued during the contract and paid at the end of the contract. Estimated total annual gross salary: 30.600€
Eligible fellows with one or more dependent children may receive an additional family allowance of €50 per month.

Mobility required : yes
Non-academic secondment : yes
Dual degree / Cotutelle possible : yes
Doctoral tuition fees and Visa fees: fully covered by TERRA-MED program
Social security: Full employer contributions covered by the recruiting entity.

Host institution	Co-host institution
CRG is a biomedical research institute in Barcelona, part of the Barcelona Institute of Science and Technology (BIST), with scientists from more than forty countries. The institute holds the Severo Ochoa Centre of Excellence status. Doctoral candidates have access to in-house genomics, sequencing and bioinformatics facilities among others, within a PhD programme that includes thesis advisory committees, retreats and transferable-skills training. The CRG is on the Barcelona Biomedical Research Park (PRBB) campus, alongside several other institutes and a large community of PhD students and postdocs	SETE is a CNRS research station in Moulis, Ariège, dedicated to theoretical and experimental ecology and set at the foot of the Pyrenees. It combines large-scale experimental infrastructure, aquatic and molecular ecology laboratories including eDNA capacity, and long-term field networks with established working relationships with natural parks and environmental managers on both sides of the border. Is affiliated with the Université de Toulouse and its doctoral school. For anyone who likes science close to the field, the setting is hard to beat with mountains, lakes and forests on the doorstep, and a working culture that mixes theory, experiments and fieldwork.

Eligibility conditions

***Horizon Europe MSCA Mobility Rule*:** Researchers must not have resided or carried out their main activity (work, studies, etc.) in the country of the host organization (France or Spain depending on the employing institution) for more than 12 months in the 36 months immediately before the recruitment date – unless as part of a compulsory national service or a procedure for obtaining refugee status under the Geneva Convention.

***Horizon Europe MSCA Eligibility Criteria*:** Applicants must be eligible for enrolment in a doctoral programme at the employer institution and must not already hold a doctoral degree at the date of recruitment. **Applicants who do not fulfill the Mobility Rule and the Eligibility Criteria WILL NOT be considered for the research position.** ***Language requirements*:** Applicants must demonstrate sufficient proficiency (B2) in English to successfully conduct doctoral research and participate in the TERRA-MED training programme. For more information on this call for candidates see our website here and the guide for applicants here.
APPLY HERE BY Decembre 31st 2026
Administrative Contact TERRA-MED Programme Office (only for general administrative questions and redress demands. Any research-related question must be addressed to the supervisors by email, see second page) **Email**: terramed@euroregio-epm.eu