GHENT UNIVERSITY

MASTER BIOLOGY OVERVIEW

A Modern Biologist

Modern biologists bridge classical biology with technological and interdisciplinary innovation.

They work on both fundamental research and practical applications, seeking solutions to improve human and ecosystem health, environmental sustainability, and our understanding of life itself.

General Courses

50 ECT

English

- Integrated Research Project
- Academic Grant Writing
- Scientific Communication
- Advanced Biostatistics
- Master's Dissertation

Choose your Major

40 ECT

Functional Biology

Biodiversity & Evolution

Global Change Ecology

Educational Master

Choose your Focus

30 ECT

SCAN ME

- Choose courses from another major or from a wide variety of elective courses or put focus on:
  - Marine Biology
  - Professional skills
  - Bio-inspired innovation and sustainability

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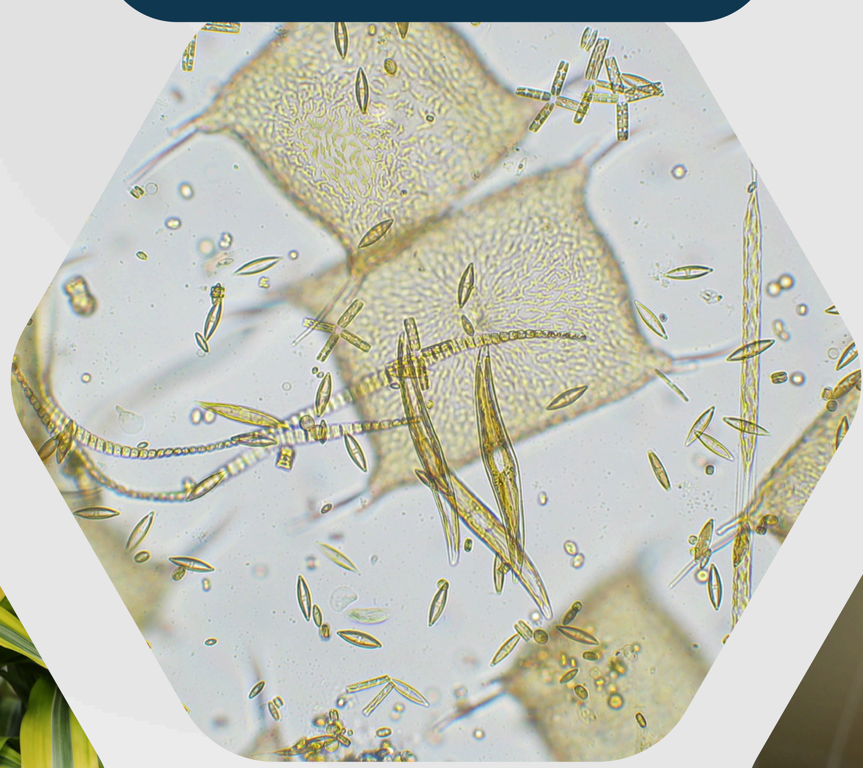
MASTER BIOLOGY

WORLD CLASS RESEARCH

Protistology & Aquatic Ecology



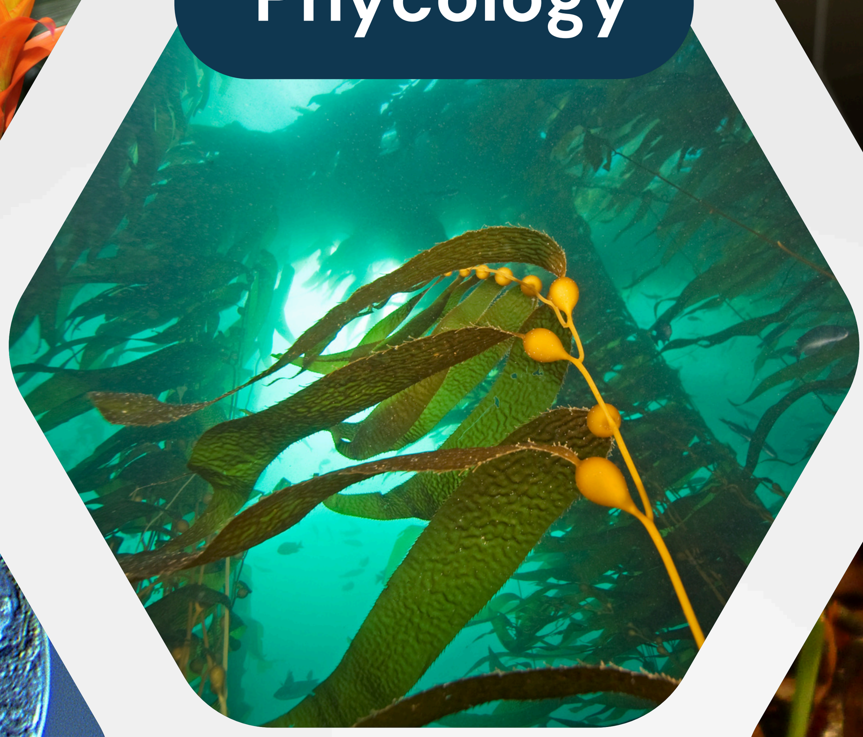
Functional Plant Biology

Systematic & Evolutionary Botany

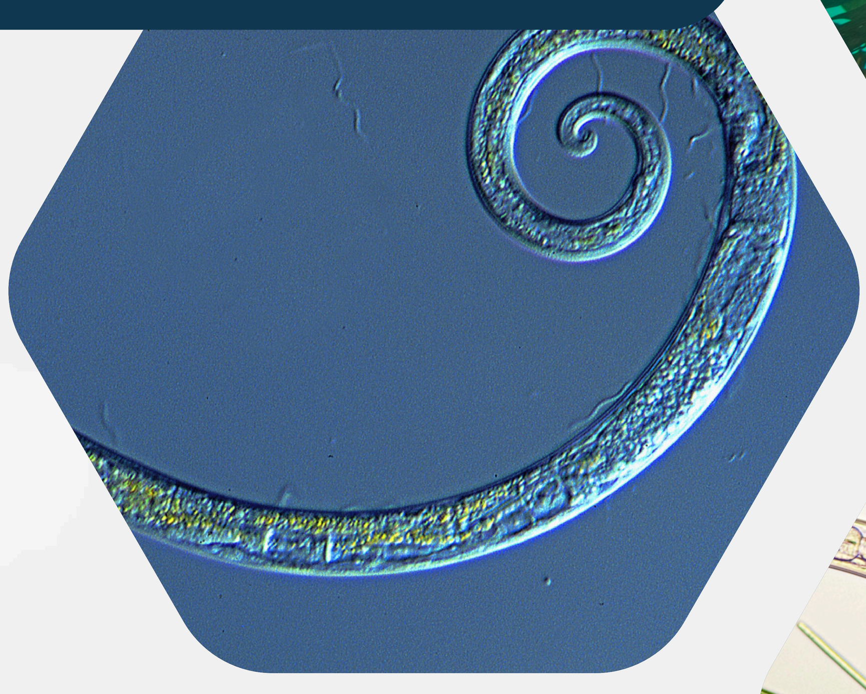
Terrestrial Ecology

Evolution and Optics of Nanostructures

Phycology



Nematode Physiology

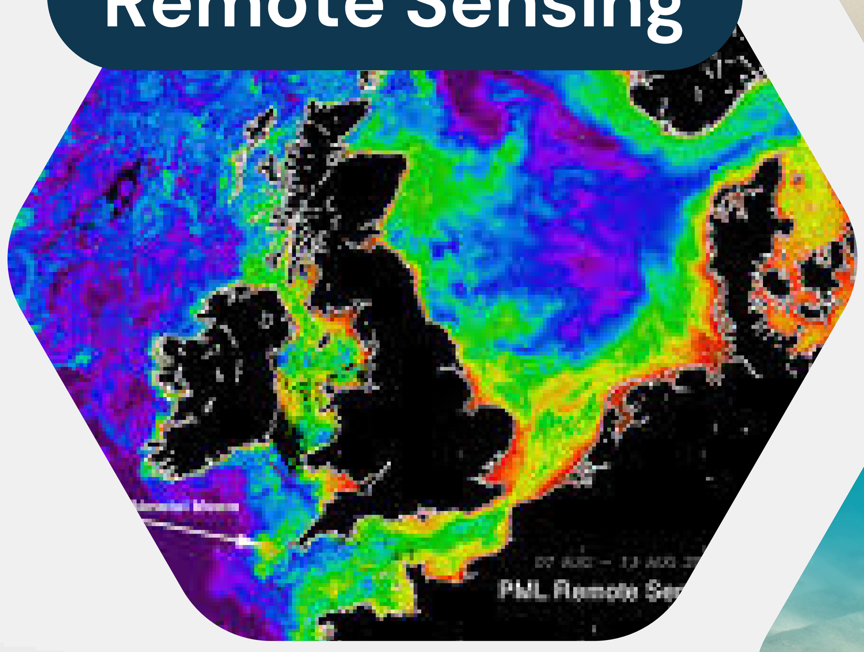


Mycology

Nematology

Evolutionary Morphology of Vertebrates

Marine Optics & Remote Sensing

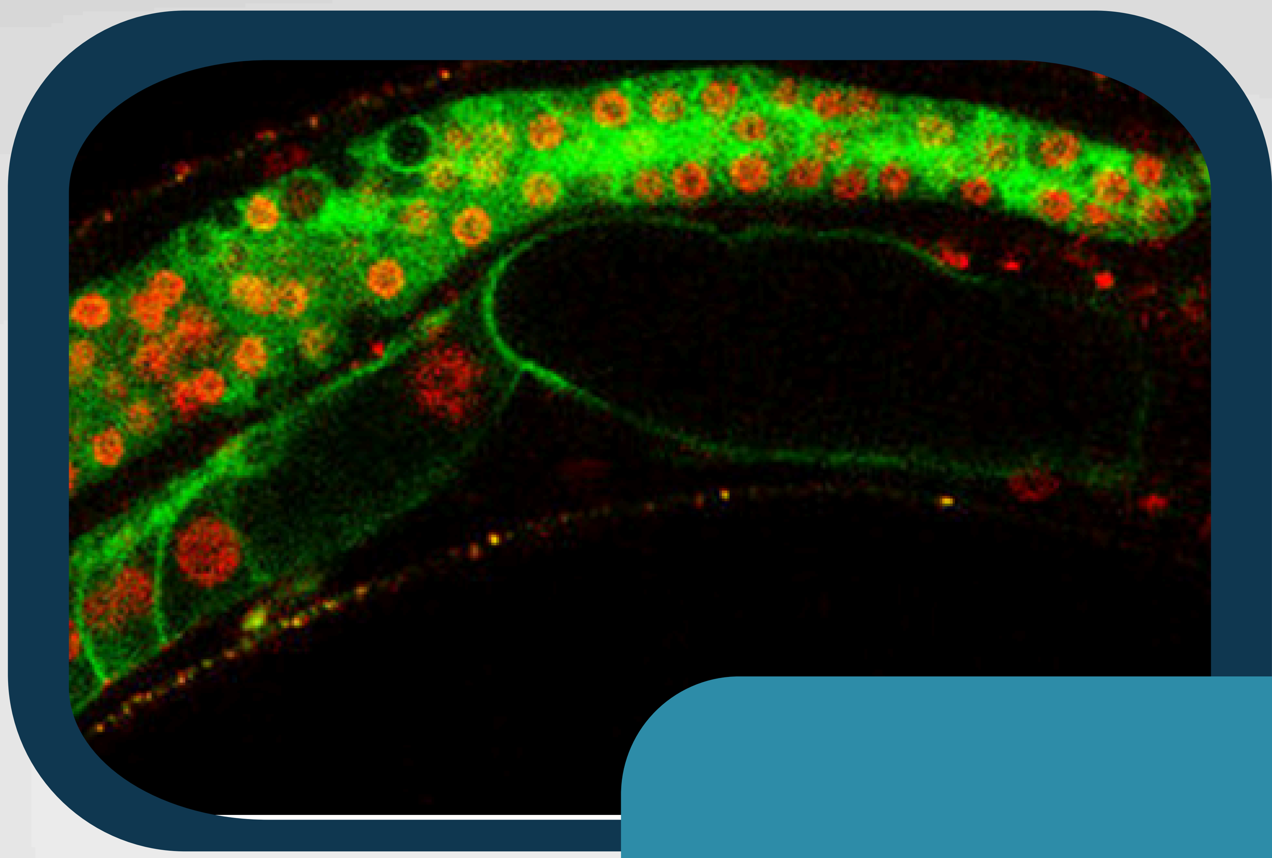


Limnology

Marine Biology

Evolutionary Developmental Biology

SCAN ME



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FUNCTIONAL BIOLOGY
OVERVIEW

WHAT

Functional Biology is a research field in Biology that focuses on **how life works** at the level of the **individual organism**. In the major program 'Functional Biology' you study the **functioning** of microbes, plants and animals throughout their life cycle as well as how they **interact with the environment**.

WHY

Knowledge of the complex details on how organisms work, their possibilities, flexibility, and constraints is of importance in many branches such as nature conservation, agriculture, and medicine.

HOW

Core courses

- **Development:** How can a fertilized egg develop into an entire multicellular organism and how is this process shaped by evolution?
- **Physiological Regulation:** How do cells communicate and work in concert to create a fully functional individual?
- **Functional Abiotic Interactions:** How does an organism respond to a changing environment?
- **Functional Biotic Interactions:** How do organisms interact with each other?

In-Depth courses

Provide further detail on these topics or focus on related matter (e.g. aging, brain function, immunology, molecular biology, methods and tools).

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FUNCTIONAL BIOLOGY

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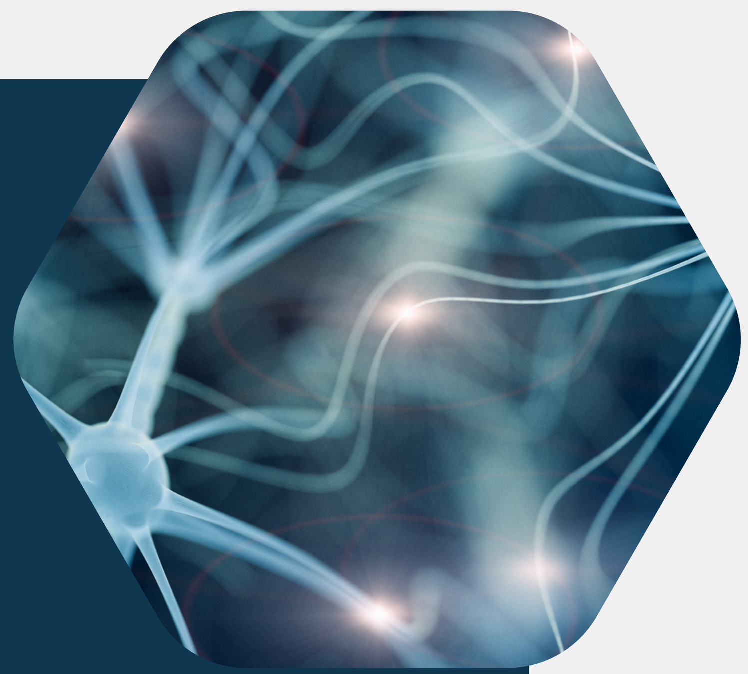
Evo-Devo: how evolution shaped the developmental process

The Functional Biology major explores Evolutionary Developmental Biology (Evo-Devo) in plants and animals, focusing on how genetic and developmental processes drive diversity in body plans, structures, and adaptations.
Animal Evo-Devo examines how morphological diversity arises through gene expression, despite limited genetic variability. Key concepts include developmental constraints, modularity, the role of Hox genes, and homologous pathways shaping vertebrate organs.
Plant Evo-Devo addresses plant resilience to climate change, evolution of photosynthesis and focuses on advanced reproductive strategies. It emphasizes genetic and morphological adaptations allowing plants to survive terrestrial environments and also focuses on human-driven evolution via domestication.
These courses equip students interested in genetics, biodiversity, and evolutionary biology with key insights into the genetic underpinnings of development and adaptation.

Physiological Regulation: how cells communicate to play the symphony of multicellular life



Multicellular organisms maintain stability and efficiently respond to environmental stimuli. To that purpose, animals use nervous and endocrine systems. These are featured in the course Physiological Regulation in Animals, which discusses mechanisms like neurophysiology, hormone signaling, and homeostasis. Topics range from neural transmission and sensory perception to higher brain functions, with practical insights gained through lab excursions and research presentations. The Physiological Regulation in Plants course investigates regulatory networks governing growth based on internal signals (e.g., hormones) and environmental cues (e.g., light). These courses offer the students essential insights into physiological adaptations crucial to biology, health sciences, and sustainable agriculture.

Functional interactions: how organisms respond to a changing environment

The Functional Biology major explores how organisms interact with their environments—both living and non-living—through physiological, molecular, and evolutionary mechanisms.
Courses on Functional Abiotic Interactions examine how bacteria, plants, and animals adapt to extreme and fluctuating abiotic factors, such as temperature, light, and chemical stress.
Plant Biotic Interactions and Host-Parasite Interactions focus on organismal interactions, covering mutualistic and pathogenic relationships, from bacterial quorum sensing to plant and animal immunity.
The Global Change Physiology course integrates ecology and physiology to explore organismal responses to global challenges, such as climate change and pollution. These studies are vital for predicting environmental impacts on ecosystems and aiding biodiversity conservation and ecological sustainability efforts, helping to mitigate future environmental change effects.

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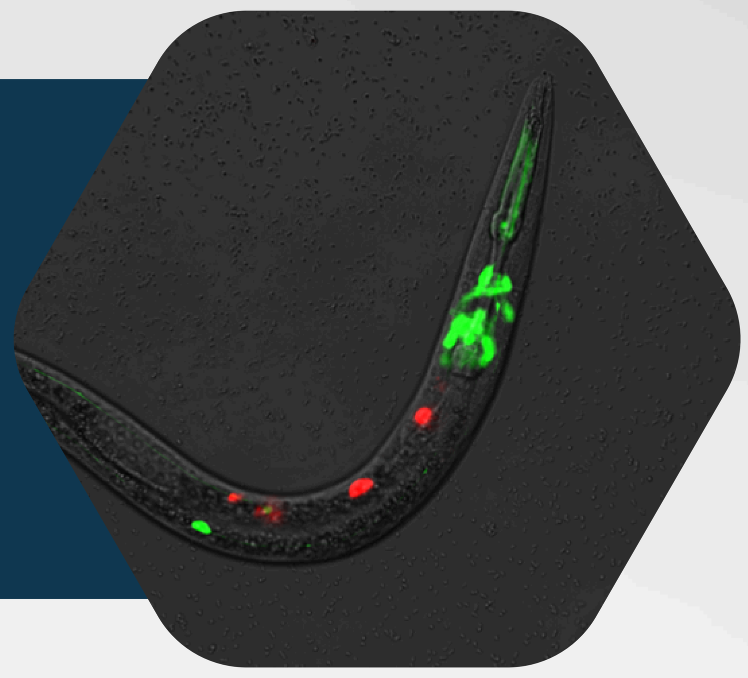
FUNCTIONAL BIOLOGY

RESEARCH IN THE PICTURE

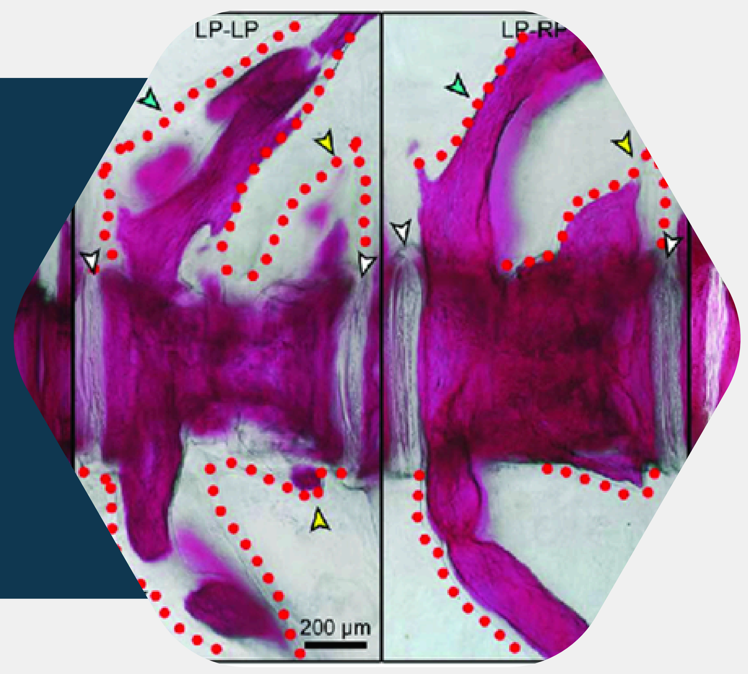
The function of *C. elegans* globins

Globins are an ancient protein family found across bacteria, archaea, and eukaryotes. In the nematode *Caenorhabditis elegans*, 34 globins were identified, many expressed in neurons and likely involved in signaling. We found that GLB-12, a membrane-bound globin, regulates worm reproduction by generating superoxide and hydrogen peroxide signals in the gonad. Its neuronal function remains unclear. Currently other globins are under investigation.



Development and plasticity of the fish skeleton

Our research explores the development, plasticity, and remodeling of skeletal tissues, particularly bone, cartilage, and teeth in teleost fish, the most diverse vertebrate group. We study these processes in a comparative developmental and evolutionary context, focusing on continuous tooth replacement. The group's research also contributes to biomedical studies and works to prevent skeletal malformations in farmed fish.

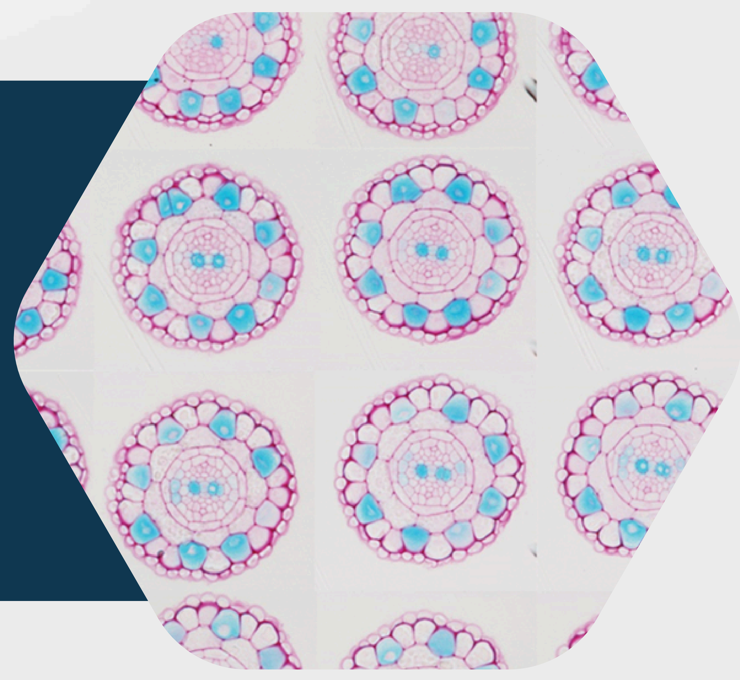


Unravelling host-symbiont interactions

We use arthropod models, specifically herbivorous insects and mites, to address important questions in the broader fields of speciation, herbivory, and symbiosis. Within these research fields, we dissect the molecular-genetic basis of key complex traits, including hybrid defects, xenobiotic detoxification, and symbiont-mediated cytoplasmic incompatibility. We integrate methodologies from field, population, and theoretical biology with those from cytology, genomics, and genetics.

Rooting for stronger crops

The root system of *Arabidopsis thaliana* is an excellent model to study the relationship between cell cycle regulation and growth and development. Understanding this offers a great potential for altering root architecture and water uptake, allowing to design plants to survive under dryer conditions.



Plant biofortification

As the global population is projected to exceed 11 billion by 2100, food security faces significant challenges, particularly due to climate change, which can reduce crop yields by 20-40%. This disproportionately affects underdeveloped regions and the poorest populations. The Laboratory of Functional Plant Biology focuses on sustainable plant production, studying plant growth, stress control, and biofortification to combat micronutrient deficiencies and improve food security.



GHENT UNIVERSITY

BIODIVERSITY & EVOLUTION

OVERVIEW

WHY

A thorough understanding of the eco-evolutionary processes that generate and shape the biodiversity of life on Earth is essential for understanding how life forms will respond to human-induced global change, and how we can best protect biodiversity.

WHAT

In this major, you gain tools to study Earth's life **diversity**, its **distribution** in space and time, and **evolution**. It covers multidisciplinary approaches, including **taxonomy**, **phylogenetics**, **genomics**, **fossils**, and **conservation**.

HOW

Core courses

- **Taxonomy and systematics:** What guides modern taxonomy and what state-of-the-art tools are used?
- **Spatial processes and patterns in biodiversity:** What processes shape biodiversity's spatial organization?
- **Paleobiology:** What do fossils reveal about life's evolution and the past interaction of the biosphere and geosphere?
- **Phylogenetics:** How can we reconstruct and interpret genealogical relationships between genes, organisms, and evolution?
- **Evolutionary genomics:** How can advanced molecular-genomic and statistical tools reveal how genome evolution drives adaptation and speciation?
- **Evolutionary morphology:** What concepts, patterns and processes define and guide the morphological evolution of living organisms?
- **Biodiversity conservation:** How can fundamental and applied knowledge guide effective biodiversity conservation, and what international agreements govern it?

In-Depth courses

Choose a biodiversity and evolution course focused on specific organisms (prokaryotes, fungi, plants, birds, primates) or deepen your knowledge of Multivariate Analysis of Biological Data.

BIODIVERSITY & EVOLUTION

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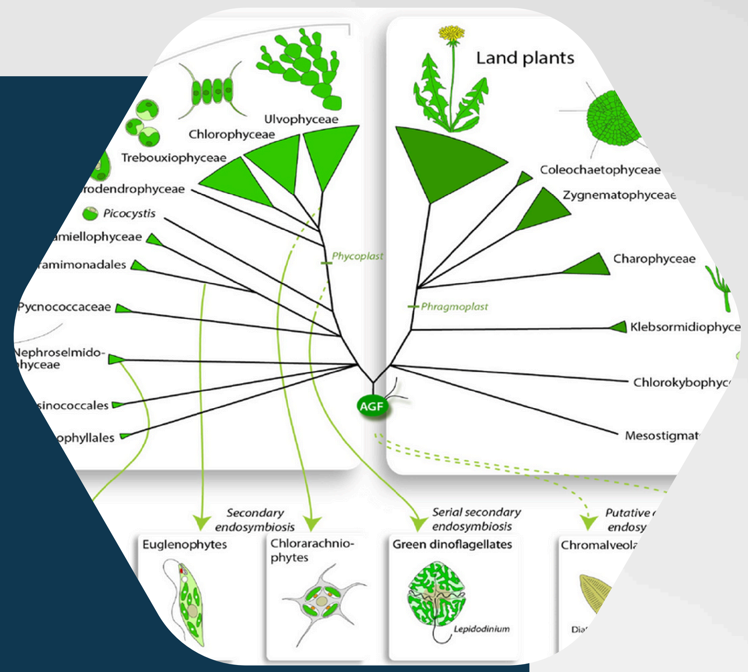
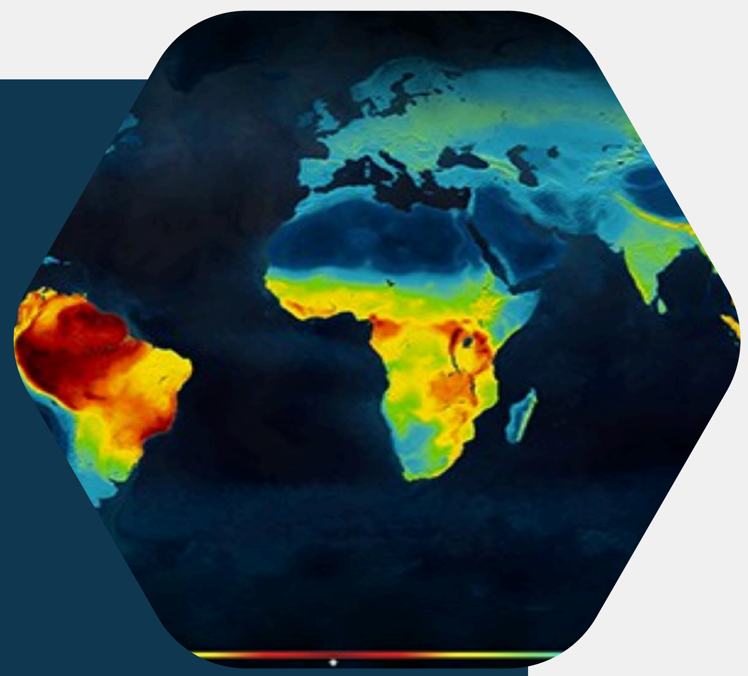
Integrative taxonomy - how do we inventory and describe biodiversity in the 21st century?



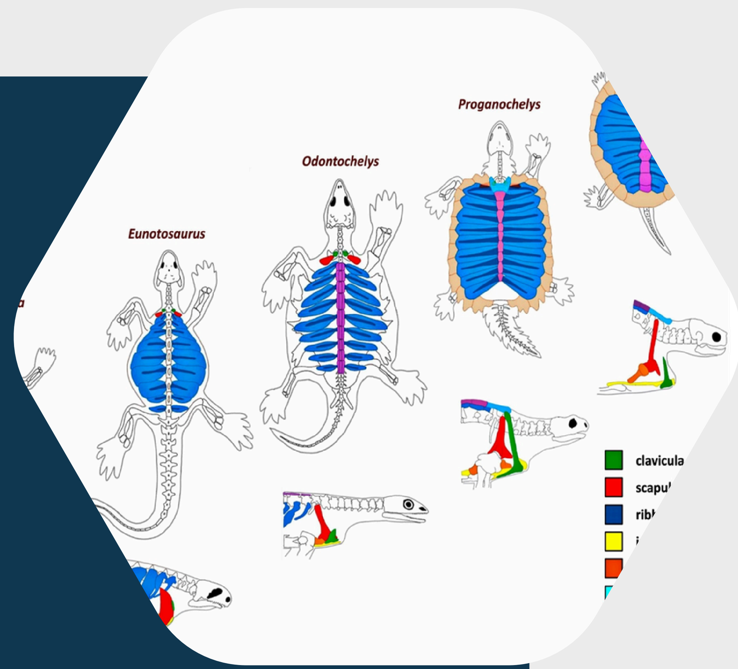
Several research groups in the UGent Department of Biology are internationally recognized for their expertise in the taxonomy and systematics of various life forms, ranging from microalgae and seaweeds, to Fungi, flowering plants and invertebrates. The 'Taxonomy and systematics', 'Phylogeny', and selected in-depth courses, rely on this expertise to train the students in the tools and skills needed for contemporary, integrative taxonomic research, which draws on independent lines of evidence (morphology, molecular-genomic, reproduction, etc.) to accurately delineate and describe species.

How is biodiversity distributed in space and time?



Multiple factors and processes shape patterns of biodiversity in space and time. We study how contemporary and past environmental and climatological variation, stochastic processes, organismal attributes (e.g. dispersal biology) and biotic interactions structure the biodiversity of communities on multiple spatial and temporal scales. Understanding the ecological and evolutionary processes that shape distributions is essential to predict future biodiversity responses to climate change and human pressures, and to guide adequate protection and conservation strategies.

How did the diversity of life forms evolve?

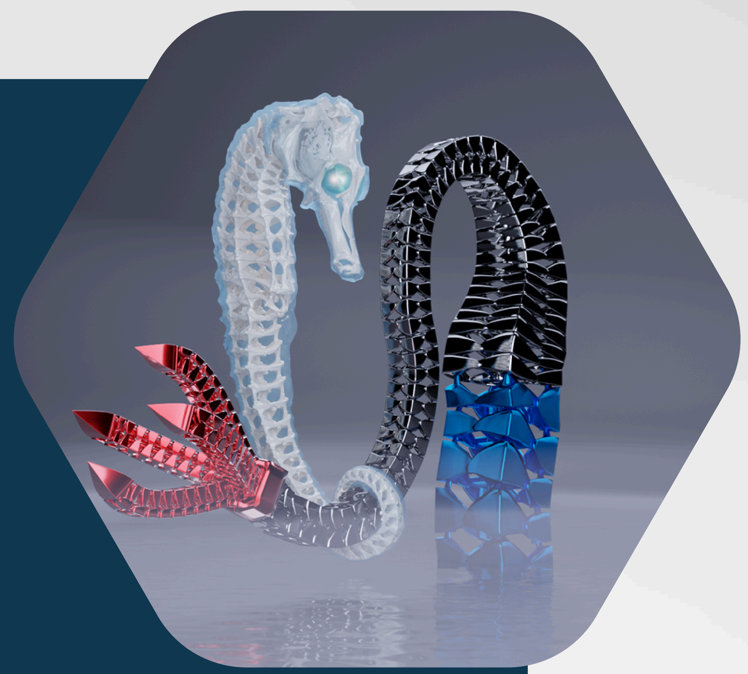


Evolution is a complex process, driven by the interplay between various genetic (e.g. population and quantitative genetics, evolvability, phenotypic plasticity, epigenetics), developmental and ecological (e.g. demographic change, selection) processes. In the courses 'Phylogenetics', 'Evolutionary genomics' and 'Evolutionary morphology' the students are familiarized with state-of-the-art tools and skills to study evolutionary relationships between organisms, and how genomic features and processes drive evolutionary change. An in depth understanding of the interactions between genomes, phenotypes and environment allows predicting how organisms adapt to environmental change, such as climate warming, ocean acidification or pollution.

BIODIVERSITY & EVOLUTION

RESEARCH IN THE PICTURE

How vertebrate evolutionary morphology can inspire innovative robotic tools



By investigating the evolutionary morphology of vertebrates, we aim to understand how essential survival functions like feeding and locomotion evolved. Our approach combines detailed morphological studies, ranging from histology to 3D reconstructions using µCT scanning, with biomechanical analyses to link structural traits to functional performance. These findings are applied to develop nature-inspired robotic tools, such as the seahorse tail, which address modern biomedical challenges. This research bridges biology and engineering, offering innovative solutions for current and future technological and medical advancements.

Understanding deep-sea biodiversity patterns

We explore taxonomic and functional biodiversity patterns in deep-sea sediments, focusing on meiofauna — the most abundant microscopic animals in this environment. Using both traditional morphological identification and DNA metabarcoding, we study how these communities change over space and time to determine potential drivers of these changes. This helps us to predict and assess the impacts of human activities, such as deep-seabed mining, on these fragile ecosystems, and to guide conservation efforts.

Biodiversity and evolution of polar lake and soil microbiomes

Polar microbiota were long believed to comprise cold-adapted species recruited from a globally dispersing pool, unlike polar plants and animals. However, UGent research shows that limited dispersal between the Arctic and Antarctic, along with isolation-driven diversification, have played key roles in shaping polar microbiomes. By uncovering these evolutionary processes, we gain insight into the uniqueness of polar microbial biodiversity and its susceptibility to climate change and biotic homogenization, emphasizing the need to protect these fragile ecosystems.

Harnessing seaweed biodiversity for the Blue Economy

Seaweeds offer untapped potential for sustainable food, feed, and the chemical industry, positioning seaweed aquaculture as a top EU priority. Our research integrates genetic diversity with physiological factors like attachment, growth, and reproduction to support seaweed cultivation in the North Sea. Pilot-scale Sugar kelp trials are underway in offshore windfarms. This will inform the development of seaweed varieties, similar to terrestrial crop breeding, paving the way for large-scale seaweed farming in Europe.

Diversity and evolutionary history of milkcaps

Milkcaps (*Lactarius* and *Lactifluus*) are dominant ectomycorrhizal players in all forest ecosystems world-wide. We use a fruitbody based approach (collecting, describing field characters, ecology, microscopy, molecular data) as well as environmental DNA to assess their diversity and understand the distribution. We combine molecular and morphological data to delimitate species and understand the evolution of this group.

GHENT UNIVERSITY

GLOBAL CHANGE ECOLOGY

OVERVIEW

WHAT

Learn how **climate change**, **habitat fragmentation**, **land-use change**, and **pollution** impact terrestrial, freshwater, and marine ecosystems. Focus on understanding **ecological**, **evolutionary**, and **societal impacts on biodiversity,** applying insights to conservation and nature-based solutions.

WHY

Studying Global Change Ecology is essential for understanding ecosystem responses to rapid environmental shifts. This knowledge **helps predict** future changes, **supports** targeted **conservation**, **sustains** essential **ecosystem services**, and informs **policy decisions**.

HOW

Core courses

- **Climate change and mitigation:** What responses can populations, species, ecosystems show?
- **Spatial Processes and patterns in biodiversity:** What ecological and evolutionary processes shape the the spatial organisation of biodiversity?
- **Ecosystem dynamics:** How do dynamics of organisms and ecosystems change over time. What can we learn from the past?
- **Ecophysiology**: How do environmental changes affect physiological processes? What are the consequences for species dynamics?
- **Behavioural ecology:** How is an organism's behavior adapted to its environment, ensuring survival, reproduction, and population persistence?
- **Ecological modelling**: How can we model ecological and evolutionary changes to forecast natural systems?
- **Human and political ecology: a global perspective**: How are ecological and social systems connected, and influenced by politics and economics?

In-Depth courses

- Specialist methods in ecology: Individual Based Modelling, Conservation Genetics, and Multivariate Data Analysis of Biological data.
- System specific ecology of Microbial, Freshwater, Marine and Soil environments.

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GLOBAL CHANGE ECOLOGY

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Understanding drivers of biodiversity change

Understanding biodiversity change drivers is vital to addressing ecosystem shifts. Natural and human-driven factors, such as habitat destruction, climate change, pollution, invasive species, and overexploitation, interact, amplifying their impacts. Identifying and addressing these factors in terrestrial, marine, and freshwater systems is key to developing effective conservation strategies to preserve biodiversity.

Eco-evolutionary dynamics

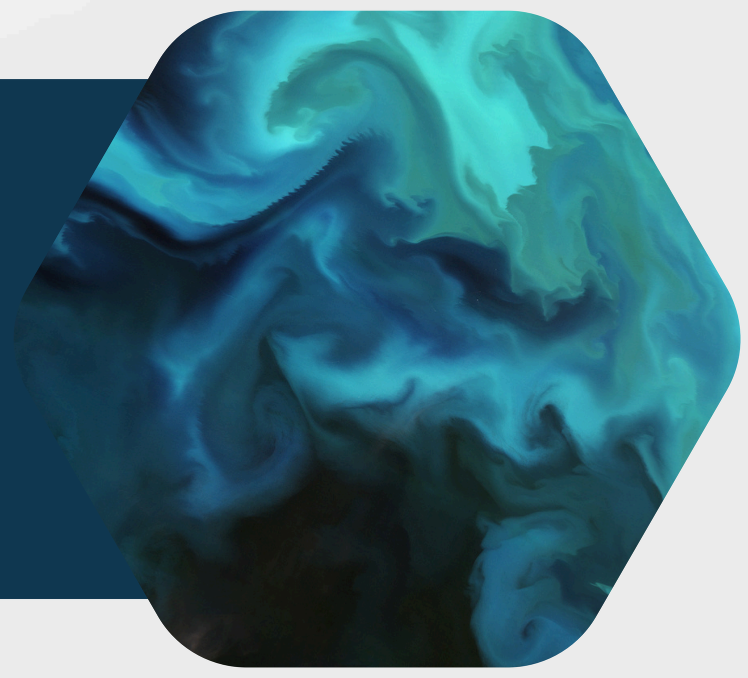
Co-evolutionary dynamics show that evolution occurs rapidly, with ecological and evolutionary changes influencing each other on similar timescales. Eco-evolutionary dynamics are studied in relation to global anthropogenic stressors, where species must quickly adapt in physiology, behavior, and life history, which can, in turn, affect their ecosystems.

Ecological interactions: from competion to foodwebs

Ecological interactions shape species coexistence, survival, and adaptation, stabilizing ecosystems and supporting biodiversity. These relationships, from mutualism to competition, are influenced by evolutionary history and environment. Research on the genetic and ecological basis of interactions in microbial, plant, and animal networks helps understand biodiversity patterns across marine, terrestrial, and freshwater gradients.

Reconstructing and predicting biochemical cycles

Reconstructing past and predicting future biogeochemical cycles helps understand climate and ecosystems. Studying past changes reveals variability, resilience, and vulnerabilities, while future predictions guide resource management, climate mitigation, and biodiversity conservation. Paleoenvironmental research uses lake sediment records and employs remote sensing and robotics to study carbon cycles and ecosystem dynamics across oceans and continents.



Integrating ecology into society

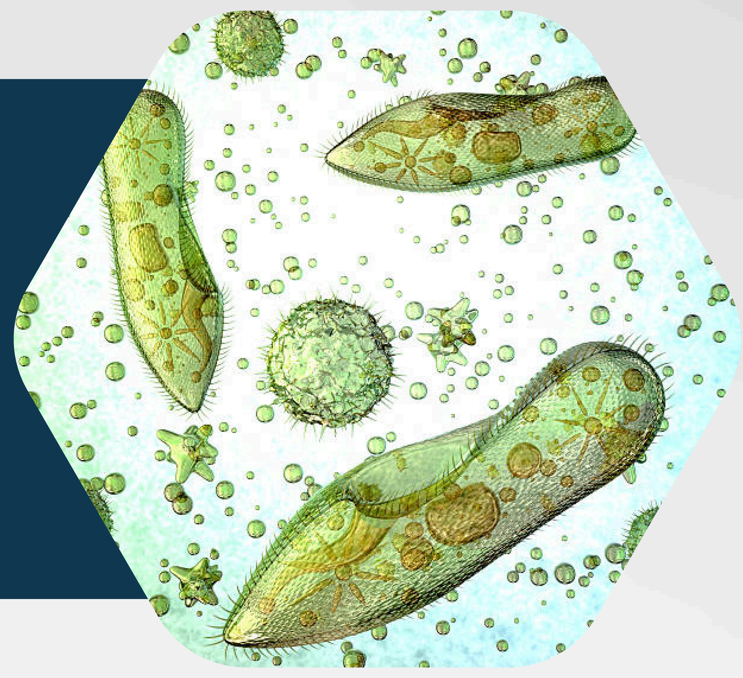
Integrating ecology into society and conservation bridges scientific knowledge with social values, policy, and sustainable development. Recognizing humans as part of ecosystems, this approach links ecosystem health to human well-being. By leveraging expertise, it fosters a future where ecosystems and communities thrive together, using Nature-based Solutions to build resilience against environmental challenges.

GLOBAL CHANGE ECOLOGY

RESEARCH IN THE PICTURE

The (un)appreciated role of microbes in ecosystems

We study the biology, ecology, and interactions of microorganisms across diverse habitats, focusing on their roles in biogeochemical cycles and ecosystems. We explore their genetic potential, activity, and responses to environmental changes, highlighting their importance in nutrient cycling, primary production, and greenhouse gas dynamics. We investigate their importantce for ocean carbon cycle using innovative remote sensing technologies.



Foodwebs and ecosystem functioning of marine environments

Human activities and climate change impact marine ecosystems, focusing on food web structure and energy flow. Using food web models, we examine how complexity, stability, and commercial species production change under various pressures. Our research targets sand extraction, offshore wind farms in the North Sea, and glacier melting in Greenland fjords.

Cognition and behavioural flexibility in birds

Learning and behavioral flexibility are important cognitive mechanisms that allow birds to thrive in a wide array of environments. Our research helps explain decision-making in dynamic situations, such as avoiding predators or optimizing foraging. By integrating animal cognition, neuroscience, and behavioral ecology, we aim to understand how birds inhibit risky actions and make critical decisions.

Understanding insect decline

To understand what drives arthropod distributions, we study traits like reproduction, growth, and dispersal. Integrating this knowledge into models, we aim to create detailed forecasts of their diversity under global change. The work also supports conservation efforts, including managing rare and invasive species, enhancing habitat connectivity, and addressing urban biodiversity loss.

Biodiversity as a key component in Nature-based Solutions

Nature-based Solutions use healthy ecosystems to protect people, enhance infrastructure, and support biodiversity. For example, coastal dunes provide natural coastal defense, shaped by interactions among plants like marram grass, sand movement, and climate. These bio-geomorphological feedbacks are studied with the aim to develop predictive digital models. We specifically study how NbS impact biological connectivity and resilience to climate change.