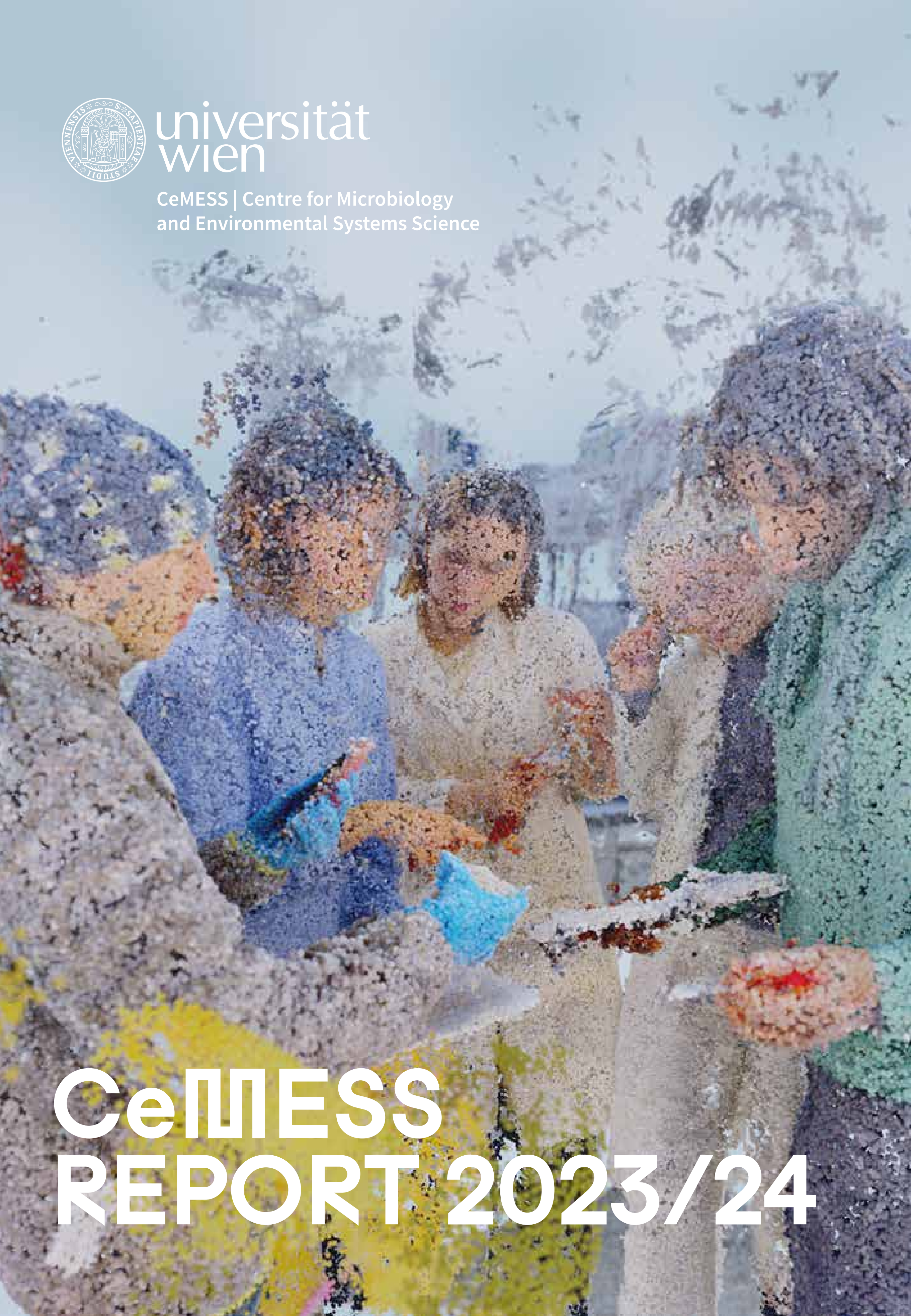


universität wien

CeMESS | Centre for Microbiology and Environmental Systems Science

CeMESS REPORT 2023/24

CeMESS REPORT 2023/24

MISSION STATEMENT

Microbes play a key role in sustaining life on Earth yet are the least studied of all life forms. Microbiomes drive all global biogeochemical cycles and are directly linked to the health of plants, animals, and humans. Microbes and their myriad functions shape both environmental and manufactured ecosystems. Much like microbes, humans engineer the environment around them, rapidly altering global element cycles, contaminating their surroundings, and causing climate change – all key areas of our research. Recent progress in method development and conceptual advances allow us to study the complex interactions between hosts and microbes, between chemicals and environment, and between microbes and climate at an unprecedented level.

The mission of the Centre for Microbiology and Environmental Systems Science, is to conduct excellent research at an internationally leading level. We develop cutting-edge methods for structure-function analyses of microbial communities in environmental and microbe-host systems, including humans. We gain insight into disease prevention, diagnosis, and treatment through functional microbiome research. We investigate the role of microbial communities in complex ecological systems, as well as the impact of human activities on environmental systems in a changing world. This understanding can be used to solve some of the most pressing environmental and medical problems of our time.

WE LIVE
SCIENCE

CeMESS STRUCTURE

The Centre for Microbiology and Environmental Systems Science (CeMESS) at the University of Vienna consists of four Research Divisions, spanning microbiology, computational biology, ecology and environmental systems science. This multidisciplinary structure empowers us to comprehensively investigate those critical biotic and abiotic processes that shape our bodies, ecosystems, and our planet at large.

CUBE

Computational Systems Biology

The Division of Computational Systems Biology is a group of bioinformaticians and computational biologists. CUBE focuses on understanding biological systems, ranging from single species to multi-species systems and ecosystems. The research is based on data from large-scale bioanalytical methods. Researchers in this group develop, improve and apply computational methods for the interpretation of molecular information in biology. They establish and analyse quantitative mathematical models.

DOME

Microbial Ecology

The Division of Microbial Ecology seeks to understand the role of microorganisms in Earth's nutrient cycles and as symbionts of other organisms. Researchers at DOME study the biodiversity, the ecology, and the evolutionary history of microbes. Their research ranges from ecophysiology, genomics, and evolution of key microorganisms in diverse environments to interactions of microbes among themselves and with eukaryotes, including the complex microbiomes of humans and animals.

EDGE

Environmental Geosciences

The Division of Environmental Geosciences investigates key processes controlling the natural environment and anthropogenic impacts. Researchers at EDGE combine field observations with experimental work, linking molecular scale mechanisms at environmental interfaces with complex large-scale environmental processes using quantitative modelling. EDGE accepts the challenges posed by the release of known and emerging pollutants and the need to understand their impact on soils, ground- and surface waters by process-based and mechanistic research.

TER

Terrestrial Ecosystem Research

The Division of Terrestrial Ecosystem Research aims to advance the fundamental understanding of how soil microorganisms and plants respond to and in turn shape their abiotic and biotic environment, and what consequences these interactions have for the functioning of the Earth's ecosystems. Researchers at TER address pressing environmental issues, such as the impact of climate change on ecosystem functioning and the role of soils in the global carbon cycle and in food security.

Andreas Richter
Head of CeMESS

Thilo Hofmann
Vice Head of CeMESS

Michael Wagner
Vice Head of CeMESS

Annina Müller Strassnig
Head of CeMESS Office

DIRECTORS' STATEMENT

CeMESS was established almost five years ago, following a bold decision by the University of Vienna to establish our Centre, which combines two rapidly developing research areas of high societal relevance: microbiology and environmental systems science. Both fields provide critical insights that address pressing global challenges, from human to environmental health. This prospectus provides an overview of our research areas, methods, and facilities, as well as introducing our researchers and their work.

Since our establishment in 2019, we have settled into a new building, built up a Doctoral School, obtained a Cluster of Excellence, and established a number of up-and-coming research groups, supported by the European Research Council (ERC), the Austrian Science Fund (FWF) and the Vienna Science and Technology Fund (WWTF). All this while weathering a global pandemic and multiple crises.

This would not have been possible without our staff and all other Centre members. It is thanks to the commitment, creativity, and collaborative spirit of all of them – the admin and technical support teams, the students, postdocs, senior scientist, group leaders, and the faculty – that the Centre became what it is: one of the best places in the world to conduct microbiome and environmental research for the benefit of the planet.

Finally, we want to thank the University of Vienna, the FWF, WWTF, and the EU – the organizations that primarily fund our research. It is because they believe in our research and support our ability to generate fundamental knowledge that we are able to provide solutions for the most pressing challenges of our time.

Andreas Richter, Thilo Hofmann,
Michael Wagner, Annina Müller Strassnig

257 SCIENTISTS & STAFF

It is the individual talent and collective team spirit of our people that makes CeMESS special.
Our team includes 36 postdocs, 14 senior scientists, 71 PhD students, 64 Master's students, and 51 support staff.

26 RESEARCH LEADERS

Our group leaders steer our research into exciting new frontiers of their respective fields.
Our Centre has 21 professors and 5 junior research group leaders.

31 COUNTRIES

We're proud to host a multicultural research community. Our staff and students hail from 31 countries across 6 continents.

13 EARLY CAREER FELLOWS

We're proud to host a large talent pool of highly qualified early-stage researchers, including 8 Marie Sklodowska-Curie Fellows, 2 FWF Esprit, 1 FWF Lise Meitner, 1 FWF Hertha Firnberg, and 1 Avina Grantee.

10 ERC GRANTS

Our faculty has been awarded 10 European Research Council Grants (Starting, Consolidator and Advanced Grants). Of those, 6 were awarded to women. We take great pride in the significant achievements of our many female researchers.

3 AUSTRIAN STARTER GRANTS

This includes 1 FWF START Award and 2 Vienna Research Groups for Young Investigators from the Vienna Science & Technology Fund (WWTF).

1 WITTGENSTEIN AWARD

We're privileged to have the FWF Wittgenstein Award winner of 2019, Michael Wagner, among our scientists. This is the most prestigious research award in Austria.

KEY NUMBERS

3.9 MILLION EUROS

CeMESS researchers consistently excel in securing third-party funding, year after year. In 2023 the research expenditure was 3.9 million, of which 1.9 came from the Austrian Science Fund (FWF) and 1.3 came from the European Union (EU).

1 CLUSTER OF EXCELLENCE

"Microbiomes Drive Planetary Health" is funded with 21 Million Euros from the FWF over the next 5 years. The Cluster is led by 30 researchers from 8 institutions, 18 of which are from CeMESS.

598 PUBLICATIONS

We consistently achieve a high publication rate, driving forward the frontiers of knowledge. Of the 598 peer-reviewed journals we have written from 2019 to 2023, about 75% were published in Q1 journals.

15,100 CITATIONS

The frequent citations of our researchers' work demonstrate its wide-reaching global impact. As of January 2024, the 598 publications that we wrote from 2019 to 2023 were cited more than 15,100 times.

5 HIGHLY CITED RESEARCHERS

In 2023, five of our scientists were named Highly Cited Researchers by Clarivate, placing them in the global top 1% of their fields. CeMESS researchers make up more than 10% of Austria's Highly Cited Researchers.

EXPANDING KNOWLEDGE

RESEARCH AREAS

MICROBIOMES, SYMBIOSIS AND EVOLUTION

UNDERSTANDING THE VITAL ROLES OF MICROBES FOR OUR PLANET

We live in a microbial world. Microbes are the dominant form of life – the most abundant and diverse of all organisms. All other life depends on microbes and the functions they perform, such as oxygen production, nitrogen cycling and degradation of organic carbon. Because microbes are also the most ancient organisms, all other life evolved on a planet already teeming with complex microbial communities. The lives of modern plants and animals, including humans, are therefore intricately intertwined with those of the smallest organisms around them, and microbes are often key to the wellbeing of their larger hosts.

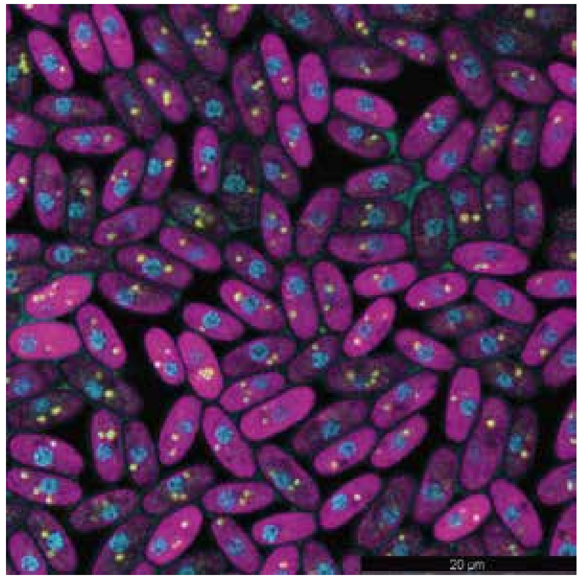
At CeMESS, we study microbial communities in a variety of natural and engineered ecosystems, to understand how they perform their functions and how they evolved to encode them. Specifically, we explore the evolution of mutualism and parasitism, the ecology and biology of marine symbioses, and the interaction of microorganisms with each other, with their predators and with plants. Finally, an important and growing topic is how microbial processes influence the health of humans and other organisms.

SELECTED HOST-MICROBE RELATIONSHIPS

- Beneficial symbionts in animals
- Intracellular microbes and pathogens
- Microbe-plant interactions
- Bacteria-virus (phage) dynamics in the wild
- Microbiomes in biotechnology and industry, e.g., wastewater treatment

SELECTED MICROBIOMES

- Soil microbiomes, e.g., grasslands and permafrost
- Microbiomes of ocean waters and sediments
- Human and animal microbiomes, e.g., gut and skin
- Microbiomes in biotechnology and industry, e.g., wastewater treatment



MICROBIOMES, MICROBIAL SYMBIONTS AND PATHOGENS

The term "microbiome" describes the microbes associated with a specific environment, such as ocean water, desert soil, or the human body. These communities are often highly diverse, consisting of eukaryotes, bacteria, archaea and viruses. Their interactions with each other and with their environment determine functions such as large-scale ecosystem processes and global nutrient cycles. Many of these functions can also be exploited as biological solutions to waste and pollution.

Animal- and plant-associated microbiomes can include microbes that are highly specific and either benefit or harm their host. Beneficial symbionts may provide essential nutrients to their hosts, in exchange for an optimised environment. Bacterial pathogens on the other hand exploit their hosts, sometimes with fatal consequences. Yet, there is a fine line between the two. The molecular mechanisms underlying host-symbiont or host-pathogen interactions are often similar, and the outcome of these associations often depends on environmental conditions, as well as genetics and lifestyle of the host.

We study a wide range of systems to elucidate general ecological mechanisms as well as system-specific interactions. Our ultimate goal is to translate fundamental knowledge into a better understanding of how global change will affect ecosystem services, and how we can influence the health of plants, animals and humans.

MICROBIAL EVOLUTION

The process of evolution underlies adaptation of organisms to everchanging environmental conditions. Because microbes have fast generation times, evolutionary change happens on shorter time scales than in plants and animals, making microbes important model systems to understand the causes and consequences of evolution in general terms.

However, the modes of evolution also differ in bacteria and archaea from those in eukaryotes. Horizontal gene transfer between unrelated individuals can introduce entirely novel sets of genes to genomes, and it is such genes that may, for example, turn a harmless bacterium into a pathogen, allow a microbe to utilise a new nutrient, or introduce antibiotic resistance to entire communities of organisms. Because evolution in microbes is fast, it can happen on ecological timescales, thus influencing how populations and communities of organisms change under different conditions.

We cover diverse topics in microbial evolution, ranging from reconstruction of evolutionary history of genes and pathways to how species and populations arise and change. This includes investigating how organisms adapt to each other, such as how resistance to viruses evolves in microbes in the wild. Finally, we use experimental evolution to explore to what extent outcomes of evolutionary processes are reproducible and predictable.

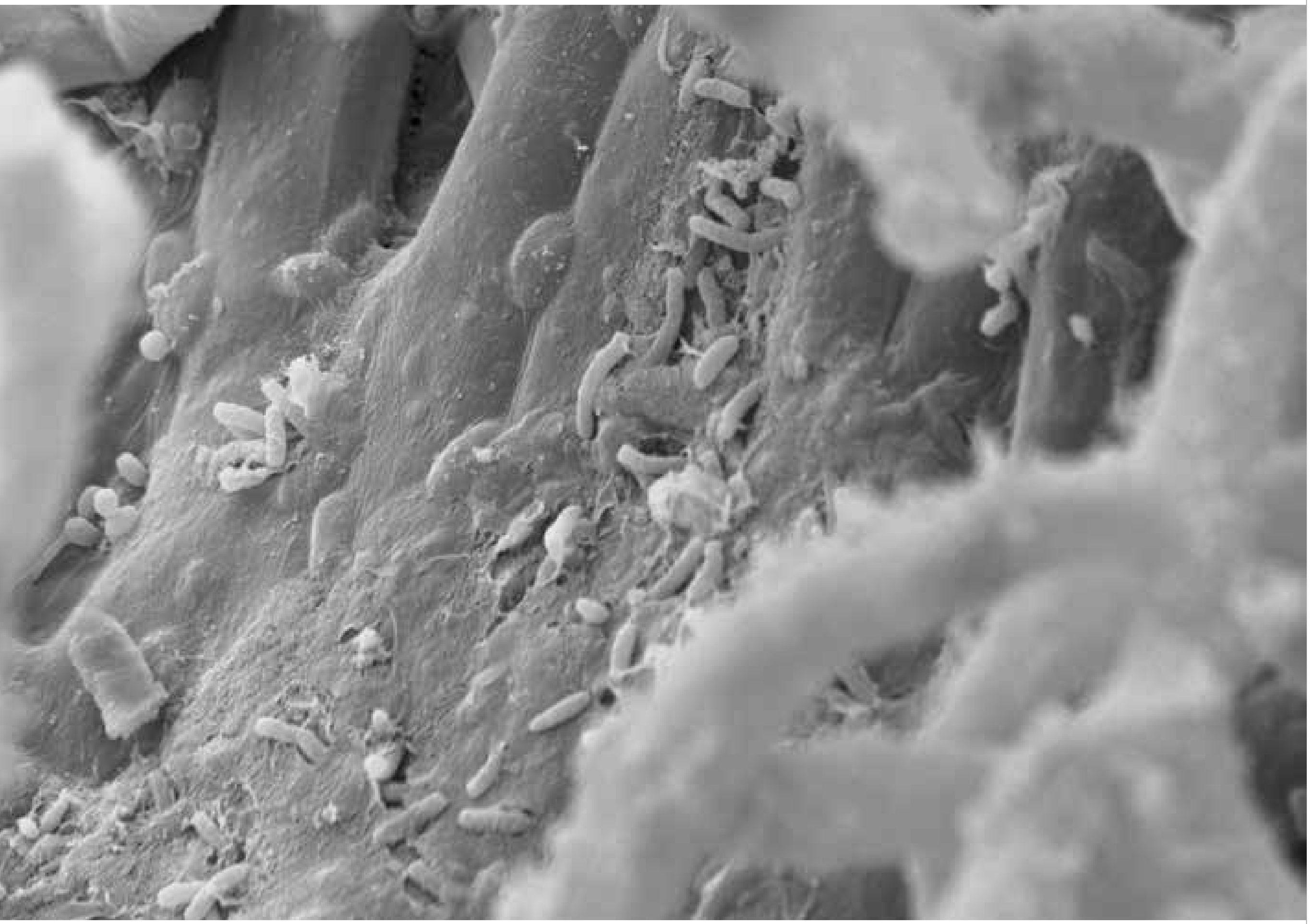
SELECTED TOPICS IN MICROBIAL EVOLUTION

- Population genomics
- Evolution of resistance in hosts and counter resistance in viruses
- Horizontal gene transfer rates and bounds in the wild
- Mobile genetic elements

Measuring salinity while sampling seawater at Nahant, Massachusetts to study drivers of microbial population structure. Credit: Ben Roller.

Intracellular chlamydiae (in yellow) living as symbionts inside their hosts, the "slime mould" (purple). Credit: Lukas Helmlinger

MICROBIAL ECOLOGY AND ECOSYSTEMS



UNDERSTANDING BIOGEOCHEMICAL CYCLES THAT ENABLE LIFE

Microorganisms are of critical importance for all global biogeochemical cycles and for food chains in terrestrial, aquatic and engineered ecosystems. At CeMESS, we study the structure and function of environmental microbiomes and the resulting flows of nutrient elements such as carbon, nitrogen, phosphorus and sulfur. These topics are investigated across scales, from the level of whole ecosystem processes, to the ecophysiology and biochemistry of single microbial species. We aim at a deeper understanding of how microorganisms contribute to ecosystem functions and how environmental microbiomes can be optimally utilised in engineered ecosystems, such as in wastewater treatment.

MICROBIAL NITROGEN AND SULFUR CYCLING

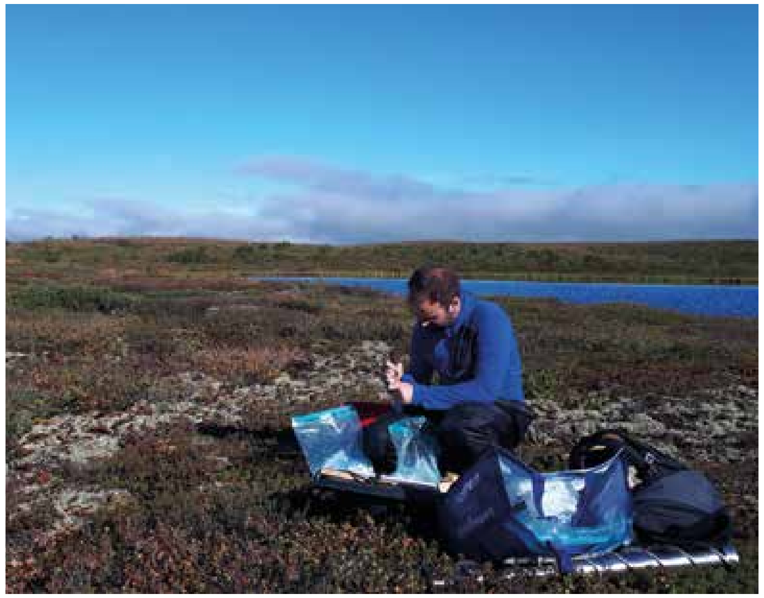
All living organisms need nitrogen (N) and sulfur (S) for the biosynthesis of nucleic acids, proteins, and other cellular components, and are thus directly dependent on the global N and S cycles. These cycles consist of multiple processes, many of which are catalysed exclusively by bacteria and archaea.

Humans are transforming the global N cycle at a record pace, primarily through using artificial nitrogen fertilisers. We cannot feed a growing global population without these fertilisers, and yet, with fertilisation efficiency often below 50%, we are releasing unprecedented amounts of ammonium into the environment. Ecological consequences range from biodiversity loss, eutrophication and "dead zones" in water bodies, to increased emissions of the greenhouse gas nitrous oxide (N_2O). Now more than ever, we urgently need science-backed strategies to ensure more efficient use of nitrogen fertilisers.

The global S cycle is intimately intertwined with other elemental cycles, mainly through the activities of microbes. Microbial sulfate respiration is a critical step in the global carbon cycle – fuelling up to 50% of organic carbon mineralisation in marine sediments. Moreover, sulfur-cycling bacteria in terrestrial wetlands provide an important control function on methane emissions from these environments. CeMESS conducts internationally leading research that aims to illuminate the complex biology of the N and S cycles. This knowledge is indispensable for predicting and mitigating environmental threats caused by human activities and global change.

SELECTED TOPICS, NITROGEN AND SULFUR CYCLING

- Nitrogen fixation by free-living and plant-associated microbes
- Ecophysiology, biochemistry, and evolution of nitrifying microorganisms in terrestrial, aquatic, and engineered ecosystems
- Interactions of nitrifying microbes and plants in the rhizosphere
- Utilisation of organic and inorganic nitrogen compounds by plants and microorganisms
- Physiology and evolution of organic and inorganic sulfur-compound-utilising microorganisms in marine sediments and terrestrial wetlands
- Development of isotope techniques to quantify nitrogen and sulfur cycle processes

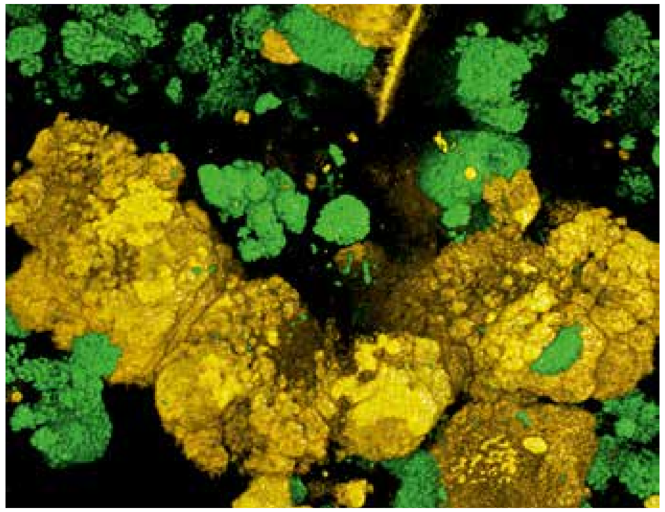


MICROBIOLOGY OF SOILS

Soils play a pivotal role in the functioning of the Earth's terrestrial ecosystems and harbour an almost inconceivable diversity of microorganisms. Our research addresses fundamental questions about what shapes this extensive microbial diversity, how microbial communities survive and thrive, and what functional roles they play in terrestrial ecosystems.

Soil microorganisms are key players in the terrestrial carbon cycle. They decompose, transform and stabilise soil organic matter, the largest reservoir of organic carbon on Earth. To build a deeper understanding of soil organic matter dynamics and nutrient cycling, we explore questions about how microorganisms interact with each other, and with plants, animals, and the soil matrix.

Finally, we explore the impact of climate and land-use change on the functioning of soil ecosystems and the potential repercussions on human wellbeing.



SELECTED TOPICS IN SOIL MICROBIOLOGY

- Microbial C and N use efficiency
- Microbial dormancy and resuscitation
- Soil organic matter formation and soil carbon storage
- Extracellular decomposition and microbial utilisation of soil organic C, N and P
- Plant-soil-microbe interactions
- Mathematical modelling of soil microbial communities

Bacteria colonising a mycorrhizal root tip of a beech tree. Credit: Core Facility for Cell Imaging and Ultrastructure Research, University of Vienna

Probing nitrogen cycling in permafrost environments in the Canadian Arctic. Credit: Victoria Martin

Wastewater treatment plant biofilm. Ammonia-oxidizing bacteria in green, nitrite-oxidizing bacteria in yellow.

GLOBAL CHANGE AND ENVIRONMENTAL PROCESSES

UNDERSTANDING ENVIRONMENTAL SYSTEMS IN A CHANGING WORLD

Environmental systems are in a state of constant change, especially due to human activities. At CeMESS, our aim is to identify, elucidate and model processes in terrestrial and aquatic ecosystems to understand how they are impacted by anthropogenic influence. More specifically, we explore questions concerning changes in biogeochemical cycles, their feedback to the climate, and the dynamics of pollutants. This allows a comprehensive understanding of complex environmental processes and the human influence on them, which is crucial for future societal decisions.

MICROBES AND CLIMATE CHANGE

Microorganisms have shaped the climate throughout Earth's history, but conversely, microbial communities are also affected by climate change. Microorganisms may acclimate or adapt in response to changing environmental conditions, leading to shifts in the composition and function of microbial communities, with potential cascading alterations to biogeochemical cycles. The functional plasticity and diversity of microbes in the environment and their complex interplay with other organisms make the prediction of future effects of climate change on microbially-mediated ecosystem functions and services one of the most challenging frontiers of today's ecological research.

Research at CeMESS explores which microorganisms will respond to climate change in the coming decades and how. This includes how warming-induced changes to soil organic matter breakdown can alter microbial greenhouse gas production, leading to positive soil-climate feedbacks. We identify genetic and metabolic properties of key microbial players of biogeochemical cycles, and unravel their complex metabolic interactions, to understand the effects of changing microbiome composition on ecosystem processes.

ENVIRONMENTAL INTERFACES

Interfaces between the geosphere, biosphere, hydrosphere, and atmosphere are locations of intense biological activity, where pollutants are transformed, mobilised or immobilised, and where information about current or ancient biomes is archived. Environmental interfaces span a range of scales, from vast global phenomena to the minute boundaries of nanoparticles. But to understand interfacial processes, we must focus on an even smaller scale: the molecular domain.

Our goal is to develop quantitative models that can ultimately inform costly decisions regarding environmental remediation or protection. This requires investigation of processes on a range of spatiotemporal-scales – a challenge we are well equipped to tackle. In order to trace and elucidate interfacial processes, we develop novel analytical methods for nanoparticle investigation, utilise advanced spectroscopic methods, probe radiation from X-ray to IR, and use mass spectrometry, including non-traditional isotope geochemistry.

EMERGING ENVIRONMENTAL POLLUTANTS

Chemical pollution is among the nine planetary boundaries that define Earth's stress limits. Pollutants have the potential to irreversibly affect all ecosystems and are a threat to human and environmental health. Anthropogenic and naturally occurring chemicals are linked to complex sources and reactions in the environment, including their formation, transport, transformation, and degradation.

Our overall goal is to understand the complexity of environmental systems and to apply those fundamental insights to solving the most pressing environmental problems of tomorrow. We investigate threats of global concern like micro- and nanoplastics, manufactured and incidental nanoparticles, or freshwater contamination. Equally important to us are pollutants of natural origin. For instance, redox-driven uranium pollution, asbestos in road construction, or persistent free radicals formed in wildfires. Our research aims to elucidate the occurrence, fate and (bio-)transformation of these substances from the molecular scale to a systems' understanding – fundamental prerequisites for accurate risk management. This knowledge is essential for safe use of existing and future products, and is required to design competitive remediation strategies and environmentally benign chemicals.

SELECTED TOPICS, MICROBES AND CLIMATE CHANGE

- Soil warming, microbial acclimation and soil-climate feedbacks
- Impact of sulfur-cycling microorganisms on wetland methane emission
- Interactive effects of elevated atmospheric CO_2, warming and drought on soil processes
- Nitrogen fertilisation/eutrophication and nutrient imbalances

SELECTED TOPICS, ENVIRONMENTAL POLLUTANTS

- Impact of engineered and incidental nanoparticles
- Micro- and nanoplastics in the environment
- Biotransformation of anthropogenic chemicals
- Behaviour of emerging environmental pollutants and innovative remediation strategies

SELECTED TOPICS, ENVIRONMENTAL INTERFACES

- Mineral surfaces as information archives for past biomes
- Biological processes at environmental interfaces
- Interfacial processes mobilising or immobilising pollutants
- Natural nanoparticles, their (bio-)synthesis and their role in pollutant transport

The ClimGrass experimental facility, which simulates drought and future climate conditions. Credit: Agricultural Research and Education Centre Raumberg-Gumpenstein.

Vegetable crops protected by plastic mulch, a source of micro- and nanoplastics in soils. Credit: Maciej Bledowski

In situ flumes field study: CeMESS researchers measure changes in microbial biofilm functioning following pulsed inputs to investigate post-fire changes to river functioning.

MICROBIOMES DRIVE PLANETARY HEALTH

CLUSTER OF EXCELLENCE

The invisible world of microorganisms holds the secret to the stability of our Earth. As the oldest inhabitants of our planet, they are found in all ecosystems in often highly complex communities known as microbiomes. Although microorganisms are only about a thousandth of a millimetre in size, their total biomass on our planet is greater than that of animals and humans combined. Microbiomes are not only the invisible architects of the biosphere – they also control the Earth's biogeochemical elemental cycles and influence global change. As symbionts, they also colonise all plants, animals, and humans.

Planetary health, the health of human civilisation and the natural systems in which it is embedded, is the highest attainable standard of global health and wellbeing. This comprehensive health perspective recognizes the inextricable link between humans and the environment and all living things. Microbiomes play a central role here: As symbionts of all higher organisms, they are essential to their health and provide the basis for the ecosystem services on which humans depend. Yet despite their importance, the links between microbiomes and planetary health are still very poorly understood.

Despite the many similarities between ecologically and medically relevant microbiomes, research in these areas has traditionally been conducted separately. In addition, microbiome research is still mostly limited to correlative approaches, which provide exciting hypotheses about the role of microbiomes in human and environmental health, but do not lead to a causal understanding of how microbiomes function. Therefore, current attempts to specifically manipulate the composition and function of microbiomes in ecosystems or humans have had limited success.

INSTITUTIONS COLLABORATING IN THE CLUSTER OF EXCELLENCE "MICROBIOMES DRIVE PLANETARY HEALTH"

- University of Vienna (Lead Institution)
- Austrian Institute of Technology
- Institute of Science and Technology Austria
- Johannes Kepler University Linz
- Medical University of Graz
- Medical University of Vienna
- Research Center for Molecular Medicine of the Austrian Academy of Sciences
- Technical University of Vienna

RESEARCH THEMES AND TOPICS

MICROBIOME INTERACTIONS

- The small intestine: an underexplored habitat with impliaction for human health
- The influence of invasive species on host-associated microbiomes
- Cross-kingdom interactions in the ectomycorrhizal symbiosis
- Control of eukaryotic microbial populations by viral parasites
- Probing interkingdom crosstalk during inflammation

MICROBIOME PERTURBATIONS

- Impact of drugs on microbiomes in humans and wastewater treatment
- Impact of emerging pollutants on microbiomes across systems
- Microbial interactions under climate extremes
- Perturbations of permafrost microbiomes and the climate feedback
- Control of nitrous oxide emissions in soils

MONITORING AND INTERVENTIONS

- Wastewater microbiomes for next-gen public health monitoring
- Microbiome modification by fecal microbiota transplantation
- Eavesdropping interdomain signals and modulators
- Microbiome-based improvement of nitrogen and phosphorus nutrition in crop production
- Microbiome-enhanced silicate weathering
- Role of selective sulfur nutrients across human and environmental microbiomes and for precision microbiome editing

To address these gaps in knowledge, and to further strengthen Austria's position as one of the leading countries in the field of microbiome research, CeMESS initiated an application for a Cluster of Excellence "Microbiomes drive Planetary Health" as part of the FWF Austrian Excellence Initiative. This cluster was selected as one of five Austrian Clusters of Excellence 2023 in a highly selective multi-stage process. Directed by CeMESS Vice Head Michael Wagner, the cluster comprises 30 key researchers, 18 of which are from CeMESS. It will receive €21 million in funding from the Austrian Science Fund FWF over the next five years. This will be supplemented by in-kind contributions from the eight participating research institutions, bringing the total funding available for the first five-year period to €35 million.

The cluster will focus on three central themes: Microbiome Interactions, Microbiome Perturbations and Microbiome Monitoring & Interventions. These are undertaken jointly by teams of experts from the fields of ecological and medical microbiome research using state-of-the-art technologies from across our nine method facilities. By providing all cluster members with mutual access to these facilities, we empower them to take full advantage of the synergies arising from the fusion of the two disciplines. The aim of the cluster is to synthesize knowledge obtained across disciplines to identify the fundamental principles of microbiome structure and function. This will enable a fundamentally new understanding of the microbiology of global change and the function of the human microbiome, which will be essential to harness the full potential of microbiomes to steer our planet towards a sustainable future.

Board of Directors, Cluster of Excellence "Microbiomes Drive Planetary Health". Credit: FWF, Daniel Novotny

Across our planet, are key drivers of health in diverse systems including agriculture, the environment, engineered systems, and human health. Credit: MNStudio

PASSION FOR SCIENCE

TEAM

50 PROFESSORS

71 JUNIOR RESEARCH GROUP LEADERS

75 SENIOR SCIENTISTS

81 STUDENTS & EARLY CAREER RESEARCHERS

83 TECHNICIANS, ADMIN & IT STAFF

Mark Anthony’s research focuses on the ecology and evolution of fungi. By employing genomic tools to characterize the composition, diversity, and functioning of fungal communities, Mark and his group investigate how the forest mycobiome drives emergent forest functions, like forest productivity and soil carbon storage.

They also explore how soil fungi respond to ongoing environmental change, from invasive species to global warming. Recent work has encompassed multiple trophic levels, examining interactions among fungi, prokaryotes, plants, and animals. Current studies focus on the roles of mycorrhizal fungi in shaping tree responses to climate change, the functioning of common mycorrhizal fungal networks, the ecology of fungal endophytes, and microbiome engineering to manipulate plant growth, reproduction, and death. Mark was recently awarded a Swiss National Science Foundation (SNSF) Ambizione Fellowship and a WWTF Vienna Research Groups for Young Investigators grant.

Mark Anthony
TER – Division of
Terrestrial Ecosystem Research

Assistant Professor (Tenure Track)
+43 1 4277 91278
mark.anthony@univie.ac.at

MAIN RESEARCH AREAS

- Fungal ecology
- Fungal evolution, with a focus on biotrophic fungi
- Plant-microbe symbioses, with a focus on mycorrhizae and endophytes
- Global change biology, with focus on effects of multiple simultaneous stressors

CURRICULUM VITAE

Since 2024: Assistant Professor (Tenure Track), University of Vienna

Since 2022: Ambizione Fellow, Swiss Federal Research Institute WSL

2022–2023: Guest Researcher, Agroscope

2019–2022: Postdoctoral Researcher, ETH Zürich

2015–2019: PhD in Environmental System Sciences, University of New Hampshire

SELECTED PUBLICATIONS

Enumerating soil biodiversity.
Anthony, MA, Bender SF, van der Heijden M. 2023 – PNAS, 120: e2304663120.

Forest tree growth is linked to mycorrhizal fungal composition and function across Europe.
Anthony MA, Crowther TW, van der Linde S, Suz LM, Bidertondo MI, Cox F, … Averill C. 2022 – ISME J, 16: 1327-36.

Defending Earth’s terrestrial microbiome.
Averill C, Anthony MA, Baldrian P, Finkbeiner F, van der Hoogen J, Kiers T, … Crowther TW. 2022 – Nature Microbiol, 7: 1717-25.

Fungal community structure and function shifts with atmospheric nitrogen deposition.
Moore JAM, Anthony MA, Pec GJ, Trocha LK, Trzebny A, Geyer KM, van Diepen LTA, Frey SD. 2021 – Glob Chang Biol, 27:1349-64.

Plant invasion impacts on fungal community structure and function depend on soil warming and nitrogen enrichment.
Anthony MA, Stinson KA, Moore JAM, Frey SD. 2020 – Oecologia, 194: 659-72.

Oceans and lakes are home to a plethora of different microorganisms which drive biogeochemical cycles on our planet. Barbara Bayer’s research focusses on the interactions between aquatic microorganisms and their environment and on understanding the environmental regulation of microbial processes that control carbon and nitrogen cycling in the water column.

Barbara and her team combine diverse isotope approaches, cultivation, and multi-omics techniques to quantify biogeochemical processes and identify novel microorganisms and metabolic pathways. Barbara has received an ERC Starting Grant to investigate microbial methane cycling in aquatic ecosystems and has also been granted an Austrian Science Fund (FWF) START Award.

Barbara Bayer
DOME – Division of
Microbial Ecology

ERC Starting Grant, FWF Start Award
+43 1 4277 91236
barbara.bayer@univie.ac.at

MAIN RESEARCH AREAS

- Carbon and nitrogen cycling in aquatic ecosystems
- Marine microbial ecology
- Microbial metabolism and interactions

CURRICULUM VITAE

Since 2024: Group Leader, University of Vienna

2021–2023: Postdoctoral Researcher, University of Vienna

2019–2021: Postdoctoral Research Fellow, University of California

2019: PhD in Biology, University of Vienna

SELECTED PUBLICATIONS

Carbon content, carbon fixation yield and dissolved organic carbon release from diverse marine nitrifying microorganisms.
Bayer B, McBeain K, Carlson CA, Santoro AE. 2023 – Limnol Oceanogr, 68: 84-96.

Prokaryotic Life in the Deep Ocean’s Water Column.
Herndl GJ, Bayer B, Baltar F, Reinthaler T. 2023 – Ann Rev Mar Sci, 15: 461-83.

Global-scale abundances, nitrification rates, and carbon fixation rates of marine nitrifying microorganisms.
Zakem EJ, Bayer B, Qin W, Santoro AE, Zhang Y, Levine NM. 2022 – Biogeosciences, 19: 5401-18.

Metabolic versatility of the nitrite-oxidizing bacterium Nitrospira marina and its proteomic response to oxygen-limited conditions.
Bayer B, Saito MA, McIlvin M, Lücker S, Moran DM, Lankiewicz TS, Dupont CL, Santoro AE. 2021 – ISME J, 15: 1025-39.

Ammonia-oxidizing archaea release a suite of organic compounds potentially fueling prokaryotic heterotrophy in the ocean.
Bayer B, Hansman R, Bittner MJ, Ortega-Noriega BE, Niggemann J, Dittmar T, Herndl GJ. 2019 – Environ Microbiol, 21: 4062-75.

David Berry
DOME – Division of
Microbial Ecology

Full Professor
+43 1 4277 91212
david.berry@univie.ac.at

Research in David Berry's group is focused on understanding the biology of the human microbiota and its role in health and disease. He has pioneered the development of novel experimental and computational tools to reveal the functionof microbial communities and has developed single cell isotope labelling techniques to characterise functional guilds in the intestinal ecosystem.

The main research aims of David's group are to gain a fundamental understanding of the assembly and interactions of the intestinal microbiota and to uncover how the microbiota affects host physiology. David is active in translational and clinical research in several fields, including chronic inflammation, nutrition, metabolic syndrome, cancer, and gut-immune-brain axis development in newborns. He is coordinator of an Austrian Science Fund (FWF) research consortium focused on premature infant health (2023).

MAIN RESEARCH AREAS

- Ecology and evolution of the human microbiome
- Intestinal microbiota in health and disease
- Modelling approaches to study microbial communities
- In situ analyses of microbes using single-cell isotope probing

CURRICULUM VITAE

Since 2018: Full Professor for Human Microbiome Research, University of Vienna

Since 2018: Operational Director of the Joint Microbiome Facility (JMF), Medical University of Vienna and University of Vienna

2016–2017: Associate Professor, University of Vienna

2012–2016: Assistant Professor, University of Vienna

2009–2012: Postdoctoral Researcher, University of Vienna

2009: PhD in Environmental Engineering, University of Michigan

SELECTED PUBLICATIONS

Identification of inulin-responsive bacteria in the gut microbiota via multi-modal activity-based sorting.
Riva A, Rasoulimehrabani H, Cruz-Rubio JM, Schnorr SL, von Baeckmann C, Inan D, ... Berry D. 2023 – Nature Commun. 14: 8210.

Impaired mucosal homeostasis in short-term fiber deprivation is due to reduced mucus production rather than overgrowth of mucus-degrading bacteria.
Overbeeke A, Lang M, Hausmann B, De Paepe K, Watzka M, Nikolov G, ... Berry D. 2022 – Nutrients, 14: 3802.

Aberrant gut microbiota-immune-brain axis development in premature neonates with brain damage.
Seki D, Mayer M, Hausmann B, Pjevac P, Giordano V, … Berry D, Wisgrill L. 2021 – Cell Host & Microbe, 29: 1558-1572.e6.

Rational design of a microbial consortium of mucosal sugar utilizers reduces Clostridiodes difficile colonization.
Pereira FC, Wasmund K, Cobankovic I, Jehmlich N, Herbold CW, Soo Lee K, … Berry D. 2020 – Nature Commun, 11: 5104.

A fiber-deprived diet disturbs the fine-scale spatial architecture of the murine colon microbiome.
Riva A, Kuzyk O, Forsberg E, Siuzdak G, Pfann C, Herbold CW, … Berry D. 2019 – Nature Commun, 10: 4366.

Thomas Böttcher
Joint Professorship CeMESS
and Faculty of Chemistry

Full Professor
+43 1 4277 70550
thomas.boettcher@univie.ac.at

Thomas Böttcher's group investigates the chemistry of microbial interactions, as well as chemical strategies for modulating coordinated population behaviours of microbes. Thomas and his team elucidate chemical structures of metabolites that mediate and control interactions between microbes and their human host.

Their research exploits these compounds by synthetic chemistry, in order to develop species-specific antibiotics and anti-virulence compounds. Additionally, the group is interested in chemical probes for active-site directed labelling of virulence-related enzymes and the development of customised inhibitors. Thus, Thomas' research aims not only to build fundamental knowledge of the chemical interactions of microbes, but also to create chemical tools for precision microbiome interventions, with the ultimate vision of chemical microbiome engineering. Thomas has received a European Research Council (ERC) Consolidator grant to investigate the chemistry of prophage induction.

MAIN RESEARCH AREAS

- Discovery of microbial metabolites
- Species-specific antibiotics and anti-virulence strategies
- Chemical strategies for modulating microbial behaviour and signalling
- Development of chemical probes and customised enzyme inhibitors
- Chemistry of microbe-phage interactions

CURRICULUM VITAE

Since 2020: Full Professor for Microbial Biochemistry, University of Vienna

2014–2020: Emmy-Noether Group Leader, Department of Chemistry, University of Konstanz

2011–2014: Postdoctoral Researcher, Harvard Medical School

2010–2011: Co-founder and Project Leader of start-up AVIRU GmbH

2010: Postdoctoral Researcher, Technical University Munich

2009: PhD in Chemical Proteomics, LMU Munich

SELECTED PUBLICATIONS

Identification of the bacterial metabolite aerugine as potential trigger of human dopaminergic neurodegeneration.
Ückert AK, Rütschlin S, Gutbier S, Wörz N C, Miah MR, … Böttcher T, Leist M. 2023 – Environ Int, 180: 108229.

A metabolite of Pseudomonas triggers prophage-selective lysogenic to lytic conversion in Staphylococcus aureus.
Jancheva M, Böttcher T. 2021 – J Am Chem Soc, 143: 8344-51.

Competitive metabolite profiling of natural products reveals subunit specific inhibitors of the 20S proteasome.
Pawar A, Basler M, Goebel H, Alvarez Salinas G, Groettrup M, Böttcher T. 2020 – ACS Cent Sci, 6: 241-6.

A thiochromenone antibiotic derived from Pseudomonas quinolone signal selectively targets the Gram-negative pathogen Moraxella catarrhalis.
Szamosvári D, Schuhmacher T, Hauck C, Böttcher T. 2019 – Chem Sci, 10: 6624-8.

Competitive live-cell profiling strategy for discovering inhibitors of the quinolone biosynthesis of Pseudomonas aeruginosa.
Prothiwa M, Englmaier F, Böttcher T. 2018 – J Am Chem Soc, 140: 14019-23.

Holger Daims

DOME – Division of
Microbial Ecology

Full Professor
+43 1 4277 91204
holger.daims@univie.ac.at

Nitrogen-cycling microorganisms perform critical roles in natural ecosystems, agricultural settings, and water treatment facilities. Research in Holger Daims' group investigates the diversity, ecophysiology, and evolution of these organisms. One of their key research goals is to understand how microorganisms interact and maintain their activities amidst fluctuating environmental conditions. This knowledge helps improve strategies to utilise and control nitrogen-cycling microbes in soils and engineered systems.

Holger and his team have revealed a hidden metabolic versatility of nitrite-oxidising bacteria and made key contributions to the discovery and characterisation of complete ammonia oxidisers (comammox). An additional research area is the development and application of in situ labelling and imaging methods to characterise microorganisms in spatially complex environments, such as environmental and medical biofilms. Software developed by Holger's group is among the most widely used programs for digital image analysis in microbial ecology, with applications in >500 studies worldwide.

MAIN RESEARCH AREAS

- Evolution and ecophysiology of nitrite-oxidising bacteria and completely nitrifying organisms (comammox)
- Functioning of complex microbiota in engineered systems
- Microbial interactions in biofilms
- Development of methods to study microorganisms directly in their environment

CURRICULUM VITAE

Since 2018: Head of the Comammox Research Platform, University of Vienna

Since 2017: Full Professor for Ecophysiology of Microorganisms, University of Vienna

2012–2017: Associate Professor, University of Vienna

2010–2012: Assistant Professor (Tenure Track), University of Vienna

2003–2010: Assistant Professor, University of Vienna

2001–2003: Postdoctoral Researcher, Technical University Munich

2001: PhD in Microbiology, Technical University Munich

SELECTED PUBLICATIONS

Cultivation and genomic characterization of novel and ubiquitous marine nitrite-oxidizing bacteria from the Nitrospirales.
Mueller AJ, Daebeler A, Herbold CW, Kirkegaard RH, Daims H. 2023 – ISME J, 17: 2123-33.

Genomic and kinetic analysis of novel Nitrospinae enriched by cell sorting.
Mueller AJ, Jung MY, Strachan CR, Herbold CW, Kirkegaard RH, Wagner M, Daims H. 2021 – ISME J, 15: 732-45.

Low yield and abiotic origin of N_2O formed by the complete nitrifier Nitrospira inopinata.
Kits KD, Jung MY, Vierheilig J, Pjevac P, Sedlacek CJ, Liu S, … Daims H. 2019 – Nat Commun, 10: 1836.

Kinetic analysis of a complete nitrifier reveals an oligotrophic lifestyle.
Kits KD, Sedlacek CJ, Lebedeva EV, Han P, Bulaev A, Pjevac P, … Daims H, Wagner M. 2017 – Nature, 549: 269-72.

Complete nitrification by Nitrospira bacteria.
Daims H, Lebedeva EV, Pjevac P, Han P, Herbold CW, Albertsen M, … Wagner M. 2015 – Nature, 528: 504-9.

Thilo Hofmann

EDGE – Division of
Environmental Geosciences

Full Professor
+43 1 4277 53320
thilo.hofmann@univie.ac.at

Environmental contamination is a planetary boundary being crossed. Thilo Hofmann's group focuses on the fate of emerging contaminants in environmental systems and aims to inform solutions to these pressing problems. His research aims to elucidate the dynamics, fate and environmental behaviour of organic contaminants, and to develop remediation strategies. A current research focus addresses forever chemicals including PFAS, plastic pollution of our planet, agricultural practices, tire wear particles and additives of concern.

Thilo is co-director of the University of Vienna's new Environment and Climate Research Hub, which includes leading scientists from natural sciences, humanities, law, and economics, aiming to tackle today's environmental challenges. He has received awards from the German Academic Scholarship Foundation, Berlin Technical University, and the German Water Chemical Society. He is adjunct/visiting professor at Duke (NC, USA) and Tianjin (China) University.

MAIN RESEARCH AREAS

- Fate of contaminants from the molecular scale to soil and groundwater remediation
- Natural, incidental and engineered nanoparticles in the environment
- Plastic pollution and additives
- Forever chemicals, PFAS remediation

CURRICULUM VITAE

Since 2022: Co-director of the University of Vienna Environment and Climate Research Hub

Since 2019: Vice Head of CeMESS

Since 2018: Guest Professor, Nankai University

Since 2017: Adjunct Full Professor, Duke University

2015-2022: Director of the University of Vienna Environmental Science Research Network

2012–2016: Dean of the Faculty of Geosciences, Geography and Astronomy, University of Vienna

Since 2005: Full Professor for Environmental Geosciences, University of Vienna

2003–2005: Lecturer, University Mainz

1999–2003: Research Associate, University Mainz

1998: PhD in Aquatic Geochemistry, University of Bremen

SELECTED PUBLICATIONS

Plastics can be used more sustainably in agriculture.
Hofmann et al. 2023 – Commun Earth Environ, 4: 332.

Environmentally persistent free radicals are ubiquitous in wildfire charcoals and remain stable for years.
Sigmund G, Santín C, Pignitter M, Tepe N, Doerr SH, Hofmann T. 2021 – Commun Earth Environ, 2: 68.

Technology readiness and overcoming barriers to sustainably implement nanotechnology-enabled plant agriculture.
Hofmann T, Lowry GV, Ghoshal S, Tufenkji N, Brambilla D, Dutcher JR, … Wilkinson KJ. 2020 – Nature Food, 1: 416-25.

A deep learning neural network approach for predicting the sorption of ionizable and polar organic pollutants to a wide range of carbonaceous materials.
Sigmund G, Gharasoo M, Hüffer T, Hofmann T. 2020 – Environ Sci Technol, 54 : 4583-91.

Legal and practical challenges in classifying nanomaterials according to regulatory definitions.
Miernicki M, Hofmann T, Eisenberger I, von der Kammer F, Praetorius A. 2019 – Nature Nanotech, 14: 208-16.

Matthias Horn
DOME – Division of
Microbial Ecology

Full Professor
+43 1 4277 91208
matthias.horn@univie.ac.at

Research in Matthias Horn's group focuses on bacteria and viruses infecting and residing within eukaryotic cells. Using an array of molecular and computational methods, his group has discovered novel intracellular microbes, and deciphered molecular mechanisms and evolutionary processes underlying these associations.

Bacteria living within eukaryotic cells comprise both important pathogens as well as symbionts of their hosts. Yet, intracellular microbes have long been underestimated with respect to diversity, distribution in nature, and their ecological importance. To address this knowledge gap, the group investigates selected non-model organisms, including symbionts of amoeba and giant viruses infecting protists. Current studies include the effects of co-infections with multiple intracellular microbes, as well as ancestral genome reconstruction and evolution experiments to better understand how microbe-host interactions evolved through time. Matthias has received an ERC Starting Grant (Consolidator Track) and an FWF START Award. He is currently coordinating an FWF-funded PhD program on Microbial Symbiosis.

MAIN RESEARCH AREAS

- Microbial symbioses
- Evolution, molecular and cellular biology of intracellular bacteria
- Giant viruses infecting protists
- Microbial genome evolution
- Bacteria-host interactions

CURRICULUM VITAE

Since 2019: Head of the Department of Microbiology and Ecosystem Science, University of Vienna

Since 2007: Full Professor for Microbial Symbioses, University of Vienna

2005: Associate Professor, University of Vienna

2003: Assistant Professor, University of Vienna

2001: PhD in Microbiology, Technical University Munich

SELECTED PUBLICATIONS

Gene gain facilitated endosymbiotic evolution of Chlamydiae.
Dharamshi JE, Köstlbacher S, Schön ME, Collingro A, Ettema TJG, Horn M. 2023 – Nature Microbiol, 1: 40-54.

Defensive symbiosis against giant viruses in amoebae.
Arthofer P, Delafont V, Willemsen A, Panhölzl F, Horn M. 2022 – Proc Natl Acad Sci USA, 119: e2205856119.

Evolutionarily recent dual obligatory symbiosis among adelgids indicates a transition between fungus- and insect-associated lifestyles.
Szabó G, Schulz F, Manzano-Marín A, Toenshoff ER, Horn M. 2022 – ISME J, 1: 247-56.

Pangenomics reveals alternative environmental lifestyles among chlamydiae.
Köstlbacher S, Collingro A, Halter T, Schulz F, Jungbluth SP, Horn M. 2021 – Nature Commun, 12: 4021.

Molecular causes of an evolutionary shift along the parasitism-mutualism continuum in a bacterial symbiont.
Herrera P, Schuster L, Wentrup C, König L, Kempinger T, … Rattei T, Horn M. 2020 – Proc Natl Acad Sci USA, 117: 21658-66.

Christina Kaiser
TER – Division of
Terrestrial Ecosystem Research

Associate Professor
+43 1 4277 91263
christina.kaiser@univie.ac.at

Looking at soil from the perspective of complex systems science, Christina Kaiser's group explores how small-scale microbial processes ultimately govern the composition and functioning of the community, and in turn, how this affects system processes like soil organic matter turnover. Her work combines soil microbial ecology and theoretical modelling with ecosystem biogeochemistry.

Christina's group furthermore investigates carbon and nitrogen exchange in the tripartite symbiosis of plants, mycorrhizal fungi, and soil microbial decomposers. They combine state-of-the-art stable isotope techniques with nanoscale secondary ion mass spectrometry (NanoSIMS) to trace carbon and nitrogen through the plant-soil system, and to visualise elemental exchange at the plant-microbe interface, in situ and at subcellular scales. This allows deeper insights into the controls of this exchange and its consequences for ecosystem carbon and nitrogen cycling. Christina has received an ERC Consolidator grant to study self-organisation of microbial soil organic matter turnover.

MAIN RESEARCH AREAS

- Emergent phenomena of complex microbial communities
- The spatial aspect of rhizosphere priming
- Interactions between soil microarchitecture and soil microbial ecology
- Carbon and nitrogen exchange between plants, mycorrhizal fungi and soil bacteria
- Effect of mycorrhizal associations on soil organic matter decomposition

CURRICULUM VITAE

Since 2022: Associate Professor, University of Vienna.

2018–2022: Assistant Professor (Tenure Track), University of Vienna

2014–2018: Group Leader and Assistant Professor (Univ. Ass.), University of Vienna

2014–2018: Guest Researcher at the International Institute for Applied Systems Analysis (IIASA)

2012–2014: Postdoctoral Fellow, IIASA

2011: Postdoctoral Fellow, University of Western Australia (UWA)

2010: PhD in Ecology, University of Vienna

SELECTED PUBLICATIONS

A pulse of simulated root exudation alters the composition and temporal dynamics of microbial metabolites in its immediate vicinity.
Wiesenbauer J, König A, Gorka S, Marchand L, Nunan N, Kitzler B, Inselsbacher E, Kaiser C. 2024 – Soil Biol Biochem 189: 109259.

Persistence of soil organic carbon caused by functional complexity.
Lehmann J, Hansel CM, Kaiser C, Kleber M, Maher K, Manzoni S, … Kögel-Knabner I. 2020 – Nature Geosci, 13: 529-34.

Nitrogen and phosphorus constrain the CO_2 fertilization of global plant biomass.
Terrer C, Jackson RB, Prentice IC, Keenan TF, Kaiser C, Vicca S, … Franklin O. 2019 – Nature Clim Chang, 9: 684-9.

Recently photoassimilated carbon and fungus-delivered nitrogen are spatially correlated in the ectomycorrhizal tissue of Fagus sylvatica.
Mayerhofer W, Schintlmeister A, Dietrich M, Gorka S, Wiesenbauer J, Martin V, ... Kaiser C. 2021 – New Phytol, 232: 2457-74.

From diversity to complexity: Microbial networks in soils.
Guseva K, Darcy S, Simon E, Alteio LV, Montesinos-Navarro A, Kaiser C. 2022 – Soil Bio Biochem 169: 10860.

Stephan Krämer

Stephan Krämer
EDGE – Division of
Environmental Geosciences

Full Professor
+43 1 4277 53463
stephan.kraemer@univie.ac.at

Stephan Krämer's group studies the interactions of the biosphere with earth materials. Surface chemistry processes at the interface of biotic and abiotic materials play a critical role in driving environmental processes like pollutant transport, nutrient availability, mineral weathering, and global element cycling.

Stephan and his group study the mechanisms underlying surface biogeochemical processes in various contexts, from the transformation and mobilisation of pollutants to the acquisition or loss of nutrients in plants. His group uses modern methods such as non-traditional stable isotope geochemistry and synchrotron X-ray adsorption spectroscopy to study these processes on a molecular scale. Notably, they also explore how interactions between mineral surfaces and nucleic acids (DNA, RNA) leads to the preservation or degradation of environmental DNA.

MAIN RESEARCH AREAS

- aDNA and eDNA preservation at mineral surfaces
- Mobilisation and immobilisation of inorganic contaminants in soils and sediments
- Biological trace nutrient acquisition
- Mineral surface chemistry
- Rhizosphere chemistry

CURRICULUM VITAE

Since 2012: Head of the Department of Environmental Geosciences, University of Vienna

Since 2006: Full Professor for Environmental Geosciences, University of Vienna

2005: Habilitation in Environmental Geochemistry, ETH Zürich

2000–2006: ETH-Oberassistent, Department of Environmental Sciences, Swiss Federal Institute of Technology Zürich

1998–1999: Guest Scientist, Department of Environmental Science, Policy and Management, University of California, Berkeley

1997: PhD in Geosciences, TH Darmstadt

SELECTED PUBLICATIONS

Stability of coumarins and determination of the net iron oxidation state of iron–coumarin complexes: Implications for examining plant iron acquisition mechanisms.
Kang K, Schenkeveld WDC, Weber G, Kraemer SM. 2023 – ACS Earth Space Chem.

Rates and mechanism of vivianite dissolution under anoxic conditions.
Metz R, Kumar N, Schenkeveld WDC, Kraemer SM. 2023 – Env Sci Technol, 57: 17266-77.

Effect of competing metals and humic substances on uranium mobilization from noncrystalline U (IV) induced by anthropogenic and biogenic ligands.
Chardi KJ, Schenkeveld WDC, Kumar N, Giammar DE, Kraemer SM. 2023 – Env Sci Technol, 57: 16006-15.

Copper limiting threshold in the terrestrial ammonia oxidizing archaeon Nitrososphaera viennensis.
Reyes C, Hodgskiss LH, Baars O, Kerou M, Bayer B, Schleper C, Kraemer SM. 2020 – Res Microbiol, 171: 134-42.

The effect of pH and biogenic ligands on the weathering of chrysotile asbestos; the pivotal role of tetrahedral Fe in dissolution kinetics and radical formation.
Walter M, Schenkeveld WDC, Reissner M, Gille L, Kraemer SM. 2019 – Chemistry, 25: 3286-300.

Alexander Loy

Alexander Loy
DOME – Division of
Microbial Ecology

Full Professor
+43 1 4277 91205
alexander.loy@univie.ac.at

Alexander Loy's research covers a diverse spectrum of topics in microbial ecology and symbiosis, from the role of intestinal microbiota in health and disease, to the ecology and evolution of sulfur-compounds-utilising microorganisms. He has long-standing expertise in developing and applying stable isotope-labelling and molecular biology methods for in situ analysis of complex host-associated and environmental microbiota.

Alexander's group explores how physiological interactions among microbiome members impacts their environment or host. This includes how environmental microbes impact sulfur and carbon cycling, as well as how symbionts and pathogens affect the health and nutrition of their hosts. This knowledge could ultimately translate to development of microbiome-based health interventions. Their current projects focus on microbial sulfur metabolism in wetlands and the intestinal tract, impact of emerging pollutants on human and environmental microbiomes, as well as the development of defined microbial communities for production of new secondary metabolites, such as antibiotics.

MAIN RESEARCH AREAS

- The complex symbiotic microbiota of animals and humans in health and disease
- Evolution and ecology of sulfur microorganisms
- Development of novel methods to study microorganisms in their natural environments

CURRICULUM VITAE

Since 2017: Full Professor for Microbial Communities, University of Vienna

Since 2016: Co-founder, Austrian Microbiome Initiative (AMICI)

2013–2017: Associate Professor, University of Vienna

Since 2013: Faculty member, Austrian Polar Research Institute (APRI)

2009–2013: Assistant Professor, University of Vienna

2006–2009: Group Leader, University of Vienna

2003–2006: Postdoctoral Researcher, University of Vienna

2003: PhD in Microbiology, Technical University Munich

SELECTED PUBLICATIONS

Ecophysiology and interactions of a taurine-respiring bacterium in the mouse gut.
Ye H, Borusak S, Eberl C, Krasenbrink J, Weiss AS, Krasenbrink J, … Loy A. 2023 – Nature Commun, 1: 5533.

Genomic insights into diverse bacterial taxa that degrade extracellular DNA in marine sediments.
Wasmund K, Pelikan C, Schintlmeister A, Wagner M, Watzka M, … Herbold CW, Loy A. 2021 – Nature Microbiol, 6: 885-98.

Sulfoquinovose is a select nutrient of prominent bacteria and source of hydrogen sulfide in the human gut.
Hanson BT, Kits KD, Löffler J, Burrichter A, … Herbold CW, Rattei T, … Loy A. 2021 – ISME J, 15: 2779-91.

Hair eruption initiates and commensal skin microbiota aggravate adverse events of anti-EGFR therapy.
Klufa J, Bauer T, Hanson B, Herbold CW, Starkl P, … Loy A, Sibilia M. 2019 – Sci Transl Med, 11: eaax2693.

Peatland Acidobacteria with a dissimilatory sulfur metabolism.
Hausmann B, Pelikan C, Herbold CW, Köstlbacher S, … Wöbken D, Pester M, Loy A. 2018 – ISME J, 12: 1729-42.

Sarah Pati
EDGE – Division of Environmental Geosciences

Assistant Professor (Tenure Track)
sarah.pati@univie.ac.at

Assessing and managing anthropogenic contamination of natural resources and ecosystems represents a major challenge for a sustainable global development. To improve assessment of the environmental impact of anthropogenic compounds, Sarah Pati's group investigates the occurrence and fate of organic contaminants in aquatic systems. A particular focus lies on elucidating the reaction mechanisms of photochemical and enzymatic transformation processes with a combination of high-resolution mass spectrometry and compound-specific stable isotope analysis.

Her group's research spans from comprehensive studies at the field scale to mechanistic investigations at the molecular scale and includes both emerging and legacy contaminants as well as their transformation products. Sarah has received an Ambizione Fellowship from the Swiss National Science Foundation (SNSF) to further develop the stable isotope analysis of dissolved oxygen. With the methods and results from this project, the role of dissolved oxygen and reactive oxygen species in contaminant transformations will be investigated.

MAIN RESEARCH AREAS

- Occurrence and fate of organic contaminants in aquatic environments
- Reaction mechanisms of photochemical and enzymatic contaminant transformations
- Role of dissolved oxygen and reactive oxygen species in contaminant transformations
- Stable isotope analysis of organic contaminants and dissolved oxygen

CURRICULUM VITAE

Since 2024: Assistant Professor (Tenure Track), University of Vienna

2019–2023: SNSF Ambizione Fellow, University of Basel

2016–2019: Postdoctoral Researcher, University of Minnesota

2015: PhD in Environmental Chemistry, ETH Zurich and Eawag

SELECTED PUBLICATIONS

Improving the accuracy of $\delta^{18}O$ and $\delta^{17}O$ values of O_2 measured by continuous-flow isotope-ratio mass spectrometry with a multipoint isotope-ratio calibration.
de Carvalho CFM, Lehmann MF, Pati SG. 2024 – Rapid Commun Mass Spectrom, 38: e9652.

Substrate-specific coupling of O_2 activation to hydroxylations of aromatic compounds by Rieske non-heme iron dioxygenases.
Pati SG, Bopp CE, Kohler HPE, Hofstetter TB. 2022 – ACS Catal, 12: 6444-56.

Increased use of quaternary ammonium compounds during the SARS-CoV-2 pandemic and beyond: Consideration of environmental implications.
Hora PI, Pati SG, McNamara PJ, Arnold WA. 2020 – Environ Sci Technol Lett, 7: 622-31.

Comprehensive screening of quaternary ammonium surfactants and ionic liquids in wastewater effluents and lake sediments.
Pati SG, Arnold WA. 2020 – Environ Sci Process Impacts, 22: 430-41.

Photochemical transformation of four ionic liquid cation structures in aqueous solution.
Pati SG, Arnold WA. 2017 – Environ Sci Technol, 51:11780-7.Weber M. 2016 – Nature Microbiol, 2: 16195.

Jillian Petersen
DOME – Division of Microbial Ecology

Associate Professor
+43 1 4277 91206
jillian.petersen@univie.ac.at

Animals and plants evolved in a "sea" of microbes. It is therefore not surprising that the vast majority have evolved to rely on microbes for aspects of their health, development, nutrition, and productivity. Jillian Petersen's group contributes to this rapidly expanding research field. Her work focuses on beneficial interactions between marine invertebrate animals and their sulfur-oxidising bacterial symbionts, as well as marine and terrestrial plant-microbe interactions. The goal is to understand how the symbiotic partners establish and maintain their intimate relationship from generation to generation, and how these associations evolved in such diverse and widespread habitats, from deep-sea hydrothermal vents to shallow water seagrass beds.

Jillian and her group use the full suite of methods for understanding diversity and function of uncultured microbes in natural habitats, including high-throughput sequencing, single-cell imaging, and isotope tracing, among many others. She has received an ERC Starting Grant in 2018, an ERC Consolidator Grant in 2023, is a Board Member for the FWF, and Editor-in-Chief of the ISME Journal.

MAIN RESEARCH AREAS

- Beneficial host-microbe interactions
- Ecology, evolution and development of marine and terrestrial symbioses
- Microbial metabolism In situ imaging of microbial identity and function
- Meta-omics analyses of host-associated microbes

CURRICULUM VITAE

Since 2020: Associate Professor, University of Vienna

2015–2023: WWTF Vienna Research Group Leader, University of Vienna

2016–2020: Assistant Professor, University of Vienna

2009–2015: Postdoctoral Researcher and Senior Scientist, Max Planck Institute for Marine Microbiology

2009: PhD in Marine Microbiology, University of Bremen

SELECTED PUBLICATIONS

Gene loss and symbiont switching during adaptation to the deep sea in a globally distributed symbiosis.
Osvatic JT, Yuen B, Kunert M, Wilkins L, Hausmann B, Girguis P, ... Petersen JM. 2023 – ISME J, 17: 453-66.

Global biogeography of chemosynthetic symbionts reveals both localized and globally distributed symbiont groups.
Osvatic JT, Wilkins LG, Leibrecht L, Leray M, Zauner S, Polzin J, ... Petersen J. 2021 – PNAS, 118: e2104378118.

Chemosymbiotic bivalves contribute to the nitrogen budget of seagrass ecosystems.
Cardini U, Bartoli M, Lee R, Luecker S, Mooshammer M, Polzin J, Weber M, Petersen JM. 2019 – ISME J, 13: 3131-4.

Diversity matters: Deep-sea mussels harbor multiple symbiont strains.
Ansorge R, Romano S, Sayavedra L, Kupczok A, Tegetmeyer HE, Dubilier N, Petersen JM. 2019 – Nature Microbiol, 4: 2487-97.

Chemosynthetic symbionts of marine invertebrate animals are capable of nitrogen fixation.
Petersen JM, Kemper A, Gruber-Vodicka H, Cardini U, van der Geest M, Mussmann M, … Weber M. 2016 – Nature Microbiol, 2: 16195.

Martin Polz
DOME – Division of
Microbial Ecology

Full Professor
+43 1 4277 91207
martin.f.polz@univie.ac.at

Microbes are the most abundant and diverse organisms on the planet. Yet how this diversity is structured in the environment remains poorly understood. Martin's group is broadly interested in structure-function relationships within microbial communities. How do gene flow, environmental interactions, and selection structure populations? How does viral predation drive the ecology and evolution of microbes? How fast do microbes grow in environmental samples?

The group addresses these questions by a combination of in situ molecular approaches, environmental genomics, traditional physiological and genetic techniques, and modelling. They study patterns of diversity among co-occurring microbes from the level of the entire community to the individual genome and gene. Their model systems include marine microbes as well as animal microbiomes. Their latest projects focus on microbe-virus interactions and on growth dynamics under environmental conditions.

MAIN RESEARCH AREAS

- Microbial population genomics
- Microbial viruses
- Evolutionary ecology
- Microbiomes

CURRICULUM VITAE

Since 2020: Full Professor for Microbial Population Biology and Genetics, University of Vienna

2009–2019: Full Professor, Massachusetts Institute of Technology

2004–2009: Associate Professor, Massachusetts Institute of Technology

1998–2004: Assistant Professor, Massachusetts Institute of Technology

1998: Postdoctoral Fellow, Harvard University

1997: PhD in Organismic and Evolutionary Biology, Harvard University

SELECTED PUBLICATIONS

Recent speciation among epithelial bacteria creates a sink for a key nutritional substrate in the cow rumen.
Strachan CR, Yu X, Naubauer V, Mueller A, Wagner M, Zebeli Q, Selberherr E, Polz MF. 2023 – Nature Microbiol. 8:309-20.

Rapid evolutionary turnover of mobile genetic elements drives microbial resistance to phage.
Hussain FA, Dubert J, Esherbini J, Murphy M, VanInsberghe D, Arevalo P, … Polz MF. 2021 – Science, 374: 488-92.

Diarrheal events can trigger long-term Clostridium difficile colonization with recurrent blooms.
VanInsberghe D, Varian B, Erdman S, Polz MF. 2020 – Nature Microbiol, 5: 642-50.

A reverse ecology approach based on a biological definition of microbial populations.
Arevalo P, VanInsberghe D, Elsherbini J, Gore J, Polz MF. 2019 – Cell, 178: 820-834.e14.

A major lineage of non-tailed dsDNA viruses as unrecognized killers of marine bacteria.
Kauffman KM, Hussain FA, Yang J, Arevalo P, Brown JM, Chang WK, … Polz MF. 2018 – Nature, 554: 118-22.

Thomas Rattei
CUBE – Division of
Computational Systems

Full Professor
+43 1 4277 91280
thomas.rattei@univie.ac.at

Thomas Rattei's work covers a wide spectrum of topics from bioinformatics, genome and metagenome analysis and systems biology. He has long-standing expertise in developing and applying computational methods for the interpretation of large-scale sequence information. The international reputation of his research group triggered their involvement in numerous international (meta-) genome sequencing and analysis consortia.

Thomas' research activities not only cover individual, project-specific questions but also general problems in bioinformatics, computational infrastructure, and large-scale biological databases. Furthermore, his group develops novel, genome-based computational approaches for studying molecular inter-species interactions, such as between hosts and pathogens, between symbionts, or in microbial ecosystems.

Thomas and his team maintain and develop internationally relevant resources in computational biology, such as the web portals phendb.org, vogdb.org and effectivedb.org for microbial trait prediction, virus orthologous groups and protein families, and bacterial secreted proteins and secretion systems.

MAIN RESEARCH AREAS

- Computational and systems biology
- Genome and metagenome analysis
- Functional genomics Host-pathogen interactions
- Databases and infrastructure for bioinformatics

CURRICULUM VITAE

Since 2020: Head of the Doctoral School Microbiology and Environmental Science, University of Vienna

Since 2019: Vice Head of the Department of Microbiology and Ecosystem Science, University of Vienna

Since 2010: Full Professor for In Silico Genomics, University of Vienna

2001–2010: Group Leader and Assistant Professor, Department of Genome Oriented Bioinformatics, Technical University Munich

1999: PhD in Chemistry, Technical University Dresden

SELECTED PUBLICATIONS

DeepNOG: Fast and accurate protein orthologous group assignment.
Feldbauer R, Gosch L, Lüftinger L, Hyden P, Flexer A, Rattei T. 2020 – Bioinformatics, 36: 5304-12.

Conserved Secondary Structures in Viral mRNAs.
Kiening M, Ochsenreiter R, Hellinger HJ, Rattei T, Hofacker I, Frishman D. 2019 – Viruses, 11: 401.

eggNOG 5.0: a hierarchical, functionally and phylogenetically annotated orthology resource based on 5090 organisms and 2502 viruses.
Huerta-Cepas J, Szklarczyk D, Heller D, Hernández-Plaza A, Forslund SK, … Rattei T, … Bork P. 2019 – Nucleic Acids Res, 47: D309-14.

Critical Assessment of Metagenome Interpretation-a benchmark of metagenomics software.
Sczyrba A, Hofmann P, Belmann P, Koslicki D, Janssen S, … Rattei T, McHardy AC. 2017 – Nat Methods, 14: 1063-71.

The 5300-year-old Helicobacter pylori genome of the Iceman.
Maixner F, Krause-Kyora B, Turaev D, Herbig A, Hoopmann MR, … Rattei T, Zink A. 2016 – Science, 351: 162-5.

Andreas Richter
TER – Division of
Terrestrial Ecosystem Research

Full Professor
+43 1 4277 91260
andreas.richter@univie.ac.at

Microbial communities are key components of all global biogeochemical cycles and play a central yet poorly understood role in climate change biology. Andreas Richter's group investigates how growth and turnover of microbial communities control the deconstruction and mineralisation of organic matter in terrestrial ecosystems in current and future climates. The group has redefined and expanded the concept of microbial carbon and nitrogen use efficiency, linking it to ecological stoichiometry theory.

Andreas also pioneered the development of methods to estimate microbial growth and carbon use efficiency based on stable oxygen isotopes. Andreas' research group has extensively worked on soil organic matter storage in arctic ecosystems and permafrost-climate feedback, as well as in deep soils from the tropics to arctic. They also explore the interactive effects of future climate conditions and climate extremes on microbial processes, community composition, and plant-microbe interactions.

MAIN RESEARCH AREAS

Microbial growth, turnover, and carbon use efficiency

Effect of climate change and elevated CO_2 on soil processes

Ecological stoichiometry and carbon, nitrogen and phosphorus cycling

Arctic soil carbon storage and the permafrost-climate feedback

CURRICULUM VITAE

Since 2020: Head of CeMESS

Since 2011: Full Professor for Ecosystem Science, University of Vienna

Since 2016: Guest Research Scholar at the International Institute for Applied Systems Analysis (IIASA)

2013–2016: Director of the Austrian Polar Research Institute (APRI)

2000–2010: Associate Professor, Institute of Ecology and Conservation Biology, University of Vienna

1990–1999: University Assistant, Institute of Plant Physiology, University of Vienna

1989: PhD in Botany and Geology, University of Vienna

SELECTED PUBLICATIONS

Microbial growth under drought is confined to distinct taxa and modified by potential future climate conditions.
Metze D, Schnecker J, Canarini A, Fuchslueger L, Koch BJ, ... Kaiser C, Richter A. 2023 – Nature Commun 14: 5895.

Down-regulation of the bacterial protein biosynthesis machinery in response to weeks, years, and decades of soil warming.
Söllinger A, Séneca J, Dahl MB, … Richter A, Tveit AT. 2022 – Sci Adv 8: eabm3230

Ecological memory of recurrent drought modifies soil processes via changes in soil microbial community.
Canarini A, Schmidt H, Fuchslueger L Martin V, Herbold CW, Zezula D, … Richter A. 2021 – Nature Commun 12: 5308.

Microbial carbon limitation – the need for integrating microorganisms into our understanding of ecosystem carbon cycling.
Soong JL, Fuchslueger L, Marañon-Jimenez S, Torn MS, Janssens IA, Penuelas J, Richter A. 2020 – Glob Chang Biol, 26: 1953-61.

Microbial temperature sensitivity and biomass change explain soil carbon loss with warming.
Walker TWN, Kaiser C, Strasser F, Herbold CW, Leblans NIW, Dagmar Woebken, … Richter A. 2018 – Nature Clim Chang, 8: 885-9.

Isabella Wagner
Joint Professorship CeMESS,
Faculty of Psychology,
and Vienna Cognitive Science Hub

Assistant Professor (Tenure Track)
+43 1 4277 47133
isabella.wagner@univie.ac.at

Isabella Wagner's research focuses on interactions at the interface of the brain, cognition, and the gut microbiome. Specifically, her team's work aims at elucidating how the gut microbiome affects neural plasticity, learning and memory. To assess brain function, her team uses magnetic resonance imaging and spectroscopy, combined with advanced analysis methods such as brain connectivity and multivariate pattern techniques.

Isabella was awarded the Cortex Prize for her early career achievements in neuroscience by the Federation of European Neuroscience Societies (2023). She has received a Veni Grant from the Dutch Research Council (2020) and an FWF Stand-Alone Grant (2021). Recently, she was awarded a Young Investigator Grant from the Brain & Behaviour Research Foundation to elucidate the role of gut bacteria in stress and genetic predisposition for dementia (2023), and an FWF grant to investigate premature infant health (2023).

MAIN RESEARCH AREAS

Brain-cognition-microbiome interactions

Cognitive neuroscience of learning and memory

Genetic predisposition for dementia

Brain network interactions

Advanced fMRI analysis methods

CURRICULUM VITAE

Since 2021: Assistant Professor (Tenure Track), University of Vienna

2017–2021: Postdoctoral Researcher, University of Vienna

2017: PhD in Medical Sciences, Radboud University Medical Center

SELECTED PUBLICATIONS

Entorhinal grid-like codes and time-locked network dynamics track others navigating through space.
Wagner IC, Graichen LP, Todorova B, Lüttig A, Omer DB, Stangl M, Lamm C. 2023 – Nature Commun, 14: 231.

Durable memories and efficient neural coding through mnemonic training using the method of loci.
Wagner IC, Konrad BN, Schuster P, Weisig S, Repantis D, Ohla K, … Dresler M. 2021 – Sci Adv, 7: eabc7606.

Mnemonic training reshapes brain networks to support superior memory.
Dresler M, Shirer WR, Konrad BN, Müller NCJ, Wagner IC, Fernández G, Czisch M, Greicius MD. 2017 – Neuron, 93: 1227-35.

Physical exercise performed four hours after learning improves memory retention and increases hippocampal pattern similarity during retrieval.
van Dongen EV, Kersten IHP, Wagner IC, Morris RG, Fernández G. 2016 – Curr Biol, 26: 1722-7.

Parallel engagement of regions associated with encoding and later retrieval forms durable memories.
Wagner IC, van Buuren M, Bovy L, Fernández G. 2016 – J Neurosci, 36: 7985-95.

Michael Wagner
DOME – Division of
Microbial Ecology

Full Professor
+43 1 4277 91200
michael.wagner@univie.ac.at

Humans are strongly impacting the global nitrogen cycle by massive use of nitrogen fertilisers. Nitrification leads to fertiliser loss, eutrophication, and greenhouse gas emission, but is essential for efficient wastewater treatment. Research in Michael Wagner's group focuses on the ecology, physiology, and evolution of nitrifying microorganisms. Michael Wagner's group has discovered, cultured, and characterised important new nitrifying bacteria and archaea, including the long sought-after complete nitrifiers, describing unexpected physiological traits in the process.

Michael also has a strong interest in microbial communities driving sewage treatment and in the microbiomes of marine sponges. His group also develop innovative single cell tools to study functional properties of microbes in their natural environment. Michael is an EMBO member, has received an ERC Advanced Grant, the FWF Wittgenstein Award (highest Austrian science award), the Jim Tiedje Award of the International Society for Microbial Ecology, and the Schrödinger Prize of the Austrian Academy of Sciences. He is the director of the FWF Cluster of Excellence "Microbiomes Drive Planetary Heath".

MAIN RESEARCH AREAS

- Nitrification with a focus on ammonia-oxidation and complete nitrification (comammox)
- Functional analyses of microbes using single-cell isotope probing
- Wastewater microbiology
- Sponge microbiology
- Microbial physiology

CURRICULUM VITAE

- **Since 2022 & 2009-2019:** Member of the Senate, University of Vienna
- **2019–2022:** Guest Professor, University of Oxford
- **Since 2020:** Vice Head of CeMESS
- **Since 2019:** Distinguished Professor (20%), Aalborg University
- **2019–2020:** Founding Head of CeMESS
- **2016:** Visiting Faculty Fellow, Caltech
- **Since 2003:** Full Professor for Microbial Ecology, University of Vienna
- **2001–2003:** Associate Professor, Technical University Munich
- **1996–2000:** Assistant Professor, Technical University Munich
- **1995–1996:** Postdoctoral Fellow, Northwestern University
- **1995:** PhD in Microbiology, Technical University Munich (summa cum laude)

SELECTED PUBLICATIONS

SRS-FISH: A high-throughput platform linking microbiome metabolism to identity at the single-cell level.
Ge X, Pereira FC, Mitteregger M, Berry D, … Schintlmeister A, Wagner M, Cheng JX. 2022 – Proc Natl Acad Sci USA, 26: e2203519119.

An automated Raman-based platform for the sorting of live cells by functional properties.
Lee KS, Palatinszky M, Pereira FC, … Daims H, Berry D, Wagner M, Stocker R. 2019 – Nat Microbiol, 6: 1035-1048.

Kinetic analysis of a complete nitrifier reveals an oligotrophic lifestyle.
Kits KD, Sedlacek CJ, Lebedeva EV, Han P, Bulaev A, … Daims H, Wagner M. 2017 – Nature, 549: 269-272.

Complete nitrification by Nitrospira bacteria.
Daims H, Lebedeva EV, Pjevac P, Han P, Herbold C, Albertsen M, … Wagner M. 2015 – Nature, 528: 504-509.

Cyanate as an energy source for nitrifiers.
Palatinszky M, Herbold C, Jehmlich N, Pogoda M, Han P, … Daims H, Wagner M. 2015 – Nature, 524: 105-108.

Wolfgang Wanek
TER – Division of
Terrestrial Ecosystem Research

Full Professor
+43 1 4277 91262
wolfgang.wanek@univie.ac.at

Wolfgang Wanek's group focuses on the linkage between plant and microbial functioning and terrestrial ecosystem processes. Wanek has long-standing expertise in applying stable isotopes to unravel the role of plants and soil microbes and their interaction in controlling ecosystem processes, from the local to the continental scale.

Research in Wolfgang's group centres on the biogeochemistry of grasslands and forests in tropical and temperate biomes, with a focus on carbon, nitrogen and phosphorus (sulfur) cycling in the soil-plant-microbe system. Applying ecophysiological, metabolomics and isotope methods, as well as physicochemical characterization of the respective environments, his group seeks to understand biological and abiotic controls, how ecosystems respond to current and future global change, and how this feeds back on the functioning of ecosystems. His group has pioneered the development of an array of stable isotope-based methods to enable the quantification of gross element cycling processes that previously could not be measured.

MAIN RESEARCH AREAS

- Nutrient cycling in temperate and tropical grasslands and forests
- Biogeochemical cycles and plant-microbe-soil interactions under global change
- Stable isotope fractionation in plants, microbes, and ecosystems
- Isotope tracing and biomarker methods development
- Investigating soil community metabolism via metabolomics and fluxomics

CURRICULUM VITAE

- **Since 2019:** Full Professor for Physiological Ecology and Ecosystem Research, University of Vienna
- **2006–2019:** Associate Professor, University of Vienna
- **2006:** Habilitation in Physiological Ecology and Ecosystem Research, University of Vienna
- **2001–2006:** Assistant Professor, University of Vienna
- **1996–2001:** Research Assistant, University of Vienna
- **1996:** PhD in Plant Sciences, University of Vienna

SELECTED PUBLICATIONS

Long-term soil warming decreases microbial phosphorus utilization by increasing abiotic phosphorus sorption and phosphorus losses.
Tian Y, Shi S, Urbina Malo C, Kwatcho Kengdo S, Heinzle J, Inselsbacher E, … Wanek W. 2023 – Nature Commun, 14: 864.

Adjustment of microbial nitrogen use efficiency to carbon:nitrogen imbalances regulates soil N cycling.
Mooshammer M, Wanek W, Hämmerle I, Fuchslueger L, Hofhansl F, Knoltsch A, … Richter A. 2014 – Nature Commun, 5: 3694.

Host compound foraging by intestinal microbiota revealed by single-cell stable isotope probing.
Berry D, Stecher B, Schintlmeister A, … Wanek W, Richter A, … Loy A, Wagner M. 2013 – Proc Natl Acad Sci USA, 110: 4720-5.

Long-term change in the nitrogen cycle in tropical forests.
Hietz P, Turner BL, Wanek W, Richter A, Nock CA, Wright SJ. 2011 – Science, 334: 664-6.

First direct dating of Early Upper Paleolithic human remains from Mladeč.
Wild EM, Teschler-Nicola M, Kutschera W, Steier P, Wanek W. 2005 – Nature, 435: 332-5.

Anouk Willemsen
DOME – Division of
Microbial Ecology

Assistant Professor (Tenure Track)
+43 1 4277 91221
anouk.willemsen@univie.ac.at

Viruses are major but often overlooked players in ecological interactions. They are ubiquitous in nature, infecting organisms across all domains of life. Viruses have evolved many different shapes, sizes and types of genome organisation, which allows them to thrive in different environments. Research in Anouk Willemsen's group focuses on the evolutionary genetics and genomics of microbes, especially the ability of viruses to adapt (or not) to changes in their environments.

Anouk's group employs a range of molecular and microbiology techniques, experimental evolution, sequencing, genomics, phylogenetics and bioinformatics. Anouk has received two Marie Skłodowska-Curie grants and an ERC Starting Grant (2021) to investigate the role of mobile genetic elements in the ecology and evolution of giant viruses. She is the co-lead of an FWF project focused on studying giant viruses in the wild.

MAIN RESEARCH AREAS

- Virus genome architecture and stability
- Virus-host co-evolution
- Virus-host-microbe interactions
- Experimental evolution of viruses
- Bioinformatics and genomics of viruses

CURRICULUM VITAE

Since 2023: Assistant Professor (Tenure Track), University of Vienna

2020–2023: Postdoctoral Researcher, University of Vienna

2016–2020: Postdoctoral Researcher, French National Centre for Scientific Research

2012–2016: PhD in Biotechnology, University of Valencia

SELECTED PUBLICATIONS

Transcriptomic, proteomic, and functional consequences of codon usage bias in human cells during heterologous gene expression.
Picard MA, Leblay F, Cassan C, Willemsen A, Bauffe F, Decourcelle M, Demange A, Bravo IG. 2023 – Protein Science, 32: e4576.

Defensive symbiosis against giant viruses in amoebae.
Arthofer P, Delafont V, Willemsen A, Panhölz F, Horn M. 2022 – PNAS, 119: e2205856119.

Papillomaviruses infecting cetaceans exhibit signs of genome adaptation following a recombination event.
Borvető F, Bravo IG, Willemsen A. 2020 – Virus Evolution, 6:veaa038.

On the stability of sequences inserted into viral genomes.
Willemsen A, Zwart MP. 2019 – Virus Evolution, 5: vez045.

Genome plasticity in papillomaviruses and de novo emergence of E5 Oncogenes.
Willemsen A, Félez-Sánchez M, Bravo IG. 2019 – Genome Biol and Evol, 11:1602-17.

Dagmar Wöbken
DOME – Division of
Microbial Ecology

Associate Professor
+43 1 4277 91213
dagmar.woebken@univie.ac.at

Soils harbour the greatest diversity of microorganisms on Earth, but we are yet to fully understand their functional roles and how this large diversity is maintained. Dagmar Wöbken's research aims to elucidate active microbial participants in key soil processes, along with the genomic and physiological features that allow their success in challenging soil habitats.

Dagmar and her team investigate survival strategies of soil microbes, as well as patterns and processes of resuscitation in arid soils. Another area of interest are plant-microbe associations, particularly how plant microbiomes are assembled and their potential beneficial effects, like nitrogen fixation or salt-stress mitigation. Dagmar's group aims to gain a holistic view of soil microbiome functions, combining process-level measurements, meta-omics analyses and stable isotope probing coupled to single-cell investigations such as NanoSIMS. She has received an ERC Starting Grant (2020) and is a member of the Board of Directors of the Young Academy of the Austrian Academy of Sciences.

MAIN RESEARCH AREAS

- Survival mechanisms and ecophysiology of soil microorganisms
- Plant-microbe interactions
- Microbial communities and processes in biological soil crusts and microbial mats
- Microorganisms involved in atmospheric N_2 fixation
- Application of single cell methods in terrestrial and plant-associated systems

CURRICULUM VITAE

Since 2022: Associate Professor, University of Vienna

2017–2022: Assistant Professor (Tenure Track), University of Vienna

2012–2017: Group Leader, University of Vienna

2008–2011: Postdoctoral Researcher, Stanford University/ NASA Ames Research Center/ Lawrence Livermore National Laboratory

2007–2008: Postdoctoral Researcher, Max Planck Institute for Marine Microbiology

2007: PhD in Marine Microbiology, University of Bremen

SELECTED PUBLICATIONS

Gold-FISH enables targeted NanoSIMS analysis of plant-associated bacteria.
Schmidt H, Gorka S, Seki D, Schintlmeister A, Woebken D. 2023 — New Phytol, 240: 439-51.

Both abundant and rare fungi colonizing Fagus sylvatica ectomycorrhizal root-tips shape associated bacterial communities.
Dietrich M, Montesinos-Navarro A, Gabriel R, Strassner F … Richter A, Kaiser C, Woebken D. 2022 – Commun Biol, 5: 1261.

Nitrogen fixation by diverse diazotrophic communities can support population growth in arboreal ants.
Nepel M, Pfeifer J, Oberhauser FB, Richter A, Woebken D, Mayer VE. 2022 – BMC Biol, 20: 135.

Distribution of mixotrophy and desiccation survival mechanisms across microbial genomes in an arid biological soil crust community.
Meier DV, Imminger S, Gillnor O, Woebken D. 2021 – mSystems, 6: e00786-20.

Acidobacteria are active and abundant members of diverse atmospheric H_2-oxidizing communities detected in temperate soils.
Giguere AT, Eichorst SA, Meier DV, Herbold CW Richter A, Greening C, Woebken D. 2021 – ISME J, 15: 363-76.

Michael Zumstein
EDGE – Division of
Environmental Geosciences

Assistant Professor (Tenure Track)
+43 1 4277 53372
michael.zumstein@univie.ac.at

Michael Zumstein's group investigates the biotransformation and biodegradation of anthropogenic organic chemicals in natural and engineered environments. The group combines techniques from environmental analytical chemistry and molecular biology to obtain a fundamental understanding of the activity, specificity, and identity of enzymes involved in these processes.

Regarding classes of chemicals, the current research focus is on polymers that are important for home and personal care, as well as on biomolecules (and derivatives thereof) that are promising alternatives to conventional pharmaceuticals and pesticides. Michael has received an Ambizione Fellowship from the Swiss National Science Foundation (SNSF) to investigate the biotransformation of peptide-based antibiotics in wastewater systems. He leads a research cooperation between the University of Vienna and BASF SE on the biodegradation of water-soluble polymers. The process-level insights obtained through the group's research inform the development of biodegradable chemicals.

MAIN RESEARCH AREAS

- Biotransformation and biodegradation of anthropogenic organic chemicals
- Extracellular enzymes in natural and engineered systems
- Environmental analytical chemistry
- Environmental biochemistry of polymers

CURRICULUM VITAE

- **Since 2022:** Assistant Professor (Tenure Track), University of Vienna
- **2021–2022:** Junior Group Leader, University of Vienna
- **2019–2020:** Postdoctoral Researcher and SNSF Ambizione Fellow, Eawag
- **2018–2019:** Postdoctoral Researcher, Cornell University
- **2017:** PhD in Environmental Chemistry, ETH Zurich

SELECTED PUBLICATIONS

Environmental biodegradation of water-soluble polymers: Key considerations and ways forward.
Zumstein M, Battagliarin G, Kuenkel A, Sander M. 2022 – Acc Chem Res, 55: 2163-7.

Effect of polymer properties on the biodegradation of polyurethane microplastics.
Pfohl P, Bahl D, Rückel M, Hüffer T, Zumstein M, Hofmann T, Wohllebern W. 2022 – Environ Sci Technol, 56: 16873-84.

Identifying functional groups that determine rates of micropollutant biotransformations performed by wastewater microbial communities.
Rich SL, Zumstein M, Helbling DE. 2021 – Environ Sci Technol, 56: 984-94.

Exploring the specificity of extracellular wastewater peptidases to inform the design of sustainable peptide-based antibiotics.
Zumstein M, Werner J, Helbling D. 2020 – Environ Sci Technol, 54: 11201-9.

Biotransformation of antibiotics: Exploring the activity of extracellular and intracellular enzymes derived from wastewater microbial communities.
Zumstein M, Helbling D. 2019 – Water Res, 155: 115-23.

JUNIOR RESEARCH GROUP LEADERS

Carlos Arellano-Caicedo
TER

The microhabitats where microbes grow and interact in nature are heterogeneous and fragmented. Although this determines how microbes behave, traditional experimental approaches overlook such habitat complexity. Carlos Arellano's group employs microfluidics, a technique for manipulating and controlling structures and flows at micro- and nanoscales, to simulate realistic soil microbial habitats. During his PhD, Carlos studied the impact of channel geometry and maze complexity on the interactions of bacteria and fungi. In his postdoc, he focused on how microhabitats affect different ecological processes of bacteria, such as diversity and bacterial association. Currently, Carlos and his team use microfluidics to explore how soil microhabitats determine soil microbial interactions, and how these affect soils ecosystem functions.

CURRICULUM VITAE

Since 2023: Junior Research Group Leader, University of Vienna

2021–2022: Postdoc, Lund University

2021: Junior Lecturer, National Polytechnic School

2016: PhD in Biology, Lund University

Elizabeth (Liz) Hambleton
DOME

Liz Hambleton's group studies the evolution and molecular mechanisms of diverse, ecologically important photosynthetic symbioses ("photosymbioses") between symbiotic dinoflagellate algae and marine invertebrates. Her main research questions include: how do different host organisms interact on the cellular level with the same intracellular algal symbiont? What are the molecular mechanisms underlying these symbioses, particularly metabolic exchange? Liz's group combines functional experimentation in model systems, single-cell transcriptomics, metabolomics, and mass spectrometry-based metabolic imaging. Throughout her career, Liz has been an expert in studying molecular mechanisms of coral-algal symbiosis, including the exchange of essential sterol nutrients. In addition, her group is also establishing a new model system with symbiotic acoel flatworms. The group's ultimate aim is to understand globally widespread and evolutionarily important photosymbioses and their responses to environmental change.

CURRICULUM VITAE

Since 2020: Junior Research Group Leader, University of Vienna

2014–2020: Postdoc, University of Heidelberg

2013–2014: Early Career Fellow, Center for Ocean Solutions, Stanford University

2013: PhD in Biology, Stanford University

Shaul Pollak
DOME

Bacterial activity has shaped our world for billions of years, and is still critical for the function of virtually all ecosystems on earth. Shaul Pollak is interested in how bacterial interactions mediate functions like protecting plants from pathogens or carbon cycling in soils and oceans. Shaul loves questions that span levels of organization, like how an interaction between specific genes on a chromosome translate to planetary-scale changes in carbon fluxes. To answer these questions, Shaul's group integrates genomics, high-throughput experiments and genetics with ecological/ evolutionary theory and machine learning. Current projects include using "genomic dark matter" to predict carbon fluxes in soils, as well as investigating the effects of environmental change on plant-bacteria genetic interactions. Another focus is the evolutionary genomics of the most abundant photosynthetic organism on earth: the marine cyanobacterium Prochlorococcus marinus.

CURRICULUM VITAE

Since 2023: Junior Research Group Leader, University of Vienna

2022–2023: Postdoc, Massachusetts Institute of Technology

2018–2022: Postdoc, Massachusetts Institute of Technology

2014–2018: PhD in Evolutionary Systems Biology, Tel Aviv University

Lucia Fuchslueger
TER

Lucia Fuchslueger's group investigates the ecology and biogeochemistry of soil microorganisms and the processes they mediate in interaction with plant roots and the soil matrix. In particular, Lucia investigates the sensitivity, responses, and resilience of soil microbial communities to changing nutrient and environmental conditions. Her group combines field and laboratory experiments using microbial biomarkers, analytical methods and stable isotopes as tools to trace carbon, nitrogen, and phosphorus through the plant-soil-microbe continuum and to investigate soil microbial resilience to global change factors like elevated CO_2, drought, and warming. Current projects explore the impact of plant root exudates on agricultural soils, aiming to describe compounds that target ammonia oxidizers to potentially reduce nitrification and greenhouse gas emissions. Another focus is understanding climate change feedbacks and microbial organic matter turnover in mineral nutrient-constrained ecosystems, like tropical rainforests.

CURRICULUM VITAE

Since 2023: Junior Research Group Leader, University of Vienna

Since 2020: REWIRE Fellow & Co-PI Young Investigator Research Group, University of Vienna

2017–2020: Postdoc, University of Antwerp

2015–2017: Postdoc, National Institute for Amazon Research

2015: PhD in Biology, University of Vienna

Adrian Tett
CUBE

Adrian Tett's group develops and utilises computational approaches combined with metagenomics to understand the human microbiome in fine detail. Specifically, the group explores the hidden diversity in novel species and sub-species and its relationship to health or disease. Adrian's group exploits the thousands of available metagenomes and uses large-scale metanalyses to identify and target potentially important microbiome members for further analysis and characterisation. For instance, the group was involved in revealing the gut bacterium Prevotella copri to be far more diverse than appreciated, which, with further ongoing characterisation, may explain the conflicting reports of P. copri in human health. Another focus is utilising ancient microbial fossils and pre-industrialised populations to determine how industrialisation has dramatically and rapidly changed the co-evolved human microbiome and the potential implications on human health.

CURRICULUM VITAE

Since 2020: Junior Research Group Leader, University of Vienna

2014–2020: Postdoc, University of Trento

2012–2013: Postdoc, Quadram Institute

2008–2011: Postdoc, John Innes Centre

2007: PhD in Microbiology and Bioinformatics, UK Centre for Ecology and Hydrology

SENIOR SCIENTISTS

Astrid Collingro
DOME

microbial symbioses
genome evolution
Chlamydiae

Fascinating by the interactions between intracellular bacteria and their eukaryotic host cells, Astrid started working on bacteria-protist symbioses at the Technical University Munich (Germany), eventually joining the University of Vienna in 2003. She currently works mainly with chlamydial symbionts.
By using infection experiments, comparative ‘omics and phylogenetic methods, she explores how bacteria evolved from symbionts of protists to pathogens of animals and humans. Her work often focuses on yet unexplored chlamydial lineages using ‘omics methods, together with different cultivation approaches. Recently, the impact of chlamydial symbionts on ecosystem processes and microbial community composition have gathered her interest.

Stephanie A. Eichorst
DOME

microbial physiology
soil microorganisms
Acidobacteriota

One gram of soil contains over a million microorganisms, yet much of their function remains unknown. Stephanie started studying soil microbes during her PhD at Michigan State University, and continued as a postdoc at Los Alamos National Lab, coordinator of the Microbial Diversity Course at the Marine Biological Laboratory, and scientist at the Joint BioEnergy Institute (USA). Since joining the University of Vienna in 2012, she has been investigating soil microorganisms (Acidobacteriota) via cultivation, ‘omics methods and metabolic process measurements. She is currently exploring atmospheric gas oxidation as a means of survival during periods of energy limitation, as well as factors governing the use of different terminal oxidases in soil microbes, which may underpin their physiological flexibility.

Thorsten Hüffer
EDGE

particulate contaminants
plastic fragmentation
leaching

Globally, chemical pollution is irreversibly affecting ecosystems. The fate of these chemicals in the environment is largely governed by phase transfer processes.
Since his PhD at the University of Duisburg-Essen (Germany), Thorsten has investigated how biotic and abiotic processes change plastic-xenobiotic interactions in aquatic and terrestrial ecosystems. Recently, he has been exploring how environmental factors impact the release of additives from plastics, like phthalates, causing them to become long-lived sources of pollution in environmental systems. Similarly, he investigates the factors that shape the continuous leaching of xenobiotics from tire materials and their products, which can be take up by agricultural plants, thereby entering the human food web.

Frank von der Kammer
EDGE

manufactured nanoparticles, micro- and nanoplastics
environmental colloid chemistry and analytics
nanotechnology risk assessment

Colloids and nanoparticles constitute a large part of the total reactive surface area of the planet. Their role in environmental processes is only partially understood. Frank develops specific experimental and analytical methods to elucidate the transformation, interaction and general behaviour of colloidal/nanoscale particles in the environment. His group uses the acquired knowledge and sophisticated analytical techniques to better understand environmental nanoscale processes. He supports the risk assessment of nanomaterials by improving our understanding of incidental and manufactured nanoparticles in the environment. This includes development of methods for identification and quantification of nanomaterials in food, cosmetics and the environment, as well as the development of regulatory tools on OECD and ISO levels.

Katharina Kitzinger
DOME

nitrogen cycling
microbial physiology
stable isotope probing

Few elemental cycles are as dependent on microbial activity as the global nitrogen cycle. Katharina began exploring nitrogen cycling, biogeochemistry and microbiology during her joint PhD between the University of Vienna and the Max Plank Institute for Marine Microbiology (Germany). She has been a senior scientist at the University of Vienna since 2022, investigating the physiological versatility and life strategies of nitrifying microorganisms. Her methods range from cultivation and investigation of microbial physiology under laboratory conditions, to biogeochemical process measurements via stable isotope incubations in the field, and single cell and molecular techniques to link the identity of specific microorganisms in complex communities to their activities in situ.

Alejandro Manzano Marín
DOME

marine sediments
element cycling
meta-omics

Animals are thriving with microbial life, often establishing intimate symbiotic relationships with their tiny companions. When these persist over evolutionary time, they bring about deep changes to both the hosts and their symbionts.
Since his early studies at the National Autonomous University of Mexico and subsequent PhD at the University of Valencia (Spain), Alejandro has been exploring the impact of symbiotic interactions on the biology and evolution of hosts and symbionts at the genomic, metabolic, and morphological levels. His research deals with animal-microbe symbioses, with a focus on two animal systems with nutrient-restricted diets: aphids and blood-feeding leeches. He approaches the study of these organisms using genomic, microscopic, and evolutionary methods.

Marc Mußmann
DOME

- marine sediments
- element cycling
- meta-omics

Marc’s research investigates the valuable ecosystem service provided by marine coastal sediments as biocatalytic filters. As a PhD and postdoctoral researcher at the Max Plank Institute Bremen (Germany), he studied the role of microbes in breaking down organic matter and pollutants, such as hydrogen sulfide. Currently, he investigates the function of the globally abundant bacterial family Woeseiaceae in marine sediments using various molecular techniques. Recently, he has discovered the presence of electroactive bacteria in marine sediments that thrive on minerals as “batteries.” He also develops novel methods to identify and study macromolecule-degrading microbes in diverse habitats. To support research at the UBB, he provides training and support in flow cytometry.

Petra Pjevac
DOME

- microbiome research
- soil microbiology
- microbial physiology

Sequencing-based methods are currently the most widely applied techniques in microbiome research, both in clinical and environmental studies. As a staff scientist in the Joint Microbiome Facility, Petra supports researchers in all steps of sequencing-based microbiome analysis, from study design and data generation to analysis and interpretation of results. In her own research, she investigates factors that shape microbial communities and drive niche differentiation between microorganisms. Besides sequencing-based approaches, she uses physiological experiments and biogeochemical data to address these questions. Petra is particularly interested in chemolithoautotrophic microorganisms in complex environments like soils and sediments – mainly those involved in nitrogen, sulfur and metal cycling.

Arno Schintlmeister
DOME

- NanoSIMS
- SRS
- stable isotope probing

Topochemical analysis deals with the structural and chemical characterization of materials. Since its establishment at the University of Vienna in 2010, Arno has worked with nanometer-scale secondary ion mass spectrometry (NanoSIMS), a cutting-edge imaging technique dedicated to (ultra) trace element and high-sensitivity isotope analysis with utmost spatial resolution. Recently, he has extended analytic capacity at CeMESS with the establishment of Stimulated Raman Scattering Spectroscopy (SRS)-based imaging, coupled to fluorescence in situ hybridisation (FISH). After graduation at Innsbruck University, he spent seven years in industry (Plansee SE) before returning to academia (Technical University Vienna). Today, he enjoys performing collaborative research with colleagues from diverse fields, ranging from microbiology, biomedical sciences, geology, and materials sciences.

Markus Christian Schmid
DOME

- Raman spectroscopy
- microscopy

In the beginning of his career at the Technical University Munich and later at the University of Nijmegen, Markus worked mostly on the detection of microorganisms involved in different parts of the nitrogen cycle. This included ammonia oxidizing bacteria, anaerobic ammonium oxidizers (ANAMMOX) and denitrifying eukaryotes in many different environments, including wastewater, soil, freshwater and marine systems. Since joining the University of Vienna in 2008, he has continued to work with microscopic techniques, and is now responsible for several aspects of microscopy at CeMESS, including epifluorescence and confocal laser scanning microscopy as well as laser microdissection and Raman spectroscopy.

Hannes Schmidt
TER

- soil microbiomes
- microbial imaging
- synthetic soil ecology

Soil microbiomes are fundamental to ecosystem functioning. Since his PhD at the University of Bremen (Germany), Hannes has been studying root-associated archaea and bacteria via multi-scale imaging, sequencing, and stable isotope techniques. Currently, he delves into fundamental questions of soil ecology via reductionist approaches using defined minimal microbial communities and artificially composed soils. As a co-supervisor of MSc and PhD students, he investigates microbial communities and their processes in soils, ranging from the tropics to the polar regions. From 2020 to 2022, Hannes supported university operations by managing the COVID-19 test system at the University of Vienna. He also engages in outreach activities (like KinderUni Wien) and initiatives to improve lab sustainability.

Katharina Sodnikar
EDGE

- environmental analytical chemistry
- emerging, organic pollutants

Understanding the fate of organic pollutants in the environment is essential to assess their effect on environmental and human health. In her PhD at ETH Zurich (Switzerland), Katharina investigated the environmental fate of double-stranded ribonucleic acids and deoxyribonucleic acids, the former of which are used as biopesticides in agricultural soils. There, she elucidated the factors governing nucleic acid adsorption to mineral surfaces and determined the effect of adsorption on their biodegradation. As a senior scientist at the University of Vienna, she develops analytical tools to detect organic chemicals such as tire additives, pharmaceuticals, pesticides, water-soluble polymers, and per- and polyfluoroalkyl substances (PFAS), as well as potential degradation products thereof.

Daan Speth
DOME

bioinformatics
nitrogen cycle
protein evolution

Recent advances in sequencing technologies have dramatically altered our view of microbial diversity, and led to major discoveries of novel organisms involved in the carbon and nitrogen cycles. During his PhD at Radboud University (Netherlands), Daan applied metagenomics and other sequence-based bioinformatics to study microbial communities in wastewater and marine environments, with a focus on nitrogen and carbon transformations. He continued this work at Caltech (USA) and the Max Plank Institute of Marine Microbiology (Germany), and additionally became fascinated by the evolutionary history and diversity of protein families essential for anaerobic microorganisms. Since 2023, he has continued working on nitrogen cycling organisms as well as protein evolution at the University of Vienna.

Martin Stockhausen
EDGE

ICP-MS
inorganic pollutants

Martin's research focuses on the migration of natural and anthropogenic pollutants – both inorganic and organic. His PhD and subsequent postdoc primarily focused on experimentally investigating the generation, migration and release of hydrocarbons in the course of catagenesis. Of particular interest were interactions of the generated products with the rock matrix and pore water, as well as the resulting fractionation processes (geochromatography). Since joining the University of Vienna, he has worked in a much broader field of environmental science. This includes nanominerals and nanoparticles and their role in the transport of contaminants, as well as the use of gadolinium (Gd)-based contrast agents as a tool to calculate groundwater travel times and calibrating groundwater models.

STUDENTS & EARLY CAREER RESEARCHERS

Sarah Al-Ajeel
Cristina Alcaraz
Wajdi Allagui
Hanin Alzubaidy
Felix Arndorfer
Markus Arndorfer
Eloise Atkinson
Nina Bartlau
Markus Beicht
Stanislava Bezdicek Kralova
Sobia Bibi
Olga Bochkareva
Theresa Böckle
Lino Böhler
Iakovos Bomponis
Anita Brijit
Alberto Canarini
Songcan Chen
Viktoria Cizek
Otto Cordero
Mehmet Orkun Coruh
Klarensa Culli
Anna-Celine Danklmaier
Sean Darcy
Berna De Vries
Jessica Drozdz
Stefan Eckensperger
Katharina Egger
Sophie Elixhauser
Florian Exler
Nathalie Friedl
Christoph Gall
Kilian Gandolf
Kirsten Gassner
Andrew Giguere
Bettina Glasl
Emily Grubb
Richard Johannes Gruseck
Ksenia Guseva
Luzian Elijah Hämmerle
Klaus Hartmann-Baruffi
Vera Hechtl
Nathalie Heldwein
Cathrine Hellerschmied
Lukas Helmlinger
Johannes Hettler
Adnan Hodzic
Jenny Hofbauer
Christin Hristova
Huifeng Hu
Stefanie Imminger
Kian Jenab
Paul Jimenez Nuno
Mina Joseph
Iris Karbon
Sanaz Khadem
Aaron Kintzi
Anna-Sabrina Kistler
Katharina Klawatsch
Ronja Kok
Marianne Koranda
Lisa Korner
Johanna Krall
Julia Krasenbrink
Vasiliki Laspita
Mona Lauritz

Raisibe Florence Lehutso
Lukas Leibrecht
Tao Li
Yuhua Li
Xiaofei Liu
Alejandro Llanos Lizcano
Anna Lopatina
Laura Lotteraner
Daniel Loy
Shenglan Ma
Konstanze Madani
Victoria Sophie Martin
Elsa Martineau
Lotte Luise Mayer
Martina Mayer
Martina Mayrhofer
Tobias Medicus
Georg Mlynek
Moritz Mohrlok
Karolin Möller
Sandra Milena Montano Salazar
Simone Müller
Lilian-Lee Müller-Fischer
Nicolas Nemeth
Victor Nogay
Clarissa Obinger
Marton Palatinszky
Stephanie Pejrimovsky
Ruoting Peng
Alexander Pfundner
Miriam Philipp
Christoph Posch
Michael Predl
Paul Prinz
Hana Prosser
Dania Randi
Christian Ranits
Hamid Rasoulimehrabani
Sofie Reiter
Victoria Marie Ritter
Lena Rohrhofer
Paula Andrea Rojas Pinzon
Benjamin Robert Roller
Cornelia Rottensteiner
Marie Rutsch
Rahul Samrat
Laura Sanchez
Philipp Schmelz
Daniela Schwarz
Angelika Schwarzhans
Anne-Sophie Schwenk
Christopher Sedlacek
Joana Séneca Cardoso
Da Silva
Lior Shachar
Barira Shoukat
Gabriel Sigmund
Eva Simon
Dylan Simon
Dave Sirbu
Nataliia Solntseva
Peter Špaček
Natália Stanic
Kerrin Steensen
Marlis Stenzl
Christina Straub
Anton Strunov
Marta Lidia Sudo
David Szamosvari
Thayer Taft
Ashlyn Elizabeth Tew
Nadeshda Todorova
Lovro Trgovec-Greif
Johannes Tüchler
Esther Van der Sluijs
Dean Velikov
Wenhao Wang
Min Wen
Natalie Wichmann
Julia Wiesenbauer
Valerie Wilkeit
Teresa Maria Rosa Winter
Jan-Philipp Wittlinger
Liyang Yang
Xiaoqian Yu
Dominik Zöllner

TECHNICIANS, ADMIN & IT STAFF

Ahmet Arikan
Johanna Avato
Franziska Bauchinger
Petra Berger
Johann Dorn
Michael Feichtinger
Janette Ferchichi
Lisa Fragner
Julia Gebetsberger
Elisabetta Gianesini
Nadja Holzleitner
Mariya Juric
Lilian Mira Kaufmann
Pranjal Khan
Gudrun Kohl
Sabine Kranzl
Martin Kunert
Herwig Lenitz
Federico Lo Nardo
Eva Lugbauer
Sara Malinowski
Krisztina Manzano-Szalai
Sabine Maringer
Kiri Marker
Tamara Matzhold
Cornelia Mazza
Beatrix Mitsch
Sladana Mlinkov
Annina Müller Strassnig
Michael Neumayer
Georgi Nikolov
Christof Oberwalder
Johanna Ostah
Hayk Palabikyan
Catia Pinto
Sabrina Pober
Christopher Pree
Judith Prommer
Julia Ramesmayer
Sofie Marie Reiter
Sören Risse
Ludwig Seidl
Peter Spacek
Maria de los Angeles
Tarazona Montoya
Jasmine Thekkumthott Athil
Michaela Thoß
Christine Wagner
Susanne Wagner
Margarete Watzka
Chiara Maria Angela Weiß
Barbara Wolf
Michael Wolfram

METHODS & TECHNIQUES

COMPARATIVE GENOMICS

Life on Earth has been evolving for billions of years. Living organisms are found in virtually every environment, surviving and thriving under extreme heat, cold, radiation, pressure, salt, acidity, and darkness. Many of these environments are exclusively colonised by "simple" microorganisms, and the only nutrients available come from chemical compounds that only microbes can use. Their unparalleled genetic and metabolic diversity and range of environmental adaptations indicate that microbes long ago "solved" many problems for which scientists and engineers are still actively seeking solutions including carbon capture and nitrogen fixation.

The secrets to these adaptations are encoded in their genomes, which contain all the necessary instructions for building functioning organisms. The first complete bacterial genome was deciphered in 1995. Since then, the number of complete genomes sequenced has grown exponentially. Powerful computers and sophisticated bioinformatics software are the key to unlocking the potential of these massive amounts of genomic data for medical and environmental applications.

The majority of microorganisms and viruses cannot be cultivated in the laboratory so far. We therefore use culture-independent approaches such as amplicon sequencing and metagenomics, which can be applied directly to nucleic acids isolated from any environment, to study the diversity, structure, and functional potential of microbial communities. State-of-the-art sequencing technologies combined with computational methods often allow us to reconstruct complete genomes from metagenomes, and to predict phenotypic traits from these genome sequences.

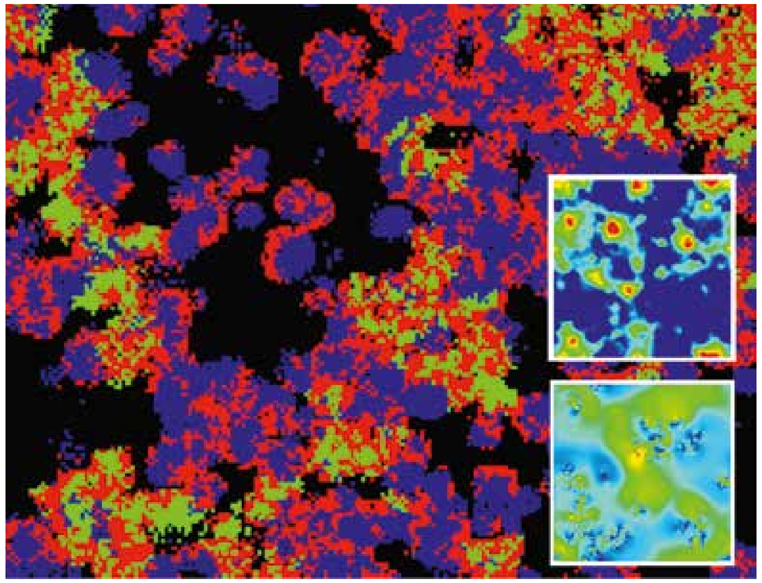
CeMESS is involved in a wide range of genome sequencing and metagenomics projects and has established efficient tools and workflows for interpreting (meta)genomic data. We are engaged in maintaining and improving genomic data in public databases. We also create new software to push the limits of accuracy and throughput in computational genomics.

OUR METHODS, AT A GLANCE

- High-throughput community profiling using short- and long-read amplicon sequencing
- Genome annotation: EffectiveDB, SIMAP, pCOMP, GenSkew, ConsPred
- Functional genomics: NVT
- Comparative genomics: Gepard, PICA, PhenDB, DeepNOG, VOGDB
- Metagenomics: probeBase, probeCheck, HoloVir

Genome sequence map, artist impression. Credit: Tetiana Lazunova

MICROBIAL COMMUNITY MODELLING



OUR METHODS, AT A GLANCE

- Individual-based microbial community modelling
- Co-occurrence networks in environmental samples
- Computational models for molecular inter-species interactions
- Computational prediction of phenotypic roles of bacterial species
- Steady-state modelling of the metabolism of species and microbial communities

Microbial communities in natural environments are composed of a diverse array of functionally distinct individuals. These communities are not just simple gatherings but intricate networks where microbes interact in myriad ways, including direct competition or predation, and more subtle interactions like metabolite exchange. These interactions are pivotal in driving the community's metabolism and influencing the ecosystem's behavior across ecological and evolutionary timescales. Such dynamics play a crucial role in determining the system's response, resilience, and resistance to environmental changes. However, understanding these interactions and their outcomes, which often transcend the sum of the properties of individual organisms and lead to emergent collective phenomena, remains a complex challenge.

At CeMESS, we use mathematical modelling as a tool to explore the underlying mechanisms that govern the dynamics and functioning of these complex microbial communities. Our approach involves various types of mathematical models, each designed to shed light on different aspects of microbial life. We use individual-based modelling to simulate interactions, both competitive and synergistic, among microbial decomposers within structured micro-environments. This helps us understand how system properties emerging from these interactions influence overall community behavior.

In addition, we also explore microbial interaction networks. Using network models based on Lotka-Volterra dynamics and other approaches like time series analysis, we evaluate how diverse interactions affect community properties, like stability and resilience. Furthermore, by harnessing the power of meta-omic data, we're able to predict the structure of metabolic pathways, phenotypic roles, and growth rates of various species in microbial communities. Our steady-state metabolic modelling extends this understanding, predicting how these communities respond to changes in nutrient availability and other critical factors, such as microbiome host influences. This comprehensive modelling approach at CeMESS is integral to advancing our understanding of microbial community dynamics and their environmental (and medical) implications.

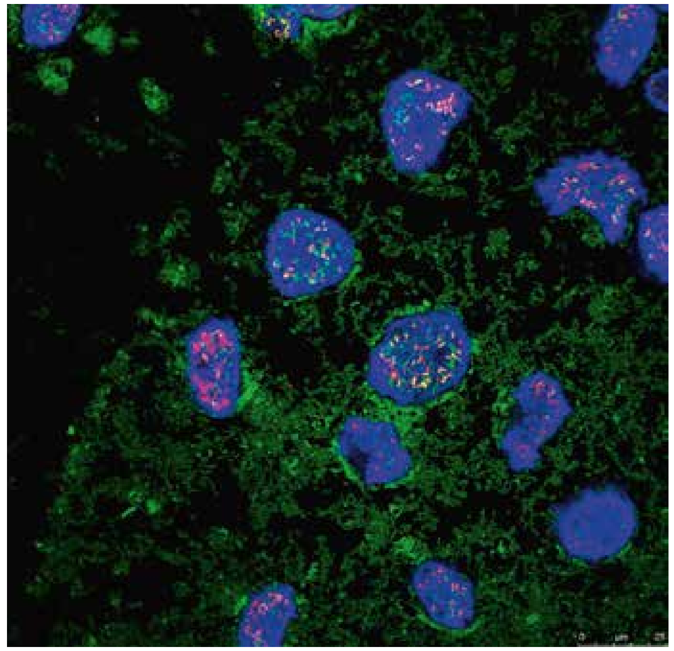
Snapshot of an individual-based model simulation of microbes belonging to three different functional groups decomposing leaf litter. Each coloured dot represents a microbe, inserts show distribution of soluble metabolic products. Credit: Raphael Gabriel

MICROSCOPY FOR MICOROBIAL IMAGING

Microorganisms and viruses predominate all ecosystems on our planet, and yet, this microbial world is invisible to the naked eye. Indeed, its existence remained unknown until the invention of the microscope over three centuries ago, which opened our eyes to the overwhelming richness of microbes in the environment and the human body. Today, microscopy remains a key technique in modern microbiology and microbiome research, serving as a basis for cutting-edge fluorescence and chemical imaging methods.

State-of-the-art light microscopes are complex devices that have little in common with their precursors from the seventeenth century. Of special importance for microbiome research at CeMESS is fluorescence light microscopy in combination with methods like fluorescence in situ hybridisation (FISH) and immunofluorescence, which are used to label specific microorganisms or their molecular components with fluorescent dyes. Modern confocal laser scanning microscopes (CLSMs) record sharp, three-dimensional images of such labeled microbial communities and thus allow us to study the composition and spatial structure of complex microbiomes in detail.

CeMESS is well-equipped for confocal and epifluorescence microscopy, and many research projects depend on these techniques. However, even with our best microscopes, the spatial resolution is restricted to the diffraction limit of light at about 200 nm and finer details cannot be resolved. In 2023, we obtained funding through the Austrian Research Promotion Agency (FFG) for a high-end, super-resolution CLSM for multicolor stimulated emission depletion (STED) imaging. This new instrument will boost our research, as we will visualize microbes and viruses with a much higher resolution (< 50 nm) and explore previously hidden secrets of their molecular structures and interactions.

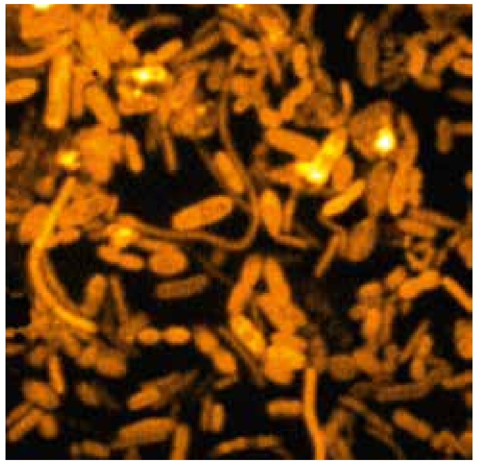


OUR METHODS, AT A GLANCE

- Detecting and visualizing specific microorganisms and molecular components by fluorescence labeling techniques and fluorescence microscopy
- Confocal laser scanning microscopy (CLSM) for visualizing complex microbiomes in all three spatial dimensions
- Super-resolution, multicolor confocal stimulated emission depletion (CLSM-STED) imaging for resolving fine structural details of microbial cells and viruses

Acanthamoeba spp. (blue) hosting varied intracellular bacterial symbionts (yellow, red), amidst a bacterial matrix (green) serving as nourishment. FISH image captured via CLSM. Credit: Nadja Holzleitner

SINGLE CELL ANALYSIS



Visualizing deuterium incorporation of defined human gut microbiome members using SRS and FISH. Credit: Xiaowei Ge, Fatima Pereira, and Jannie Munk Kristensen.

Virtually all microbial communities on our planet are dominated by a great diversity of uncultured microorganisms, which cannot be studied by traditional approaches in microbiology. In their habitats, microbes often coexist in spatially complex assemblies colonising sediments, soils, roots, teeth, the gut, and many other environments with an intricate three-dimensional architecture. Within these consortia, microbes are influenced by numerous abiotic factors (e.g., fluctuations in nutrient concentrations) and involved in a plethora of biotic interactions.

To understand this complex microbial life, we must look directly at single cells and the microscopically small niches where they thrive and interact with other organisms. Only then can we decipher the in situ metabolic activities and symbioses of uncultured microbes. However, single-cell microbiology is an enormous methodological challenge if we consider the tiny size of a microbial cell and the ultra-low amounts of substrates that are taken up, utilised, and exchanged by single cells.

CeMESS plays a leading role in the development and application of single-cell techniques to study uncultured microorganisms in situ. Our toolbox includes cutting-edge methods for labelling cells with isotope tracers, detecting metabolic activities at the single cell level, monitoring the flow of substrates through microbial communities, resolving 3D localisation patterns of microbial cells, and activity-based cell sorting for down-stream analyses and single-cell genomics. All our research projects make heavy use of these powerful approaches. We continually optimise and adapt our single-cell tools to address new research questions and push their limits of sensitivity, accuracy, and spatial resolution.

OUR METHODS, AT A GLANCE

- Single-cell chemical imaging using NanoSIMS, spontaneous Raman microspectroscopy and stimulated Raman scattering (SRS)
- Visualising and quantifying uncultured microbial cells by fluorescence in situ hybridisation (FISH) and confocal laser scanning microscopy (CLSM)
- 3D visualisation and image analysis software "daime" (developed in-house)
- Single cell manipulation and sorting by laser microdissection
- Flow cytometry and fluorescence activated cell sorting
- Raman-activated microfluidic cell sorting

ISOTOPE BIOGEOCHEMISTRY

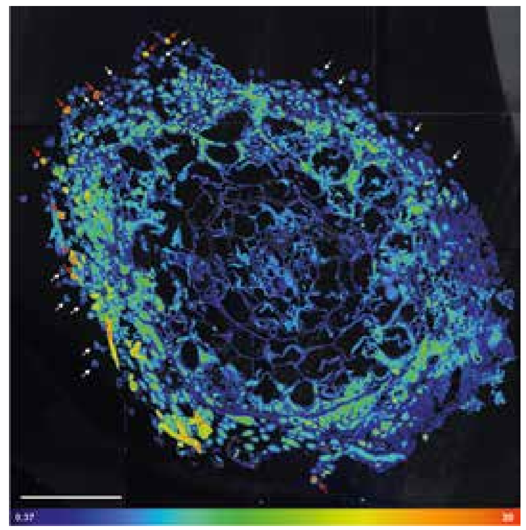
Isotope compositions offer invaluable insights in fields like microbial ecology, ecosystem science, and environmental research. They are crucial for linking microbes to their ecological functions, studying uncultivable microorganisms, and understanding host-microbe interactions. They also play a crucial role in quantifying broader environmental processes, and have even been instrumental in tracing ancient human migration patterns.

At CeMESS, we employ a range of methods to study both light and heavy element stable isotopes, as well as radiogenic and radioactive isotopes. Our focus spans across light elements essential to living organisms and the environment (such as hydrogen, carbon, nitrogen, oxygen, sulfur, and phosphorus), and extends to heavy elements that can be either potent environmental pollutants (like mercury) or vital tracers for understanding human history (such as strontium). Our pioneering work in isotope methodology has led to significant advancements in several key research areas.

We utilise stable isotope probing (SIP) techniques for uncovering active environmental microbes that process target compounds. Our innovative radioisotope approaches, including isotope microarrays and the combination of fluorescence in situ hybridisation (FISH) with microautoradiography, allow us to link microbial community structure to specific functions and to measure soil and microbial light element dynamics. Advanced techniques like NanoSIMS and Raman spectromicroscopy allow us to conduct detailed chemical and isotopic imaging at the single-cell level. Our work also encompasses isotope tracing in various processes like nitrogen fixation, cellulose breakdown, and microbial activity, growth, and metabolism in diverse environments, from guts to soils. Isotope pool dilution measurements help us study gross rates of microbial cycling of key elements in soils and sediments, while natural stable isotope abundances are used for tracing matter flow and investigating source-sink dynamics. Our expertise also extends to isotope hydrology and non-traditional isotope geochemistry, essential for tracing complex environmental processes. In the realm of early human studies, our application of strontium-isotope geochemistry as a tracer has provided critical insights into human migration patterns. Overall, these methodological advances and further innovation will help to uncover the metabolic underpinnings of biogeochemical and pollutant dynamics, from the single cell and organism to landscape levels and beyond.

OUR METHODS, AT A GLANCE

- Isotope pool dilution measurements and the use of natural stable isotope abundances for studying microbial cycling and tracing matter flow in ecosystems
- Isotope hydrology and non-traditional isotope geochemistry for complex environments
- Stable and radioisotope probing techniques, including isotope microarrays and FISH-microautoradiography
- NanoSIMS and Raman spectroscopy for chemical imaging in single cells



NanoSIMS visualization showing ^{15}N enrichment within an ectomycorrhizal root tip of beech (Fagus sylvatica) associated with fungi from the genus Thelephora.

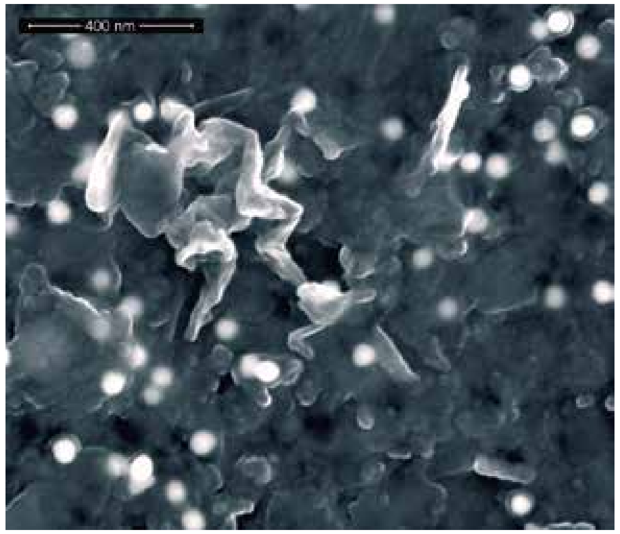
NANOPARTICLE ANALYSIS

Nanoparticles and colloids play a pivotal role in many environmental processes, bridging the gap between solutes and solids. Their small size (ranging from 1–1000 nm) results in a large specific surface area, heightened reactivity, rapid particle dynamics, and potential mobility across diverse environments including marine and freshwater systems, groundwater, soils, and sediments. In these settings, pollutants often adsorb to nanoparticle surfaces or co-precipitate during particle formation. Additionally, manufactured nanoparticles themselves may pose as potential environmental pollutants.

Investigating the critical role of nanoparticles and colloids in environmental processes requires specialised instruments and methodologies, beyond the scope of typical environmental chemistry. At CeMESS, we pioneer the development of innovative methods to detect, identify, quantify, and characterize nanoparticles – be they natural, incidental, or manufactured. This involves a multifaceted approach encompassing sampling, sample preparation, and advanced analysis techniques.

We use laser-based particle sizing techniques (based on beam shading, static and dynamic light scattering) to determine particle size distributions from 0.6 nm to 600 µm. This also tells us about the shape and fractal dimension of particles and their aggregates. To investigate the zeta potential and isoelectric point of particles, we use laser doppler anemometry in liquid samples, or determine the streaming potential on surfaces or in porous media.

In our world-leading laboratory for field flow fractionation (FFF) analysis, we operate different instruments (asymmetric flow-, hollow fiber and centrifugal FFF) alongside multi-detection systems. This allows us to separate and size particles in our samples. Our lab also boasts one of the few inductively coupled plasma-time of flight mass spectrometer (ICP-TOFMS) in Austria, operated jointly with the Faculty of Chemistry. This machine collects full elemental spectra for each nanoparticle, surpassing the limitations of standard ICP-MS instruments that may only detect one isotope in a time-resolved mode. With our instrumentation, methodologies and expertise, we shine light into "the world of neglected dimensions" (W. Ostwald).



Gold nanoparticles (30 nm) among natural soil-derived nanoparticles in a scanning electron microscope.

OUR METHODS, AT A GLANCE

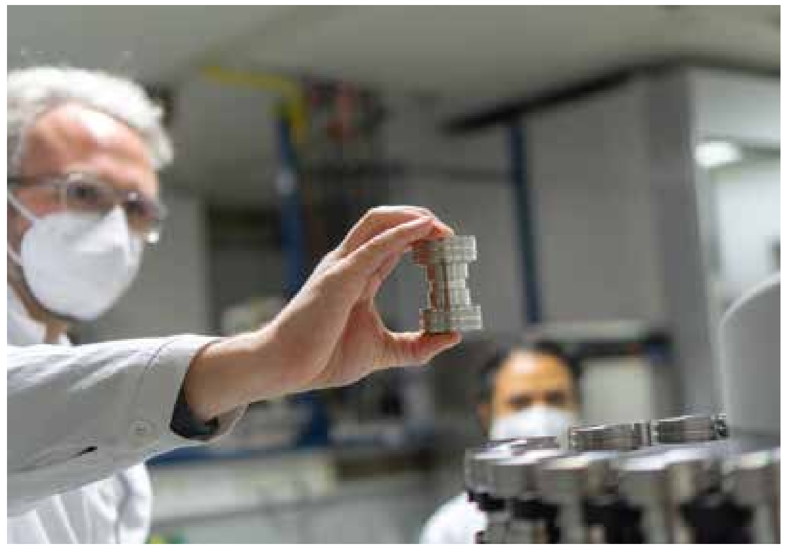
- Laser-based particle sizing techniques
- Dynamic light scattering/laser doppler anemometry
- Field flow fractionation analysis (FFF) including symmetric flow-, asymmetric flow-, hollow fiber and centrifugal FFF.
- Inductively coupled plasma-time of flight mass spectrometry (ICP-TOFMS)

ENVIRONMENTAL TRACE ANALYSIS

The emission of hazardous and persistent contaminants like synthetic organic compounds, heavy metals, and radioactive materials is a major threat for environmental and human health. Our goal is to obtain insights into these pressing environmental challenges and inform solutions. We use quantitative and qualitative approaches to explore the fate of organic and inorganic trace compounds at the molecular scale and to decipher key processes in aquatic and terrestrial environments. At CeMESS, our methods cover the full analytical circle: starting from sample collection in the field, to sample preparation (digestion, extraction, and preconcentration), to controlled laboratory experiments and advanced data analysis.

Gas and liquid chromatographic separation, paired with triple quadrupole tandem mass spectrometry, is a cornerstone of our methodology, allowing for the precise quantification of a wide range of organic pollutants. These pollutants include everything from conventional non-polar substances leaching from plastics to chemicals of emerging concern such as tire additives, pharmaceuticals, pesticides, and PFASs. Complementarily, we use liquid chromatography coupled with high-resolution mass spectrometry to detect and identify unknown organic chemicals in complex environmental samples. This approach is particularly valuable for deciphering biotransformation pathways of pollutants, also in conjunction with studies on the involved enzymes.

For elemental analysis, we rely on inductively coupled plasma optical emission spectrometry (ICP-OES) for high-throughput analysis of main and trace elements across various matrices. Additionally, our use of inductively coupled plasma mass spectrometry (ICP-MS and ICP-MS/MS) enables ultra-trace analysis of elements like metals and metalloids, sulfur, and phosphorus. These ICP-MS systems are specially equipped with advanced features for removing interferences and enhancing our capability to analyze rare earth elements at extremely low concentrations.



Accelerated solvent extraction: Organic pollutants are extracted from soil or sediment samples at high temperature and pressure. Credit: Gabriel Sigmund

OUR METHODS, AT A GLANCE

- Chromatographic separation with mass spectrometry for organic pollutant analysis
- High-resolution mass spectrometry for complex organic chemical identification
- ICP-OES for high-throughput elemental analysis
- ICP-MS and ICP-MS/MS for ultra-trace elemental analysis

EDUCATION

TEACHING AT CeMESS

FOR A NEW GENERATION OF SCIENTISTS

It is our goal to empower a new generation of professionals and scientists with the skills required to solve the planetary challenges ahead. To this end, we are engaged at all levels of teaching, from bachelor's and master's to PhD curricula, across a broad range of disciplines. We contribute to curricula and teach courses spanning from microbiology and bioinformatics to ecology and environmental sciences. In all our teaching, we maintain a student-centric mindset, striving to create an interactive and motivating learning environment.

UNIVERSITY DEGREE PROGRAMMES

At the undergraduate level, we help students to gain foundational skills and knowledge in their chosen domains, while developing their ability to critically think about scientific problems. Within the University of Vienna, we contribute to curricula in the following:

BACHELOR'S PROGRAMMES

- Biology
- Earth Sciences

CeMESS is particularly engaged in teaching at the master's level. We aim to provide the highest level of training, actively creating opportunities for scientific careers and ensuring high student employability. Within the University of Vienna, we contribute to curricula in the following:

MASTER'S PROGRAMMES

- Computational Science
- Bioinformatics
- Molecular Microbiology, Microbial Ecology, and Immunobiology
- Ecology and Ecosystems
- Environmental Sciences
- Earth Sciences

INTERNATIONAL FISH COURSE

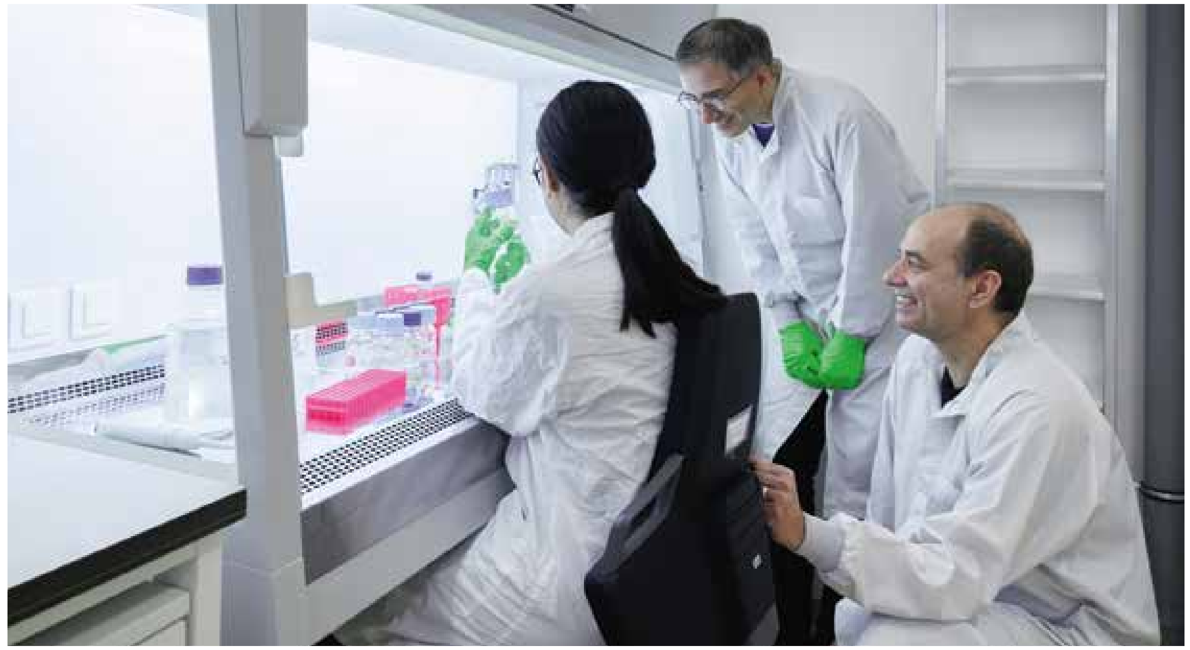
CeMESS offers an annual summer school for researchers at all degree levels interested in fluorescence in situ hybridisation (FISH), an advanced molecular method to study the structure and function of microbial communities. For over a decade, this course has been a hub for transnational scientific exchange and collaboration.

AWARD-WINNING TEACHING

Thomas Rattei received the University of Vienna Teaching Award in 2013, a prize recognizing excellence in teaching at the University of Vienna. During the SARS-CoV-2 pandemic, a team of PhD students from the Centre won the University of Vienna "2020 Corona Teaching Award" for their innovative digital field class. Holger Daims, Matthias Horn, and Alexander Loy received the national Ars Docendi Recognition Award 2022 for their pioneering concepts in microbial ecology pedagogy.

VDS MES: OUR DOCTORAL SCHOOL

TRAINING THROUGH RESEARCH



The Vienna Doctoral School in Microbiology and Environmental Science, established in July 2020, offers interdisciplinary training at the interfaces of microbiology, ecology, and environmental science. Our PhD students benefit from the collaboration between two research institutions with internationally recognised reputations: CeMESS and Max Perutz Labs.

Since operations began in October 2020, we have been offering our PhD students an inspiring environment that empowers them to address the major environmental or medical challenges of the 21st century. In an international setting with members from over 25 different countries, our students conduct cutting-edge research using state-of-the-art scientific infrastructure.

Training through research is a basic principle of the school. Thus, all PhD students are fully integrated into the faculty's research groups. Moreover, we offer advanced training in cutting-edge methods through workshops and seminars, research stays in partner labs, one-to-one coaching, annual retreats, regular team meetings, as well as individual meetings with supervisors. In additional seminars, students can interact with high-profile international speakers and leading scientists in their fields.

We place very high value on an active feedback culture, encouraging students to improve our programme by providing input. Student representatives are in constant exchange with the two heads and the coordinator of the doctoral school. Their ideas have considerably shaped past and ongoing events, courses, and workshops.

MAINTAIN

CeMESS coordinates the doc.funds project MAINTAIN, a PhD programme financed by the FWF running until September 2024. MAINTAIN supports 10 PhD students researching Microbial Symbiosis and Interactions, both at CeMESS and at the Faculty of Life Sciences. This project is thus a thematically coherent PhD programme within the Doctoral School.

WHAT WE OFFER

We pride ourselves on nurturing a dynamic feedback culture and maintaining regular dialogue with student representatives. The support and opportunities we offer our doctoral students is constantly evolving, and currently includes:

SUPPORT AND OPPORTUNITIES FOR DOCTORAL STUDENTS

- Coursework in quantitative methods, bioinformatics, or environmental science
- Individual career coaching
- Intensive paper writing courses
- 1-on-1 support for research data management
- Visa and residence title support for international PhD students
- Financial support (finishing grants, funding for conference attendance)
- Annual anonymous supervision surveys
- Diversity training
- Alumni network

ABOUT THE DOCTORAL SCHOOL

A snapshot from our third year of operations (data from winter semester 2023/2024).

32 GRADUATES

During our first three years of operation, 32 students have completed their PhD studies with us, marking the first milestone in their promising careers in microbiology or environmental systems sciences.

78 STUDENTS

In 2023, VDS MES was home to 78 PhD students, actively contributing to research in their fields, while upskilling in the core principles and practices of science.

STUDENT NATIONALITIES

VDS MES students hail from diverse corners of the world.
31.0 % Austria
14.9 % Germany
17.6 % EU
36.5 % Non-EU

93% FULLY FUNDED

Almost all our PhD Students are fully funded. From those, 68% are funded by third-party projects, 32% by the University of Vienna, 13% are funded by external institutions, and 5% received an independent grant or stipend.

1:2.4 FACULTY: STUDENT RATIO

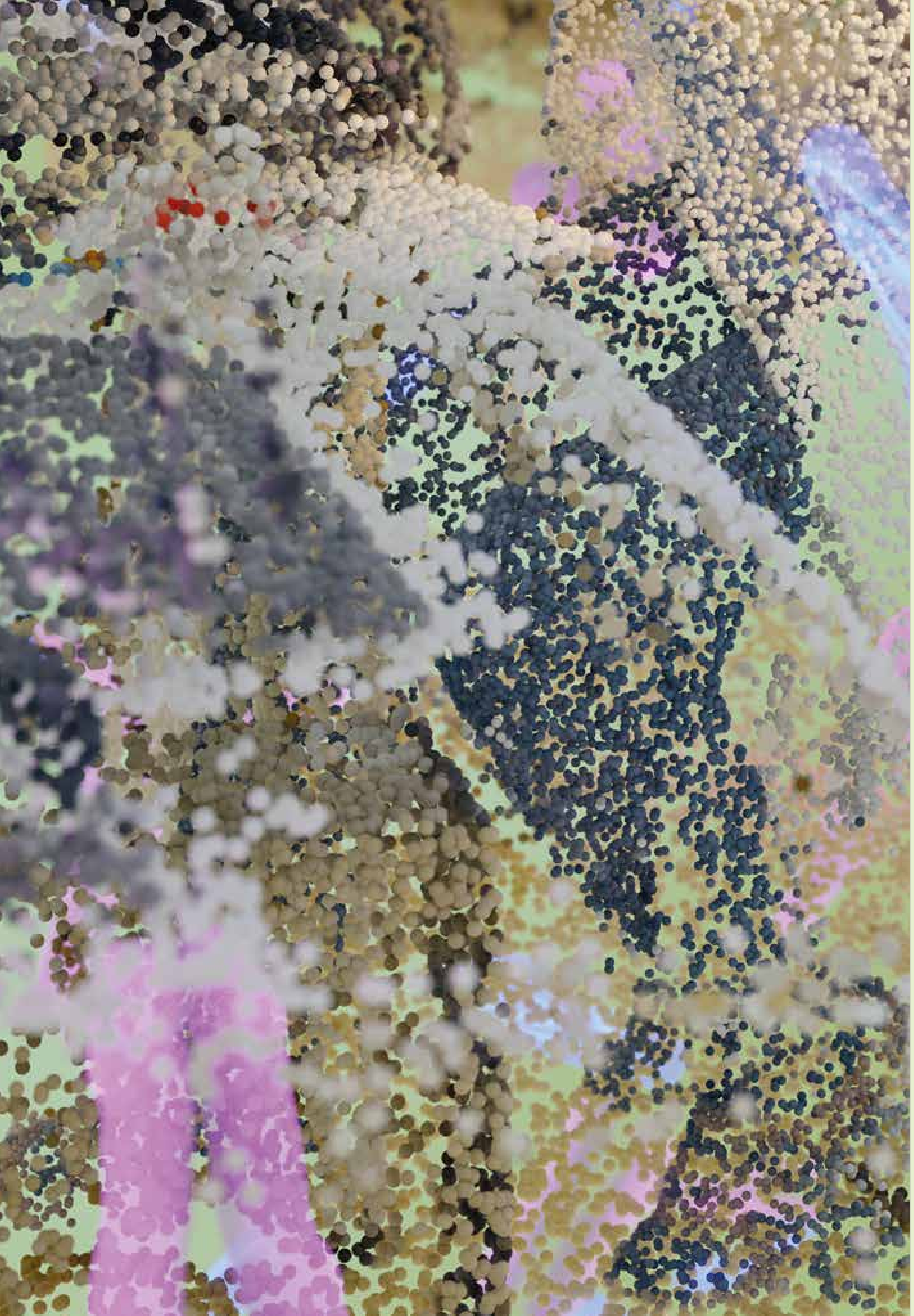
With 32 faculty members and 78 students, we're proud to offer an exceptional faculty-to-student ratio that ensures detailed supervision and access to research opportunities for each of our students.

FEMALE REPRESENTA-TION

VDS MES takes pride in our community with 54% female students and 38% female faculty, championing inclusivity and representation in science.

4 FIELDS OF STUDY

Our Doctoral School comprises diverse fields of research, hosting 62 students in Biology, 12 in Environmental Science, 3 in Molecular Biology, and 1 in Geosciences.



FACILITIES

LiSC

LIFE SCIENCE COMPUTE CLUSTER

CeMESS operates a medium-sized high-performance compute cluster specialised in bioinformatics and computational life science. The main difference to larger, generic computing facilities such as the Vienna Scientific Cluster (VSC) is the rich, flexible, and up-to-date bioinformatics software repository, the availability of major biological databases on-site, and fast, local storage space for processing of big data. This system allows most users to analyse their data without any software installation, simply by using the pre- installed tools and databases.

The cluster is based on common PC architecture and contains several login nodes for job testing and submission, the actual compute nodes, and a large storage array. It contains more than 3500 CPU cores and up to 2 TB RAM per node. Copies of relevant biological databases (such as NCBI nt and nr) are available. Local high-speed disks in all compute nodes accelerate I/O intensive tasks. Software is provided via a modular environment, where applications and specific versions are activated and deactivated as needed. The storage system has a total capacity of about 1.5 PetaByte based on redundant, network attached disk arrays and parallel filesystems. We operate three redundant virtualisation servers that host specific working environments. Virtual machines are also used to operate our publicly available resources, such as web portals, databases and user-friendly visualisation tools.

The Life Science Compute Cluster is frequently used by CeMESS members and is jointly operated for the Faculties of Chemistry and Life Science, the Max-Perutz Laboratories, and with collaboration partners inside and outside the University of Vienna. As most of the users are non-specialists in high-performance computing, CeMESS provides a user help-desk and software installation support.

Login nodes, compute nodes, server nodes and storage nodes, all mounted in 19″ racks and housed at the University of Vienna Biology Building (UBB). Credit: Joseph Krpelan

JMF

JOINT MICROBIOME FACILITY

THE HIGH-THROUGHPUT SEQUENCING SERVICES AVAILABLE INCLUDE:

- Illumina MiSeq-based highly multiplexed gene amplicon sequencing (e. g. 16S rRNA genes, 18S rRNA genes, ITS region)
- Illumina MiSeq-based microbial isolate genome sequencing
- Illumina HiSeq-/NovaSeq-based (meta-)genome and (meta-)transcriptome sequencing Oxford Nanopore MinION and PromethION technologies for long-read sequencing

The Joint Microbiome Facility (JMF) provides advanced ‘omics sequencing workflows and analytical pipelines to investigate and characterise complex microbial communities. In recent years, scientists have begun to appreciate the critical role of microbiomes to both human and environmental health. Microbiome research is now rapidly developing, with new programs and institutions being established worldwide. Equipped with state-of-the-art technology and world-class expertise, the JMF supports both local and international research groups to conduct the highest standard of sequencing-based microbiome research.

Our facility offers individualised consulting services, supporting all stages of research, from experimental design to sample processing, sequencing, bioinformatic analysis, and data interpretation. We offer a range of cost-effective, high-throughput services to enable researchers to comprehensively assess microbial composition and activity in their systems. These services include DNA/RNA extraction from diverse sample types, gene amplicon sequencing, full length primer-free rRNA profiling, and metagenomic and meta-transcriptomic shotgun sequencing. Specifically, we offer Illumina MiSeq-based highly multiplexed gene amplicon sequencing (e.g., 16S rRNA, 18S rRNA, ITS), Illumina NovaSeq-based metagenome and metatranscriptome sequencing, as well as long read (Oxford Nanopore Technologies based) microbial isolate genome and metagenome sequencing.

Established in 2018, the JMF is a collaborative venture between the Medical University of Vienna and the University of Vienna. We have extensive expertise in characterising microbial communities from various habitats, ranging from human, animal, and plant microbiomes to soils, sediments, aquatic environments, and hot springs. Beyond this, the JMF is actively advancing the field of microbiome research by benchmarking existing approaches and developing new technological and analytical strategies.

The Oxford Nanopore PromethION System enables high throughput long read sequencing for generating high quality (meta) genomic datasets. Credit: Joseph Krpelan

SILVER

STABLE ISOTOPE FACILITY OF THE UNIVERSITY OF VIENNA FOR ENVIRONMENTAL RESEARCH

CeMESS runs the Stable Isotope Facility of the University of Vienna for Environmental Research (SILVER), which specialises in analysing stable isotopes of light elements in environmental samples. It is the largest facility of its kind in Austria, and one of the leading laboratories for ecological research with stable isotopes in Europe. At SILVER, we analyse isotopes of light elements that constitute the biosphere (such as hydrogen, carbon, nitrogen, oxygen, and sulfur), which naturally exist in more than one stable (non-radioactive) isotopic form. The ratio between heavy and light stable isotopes (like $^{13}C/^{12}C$ or $^{15}N/^{14}N$) in a sample can provide valuable information about the physical, chemical, and biological processes occurring in the environment, and about sources and sinks of matter. Moreover, by experimentally enriching specific compounds with heavy stable isotopes, we can precisely trace their fate and transformations in complex environmental systems – which is not possible by any other approach.

SILVER is part of the Large-Instrument Facility for Advanced Isotope Research at the University of Vienna. The SILVER facility boasts five continuous flow isotope ratio mass spectrometers (IRMS), each designed for specific types of analysis. This includes an elemental analyser (EA-IRMS) system for analysing 13C and 15N in solid samples, a high-temperature pyrolysis unit for 2H and 18O in solids and liquids, and a Gasbench-IRMS for concentrating and measuring stable isotopes in trace gases. We also combine IRMS with liquid chromatography (LC-IRMS) and gas chromatography (GC-IRMS) to analyse 13C, 15N and 2H in organic solutes in a compound-specific way.

INSTRUMENTATION OF THE SILVER FACILITY

EA – IRMS: Elemental analyser for ^{13}C and ^{15}N in solid environmental samples

Pyrolysis-IRMS: High-temperature pyrolysis system for ^{2}H and ^{18}O in solid samples and water

Gasbench-IRMS: Trace gas pre-concentrator for ^{15}N analysis of N_2O, and for ^{13}C analysis of CO_2 and CH_4, and ^{18}O and ^{2}H analysis of water

LC-IRMS: HPLC-Isolink for ^{13}C analysis of organic solutes

GC-IRMS: GC-Isolink for ^{13}C, ^{15}N and ^{2}H analysis in organic analytes

A suite of isotope ratio mass spectrometers (IRMS) for bulk and compound-specific analysis of hydrogen, carbon, nitrogen and oxygen in environmental samples. Credit: Pamela Nölleke

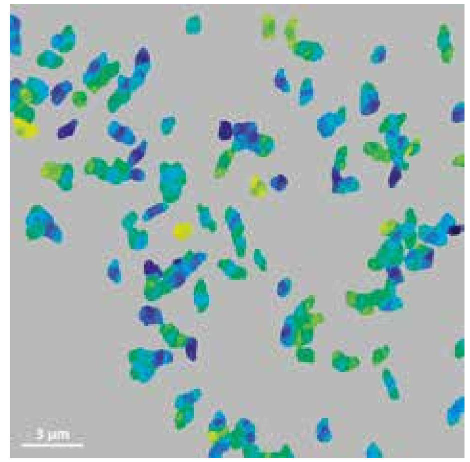
NANOSIMS

NANOSCALE SECONDARY ION MASS SPECTROMETRY

Acquired in 2010 as part of the Large-Instrument Facility for Advanced Isotope Research, CeMESS operates a CAMECA NanoSIMS 50L. NanoSIMS is an advanced type of secondary ion mass spectrometer (SIMS) that allows us to determine the content of trace elements and isotopes with utmost sensitivity, down to sub-micrometer scales – smaller than a single microbial cell. It does this by bombarding a sample with a focused ion beam, which causes atoms and molecules from the sample to be ejected. The fraction of ionized particles is then detected based on the mass-to-charge ratio. NanoSIMS can detect up to seven distinct secondary ion species simultaneously, at single-ion-counting sensitivity. This method is perfectly suited for visualizing where different elements and isotopes are located in a variety of materials, ranging from sub-micrometer sized grains of minerals and alloys to tissues and microbial cells even down to the sub-cellular level.

At CeMESS, the NanoSIMS is primarily used for research in microbial ecology. It is often combined with other techniques like stable isotope probing and bulk analysis with isotope ratio mass spectrometry (EA-IRMS), as well as optical microscopy techniques like fluorescence in situ hybridisation (FISH). With this approach, we can learn about the phylogenetic identity, physiological function and interactions of microbes in various environments, such as soils, microbial mats, activated sludge, deep groundwater and even within symbiotic host organisms. In recent years, the NanoSIMS has been upgraded with a new oxygen ion source, enhancing its capabilities in ultra-trace metal analysis. This allows for new types of studies, like investigating the role of metals in microbial cells.

This instrument is the only one of its kind in Austria. As such, the NanoSIMS facility at CeMESS collaborates with a wide range of research groups, both locally and internationally. Beyond conducting measurements, we also provide extensive support in designing studies, preparing and pre-characterising samples, and evaluating and interpreting data.



CO_2 fixation by single cells visualized by stable isotope probing and NanoSIMS imaging.

Senior scientist Arno Schintlmeister refines settings on the CAMECA NanoSIMS 50L.

EMS

ENVIRONMENTAL MASS SPECTROMETRY

The Environmental Mass Spectrometry Facility (EMS) provides state-of-the-art mass spectrometers for studying environmental processes at the nanometre and molecular scale. Since 2005, our facility has been pioneering novel methods in environmental analytical chemistry uniquely tailored to addressing relevant questions in terrestrial and aquatic systems. Our research focuses on natural and anthropogenic contaminants, which represent an extremely wide group of organic and inorganic substances, including unknown structures, substances of emerging concern, and transformation products. At the EMS, we not only detect substances down to ultra-trace levels, but we also investigate stable isotope fractionations and conduct non-target analytics. Our studies include source tracing, as well as identification of processes controlling the biogeochemical cycling of metals.

Recent advances in mass spectrometry (MS) have led to an increasingly sophisticated arsenal of instruments designed to analyse complex environmental samples. The great benefit of high-resolution MS is its ability to identify and quantify numerous analytes in complex mixtures in a single run. Our facility focuses on high-resolution MS and tandem MS to achieve faster high-throughput analyses with minimum sample preparation, as well as multi-collector inductively coupled plasma (ICP) MS for stable isotope ratio measurements.

Our suite of analytical capabilities includes ICP time-of-flight MS (ICP-TOF-MS) for recording elemental mass spectra down to attogram levels in single nanoparticles. We use liquid chromatography coupled to tandem MS (triple quadrupole and Orbitrap) for increased selectivity and non-target analytics, as well as gas chromatography coupled to tandem MS (GC-MS/MS). We also use triple quadrupole ICP-MS coupled to size exclusion chromatography or field flow fractionation, which offers flexibility in method development and provides unrivalled control of interferences, delivering greater accuracy and more consistent results. Isotope analyses are performed on a multicollector ICP-MS with sixteen Faraday cups for simultaneous detection of multiple isotope ratios. A clean room and workspaces with controlled atmospheres are available for sample preparation. Our facility conducts research in cooperation with researchers not only from our Centre, but also from the Faculties of Chemistry, Earth Sciences and Life Sciences, as well as other national and international partners.

Pump of an LC-MS/MS instrument used in the EMS. Credit: Gabriel Sigmund

Sample preparation under controlled atmosphere and under clean-room conditions. Credit: Gabriel Sigmund

RESEARCH NETWORKS

INTERDISCIPLINARY COLLABORATION IS AT THE HEART OF WHAT WE DO. MEMBERS OF CeMESS COLLABORATE IN DIVERSE RESEARCH PLATFORMS AND NETWORKS ACROSS THE UNIVERSITY OF VIENNA.

COMAMMOX RESEARCH PLATFORM

Research platform with the Center for Molecular Biology, headed by Holger Daims

DATA SCIENCE @ UNI VIENNA

Research network that presents a hub on all activities in data science at the University

ENVIRONMENT & CLIMATE HUB

Research network that connects researchers from all faculties working in related fields, co-headed by Thilo Hofmann

HUMAN EVOLUTION AND ARCHAEOLOGICAL SCIENCES (HEAS)

Research network with Faculty of Life Sciences, Faculty of Historical and Cultural Studies, Faculty of Physics, and Faculty of Earth Sciences, Geography & Astronomy

MINERALOGICAL PRESERVATION OF THE HUMAN BIOME FROM THE DEPTH OF TIME (MINERVA)

Research platform together with the Faculty of Life Sciences, vice-headed by Stephan Krämer und Thomas Rattei

PLASTICS IN THE ENVIRONMENT AND SOCIETY (PLENTY)

Research platform with Faculties of Life Sciences, Social Sciences and Earth Sciences, Geography & Astronomy

SECONDARY METABOLOMES OF BACTERIAL COMMUNITIES (METABAC)

Research platform with Faculty of Life Sciences and Faculty of Chemistry, vice-headed by Alexander Loy

RESPONSIBLE RESEARCH AND INNOVATION IN ACADEMIC PRACTICE

Research platform with Faculty of Social Sciences, vice-headed by Andreas Richter

THE CHALLENGE OF URBAN FUTURES: GOVERNING THE COMPLEXITIES IN EUROPEAN CITIES

Research platform with Faculty of Social Sciences, Faculty of Historical and Cultural Studies, Faculty of Earth Sciences, Geography and Astronomy, and Faculty of Computer Science

VIENNA COGNITIVE SCIENCE HUB

Research network that connects researchers active in various disciplines of Cognitive Science and Cognitive Neuroscience at the University

VIENNA METABOLOMICS CENTER

Research platform with Faculty of Life Sciences and Faculty of Chemistry

SCIENCE FOR PLANETARY HEALTH

VIENNA BIOCENTER
The University of Vienna Biology Building (UBB) is part of the Vienna BioCenter Campus, one of Europe's top life sciences research centres. Located in the third district of Vienna, it is home to 6 research Institutions (including CeMESS), almost 40 biotech companies, several research facilities, and a total of almost 2300 international researchers from 78 countries.

LOCATIONS

UBB University of Vienna Biology Building
Djerassi-Platz 1, 1030 Vienna

UNIVERSITÄTSZENTRUM II Geosciences (UZA II)
Althanstraße 14, 1090 Vienna

IMPRINT

Published by Centre for Microbiology and Environmental Systems Science (CeMESS)
University of Vienna

Responsible for the content: Andreas Richter & Annina Müller Strassnig
Project Management: Annina Müller Strassnig & Kiri Marker
Scientific Writer: Kiri Marker

Layout & Design: Cin Cin, Creative Studios
Artwork: Maximilian Prag

Photography:
Ludwig Schedl (pp 26, 52-59, 61-70, 72-74, 76-80, 105)
Joseph Krpelan (pp 88, 96, 97, 98, 102, 103)

Printed by Gugler GmbH

This report has been printed using Cradle to Cradle Certified® production methods, ensuring the highest standard of eco-printing in terms of material health, circularity, renewable energy use, and ecological stewardship.


CeMESS

CENTRE FOR
MICROBIOLOGY AND
ENVIRONMENTAL
SYSTEMS SCIENCE