

Protocol for the **second evaluation** of research and service units at SUPSI - P2VRS

Institute of Microbiology self-assessment report

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1. Introduction

Evolution of the Microbiology Institute 9 years after the transfer to SUPSI

The origin of the Institute of Microbiology (IM) is linked to the Cantonal Institute of Microbiology (ICM), established in 1964 as the “Istituto batteriosierologico cantonale” and created to fill a gap in the health care of the population of Ticino. At the end of 2012, after 48 years of activity, the ICM was closed. Following this governmental decision, clinical diagnostic microbiology was integrated into the “Ente Ospedaliero Cantonale”, EOC. After a careful cost/benefit assessment, the areas of environmental microbiology, biosafety and typing were integrated in early 2014 as the Laboratory of Applied Microbiology (LMA) in the Department of Environment Construction and Design, DACD, of the University of Applied Sciences and Arts of Southern Switzerland, SUPSI. During this period, the LMA initiated the integration process into the DACD. In 2016, the Operational Group of the Cantonal Mosquito Group, GOZt, with which first ICM and then LMA collaborated for over 17 years in the field of biosafety in the use of microbiological agents against the proliferation of tiger mosquito larvae and the problem of vector-borne diseases, providing continuous technical and scientific logistical support, was integrated into LMA.

Moreover, in 2021 the Environmental Biotechnology Laboratory (BET) of the Department of Innovative Technologies, DTI, (4 units) with which it was already collaborating on several projects was also integrated, and in the same year LMA moved to institute status as Institute of microbiology. Highlights of the evolution of IM over the past 9 years are summarized in Table 1.

Tab. 1. Chronology of key events in the integration of the LMA into SUPSI, 2012-2021

Milestone, facts and figures LMA 2012-2020	
2012	<ul style="list-style-type: none"> • Dissolution of the Cantonal Microbiology Institute, 31.12.2012 • SUPSI strategy for the integration of the activities of environmental microbiology and biosafety of the ICM in the DACD, 6.12.2012; (goal: transition from Laboratory to Institute in 2020 with 10-15 units and 1.5 Mio CHF of activity volume)
2013	<ul style="list-style-type: none"> • Message GC 6794 of 7.5.2013 on the integration of applied microbiology in SUPSI • Approval of the DSS-SUPSI agreement of 29.11.2013 regarding research, consulting and provision of additional services in the field of environmental microbiology and biosafety for the period 2014-2021. • 4.7 Full-time units, FTE + 4 Stagiaires • Confirmation of the management of the Southern Regional Biosafety Laboratory, LRSud. • Support for the Alpine Biology Center, university courses, continuity in research • Future center for applied microbiology with research and teaching tasks
2016	<ul style="list-style-type: none"> • Transfer of the Operational Group on Tiger Mosquitoes (GOZt) to the LMA • Re-evaluation of the DSS - SUPSI agreement, +230'000.- CHF, +5-6 units for the integration of GOZt • Research evaluation procedure (PVRS), external audit of LMA after the 1st four-year period in SUPSI
2017	<ul style="list-style-type: none"> • Funding 2nd four-year period, reduction CHF 60,000 from Task 4
2018	<ul style="list-style-type: none"> • Financial adjustments: <ul style="list-style-type: none"> ◦ Reduction 60'000.- CHF task 4 ◦ Increase 20'000.- CHF task 3 ◦ Increase 20,000.- CHF task 2 • LMA report, verification and confirmation of achievement of objectives of the 2016 audit (PVRS)
2019	<ul style="list-style-type: none"> • LMA Report 2019, Defining "One Health" Strategy. • Life Sciences Development Assessment in SUPSI 21.11.2019
2020	<ul style="list-style-type: none"> • NaP CdS 2020, no change in funding convention 2021-2024
2021	<ul style="list-style-type: none"> • Integration of the BET laboratory, Bio Environmental Technologies coming from the DTI • Transfer to Mendrisio of part of the activities of the LMA in the SUPSI Campus of the DACD • Modification of the institutional statute with conferral of the title of Institute (June 2021) • Message of the CdS, nr. 8093; Agreement with SUPSI for the delegation of services in the field of applied microbiology for the period 2022-2024 and related credit, 1.12.2021

2. Results of the first evaluation and effects created

- 2.1. The measures defined in the improvement plan of the first evaluation have been put into practice.

Following the report of the first external evaluation in 2016 the SUPSI management council expressed four points of recommendation resulting from the analysis of the self-evaluation report, the final report of the PVRS (Procedura Valutazione Ricerca e Servizi) and the comments made on the latter by the LMA. We therefore illustrate and discuss each of these objectives.

The PVRS, through an external audit by a commission of independent experts, was aimed at assessing in particular: the organization of research, the production of results for the academic and professional community; the relevance for society and the territory of the scientific results produced and the impact on education. Based on criteria of quality, relevance, productivity and socio-economic impact, the commission of experts expressed a positive opinion on the Laboratory's work. Having taken note of the results of the audit, on 25.2.2017 the SUPSI Directorate formulated a series of recommendations: plan for integration in the new Campus of DACD, strengthening of the Swiss network of scientific contacts, objective of subdivision of revenues into types of activities, personnel recruitment policy. These points were to be followed up over the following 24 months in order to be able to subsequently submit a request for change of status from Laboratory to Institute (see "Presa di posizione della Direzione SUPSI con riferimento alla verifica della qualità della ricerca del Laboratorio microbiologia applicata").

The fulfillment of the recommendations of the SUPSI Directorate was validated on May 9, 2018 by the Delegated Director for Research and Innovation, Prof. Giambattista Ravano. This confirmed that the LMA had the necessary elements to submit a request for change of status from Laboratory to Institute (see "Valutazione delle azioni di miglioramento a seguito della verifica della qualità della ricerca del Laboratorio microbiologia applicata").

Following the PVRS of the LMA and the related external audit that took place between 2016 and 2018, four main lines of action for strategic development were identified:

1. development of the integration of the LMA into the DACD;
2. strengthening of the Swiss network of contacts and interactions;
3. staff recruitment policy consistent with a gradual transition from a service laboratory to a research institute;
4. achievement of a 40% funding share of research.

Already in the 2018-2019 biennium, a good part of these objectives were achieved but some of them required to be pursued and completed also in the next four-year period 2021-2024.

Moreover, the strategic directions identified and chosen for the development of the future Institute are also based on the conclusions of the SWOT analysis carried out by the Life Sciences working group for the scenario chosen by the SUPSI management, namely the creation of two institutes, BioMedTech affiliated to the DTI and Microbiology to the DACD. In addition to the strategic directions already identified in the past years and the goals not yet fully completed, the main guidelines for the development of the future activities of the Institute have been identified (see chapter 10). These guidelines concern all sectors of the Institute and are presented as a whole, starting with the "One Health" strategy, which will represent the fulcrum of the lines of action for the next four years. With a view to a four-year development, the IM envisages the consolidation of existing research areas and the opening of new research areas based on the knowledge and skills acquired. In the next four-year period 2021-2024, the IM intends to focus its attention in strategic terms on several lines of development, some of which have already been the subject of a strategic assessment in previous years.

1) Develop a plan for integration into the new DACD location, together with the Department's leadership, outlining the modus operandi with its partners (EOC) and within the Department itself.

The integration plan of the IM developed with the DACD direction is based on the will to maintain the 3 main research areas of the IM: biosafety closely related to pathogens, environmental microbiology (both built and natural environment) and the fight against disease vectors (e.g. mosquitoes). From a logistic point of view, the biosafety and the regional laboratory South, closely linked to the infrastructure of the biosafety laboratory BSL3 and the diagnostic microbiology activities of the EOC will remain in the laboratories in Via Mirasole 22a in Bellinzona. It will be strengthened with viral analyses and further enhanced with the introduction of genomic and transcriptomic analyses, as desired by the PVRS, which represent an important technical leap forward for the IM.

In Bellinzona will also remain the activities related to pathogens including MALDI-TOF MS mass spectrometry which collaborates closely with EOC-EOLAB and in particular with the departments of bacteriology, hospital hygiene, veterinary medicine, for the rapid identification of pathogens and with the department of biochemistry and clinical pharmacology which uses mass spectrometry extensively.

The IM laboratories in the new DACD site in Mendrisio host the activities in the field of environmental microbiology and vectors of pathogens with the surveillance and control of invasive mosquitoes at cantonal and national level carried out by IM staff stationed until the end of 2020 in restricted laboratories in Via Castello in Canobbio and that have now found more suitable spaces in the new Campus.

In Mendrisio the activity in the field of vectors is flanked by environmental microbiology with the increased logistical possibility to perform cultures of anaerobic and aerobic phototrophic bacteria. Both these sectors are very synergistic with the activities of the IST (Institute of Earth Sciences) with regard to limnology, water biology and sensoristics, with the IMC (Institute of Materials and Construction) in the field of conservation and restoration (eg biological degradation of works of art) and indoor contamination (microbiology of the built environment) but also with the Institute of Design (IDe) for the aspects of scientific knowledge transfer very important both for the problem of invasive mosquitoes and for science-society relations related to educational activities in collaboration with the Alpine Biology Center Foundation of Piora (www.cadagno.ch).

In our view there is a great potential for synergistic development within the DACD especially in the field of microbiology of the built environment. In fact, the collaboration with the sector of Conservation and Restoration of the IMC, in addition to having led to the development of several interesting projects related to biodeterioration and degradation of works of art, has also allowed the inclusion of IM collaborators in the teaching of Bachelor and Master in Conservation and Restoration as well as in the development of Master and PhD works. A further positive development in this area is the transfer of the Environmental Biotechnology Laboratory (BET) from the DTI which has brought technical expertise related to the problems posed in the field of microbiology of the built environment. One thinks for example of the technical aspects to be considered in the search for pathogens such as SARS-CoV-2 in water treatment plants, the problem of pathogens in drinking water systems and ventilation of buildings (*Legionella pneumophila*, *Pseudomonas aeruginosa*, molds and respiratory viruses) as well as the use of microorganisms active in the precipitation of calcite used as a biological building material ecologically healthy. Some important projects in these areas are already underway. The activities of the sector Hygiene and environment by definition transversal (see PRG report) will be present both in Mendrisio and Bellinzona.

2) Further pursue the strengthening of the Swiss network of contacts and interactions, with the aim of achieving recognition as a reference research institute in at least one of its specializations, for example in infectious disease vectors. At the same time it will be able to intensify its participation in European projects, also taking advantage of the network itself.

With the recognition by a federal mandate of the Federal Office for the Environment conferred to the IM as "Coordination Center of the national network of competence for the surveillance of invasive

mosquitoes" we can affirm that we have achieved objective 2. Since 2006 the FOEN and the FOPH have been following the activities carried out in Ticino in the context of the fight against the tiger mosquito. In 2011, this collaboration led to the development of a concept for the control of tiger mosquitoes and associated diseases as well as to the establishment of an informal working group of the federal authorities involved (FOEN, FOPH, FVO and FOCP). This interdepartmental working group for vector problems (Interdepartementelle Arbeitsgruppe Vektoren, IDAV) ensures the exchange of scientifically based information on the subject.

In 2013, the Swiss Tropical Institute (TPH) in collaboration with SUPSI on behalf of the FOEN started a pilot project of national monitoring of invasive mosquitoes on the main transport network and major hubs throughout Switzerland. This monitoring is still going on.

The desire of the federal agencies is to set up a uniform, coordinated and integrated national surveillance program, consisting essentially of a concept of preventive information, systematic surveillance (control) of invasive mosquitoes and, if necessary, control measures with insecticides. An important first step in the creation of a surveillance program at the cantonal level was the definition of responsibilities regarding tasks and the creation of a coordinating body to support the cantons affected by the problem of invasive mosquitoes. The mandate of the FOEN to the IM concerns precisely the implementation of a national reference network with a coordination service at the IM, SUPSI acting as a nodal center of the information that flows from the regional stations and the Swiss monitoring program and is transmitted after validation to the Swiss Center for Wildlife Conservation (CSCF).

Also noteworthy is the acquisition of funding from the WHO for the project of application of the sterile male technique (SIT) in the fight against tiger mosquitoes in collaboration with partners in Italy and Mexico as well as from the Swiss National Fund for Scientific Research in the field of microbial ecology both for the research that IM carries out on Lake Cadagno and in the field of ecology of water streams, both with international partners (Luxembourg, France, India and Brazil). These awards place IM at the top of the research in the field of vector ecology and microbial ecology.

3) Goal of splitting revenues across activity types into a minimum of 40% research (to be achieved gradually over three years) and the rest in services.

The financial evolution of the IM is good and in the revenue split research has increased from 32% in 2014 to 59% in 2021, thus exceeding the established target of 40% (see financial situation, chapter 3.2.).

4) Implement a staff recruitment policy consistent with a gradual transition from Service Laboratory to Research Institute, while developing a policy of delegation with a view to the growth of its staff.

With a view to goal 4 at the end of 2017 and beginning of 2018, major changes in the personnel structure were made to ensure the development of genomic, metagenomic and transcriptomic analysis and the topic of stream ecology with the hiring of Dr. Andreas Bruder. The head of the Biosafety sector Dr. Valeria Guidi was promoted to senior researcher. In addition, the Vector Ecology Sector has been assigned to Dr. Eleonora Flacio (senior researcher) already in charge of the invasive mosquitoes surveillance system while the Microbial Ecology Sector has been assigned to Dr. Nicola Storelli. With the acquisition of the BET Laboratory from the DTI, the new Environmental Biotechnology Sector directed by Dr. Pamela Principi was created. In 2013 at the time of the transfer of the IM to SUPSI in the staff there were 12 employees in 2017 this number has increased to 45 at the end of 2021.

The fulfillment of the recommendations of the SUPSI Management was validated on May 9, 2018 by the Delegated Director for Research and Innovation, Prof. Giambattista Ravano, confirming that the LMA had the necessary elements to submit a request for change of status from Laboratory to Institute (see, "Valutazione delle azioni di miglioramento a seguito della verifica della qualità della ricerca del

Laboratorio microbiologia applicata"). In conclusion, it can be stated that the recommendations made during the previous audit in 2017 have already been successfully implemented during 2018 (see "valutazione delle azioni di miglioramento a seguito della verifica della qualità della ricerca del Laboratorio di Microbiologia applicata LMA del 9.5.2018"). From 2018 to 2021, the positive developments continued organically by further strengthening the synergies both internal to the IM and external with the other Institutes of SUPSI.

2.2. The research unit developed following the results of the first evaluation

Seven years after the integration of the IM, formerly LMA, in SUPSI, the overall framework of the activity sectors has been progressively structured and stabilized over time, maintaining its characteristic of an institute active both on environmental and health-related issues.

The IM is specialized in the application of identification techniques of various groups of microorganisms and for this reason the origin of the samples and the fields of investigation are very diversified. Another important aspect of this global vision is represented by the evolution of the concept of health that with the idea of protecting biodiversity has also expanded to the environment, thus becoming a "One Health" (see Fig. 1) that includes the human, animal and environmental spheres. This vision is reflected in the concept of biosafety, an important area of IM, which has as its primary objective the protection of humans, animals and the environment from dangerous biological agents, also clearly expressed in terms of legislation at the national level. From this point of view, the IM, both in its service activities and in those related to research projects, is located at the intersection between the three areas, but closer to the environmental sphere (natural and built environment) as represented in the figure below.

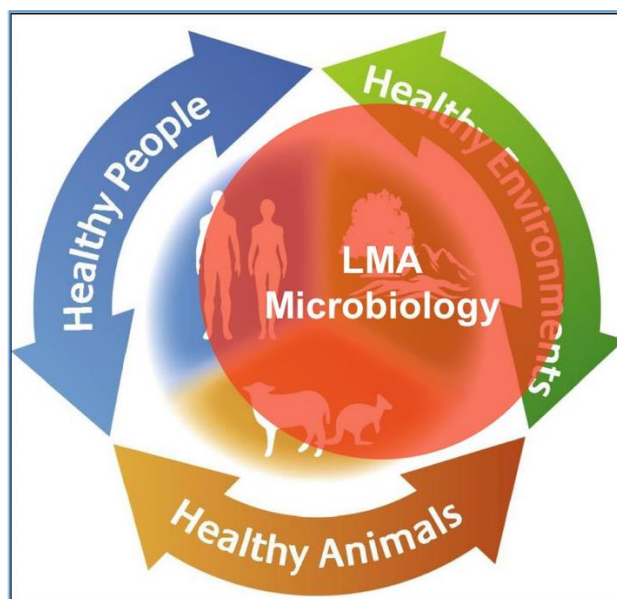


Fig. 1: "One Health" concept and positioning of IM activities (da: Thompson, A.R.C., 2013, mod.¹)

In the Swiss academic panorama, the positioning of the IM is unique because, in general, microbiology institutes are placed, for historical reasons and belonging to specific institutions, exclusively on environmental, medical or veterinary topics. This peculiarity, combined with the fact that there is no reference institute at the Swiss level for the microbiology of the built environment, is considered an important factor of competitiveness and development for the future activities of the IM within the DACD not only at the regional but also at the national level.

¹ <https://followtheoutbreak.wordpress.com/2013/10/16/opinion-do-we-need-to-induce-stress-in-the-one-health-paradigm/>

The Biosafety sector integrates the Regional Laboratory South of the Alps, LRSud. It deals with measures and procedures to protect humans, animals and the environment from biological hazards which are mainly represented by microorganisms such as viruses and bacteria. During the past years it has strengthened its activity in the detection and identification of pathogens and highly pathogenic agents (risk group 3) in environmental samples, in particular pathogens in vector organisms. In fact, the detection of arboviruses in mosquitoes represents one of the main activities of this sector in close collaboration with the Vector Ecology sector. The activity of this sector is also increasingly characterized by the validation of methods to detect human and animal pathogens (whether viral, bacterial or fungal) in environmental samples and in case of biological events (bioterrorism, pandemics, epidemics or epizootics), and by diagnostics.

The Microbial Ecology sector (ECOMIC) has evolved after the integration in SUPSI. At present the natural aquatic environment with its different river and lake ecosystems represents the main research subject of the ECOMIC sector composed of two specific areas, namely the group of "water streams ecology" and that of "microbial hydrobiology". The first one aims to understand the anthropogenic impacts on the functioning of watercourse ecosystems and biodiversity. The main purpose of the various research projects is to contribute to the conservation and management of aquatic ecosystems increasingly endangered by human actions and climate change. The second area is mainly focused on the role of microorganisms in biogeochemical cycles especially related to primary and secondary production. An important task of this area is also the coordination, support and promotion of research and teaching at the Center for Alpine Biology in Piora (www.cadagno.ch) and at the universities of Geneva and Zurich.

The Vector Ecology sector has confirmed over the years the increase in activity due to the territorial expansion of the tiger mosquito towards the north. The management aspects of monitoring and control in collaboration with the municipalities of Ticino are constantly adapted to the evolution of the particular situation thanks to the direct dialogue with the municipal technical offices and the regional civil protections, the only bodies able to act quickly on public land. There has also been a strengthening of collaboration with the Office of the Cantonal Physician for aspects of sanitary surveillance in the case of the presence of patients infected with arboviruses in urban areas of Ticino with the presence of tiger mosquitoes. Moreover, the problem has also been recognized by the Cantonal Hospital Board which is developing procedures for the management of viremic patients in the hospital environment. The evolution is positive with an excellent synergistic climate and good collaboration between the parties, so much so that the Ticino system is cited and followed as a model of the "One Health" approach at the Swiss level². The Federal Office for the Environment has mandated the IM to act as the Coordination Center of the national surveillance network of invasive exotic mosquitoes, whose system follows the model of the national network of regional biosafety laboratories for an optimal coverage of the territory and the development of a unitary system of information, monitoring and control at the Swiss level on the Ticino model. In 2019, the three-year phase of construction and commissioning of the network composed of the regional stations of Zurich (Stadt ZH), Basel (Swiss TPH), Lausanne (UNIL) and Ticino (LMA_SUPSI) was concluded and in 2020 the assignment was reconfirmed for another 3 years for the management of the national network including also the national monitoring project of the main North-South and East-West transit routes. In addition to the management of the national coordination, the Vector ecology sector has service contracts with several cantons for the management of invasive mosquitoes.

The Hygiene and Environment sector deals with the characterization of organisms isolated from different environments by methods of classical microbiology, molecular biology and proteomics. The application of MALDI-TOF mass spectrometry for the identification and typing of microorganisms, which in 2008 was introduced in Ticino by the then ICM as the first Institute of microbiological diagnostics in Switzerland, represents a specific competence that places the IM as a service laboratory for SUPSI and for external applicants at the national level. Methodologies related to genomics, transcriptomics and proteomics are also afferent to this sector, which since 2018 have

² Zinsstag, J., Schelling, E., Waltner-Toews, D., Whittaker, M., Tanner, M. One Health: The added value of integrated health approaches Vol.(CABI, 2015), ISBN 978-1-78064-341-0

been implemented and have become routine in diagnostics and at the service of research projects. In recent years, research has focused on antibiotic resistance in the environmental field, phenotypic and genotypic identifications and typings of microorganisms pathogenic to humans, animals or plants and environmental microorganisms. Fingerprinting methods are applied in different fields such as characterization of microorganisms, epidemiology and molecular epidemiology, environmental monitoring and study of natural microbial population dynamics. Many of the methodologies developed within this research task have become integral parts of the Biosafety, Microbial Ecology, and Vector Ecology tasks for projects and service mandates (MALDI-TOF mass spectrometry, molecular methods of genomics and transcriptomics, flow cytometry, etc.). In the field of microbiology, the high rate of renewal of analytical methods and the rapid evolution of the technique impose the need to have an area of research and development that allows constant updating and validation of new methods to ensure the maintenance of a high level of quality of service offered. A further area of this sector, in synergy with Microbial Ecology and Environmental Biotechnology, deals with projects related to the conservation and restoration of cultural heritage (identification and characterization of biodeteriogenic microorganisms and research of innovative technologies for the treatment and elimination of biological patinas with a green environmentally friendly and sustainable approach).

The Environmental Biotechnology Sector develops and studies processes for the transformation of biomass into biogas and for the treatment of wastewater for the removal of nutrients and contaminants. The research focuses on projects applied in close relationship with public and private operators to support companies in the area. Main aim is the development and optimization of biogas production systems and removal of contaminants and micropollutants in wastewater treatment processes. The totality of the projects in this sector is financed by third parties and many are carried out in synergy with the Hygiene and Environment sector. The technical skills of the researchers active in this area represent a great potential for IM and its development toward the microbiology of the built environment and plant engineering.

2.3. The development of research quality over the last 7 years

Several indicators reported in the annex "SUPSI research quality indicators" and in chapter 3.2. provide interesting insights into the development of research quality since the last audit in 2016. In fact, thanks to the growth in the number of scientific collaborators with different disciplinary expertise, it has been possible to acquire major projects with a size of more than 200,000 CHF including some funded by the SNSF and Innosuisse. The very number of projects with funding over 50,000.- CHF has significantly increased and has risen from about ten to over 20.

Consequently, the volume of funding has also increased from about 50,000 CHF/year in 2014 to over 1,000,000 CHF in 2021. These figures, although quantitative, attest to the recognition of the scientific quality of IM projects by the main national funding bodies (SNSF and Innosuisse) and the reputation that IM has been able to gain.

Globally the percentage of successful proposals was very high (ca. 87%) during the last 4 years. At the same time, external scientific cooperation at the national level has increased very markedly in the past 4 years, from 23 to 62. In the same period, participation in national scientific networks has also almost quadrupled from 11 to 38. These figures attest to the recognition and reputation gained by peers at the national level. At the international level we also observe the same trend, and participations in international scientific networks increased from 0 to 9 during the period mentioned above.

The production of scientific publications remained at a good level, which, however, was affected between 2020 and 2021 by the consequences of the pandemic that did not allow the completion of all planned projects and consequently the related scientific publications. During the first half of 2022, however, almost the same number of publications have already been published as in all of 2021, demonstrating a high rate of published articles in peer-reviewed journals is steadily increasing.

Also noteworthy is the increase in scientific presentations at conferences and scientific events, which increased from 21 to 34 between 2018 and 2021, concurrent with the increase in participation in national and international scientific networks.

Also very important is the development of regional projects and cooperations where their number has tripled (from 11 to 32) in the last 4 years.

All these indicators suggest an important development in the quality of the IM research.

3. Development and objectives of the research

3.1. Research pursues defined objectives consistent with the strategic planning of research and the School.

The research and service activity of IM fully pursues coherently the strategic objectives of SUPSI, particularly in terms of applied research and transfer of knowledge to the regional and national context. Regarding the 8 research axis of SUPSI (see: <http://www.supsi.ch/home/ricerca/assi-di-ricerca.html>) IM has a substantial impact in the frame of the axis 1 (Ambiente costruito, risorse naturali e sicurezza) and 6 (Sistemi sociali e salute pubblica), giving an alternative and interesting contribution to the fields of Built Environment and Biosafety.

The main activity of IM is centered on providing services for the Administration of Canton Ticino in the topic of Biosafety, Vector surveillance and vector borne diseases, Environmental microbiology, and Education. In Hygiene and environment the task "Typing and identification" is a horizontal task in support of the other units, is also financed by the Canton in order to support the continuous evolution of microbiological techniques with the constant inclusion of new methods. Moreover, beside the services to the authorities, the majority of our projects deal with applied aspects in the frame of our competences for private or public customers.

On the other hand, thanks to the possibility to enroll Master and PhD students there is also a constant input of new techniques which are then implemented in applied projects.

During the first 8 years within SUPSI, the IM developed a tight interdepartmental collaboration with the Institute of Mechanical Engineering and Materials Technology (MEMTi) at the Department of Technology and Innovation (DTI) and intradepartmental collaborations with the Institute of design (Istituto di design, IDe), as well as with the Institute of earth sciences (Istituto scienze della terra, IST).

3.2. The research is based on national and international, in particular European, criteria.

As previously explained, the IM brings with it knowledge and experience acquired during up to 30 years of activity as part of the Cantonal Institute of Microbiology. The majority of our staff has a PhD degree with specific competences recognized nationally and internationally by regular scientific publications in peer reviewed journals (see annex 9: List of the scientific publications, 2014-2022) and by their net of national and international collaborations. Moreover, the PhD projects developed within the IM are subjected to the rules of the corresponding Universities.

3.3. Targets are planned and regularly monitored.

In general, the topics covered by IM match with the tasks listed in the convention between Canton Ticino and IM: Biosafety, Vectors of pathogens, Identification/typing and Environmental microbiology. The convention covered the period from 2014 to 2021 and has been partially adapted following the needs of the Cantonal Administration. In December 2021 the convention has been prolonged until 2024.

The activity and the objectives of IM are constantly monitored and controlled by two permanent committees: from the SUPSI side, the IM Steering Committee supervising constantly the overall activity, including financial evolution of IM, and from the cantonal side the Control Board (Gruppo di

verifica del mandato IM-SUPSI) supervising yearly the activities directly related to the tasks listed in the signed convention.

In addition, starting in 2020, the figure of the senior adviser has been introduced in the organizational chart with, among others, the task of evaluating and monitoring the scientific objectives of the IM.

Within this frame, the basic research, carried out in the context of Master and PhD projects as well as in specific applied projects, completes in a synergetic way the main service activity for the Canton. Each project is led by a researcher and the ongoing projects are regularly discussed and evaluated within the group during the weekly meetings. Each researcher is responsible for the conduction of its projects. Related to this organization, some problems arise due to the part-time employment of several researchers who have to cover a quite high number of analyses and projects.

3.4. Sustainable development criteria have been integrated into the design of new projects.

To create a culture and community of sustainable development at SUPSI, a sustainable impact program promotes initiatives and engagement by students and staff. It supports student projects, teaching and research projects, and young entrepreneurs whose ideas contribute to achieving the Sustainable Development Goals (SDGs) of the United Nations.

(see https://www.supsi.ch/home_en/supsi/sostenibilita.html)

We conduct research in the field of sustainable development, and we educate and prepare our students to shape the present and the future in a way that will enable future generations to face social, economic and ecological challenges in a responsible and reflective manner.

In our field of research of the 17 SDGs the following were especially considered in the past 4 years:

- Ensure healthy lives and promote well-being at all ages (SDG nr.3), in 48% of the research projects.
- Ensure availability and sustainable management of water and sanitation for all (SDG nr.6), in 16% of the research projects.
- Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation (SDG nr.9), in 11% of the research projects.
- Make cities and human settlements inclusive, safe, resilient and sustainable (SDG nr.11), in 29% of the research projects.
- Take urgent action to combat climate change and its impact (SDG nr.13), in 20% of the research projects.
- Conserve and sustainably use the oceans, seas and marine resources for sustainable development (SDG nr.14), in 2% of the research projects.
- Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss (SDG nr.15), in 14 % of the research projects.
- Include partnerships at the global, regional, national, and local levels (SDG nr.17), in 20 % of the research projects.

3.5. Participation in scientific networks and interdisciplinary projects is verified.

We focus our research activities on the goals of the projects, most of which involve interdisciplinarity. The best possible partners are sought in order to ensure the presence of the most experienced experts from different fields in the research teams.

3.6. Equal opportunities for gender and diversity are ensured by favouring mixed groups (see annex 5: Gender and Diversity: SUPSI Checklist)³

At the end of 2021, 27 of the 45 collaborators were females. They are professionally active at each level of the IM organigram. Moreover 4 of the 5 sectors of the IM are led by women. We can therefore affirm that the equal opportunity employment is guaranteed.

4. Internal organisation and quality management measures

4.1. The unit is organised consistently with the organisation of the School.

IM is basically organized in sections defined by the Cantonal mandate and analogue to the organization of other Institutes of the DACD. Every section is led by one or two responsible researchers. The activities and responsibilities are well defined within IM, with project leaders, a detailed planning and a clear budget for each project. If an external know-how is required, this is generally searched within the DACD or other departments of SUPSI or outside the SUPSI at national or international level.

The Directory Board (DB) of IM meets once every 4 weeks for a few hours or in extraordinary meetings if needed. All the decisions concerning staff, finances, project management and in general the running of the laboratory are discussed between the director of the IM, the DB, and, if needed, the DACD director. The employment of collaborators follows the directives of the human resources services of SUPSI and DACD.

The internal scientific organization of the disciplinary unit is the responsibility of the unit itself and is approved by the Department Directorate. The head of the Institute is a professor who is an active member of the Department Directorate with the scientific and management skills to structure and conduct the activity and development of the disciplinary unit in consultation with the Department Director.

The IM is organized according to its institutional mandates, with 5 main areas of applied research, "Biosafety", "Microbial Ecology", "Vector Ecology", "Hygiene and Environment" and "Environmental Biotechnology". (See Fig. 2, Strategic Areas of the Microbiology Institute).

Each sector is led by its own manager - generally a teacher-researcher/senior researcher - who, in consultation with the Institute director, plans activities, manages internal resources, monitors quality and financial objectives. Consistent with the organizational structure of the Department, in order to promote the professional growth and personal motivation of employees, the institute implements processes of progressive delegation of roles and responsibilities to its researchers, teacher-researchers, scientific collaborators and PhD students/assistants.

³ For more information see "Recommendations for a culture of equal opportunities, Bern 2012, pages 12-13.

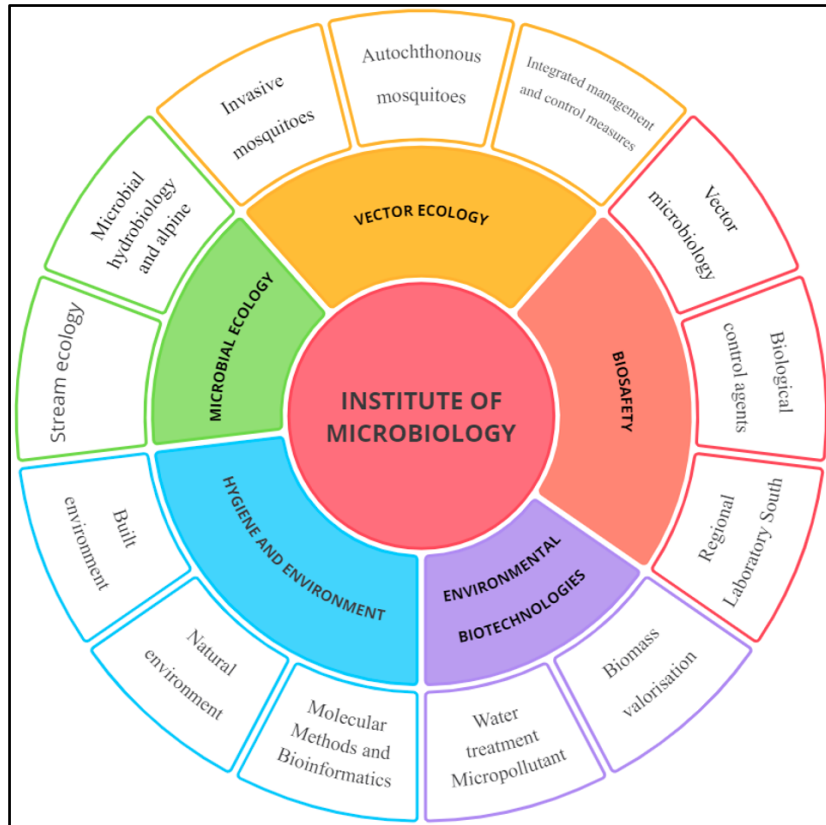


Fig.2: Strategic areas of the Institute of Microbiology.

The IM currently employs 43 collaborators (corresponding to 35.05 full-time units, status 1.1.2022) including professors, senior researchers, researchers-faculty, scientific and administrative collaborators, doctoral students and assistants (see attachment, "Collaborators on staff").

The IM is staffed with collaborators with expertise in broad areas of biology, chemistry, biochemistry, microbiology, engineering, and bioinformatics. The Institute's multiple specializations will allow for the optimal combination and dialogue of methodological sensibilities and approaches to address complex projects of an inherently interdisciplinary nature. The wide and diversified disciplinary spectrum of the Institute's collaborators is at the basis of the intense transversal collaborations between the different fields of activity of the Laboratory and the internal and external partners of DACD and SUPSI.

The academic qualifications of the Institute's collaborators mainly correspond to a high university education: of the 43 collaborators in the workforce at the beginning of 2022, 14 have a PhD, 22 have a university degree (3 BSc and 19 MSc), and 2 collaborators have other professional training diplomas (Table 2).

The significant increase in headcount over the last 3-4 years can be attributed to the implementation of a staff recruitment policy consistent with a gradual transition from Service Laboratory to Research Institute. With this strategic goal identified at the 2016 PVRS in mind, it is intended to continue in future years with the policy pursued in the past, whereby significant hires were made to include bioinformatics for genomics, metagenomics, transcriptomics and metatranscriptomics analyses, the aquatic fungi ecology topic, and MALDI-TOF mass spectrometry analysis among the expertise of scientific collaborators active in the IM. Thanks to the task "organism identifications/typing" in the last years it has been possible to increase the capacity of the IM in the field of "Next Generation Sequencing" (NGS) that allows mainly genomics and transcriptomics analysis. However, the increase in this fundamental subject has also highlighted the need for personnel qualified in bioinformatics analysis to be able to make the most of the data produced by NGS analysis. In addition, the Institute's intention to implement additional expertise in virology for future projects and analyses will require recruitment of specialists in this field. Finally, the IM management intends to

promote the professional development of its investigators and to continue the policy of appointing area managers to senior researchers.

Tab. 2: Composition by number (units and FTE) and functions of IM employees as of 1.1.2022

Function	Nr. Of Units	FTE, full time equivalent
SUPSI Professor	1	100%
Researcher-Teacher	2	180%
Senior Researcher-Teacher	1	100%
Senior Researcher	4	300%
Researcher	9	790%
Scientific Collaborator	16	1200%
Students BSc. (1), MSc (1) and/or PhD (3)	5	500%
Apprentice	3	300%
Administrative Collaborator	2	35%
Total	43	3505%

4.2. The structure has sufficient financial resources, secured on a long-term basis, to pursue its general objectives.

Each section has its own budget and is required to keep an economic sustainability which is controlled and updated by the DB four times a year (see annex 8: “List of research projects, 2014-2022”).

Summarizing the research and service projects carried out at IM, we see that 53% of them have or had a budget smaller than 50 kCHF, 23% a budget between 50 and 200 kCHF and 23% a budget higher than 200 kCHF (see table below).

	< 50 kCHF	50-200 kCHF	>200 kCHF
research	29	12	10
service	1	1	3

Analyzing the duration of the considered projects, 30.0% of them have a duration of less than 1 year, 45% last between 2 and 3 years and 25% (Cantonal mandate included) last for more than 3 years (see table below) .

	< 1 year	2-3 years	>3 years
research	17	24	10
service	0	1	4

The Cantonal mandate assures to IM a self-financing of nearly 40%. During the year 2021 the Canton decided to continue to support the task “Identification and typing” with the motivation of keeping up-to-date with modern microbiology methods and techniques. In fact, this task supports several running projects. and it is the link that connects between them all other tasks, as indicated by the following examples. The identification and typing of pathogens in environmental samples is a duty of the section “Biosafety” but this assignment can be expanded only by the support of “Identification and typing”; the identification of organisms and the molecular and proteomic typing of biological samples, insects included, belong to the “Ecology of vectors” section and is strongly supported by the analysis developed in the frame of the “Identification and typing” section; finally, the detection of antibiotic

resistance genes and antibiotic resistant bacteria in the environment directly concern this section but is linked to the “Microbial Ecology” section. It is therefore evident that the duty of “Identification and typing” is of utmost importance for the functioning of all the tasks that IM is called to carry out. Moreover, topics such as antibiotic resistance and vector-borne viruses, that are included in this section, are now more and more of public interest and there is therefore the opportunity to convert this activity into a service for the Cantonal Offices without additional costs. Such proposal has already been accepted by the Cantonal Administration and is currently part of the Cantonal mandate 2022-2024.

It is a matter of fact that in general the obtaining of financing for “big” and long-term projects from SNF or Innosuisse is very challenging for IM, and a special effort has to be made in the future for increasing this kind of financing sources.

SUPSI has planned investments in Microbial Ecology, Vector Ecology and Environmental Biotechnology that have been realized in 2021 through the construction of new infrastructures at the new campus in Mendrisio for an amount of about 2 Mio CHF. These investments have been included in the logistic budget of the construction of the new Mendrisio campus.

The Financial Development Plan for the Institute of Microbiology is summarized in Table 3 and presents a comparison between the 2015-2021 final accounts, the 2022 budget, and the financial budget regarding revenues for the years 2023-2024 (PSF2023-2024). This analysis focuses specifically on revenues already secured and those in the process of being secured for the research and services mandates.

C2021 shows compared to C2020 an increase in revenues of over CHF 900'000.- and an increase in costs of approximately CHF 600,000.- and reflects major changes in the IM structure in mid-2021. The integration of the BET unit coming from the DTI has brought higher revenues for about CHF 350'000.- while the increase in revenues from third parties for research projects already confirmed in the other sectors is quantified in CHF 250'000.-, in addition to about CHF 280'000.- of projects in the process of acquisition.

Tab. 3. Research and service funding; final C2015-C2021, budget P2022, and Financial Development Plan PSF2023-2024.

	C2015	C2016	C2017	C2018	C2019	C2020	C2021	P2022	PSF2023	PSF2024
Research & Services	-1'101'697	-1'584'770	-1'467'308	-1'589'694	-1'891'706	-1'868'001	-2'972'087	-2'905'833	-2'861'545	-2'891'545
Cantonal research funding	-	-111'795	-2'405	-15'000	-73'431	-44'279	-140'697	-40'000	-80'000	-85'000
CTI funding	-0	-	-14'700	-18'300	-17'000	-19'998	-178'239	-221'239	-45'000	-45'000
SNF funding	-	-	38	-20'093	-100'512	-124'339	-333'981	-136'387	-245'000	-250'000
EU european programs funding	-	-	-	-	-1'371	-8'223	-3'221	-6'853	-10'000	-10'000
Other research programs funding & Foundations	-9'781	-96'530	-97'131	-69'409	-87'478	-68'263	-78'320	-61'000	-330'000	-340'000
Other federal research funding	-30'612	-109'881	-35'116	-116'591	-200'892	-190'894	-552'218	-526'451	-235'000	-240'000
Research & Services cantonal Mandate (DSS)	-991'545	-1'231'545	-1'231'545	-1'171'545	-1'151'545	-1'181'545	-1'181'545	-1'181'545	-1'181'545	-1'181'545
Other research revenues	-3'959	10'107	-83'332	-136'468	-189'810	-209'578	-418'892	-642'358	-700'000	-700'000
Services	-65'800	-45'126	-3'117	-42'289	-69'667	-20'883	-84'974	-90'000	-35'000	-40'000

These forecasts lead to a rate of direct self-financing before overheads of 97%, in line with the positive results achieved in previous years (direct self-financing before overheads fluctuating between 84% and 103% in the years 2014-2020). For the years to come, given also the uncertainty generated by the Covid-19 emergency, a direct self-financing for IM without federal subsidies and cantonal contributions and without overhead of 80-82% is assumed as a goal, in line with previous years. Thanks to the new projects under evaluation or submitted to the financing bodies, the financial situation will not be substantially modified; it is therefore consolidated also for the coming years that do not foresee at the moment further significant structural growth, but rather the consolidation of the current situation.

4.3. Processes, competences and decision-making responsibilities are defined, adequately communicated and implemented accordingly.

The Section Heads are responsible to acquire, manage and complete research projects according to the work plans. In general, every researcher is encouraged to be active in proposing possible

research projects and in building up its own net of collaborations to open new research prospects even though in line with the themes of IM. Each proposal is discussed with the researchers of IM during the weekly meetings and if it receives the authorization of the DB, the project proposal can be written following a defined scheme comprising a detailed description, work packages and responsible persons, time plan and costs evaluation, as well as a confirmation of the budget and a signed contract with the partner. Afterwards a new project code can be assigned according to SUPSI rules and the project can start. Nevertheless, a well-defined and clear procedure using standardized forms is already in place in SUPSI from the outline of each new project till the closing process.

IM does not have a dedicated code for charging the hours of work for writing new project proposals. The time needed for this purpose as well as for other administrative tasks is therefore deduced from the current projects. As a consequence and in order to not affect the time dedicated to the project's leadership of ongoing tasks, the time left to design new projects is very little, in particular for those working part-time (5 researchers with a PhD degree out of 8). This situation is perceived as penalizing in particular when dealing with big projects as those for SNSF or Innosuisse which demand great efforts, and rather leads to the implementation of smaller projects.

The Quality System of the IM is organized taking into account the requirements of the Federal Ordinance concerning Microbiology Laboratories. It regulates the processes and ensures the reliability and traceability of the work. The quality system describes and covers the activities of the laboratory from the scientific-technical as well as from the management point of view. All quality system documents are accessible to all personnel and are constantly updated. The Quality Management System Manager and IM Manager prepare an annual report on the status of the system.

In order to guarantee a consistent and constant application of the procedures established by the quality management system, a quality manual has been drawn up which contains all the indications for compliance with the quality directives. All IM employees are required to comply with the provisions set forth in the quality manual in the course of their daily activities.

The quality policy of the IM is aimed at achieving the following main objectives:

- perform microbiological analyses according to validated analytical methods and according to user requirements;
- to satisfy the explicit and implicit needs of its users with regard to the quality and reliability of its services, and the respect of the budgeted time;
- confirm and maintain the reputation of the IM in the quality of analytical services, knowledge and scientific expertise;
- have a team of specialists ready to provide users with a guarantee of precision, dynamism and professionalism;
- prevent the occurrence of inefficiencies and non-conformities;
- operate in compliance with this standard and with all legal requirements in force in the area where it operates.

It should also be noted that in addition to the PVRS, in the last 5 years the IM has also undergone another quality verification procedure that involves improvement measures in the management of the quality system. In 2017, the IM applied to Swissmedic for authorization to conduct microbiological analyses for pathogens in environmental samples, which involves an inspection by Swissmedic itself to verify that the conditions for conducting the analyses are given.

The inspection by Swissmedic in 2018 was mainly oriented to the verification of the IM facilities, the preparation of the personnel, the organization, the quality management system and its effective implementation, the equipment and the IT systems available to carry out the complex microbiological analyses of samples containing pathogens. Following this inspection, a plan of measures was set up to address the recommendations raised during the Swissmedic visit. Improvement measures were introduced to ensure the traceability of the analyses carried out, the reporting of any non-conformities, the way in which validation studies are carried out, the introduction of external quality

controls, the maintenance of the equipment and finally the processing and protection of data. The introduction of these improvement measures made it possible to maintain the authorization issued by Swissmedic on 13.2.2017 until the next inspection.

4.4. Researchers are involved in decision-making processes in a regulated manner.

During the Directory Board and the Group Meetings technical and strategic issues of the Laboratory are discussed and decisions are taken considering the opinion of the collaborators.

No strict regulated decision-making processes are at the moment in place, nevertheless during 2016 IM introduced the quality system and got the Swissmedic authorization for laboratories performing analysis to detect the presence of a pathogens in environmental samples, analogue to ISO/IEC 17025 accreditation system with well-defined procedures for the management of the diagnostic part of our activity. Even if each collaborator is strongly involved in her/his projects or topic she/he is anyway continuously informed about the evolution of the strategies of the Institute. This promotes a positive working ambiance and maintains a high scientific and social cohesion within the group.

In general, quality control is entrusted to a quality manager and to the Directory Board, DB, of the IM, formed by the sector managers, which meets regularly every three weeks and provides for extraordinary meetings when necessary. All decisions concerning staff, finances, project management and in general that of the Institute itself are discussed among the Institute and sector managers and, if necessary, with the director of the DACD.

4.5. The quality of the research is checked regularly. The results are used to further improve organisational processes, project management and the services offered to partners.

The monitoring of the quality, effectiveness and efficiency, impact and relevance of IM activities is a constant and cyclical process, implemented by the head of the Institute jointly with the heads of sector that is based on three main pillars:

- the quality management system according to ISO/IEC 17025 standards;
- the procedures for verification and evaluation of quality;
- the satisfaction of partners and stakeholders in the performance of research projects and services.

The master criterion for judging the quality of the service and research activities carried out at IM is the satisfaction of the partners involved in the different projects.

Our major partner is the Cantonal Administration for which every year an annual report is prepared, submitted to the Steering Committee of IM-SUPSI and evaluated by the Cantonal Committee supervising the activity of IM (Gruppo di verifica del mandato IM-SUPSI). The evaluation report of this Committee is finally sent to the Governing Council (Consiglio di Stato) of Canton Ticino (see: - IM - rapporto di verifica del mandato 2014 - 20.03.15 and IM - rapporto di verifica del mandato 2015 - 29.03.16).

For projects involving other institutions the quality is measured by their trust in our work and our reputation expressed by assigning regularly continuations of ongoing projects or new ones.

The quality of the research is primarily measured by the number of the published scientific articles in peer reviewed journals, and in this concern IM has a quite remarkable list of publications (see: List of the scientific publications), On the other hand, IM regularly forms Bachelor, Master and PhD students which are externally evaluated by Swiss and Italian Universities. These researches often lead to scientific papers.

4.6. A quality assurance manager is defined.

Annapaola Caminada according to the quality system of IM has been designed as the quality assurance manager of the IM (see also Organigram).

Moreover, the centralization of the quality assurance at the level of DACD is foreseen, but not yet implemented.

5. Research, development and knowledge transfer

5.1. The research develops topics using methodologies corresponding to national and international standards.

The field of microbiology is continuously changing especially regarding methods and techniques employed and it is of paramount importance to be always updated using the new technologies. During the past years IM has developed competencies in identification and typing of microorganisms always applying modern techniques. In this context the tight collaboration with the diagnostic microbiology of the Hospitals of Canton Ticino (Servizio Microbiologia Ente Ospedaliero Cantonale, EOC) located in the same building helps in staying updated with the technologies specifically developed for this field. On the other hand the research projects developed during the PhD Theses at IM allow introducing new methods coming from the basic research fields, moreover the collaboration nets built for tutoring the PhD students composed of specialists from different fields force IM to stay updated with both the new technologies and topics.

5.2. The necessary long-term resources are secured for research funding.

Thanks to the Cantonal mandate the necessary funding for the IM core activities has been recently assured until 2024 with only a reduction in the contribution for "Identifications/typification" from CHF 300'000.- to CHF 180'000.- justified by the fact that the Canton does not participate in the financing of research projects but only supports the activity of updating microbiological techniques and databases for the identification of microorganisms. Moreover, IM can continue to provide its help for the very topical health problems such as viruses and antibiotic resistances, only with the cantonal support.

Applied research projects are financed by different public and private institutions but they last generally 1 or 2 years (see annex 8: List of research projects, 2014-2022).

As of 2014, most of the newly acquired projects are financially supported by regional, national and European public entities, mainly public administrations (federal, cantonal and municipal) and - during the last 4 years - competitive research funding agencies (SNSF, Innosuisse, WHO, ...).

This progressive diversification of funding sources desired since the integration of the IM into SUPSI has led to a steady growth in the percentage of Third-Party Entities sources. In 2014, funding from Third Party Entities with a 7% share accounted for a very limited portion of IM revenues. After a couple of years of settling and redefinition of research objectives it was possible, thanks to the submission of innovative projects to several competitive calls, to change this trend in the following years, steadily increasing the acquisition of funds from third parties to reach almost 60% in 2021 (see fig. 3).

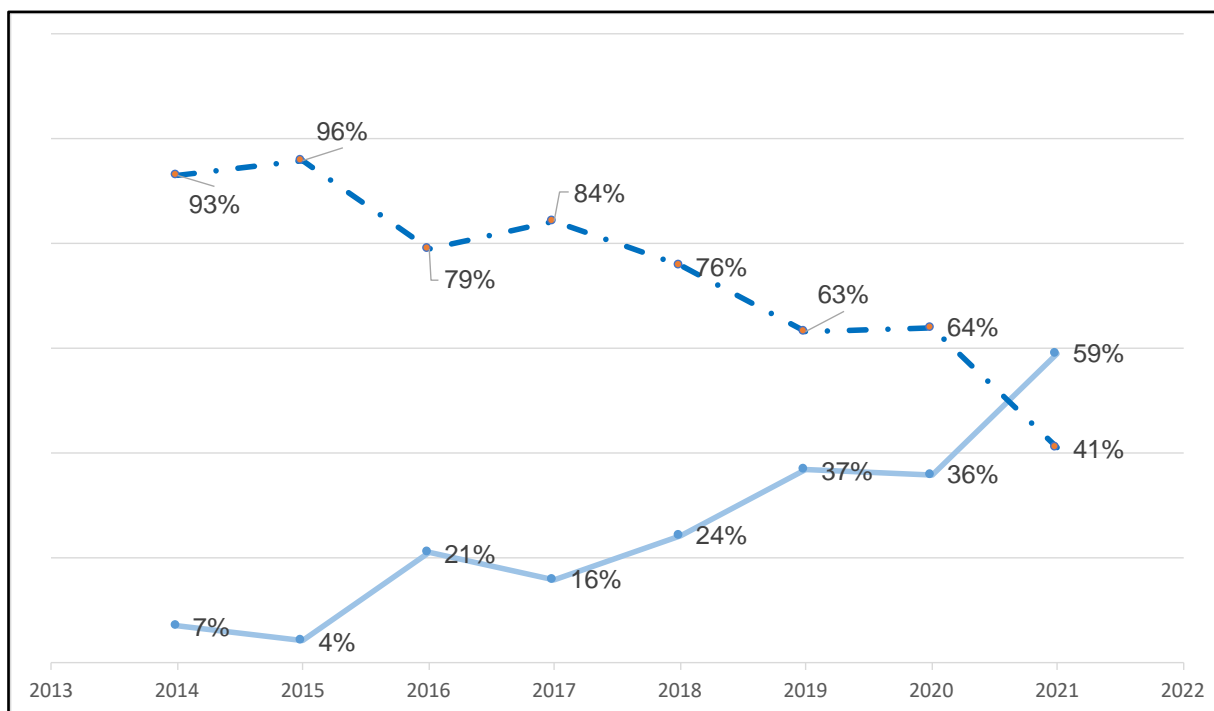


Fig. 3. Trend in the percentage of funding sources from the DSS cantonal research and services mandate (dotted line) and from Third-Party Entities (solid line), 2014-2021.

The ratio between the main sources of funding from 2020 to 2021 shows a reversal of the situation with the primacy of funding from third parties compared to the cantonal mandate and consolidating the trend towards balance and the decrease in the IM's financial dependence on the main funding of the cantonal mandate with the DSS.

The strong development of the laboratory's research activities is well detectable by the progressive and steady increase in the volume of revenues since 2014, mainly during the last 3 years (see Table 4).

Tab. 4. Trends in research revenues and self-funding (2014-2021).

Research	2014	2015	2016	2017	2018	2019	2020	2021	P2022									
	-1'062'497	-1'035'897	-1'559'858	-1'464'191	-1547405.44	-1'822'039	-1'847'118	-2'887'112	-2'815'833									
Cantonal research funding	-	0%	-111'795	7%	-2'405	0%	-15'000	1%	-73'431	4%	-44'279	2%	-140'697	5%	-40'000	1%		
Research & Services Cantonal Mandate (DSS)	-991'545	93%	-991'545	96%	-1'231'545	79%	-1'231'545	84%	-1'171'545	76%	-1'151'545	63%	-1'181'545	64%	-1'181'545	41%	-1'181'545	42%
CTI funding	-27'000	3%	-	0%	-	0%	-14'700	1%	-18'300	1%	-17'000	1%	-19'998	1%	-178'239	6%	-221'239	8%
SNF funding	-	0%	-	0%	-	0%	38	0%	-20'093	1%	-100'512	6%	-124'339	7%	-333'981	12%	-136'387	5%
Other federal research funding	-23'300	2%	-30'612	3%	-109'881	7%	-35'116	2%	-116'591	8%	-200'892	11%	-190'894	10%	-552'218	19%	-526'451	19%
EU european programs funding	-	0%	-	0%	-	0%	-	0%	-	0%	-1'371	0%	-8'223	0%	-3'221	0%	-6'853	0%
Other research programs funding & Foundatio	-1'300	0%	-9'781	1%	-96'530	6%	-97'131	7%	-69'409	4%	-87'478	5%	-68'263	4%	-78'320	3%	-61'000	2%
Other research revenues	-19'352	2%	-3'959	0%	-10'107	1%	-83'332	6%	-136'468	9%	-189'810	10%	-209'578	11%	-418'892	15%	-642'358	23%

In particular, the progression has been significant in contributions from national and/or federal entities, which in 2014 constituted 5% of the total, while today they represent a share of 37%, increasing from 50,000 CHF/year to over 1,064,000 CHF/year. This increase is a clear sign of the recognition of scientific competence at the national level, where the reputation of the IM is now consolidated in its specific fields of expertise, such as the fight against vectors of infectious diseases, biosafety, diagnostics.

The percentage breakdown of the contribution of the various mandates is shown in fig. 4.

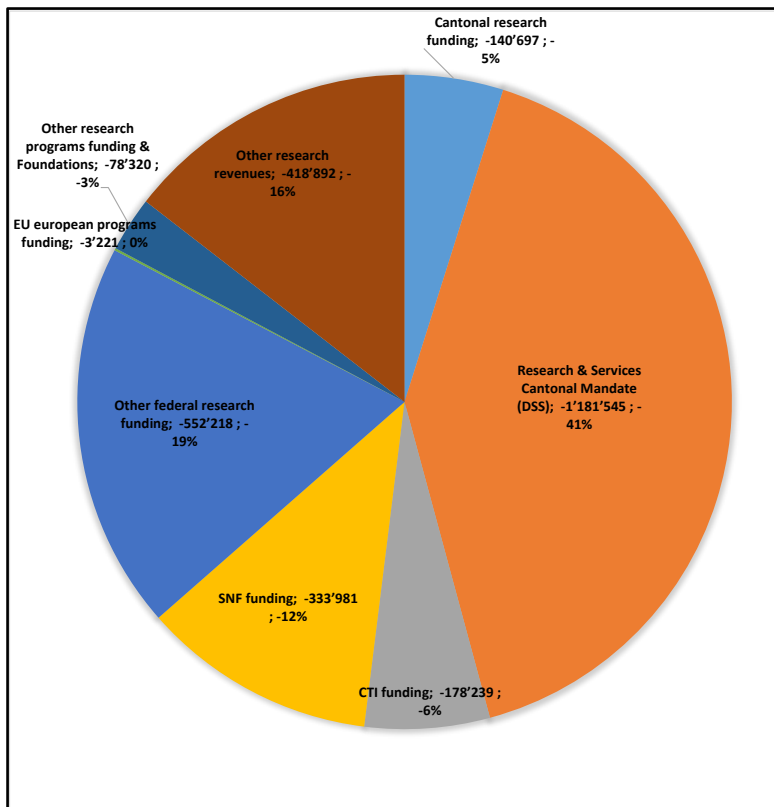


Fig. 4: Breakdown of funding sources on revenues acquired during 2021

5.3. The research is developed in collaboration with private and public bodies and organisations in the area and with other university structures.

The external collaborations are very important. They allow us to promote synergies, to increase our knowledge and enhance our possibilities to acquire innovative research projects.

The activities of the IM in the institutional mandates of applied research, service provision, and basic and continuing education have increased significantly since its integration into SUPSI, strengthening the already strong network of collaborations at the regional, national, and international levels (for details see Annex 8, "List of research projects, 2014-2022").

Since its integration in SUPSI, particular attention has been paid to the activation of internal collaborations between DACD and SUPSI. The IM collaborates closely not only with the research activities of all the Institutes and Laboratories of its own Department (ISAAC, IMC, IST, IDe) and the majority of its degree courses (visual communication, conservation and restoration, architecture and civil engineering), but also with all the other SUPSI Departments (DEASS, DFA, DTI). In particular, we can mention the fruitful collaboration started since 2014 with the Environmental Biotechnology Laboratory (BET) that from DTI has moved to IM, the collaboration with the Institute of Systems and Applied Electronics (ISEA) for projects related to the MedTec field and for the fight against infectious disease vectors, the collaboration with the Institute of Mechanical Engineering and Materials Technology (MEMTi) for the project on the development of photocatalytic filters for the elimination of microbes from the air and recently with DEASS and USI for the Swiss project, launched by the Swiss School of Public Health (SSPH⁺), Corona-Immunitas for the analysis of antibodies against the SARS-CoV-2 virus in selected groups of the population of Ticino.

At the **regional level**, thanks to its origin as part of a cantonal institute, the IM has built a strong and continuous link with its reference territory, maintaining close collaborations with many services of the cantonal administration, such as the cantonal medical and veterinary offices, the public health office, etc. In addition, the IM has ensured the coordination, advice and scientific help, as well as logistical

and organizational support, for the activities carried out at the CBA as provided in Task 2 of the agreement between the Canton and SUPSI for the IM.

The cohabitation with the EOC, in the same building in Bellinzona, leads to a close collaboration between the IM and the Service of Clinical Microbiology, SMIC, for the use of common spaces (laboratories BSL2 and Biosafety Laboratory BSL3) and for the use of analytical equipment (MALDI-TOF mass spectrometers, PCR and real-time PCR equipment, sequencers, etc.). This cooperation has led to a progressive synergy that has resulted in the acquisition of joint projects concerning, for example, the identification of mycobacteria or the problem of Legionellae.

In particular the management of the LR Sud leads to a close interaction with the EOC, the Cantonal Office of Environmental and Soil Risk Management, UGRAS, the fire department of Ticino and the cantonal police.

In the context of the fight against vectors of infectious diseases, where many actors are involved at the regional level, since 2016 the IM has taken the leadership in the management and coordination of the Working Group Mosquitoes in the surveillance and containment of the spread of tiger mosquitoes on the cantonal territory, which involves the coordination of many public and para-public bodies. In this context the IM collaborates in fact with the cantonal authorities represented mainly by the Office of Public Health and the Office of Environmental and Soil Risk Management, the civil protection, the cantonal police, the regional antennas of WSL and Agroscope, the Foundation of the Bolle di Magadino and more than 80 municipalities scattered throughout the cantonal territory.

Also at the **national level**, the management of the four main mandates for the Canton - biosafety, vector control of infectious diseases, typing and identification of organisms and coordination of environmental microbiology - has important consequences in terms of collaboration. These collaborations are carried out more in the field of scientific research than in the provision of services as is the case at regional level. The fulfillment of these management activities allows to enter several scientific networks on a national scale, where the IM stands out for its peculiar scientific competences and can thus participate in various applied research projects.

Through the management of the LR Sud as a laboratory for the diagnostic analysis of infectious germs of type 3-4 and the analysis of contaminated environmental samples dangerous to humans or animals, the IM participates in the Swiss network of regional laboratories, RLN created by the Federal Office of Public Health, FOPH, and interacts closely with the 6 laboratories of which it is composed and affiliated to various national scientific bodies and institutions. The research activities developed in this context have allowed the establishment of close collaborations with the Institutes of Parasitology and Virology of the University of Zurich, with the laboratory of Spiez, with the SSPH+ and with the group of functional biomaterials of the EPFL to name a few.

The fight against vectors of infectious diseases with the unstoppable expansion of the tiger mosquito north of the Alps is assuming great importance at the national level. In this area, thanks to the expertise acquired over the years, the IM has been able to profile itself optimally and in 2019 the FOEN recognized this specific competence by entrusting the IM with the task of coordinating monitoring at the national level through the direction of the National Coordination Center for the surveillance and control of invasive mosquitoes. This role implies the active collaboration with the cantonal institutions - more than 13 cantons entrust the monitoring to the IM - present in the group, the federal agencies (FOEN, SFO, EFBS) and Swiss institutes (Swiss Tropical and Public Health Institute of Basel, Institute of Parasitology University of Zurich, Laboratory of Spiez) and international institutions (World Health Organization, The Special Programme for Research and Training in Tropical Diseases, TDR) in order to coordinate all management and scientific activities.

In the field of environmental microbiology, the IM, thanks to the management of activities at the CBA, collaborates with a number of university and scientific institutions in the organization of residential university courses, seminars, conferences and research projects. The main partners in this perspective are the University of Zurich and the University of Geneva, which are also founding members of the CBA and which, thanks to specific agreements, allow the IM to participate in academic teaching and to direct doctoral and master works in the field of microbiology. After the

impulse to the university reality through the research initiated in the region of Piora by the Universities of Geneva and Zurich with the former Cantonal Institute of Microbiology, also the Università della Svizzera italiana (USI) has shown a renewed interest in the academic work carried out in Piora.

In the same context, a series of projects dealing with the ecosystems of the shores of Lake Lugano have been initiated, funded by the International Commission for the Protection of Italian-Swiss Waters (CIPAIS). The first one quantifies microplastic pollution, the second one measures degradation processes of natural organic matter, and the third one develops the conceptual framework for the planning and evaluation of bank renaturation projects.

Other major collaborations at the national level are with the Zürcher Hochschule für Angewandte Wissenschaften (ZHAW) Forschungsgruppe Ökohydrologie, Wädenswil; the EAWAG/ETHZ, Molecular Microbial Ecology, Dübendorf; and the Dept. Umweltsystemwissenschaften Oberflächengewässer, EAWAG Kastanienbaum; the Geologisches Institut ETH Zürich; the department Umweltwissenschaften of Uni Basel; the limnological station of UNI Zurich in Kilchberg, to name the main national academic partners.

Finally, in the area of Hygiene and Environment, the theme of the fight against antibiotic resistance, included in the health policy priorities "Health2020", is worth mentioning. Since 2013, the Federal Office of Public Health (FOPH) and the Federal Offices of Food Safety and Veterinary Affairs (USAV) and Agriculture (FOAG), in collaboration with the Federal Office for the Environment (FOEN) have activated a series of projects and intervention measures at multisectoral level to limit the emergence, transmission and spread of new antibiotic resistance. In 2020 and 2021, mandates were also acquired from Cantonal (SPAAS, UMC) and the Federal offices (FOPH, FOEN) for the analysis of the SARS-CoV-2 virus in environmental samples.

At the **international level**, the Laboratory has promoted and established an important network of collaborations with academic institutions and non-profit organizations related to the main topics of interest for the Institute. In the field of organism typing by MALDI-TOF mass spectrometry, active collaboration continued with the French company bioMérieux for the analysis of strains of bacterial and fungal genera, and with the company Mabritec AG in Riehen (BS) for quality maintenance and implementation of the various databases (including species-level identification of mosquito eggs).

In the field of biosafety, thanks to a project carried out in collaboration with other SUPSI institutes (ISEA, ISIN), the IM currently collaborates with regional (BH Suisse) and European partners such as LDT Design (York, England) GRINN (Poland) and ABAMobile (Spain).

The environmental microbiology sector, especially thanks to the research on the Cadagno Lake and the effective collaboration with the CBA, has brought together several Swiss researchers from the Universities of Bern, Lausanne, Neuchâtel and Geneva, the Swiss Federal Institute of Technology Zurich, ETHZ and the Federal Institute for Aquatic Science and Technology (EAWAG) and foreign researchers such as the National University of Australia in Canberra and the University of Luxembourg. Recently, a project was funded by the SNSF with IM as the first applicant, to study bioconvection (stirring of water by motile microorganisms), in collaboration with EAWAG and the University of Luxembourg, including a PhD student and researcher based at IM and a postdoctoral student based at EAWAG. Another SNF-funded project in collaboration with UNI Zurich, EAWAG, and UNI in Vila Velha, Brazil, which includes a PhD student based at IM, also began in 2020. This project studies the consequences of landscape depletion on small stream ecosystem communities. In the same area, a collaboration has been established with Isfahan University of Technology to develop bioindicators of Iran's streams based on invertebrate and fish communities. This project is funded through a Seed Grant from the federal Leading House South Asia and Iran and will continue into 2022 with an Iranian PhD student visiting IM for one year.

In addition to a close collaboration with the School of Biological Sciences, University of Bristol, UK on atmospheric electricity influencing microbial processes in soils and sediments (FNS Spark), some notable collaborations in the area of bacterial and hyphomycete strain determination have developed with Arabian Universities, including King Abdullah University of Science and Technology (Dr. Maged

Saad, Saudi Arabia) for a project on the determination of bacterial strains of the family Enterobacteriaceae isolated from the rhizosphere of plants adapted to dry environments.

The Hygiene and Environment sector developed a collaboration with the University of Tehran (Iran, Department of Plant Protection, Laboratory of Mycology) for the determination of the endophytic fungus of the genus *Cephalotrichum*. This resulted in a publication in the journal *Sydowia*. The collaboration led to a new joint project, submitted to the Swiss Government Excellence Scholarship for the determination of fungal populations in cheeses from alpine pastures in the southern Alps.

The BET sector is active in the biomass to energy topic exploiting the microbial metabolism to produce energy vectors such as biogas or electricity. In this research topic a national cooperation has been forged in a constructive way with ZHAW and HES-SO. Likewise, the micropollutant removal from wastewater theme is carried on in national and international cooperation: EAWAG and FHNW and with Uninsubria with a joint PhD student .

Several collaborations with Italian institutions and academics are promoted through the participation in research projects of transregional and Insubric importance, such as Regio Insubria itself, the Uni Insubria of Varese and Como, the International Commission for the Protection of Italian-Swiss Waters, CIP AIS, but also with the University of Naples in a project aimed at testing new technologies for the control of plant pests and the University of Turin in the field of lichen biodeterioration of cultural heritage in stone. Moreover, IM regularly hosts students coming from Italian Universities (University of Insubria, Varese, University of La Bicocca, Milan, University of Pisa, University of Sassari, etc.) who carry out the practical part of their Master works at IM.

5.4. Research is 'competitive' in comparison with other UASAs.

Positioning of the Institute of Microbiology in Ticino and in comparison with the Swiss UAS:

Academic teaching at the undergraduate level in Life Sciences in Ticino is limited. USI is not currently planning to create a Life Sciences curriculum although it does offer some bioengineering courses in regenerative medicine. The Institute for Research in Biomedicine, IRB, is the most accredited research center in Life Sciences in Ticino but it focuses mainly on immunology issues. From this point of view, the lines of research and teaching currently practiced in Ticino do not overlap with those proposed by SUPSI, but rather complement them.

At the national level, the environmental life sciences themes are represented in four of the Swiss UASs and their activities are centered on different themes with respect to those dealt with at SUPSI. Consequently, the research lines carried out by SUPSI have no direct competitors and represent a unicum at the national level (see Table 5). In this sense, the situation is positive and rich in prospects and opportunities, insofar as the Institute is configured in the Swiss context as a player which is well differentiated from others and capable of carving out a primary role for itself in its sectors of competence not only at a regional level, but also at a national level. This has already happened in the field of the control of vectors of infectious diseases, a sector in which, thanks to the competences acquired in the past years, the IM has assumed the leadership at the national level in the coordination of the national strategy of control of the tiger mosquito and represents for the majority of the Swiss Cantons the point of reference in the monitoring of its diffusion on the national territory.

Tab. 5: Fields of activity of UAS active in the Life Sciences sector. Berner Fachhochschule, BFH, Fachhochschule NordWest Schweiz, FHNW, Hautes écoles spécialisées de la Suisse Occidentale, HES-SO, Zürcher Hochschule, ZHAW.

SUP	Activities in the Life Sciences sector	Bachelor, Master	Main research axes
BFH	Agricultural Sciences Food Sciences	BSc, MSc BSc, MSc	Agricultural production systems, agricultural economics, agricultural development and international agriculture Sensing, agricultural economics and consumption, food processing
	Forest Sciences	BSc, MSc	Forests and Society, forest production, alpine forests and protection from natural hazards, international forest sciences
FHNW	Applied Environmental Sciences	BSc	Chemistry and bioanalytics, pharmaceutical technology, biodiagnostics
	Environmental biotechnology	MSc	Ecotoxicology, environmental biotechnology, environmental technology, water treatment, sustainable resource management
HES-SO	Agricultural Sciences Viticulture and Enology	BSc BSc, MSc	Sustainable production and environmental protection Sustainable production and environmental protection, viticulture economy
	Food Technology	BSc	Ecology and land and built environment management
	Natural Resources Management	MSc	Construction and sustainable development Landscape management
ZHAW	Biotechnology, chemistry, food science, natural resources Food Innovation	BSc MSc	Cell biology, biotechnology, new material synthesis, pharmaceutical technology, bioanalytics Food chemistry, P&E, food microbiology, food biotechnology
	Natural and Environmental Resources	MSc	Ecological Engineering, Ecosystems and Biodiversity, Agro-food systems

Life Sciences in the environmental field at SUPSI;

A number of life sciences-related activities (mainly research and services, but also some teaching) are currently ongoing within three Departments, namely the Department for Environment Constructions and Design (DACD), the Department of Business Economics, Health and Social Care (DEASS), and the Department of Innovative Technologies (DTI). However, for the enhancement of these activities there is a lack of a structure (administrative or virtual) to include and coordinate them.

The Board of Directors at SUPSI has therefore decided in 2019 to evaluate whether or not the creation of a Life Sciences (LS) structure, that would include all or at least part of the units that are involved in LS activities would be appropriate and could provide a better service to industrial and academic partners on the Cantonal and Federal territory.

Further, to define an adequate structural unit for this structure that could accommodate all partners without disrupting the present organization, at the same time leaving intact opportunities for future growth of LS within SUPSI.

This evaluation has been the subject of the work by an operational Life Science Project Working Group (LSPWG) during 2019, who was responsible for gathering the necessary documentation and all necessary activities, and preparing the evaluation needed to issue a recommendation on how to proceed to the Board of Directors at SUPSI.

The activities carried out at SUPSI in the context of Life Sciences in the environmental field are embedded in the DACD (see Table 7). The main actor in this sector is the IM to which is added the Limnology Sector of the Institute of Earth Sciences. These are joined by the Interdepartmental Competence Center for Cooperation and Development, which carries out research and teaching activities, on topics of water sanitation and hygiene in developing countries.

Tab. 6: Institutions dealing with LS in the Canton Ticino.

Institute	Activity	Collaborations with SUPSI
IRB, Bellinzona	Research in Biomedicine	DTI Institutes, IM
Agroscope, Cadenazzo	Agronomic research Phytopathology Sustainable Plant Protection Veterinary health and breeding systems Food microbiology Agroecology and environment	
WSL, Cadenazzo	Chestnut forests Protection of forest fires Invasive species, Neobiota Landscape changes	IM, on plant biodiversity
FASV/IACT	Forensic chemistry Clinical and forensic toxicology Pharmaceutical GMP	
Museo Cantonale di storia naturale, Lugano	Botany Mycology Zoology Entomology Mineralogy, Paleontology	IM identification and typing of fungi
CBA, Piora	Alpine Ecology Hydrobiology and natural history Environmental microbiology	IM, environmental microbiology
SMIC/EOC, Bellinzona	Diagnostics and clinical microbiology Biochemistry and clinical pharmacology	IM, biosafety sector
Fondazione Bolle Magadino, Magadino	Ecology Ornithology and Botany Microbiology and entomology	IM, infectious diseases vectors sector and environmental microbiology sector

At the educational level, BET lecturers have been active in the MSE (Master of Science in Engineering) since the development of the Energy and Environment profile. The lecturers have been offering both central and local modules in the topics of microbial-based processes in the wastewater treatment and remediation topics. With the integration of the BET sector in the Institute of Microbiology, the teaching activities of DACD has widened contributing to the MSE offer, sharing the IM labs facility for MSE students projects.

IM is also active in teaching in the Bachelor of Arts in Conservation and in the Master of Arts in Conservation - Restoration by SUPSI within the Swiss Conservation-Restoration Campus. At SUPSI, the students in the restoration of wall paintings, stuccoes and stone surfaces get a strong background in the field of biodeterioration. IM do mainly practical courses, laboratory and site activities to give the students the opportunity to gain practical training in sampling, characterization and identification of the main biodeteriogenic microorganisms. IM also offer formal lessons where students are helped to build a theoretical and methodological knowledge of biology applied to the conservation and restoration.

The WASH (Water Sanitation and Hygiene) competence centre has an international significance and is part of the cooperation and development projects. SUPSI is leading the Consortium for Education and Research on Water Sanitation Hygiene of the network "Swissuniversities Development and Cooperation".

Tab.7: Activities in the environmental field of life sciences at SUPSI, managers and units involved

Department	SUPSI Unit, Institute/Lab/CC	Activity sector in Life Sciences
DACD	IM Prof. M. Tonolla	<ul style="list-style-type: none"> • Biosafety, including LRSud; • Vectors of infectious diseases; • Coordination of the national tiger mosquito network; • Environmental microbiology and ecology; • Identification and typing, genomic and proteomic characterization of microorganisms • Water treatment, micropollutant removal; • Valorization of biomass through the production of biogas
DACD	IST, Limnology sector, Prof. F. Lepori	Surface water monitoring, large lakes i
DACD	CC Cooperation and development, Prof. C. Valsangiacomo	WASH: water sanitation and hygiene

The research activities are still quite diversified even though they are all centered on the microbiological theme. Moreover, the 5 sectors active in the IM have a strong value as services to the territory as they also represent the subject of the agreement between DSS and SUPSI. Also the Limnology group represents for the Canton an important reference point in the services provided through the environmental monitoring of the great lakes (Ceresio and Verbano).

Based on this analysis of the current situation of Life Sciences at SUPSI, the Working Group in charge of analyzing possible scenarios of future development formulated the proposal to create within SUPSI two new institutes dealing with Life Sciences. On the one hand, within the DTI, an institute of biomedical technologies and, on the other, at the DACD, the Institute of Microbiology as shown in fig. 5. The new Institutes became operational in mid-2021.

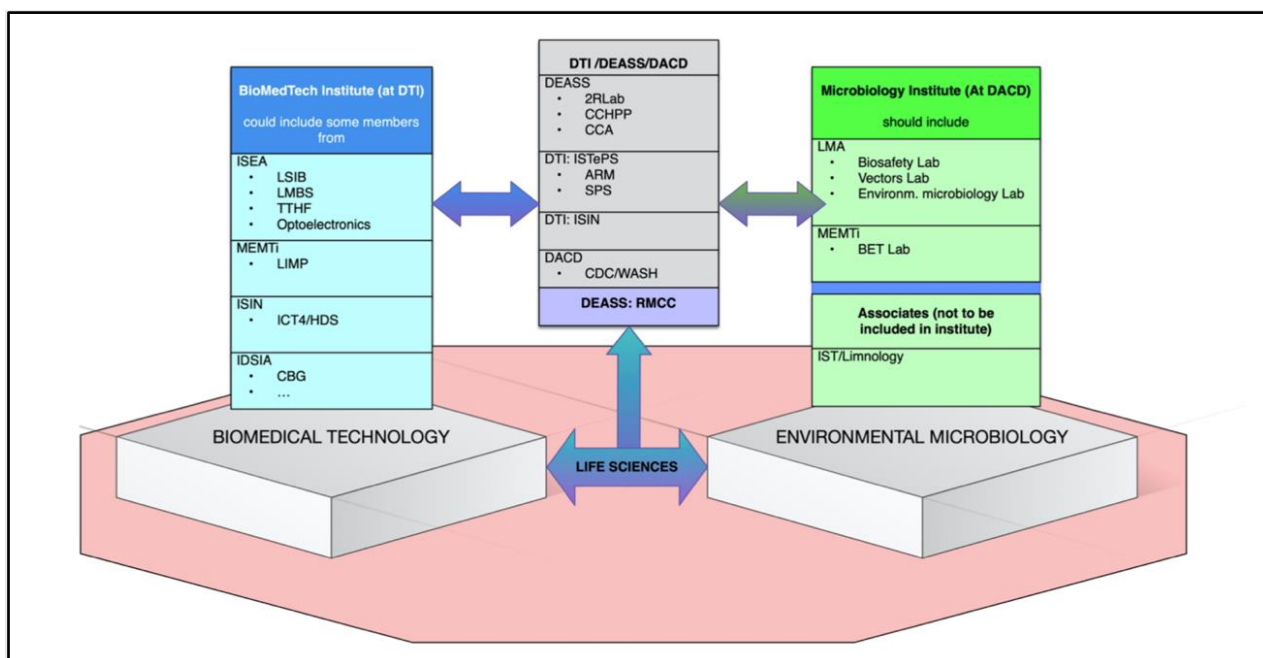


Fig.5: Life Science structure at SUPSI, based on the establishment of two new institutes. Blue box: BioMedTech Institute; Green Box: Microbiology Institute; grey box: associates/partners for ad-hoc projects

5.5. Research is oriented towards sustainable development and knowledge transfer.

In the field of microbiology every research unit is forced to stay updated and reactive to the rapid changes and the introduction of new techniques and methodologies. Thanks to the presence of Master and PhD Thesis as well as applied projects, IM tries to continuously be innovative, e.g. in proposing new approaches of applied analysis that private laboratories of microbiology cannot afford.

5.6. Innovation is monitored through appropriate evaluation tools.

The innovation at IM is monitored through the comparison with national and international microbiology institutions by keeping permanent contact with them, participating in joint projects as well as attending symposia and conferences, or organizing them. Moreover, the steering committee for IM at the SUPSI helps IM in monitoring the innovation and in taking the strategic choices.

6. Knowledge transfer

6.1. The transfer of knowledge and technology to local partners is guaranteed.

The activities and projects of IM are generally strongly linked to the region, especially the service activities for the Canton Ticino in the fields of Biosafety, vector-borne pathogens as well as the coordination of the research and educational activities at the Alpine Biology Center, Piora. In this context, and also thanks to the project BiOutils, IM started a strong enrollment in educational field building a tight bridge with the high schools of Canton Ticino. The main goal is to develop together with the teachers, laboratory experiments that can then be implemented in the schools this project runs in collaboration with the Department of education of Canton Ticino and the Department of continual education (DFA) of SUPSI. Moreover, IM organizes practical courses for the students from SPAI and SSMT where laboratory technicians and biomedical analysis technician are formed.

The surveillance and control of the tiger mosquito represents an important link with the citizens of the Canton Ticino and the Mesolcina valley (Grisons). More than 80 municipalities corresponding to about 85% of the population of Canton Ticino are involved and cooperate with the operational mosquito working group of IM in the extended monitoring and control system with the goal to keep the density of the tiger mosquito at a bearable level for keeping the risk of transmission of dangerous viruses (from imported cases coming from endemic areas) as low as possible.

Services have always represented a significant component of the Institute's activities. In fact, the service activities related to the cantonal mandate amounted at the time of the integration of the IM in SUPSI in 2014 to about two-thirds of the funding (691'500.- CHF out of 991'500.- CHF total) of the tasks deemed essential by the DSS and represented 94% of the services provided by the former LMA. The remaining 6% was generated by services to third parties. These activities have been maintained over the years on low volumes averaging around 40-50'000 CHF/year. Starting in 2019, the services included in the cantonal performance mandate with the DSS, given their nature that provides for a series of scientific evaluations that generate original results, have then been re-evaluated as research mandates, according also to the provisions of the Directive on research mandates and service mandates of SUPSI. Consequently, to date, the services defined as such represent only 2-4% of the total revenues between research and services.

The service activities were initially focused on the basis of the requests of the Canton, as the main financing body, and were made explicit in the relative convention with which the Canton itself defined the activities of cantonal interest, considered indispensable insofar as they fulfill public health and environmental knowledge tasks that cannot be renounced even in the future (management of the biosafety laboratory, monitoring and control of infectious disease vectors, investigations, expert

opinions and consultancy in environmental microbiology). Through the DSS-SUPSI convention of 2014, the Canton has therefore defined the service activities to be financed considering their interest and has established the relative financing for a total amount of 991'500.- CHF (see Tab.8). At the request of the DSS in 2016, the sector of the fight against infectious disease vectors was completely reorganized, integrating the operational tasks in the fight against the tiger mosquito, previously assumed by the Bolle di Magadino Foundation through the Operational Group tiger mosquito, GOZt. This change required an adjustment of the Convention 2014-21, ratified by the Council of State with RG 571 of February 17, 2016, and resulted in an increase in the cantonal contribution to service activities of 230'000 CHF passing to a total of 1'221'500 CHF. This integration allowed to generate synergies for related and self-financed projects, and thus to create in Ticino a national center of competence for the monitoring of invasive mosquitoes, supported by the Confederation with 60,000.- CHF per year.

Subsequently, the DSS decided to revise the subdivision of the financing of the various tasks following the evolution of the different activities. For task 4, "identification and typing of organisms", not considered by the DSS as a priority has led from 2018 to an adjustment with a first reduction of 60'000 CHF followed by a second reduction of a further 60'000 CHF for 2019. In the same year, the contribution was increased by 20'000.- CHF both for the task concerning the "Investigations and expertise in environmental microbiology" and for the "Monitoring and control of vectors of infectious diseases" attesting the total funding to 1'141'500.- CHF that the Council of State confirmed for the next four years. The reductions have been largely compensated by the increase of services for third parties.

Tab. 8: Development of the summary financial framework for the cantonal mandate to SUPSI in the field of microbiology and biosafety and distribution among the various tasks

Task	2014	2016	2018	2020
Management of the Southern Regional Laboratory, Southern LR	CHF 275'000	CHF 275'000	CHF 275'000	CHF 275'000
Investigations, surveys and consulting in environmental microbiology	CHF 290'000	CHF 290'000	CHF 290'000	CHF 310'000
Monitoring and control of infectious disease vectors	CHF 126'500	CHF 356'500	CHF 356'500	CHF 376'500
Identification and typing of organisms	CHF 300'000	CHF 300'000	CHF 240'000	CHF 180'000
Total	CHF 991'500	CHF 1'221'500	CHF 1'161'500	CHF 1'141'500

6.2. The transfer takes place through direct contacts or publications.

The transfer of knowledge is assured by direct contact for the teaching and training activity whereas reports and scientific publications are the main means of transfer for service and research activities. The researchers of IM regularly present their results in national and international symposia, through oral or poster presentations. In the past 4 years, 53 scientific papers were published and 58 oral presentations were made at national and international congresses. It was planned for the IM to organize the "Swiss microbial ecology Meeting" of the Swiss Society for Microbiology (SSM) in 2020 but unfortunately it was not possible due to the SARS-CoV-2 pandemic. However, the SVEG-Meeting (Swiss Vector Entomology Group) was successfully organized at the new SUPSI Campus in Mendrisio at the end of November 2021.

6.3. The transfer is oriented towards Open Science.

Since mid 2019 scientific articles are published Open Science.

6.4. The transfer takes place according to defined processes.

No special process is in place for the transfer of knowledge from IM to the partners. In general the transfer mode is defined by the mandates or the established contracts. Defined procedures are in place for the microbiological analyses of the regional laboratory of biosafety and have been implemented in the whole IM with the introduction of the ISO/IEC 17025 system through the Swissmedic authorisation.

6.5. Transfer and interventions are coordinated at both unit and school level.

Within the department, technology transfer is coordinated among different institutes and departmental degree programs. At the SUPSI level, coordination takes place with the institutes and degree programs of other departments.

6.6. Thanks to our innovation, other activities are developed in the area.

The IM gave in the early 2010s a crucial contribution for the implementation of the MALDI-TOF Mass Spectrometry in diagnostic microbiology laboratories; at present this technology is of central importance for the microbiology service of EOC with which we tightly collaborate.

Other examples are the routine analyses of infected fishes for the Canton (Ufficio caccia e pesca) using methods developed at IM during a PhD thesis, the creation of an educational microbiology path in the Piora region for walkers and schools fostering the outreach activities of the Alpine Biology Center Foundation, and the implementation of the surveillance system for the tiger mosquito in Switzerland.

More recently the use of aquatic fungi as indicators of the quality of natural water streams and the level of biodiversity of an aquatic ecosystem (first microbial indicator), the introduction of the SARS-CoV-2 detection methodology in wastewater, and the use of bacteria for bioconsolidation in civil engineering, architecture, and conservation and restoration can be pointed to as innovative areas of development.

6.7. The impact of research is regularly monitored through dedicated indicators.

The impact of research in the field of microbiology is measured by the number of scientific publications in ranked peer reviewed journals (see annex 9: List of the scientific publications). See research quality indicators and comment.

6.8. The management of intellectual property is regulated and addressed according to defined processes.

The dissemination of knowledge takes place through direct contacts, reports and scientific publications as well as through the presentation of results in national and international symposia. IM together with the other units of DACD and SUPSI contributes regularly with articles depicting aspects of its activity in departmental publications as well as in regional media.

See SUPSI directives

6.9. The sharing of knowledge is ensured by defined processes.

It is a rule at IM to regularly introduce current themes coming from our activities in the teaching courses at all levels, trying to keep the interest of the participants at a high level.

7. Impact on teaching

7.1. The transfer of educational research results an established practice.

Although a specific study course at bachelor or master level life science oriented is not yet offered, with the gradual increase in research volumes and academic staff, IM has been able to expand its contribution on institutional mandates related to teaching, both at basic (bachelor and master level) and continuing education. Involvement of IM staff members as faculty has focused on Bachelor of Science in Conservation, Master of Science in Engineering, MSE, Master of Science in Conservation and Restoration, and CAS Construction Management in Building and Civil Engineering.

To date the Institute offers its teaching competencies in different curricula:

Bachelor and Master level: the environmental part of the "Energy & Environment" MSE (Master of Sciences and Engineering) specialization offered at SUPSI is taught by IM lecturers. IM lecturers contribute to the SUPSI teaching with two central modules offered in Zurich and one in Lugano (Campus Viganello). To complete the study program different seminar modules and projects are taught in the lab spaces of Mendrisio campus. More than 10 students have completed the MSE study program with a thesis offered by the BET group. Since the joining of BET in the IM 4 students are tutored by IM staff member as advisor and more than 4 have attended projects in the IM labs.

Bachelor of Arts in Conservation and in the Master of Arts in Conservation – Restoration. IM is active with biology courses and Biodeterioration: analysis, treatment, evaluation courses.

Continuing education:

Biology is a rapidly evolving and progressing science. This poses a problem of adapting and updating the knowledge of science teachers and trainers. IM regularly offers courses aimed at developing and consolidating practical skills in the fields of microbiology, molecular biology, cell biology and biosafety in the laboratory for science teachers in Ticino schools. The specific topic of each course can be shaped and constructed according to the needs and curriculum of each school.

The other teaching activities have been developed in favor of a whole series of School orders at cantonal and national level.

The Microbial Ecology Group of the Microbiology Unit of the University of Geneva is integrated in the IM, allowing to carry out master and/or doctoral theses in microbiology, to organize theoretical and practical courses in collaboration with cantonal and national universities and schools, promoting academic and research synergies. The relations between IM and the University of Geneva (UNIGE) are governed by a specific convention. For this university, IM employees carry out teaching assignments in the framework of the courses "Microbiologie générale cours 13B011", biosafety "Dangers liés aux produits biologiques" and are in charge of the courses "Hydrobiologie microbienne cours 14B041 et 14B641" of "Écologie microbienne moléculaire cours 14B026" and of "Microbiologie moléculaire des milieux hydriques cours 14B053" of the University of Geneva both at the academic seat of Geneva and at the Alpine Biology Center of Piora. Furthermore IM is also an active part and member of the committees of both the doctoral school program of the "Conférence Universitaire de la Suisse Occidentale, CUSO4 and the MAS in microbiology of the University of Geneva. For this last training of 60 ECTS, LMA offers, in addition to the courses mentioned above, the possibility for the students to carry out a practical internship of 6 months in its laboratories.

Moreover, IM collaborators give ad hoc lessons at other UAS.

In collaboration with the EOC Microbiology Services, IM researchers offer courses in medical and molecular microbiology at the Cantonal Medical Technical School (SSMT: Scuola Superiore Medico-Tecnica).

IM together with the Dipartimento Formazione e Apprendimento, DFA, of SUPSI also organizes regular continuing education courses in the field of biology for high school teachers of the Canton Ticino.

Some researchers also teach molecular biology at the Scuola Professionale Artigianale e Industriale (SPAI) and collaborate with some professors at DACD in specific areas.

For an exhaustive list of the courses currently taught by the Laboratory collaborators, please refer to the attachment, "Annex 12: List of teaching courses).

8. Researchers

- 8.1. The body of researchers has adequate scientific expertise and documented qualifications.

Out of 43 collaborators at the beginning of 2022, 38 are graduated: 3 BSc, 17 MSc, 1 MedVet, 16 PhD, 0 PD PhD, 1 Prof. PhD..

- 8.2. There is a good balance of scientific expertise and practical experience in the body of researchers.

The majority of our collaborators have a PhD degree assuring a good scientific expertise and also practical experience. Given the fact that there are only two technicians, graduated co-workers are therefore greatly involved also in the lab work.

- 8.3. There is sufficient expertise among the researchers to ensure quality teaching activities.

The courses given for the University of Geneva are regularly evaluated by the automated online system ADEVEN. The MSE courses are regularly evaluated according to the SUPSI directives concerning the assurance of the teaching quality. The doctoral courses of CUSO and the specialized courses given as continuing education (MALDI-TOF MS, Mycology, ...) are generally evaluated by specific forms, whereas the courses for the SSMT Locarno and the SPAI are conducted in the framework of their respective programs.

- 8.4. Researchers, research projects are regularly subjected to evaluation procedures following defined logic and processes. Evaluation results are discussed and shared.

Beside the PhD students, which are involved in the evaluation procedures by the tutor advisory committees (TAC) following the rules of the Universities of Geneva and Zürich, no systematic evaluation procedure is in place for the research and the performance of the individual researchers. For research projects leading with scientific articles published in peer-reviewed journals the quality of the results is evaluated by the peer reviewing procedure.

Once a year, in the frame of the human resources rules of the department, an individual colloquium with each collaborator takes place. During this colloquium, the achievements and failures of the past year are discussed and the objectives for the coming year are set.

The minutes of the meeting are signed by the counterparts.

8.5. Professional development (continuous training and career plans) is an integral part of the operation of the research body.

The continuing education at IM is assured by the participation of the collaborators at congresses and at specific training courses. In the field of microbiology, updating of the knowledge is needed due to the rapid changes and innovations that occur. Moreover, our collaborators are all integrated in the biweekly internal seminars and group meetings.

In 2019 the rules for the academic staff careers and for obtaining a professorship at SUPSI have been revised and have been implemented since then (SUPSI internal directive 4B). Two new senior researcher positions are planned for the year 2022-2023 and in addition a professorship faculty position in microbial hydrobiology is planned for 2024.

9. Material resources and available space

9.1. Research has adequate and maintained infrastructure (state of the art) at its disposal in order to aim to achieve the planned objectives.

The main office of the IM is currently located in Mendrisio, at the new headquarters of the DACD in Via Flora Ruchat-Roncati 15; however, the Bellinzona office also remains active at the building in Via Mirasole 22a which houses the Cantonal Laboratory, the clinical diagnostic microbiology of the EOC and the IM itself.

The strong increase in IM staff, from about ten people in 2014 to the current 43, has posed a series of not indifferent logistical problems that have been solved with the provision of new spaces at the new DACD campus in Mendrisio, with surfaces in favor of the IM of 175 sqm for offices and 250 sqm for laboratories of biosafety level P2 that allow the manipulation of pathogens. The sectors "Microbial Ecology" and "Vector Ecology", transferred from January 2021 to Mendrisio, have had in recent years an important increase in their activities respectively in the areas of microbial ecology of Lake Cadagno (anaerobic phototrophic sulphurous bacteria), ecology of water courses (aquatic fungi), microbiology related to the degradation of cultural heritage and the expansion of the surveillance of invasive exotic mosquitoes at the national level. In addition to these sectors, the Environmental Biotechnology Laboratory, BET, from the Department of Innovative Technologies, DTI, has been added to the IM spaces in Mendrisio. Additional laboratories for a total area of about 220 square meters, specifically dedicated to the activities of the Operational Group Tiger Mosquito, GOZt, for the surveillance of vectors of infectious diseases, are then located near the study center of Trevano. In Bellinzona - where the IM has about 250 square meters - the Biosafety sector remains, more related to highly pathogenic agents, with the biosafety laboratory level 3, and will integrate the areas of Diagnostics, Genomics and Proteomics in close contact with the microbiology service of the EOC. The increased monitoring of invasive exotic mosquitoes on the territory of Ticino, carried out in close collaboration with the municipalities, will be guaranteed by the maintenance of the antenna in Trevano for the monitoring of the Lugano area and a station in Bellinzona for the Bellinzona and Locarno areas, thus reducing travel time and ensuring an adequate performance of research activities and services in the field. The laboratories are equipped with instruments suitable to carry out services and research work in the best possible way and are constantly updated to the state of the art. In the Bellinzona facility it is possible to cooperate ideally in the use of infrastructures with the clinical microbiology of the EOC.

The IM also manages the scientific part of the infrastructures of the Center of Alpine Biology, CBA, at the Cadagno lake allowing to carry out on the field (at more than 2000 meters of altitude), high level scientific research and very precious training moments in a university curriculum. The CBA has in fact two classrooms for theoretical courses, a laboratory fully equipped by the IM for practical exercises, two research laboratories, an archive-library and the necessary teaching aids. Moreover, the CBA has equipment for residential courses (80 beds, conference room, refectory) divided in three different buildings, thus guaranteeing all the necessary material for the didactic activities in a real

exercise of environmental education in the field of natural and environmental sciences (hydrobiology, microbiology, botany, zoology, geology, agronomy, alpine economy, etc.).

9.2. The management and scientific information technology (IT) infrastructure is adequate.

Thanks to the convention with the University of Geneva, we have access to all the necessary scientific supports (journals, books...), and the same access possibilities are provided by SUPSI. Moreover, the access at the IT facilities of the University of Geneva allows to process the high amount of data generated by the Next Generation Sequencing activities. For our work in identification and typing of organisms the majority of the databases are accessible online for free whereas for MALDI-TOF MS identifications we already own all needed databases.

The internal quality assurance system (IQAS) of SUPSI is based on three well-known quality assurance principles: (1) modelling of an institution through a set of key processes, (2) development of the quality of the entire institution through a continuous improvement cycle and (3) periodic external assessment through a critical comparison of quality assurance methods with external peers. The IQAS consists of 22 key processes and the key process P18 (Information technology management: management and development of ICT-resources, digitalization of processes, ICT education and support to employees, and data security) deals with the management and the ensure of the IT quality infrastructure.

The responsibility for maintaining and managing the technology infrastructure according to the IQAS is therefore competence of SUPSI's central IT services.

10. Future prospects

Since its integration in SUPSI to date, the Laboratory has experienced a strong and continuous qualitative and quantitative development, in particular:

1. the growth of the portfolio of applied research projects, especially those of a competitive nature;
2. the development of services capable of successfully supporting the valorization and dissemination of SUPSI's research and training activities;
3. the increase in the number of qualified academic personnel with diversified scientific competences in the Life Sciences sector;
4. the progressive and significant increase in the involvement of its collaborators in the activities of basic and continuous training, both at didactic and organisational level;
5. the development of interdisciplinary activities transversal to institutional mandates and in support of training, research and service provision;
6. the continuous consolidation of the objectives of self-financing of its activities.

These achievements are the result of a development path planned with the LMA integration strategy in 2014, which foresaw the transition of rank to institute in 2021, validated by the research evaluation procedure, PVR, in 2016 that confirmed the growth and consolidation of the laboratory over the years and suggested its transition to Institute, and confirmed by the conclusions of the working group on Life Sciences in SUPSI in 2019 that propose and support the creation of an Institute of Microbiology within the DACD.

The strategic directions identified and chosen for the development of the future institute are thus based on the outcome of the PVRS of 2016-2018 and on the conclusions of the working group on Life Sciences for the scenario chosen by the SUPSI management and the creation of two institutes, BioMedTech affiliated to the DTI and microbiology included in the DACD.

The main guidelines for the development of the future activities of the Institute were then identified. These guidelines concern all the sectors of the Institute and all the institutional mandates, which is why they are presented as a whole, starting with the "One Health" strategy, which will represent the fulcrum of the lines of action for the next four years. References to the fundamental strategic objectives, OSF, of the 2021-2024 strategy of SUPSI and to the relative action plan of the DACD for 2021-2024 are also indicated.

Consolidate the "One-Health" strategy., OSF3.3⁴, OSF 2.1⁵

The holistic vision "One Health", i.e. a health model based on the integration of different disciplines is based on the recognition that human health, animal health and environmental health are inextricably linked in a single complex ecosystem. This interdisciplinary vision is also recognized by the federal government, the European Commission and all international organizations as a relevant strategy in all areas that benefit from collaboration between different disciplines (physicians, veterinarians, environmentalists, economists, sociologists, etc.). The Institute intends to strengthen this interdisciplinary way of approaching problems, implementing this vision in the development of future research projects and services. This approach will allow the Institute to profile itself at the national level, and not only, as one of the few institutes capable of combining and interfacing different skills in three areas usually and historically divided as clinical, veterinary and environmental. This "One Health" concept on which the Institute will be developed will allow to address the health problems of the future by applying an innovative synergistic approach taking into account all the actors in the ecosystem and to position the new Institute as an innovative institution in the context of "Life Sciences" in Switzerland and internationally, while maintaining a more environmental orientation than clinical and veterinary.

The research and collaborations developed in recent years have allowed the IM to position itself in the international context as a specialized and privileged partner in the development of research projects that require an integrated and combined approach of different specific skills. A particularly active sector in this context is certainly that of the Vectors of infectious diseases, which in recent years has been involved as a protagonist by the federal government in the structuring and strengthening of the national network of specific monitoring for invasive mosquitoes vectors of dangerous viruses in Switzerland. After an initial three-year period in which the monitoring concept was consolidated and implemented, the next four years will focus on ensuring the operational phase of the National Reference Network for invasive mosquitoes that monitors their spread. This function as a center of competence and coordination of the Swiss network of regional stations (Zurich, Basel, Lausanne and Ticino) will continue with the strengthening of information flows and the implementation at the Swiss level of the monitoring and control model developed in Ticino. There will be a further strengthening of specific monitoring for most Swiss cantons. The role of coordination center of the Swiss network of competence for invasive mosquitoes of the IM will be further strengthened as well as the reputation of the Vector ecology sector, which has also been called to participate in the elaboration of projects of international scope. This way of working has already been tested in several projects that IM employees have initiated in recent years.

Thus, the institute intends to focus its attention on three emerging issues that close current events have brought to the attention of the scientific community and beyond;

Biosafety

In the field of biosafety, new issues in the field of biological hazards such as SARS-CoV-2 represent a complex and articulated challenge, and require to be addressed taking into account all the affected compartments. The main actor in this context will be the LRSud, already now constantly active and attentive to the evolution of biological hazards that are always unpredictable (e.g. Coronavirus pandemics, SARS epidemics, Chikungunya, etc.) that occur abroad but that have proven to be able to arrive on Swiss and Ticino soil with disastrous consequences for its health system and for the population as a whole. The laboratory is already engaged in the continuous development of

⁴ OSF3.3, Governance efficace

⁵ OSF 2.1, Ricerca e innovazione per il territorio

analytical methods for pathogens in environmental samples and in the analysis of quality controls that adapt as the risks evolve. This is an activity that provides 24/7/365 picket duty to the Canton for hazardous biological events (pandemics, epidemics, suspicious dust bags, biological incidents, etc.) and support to diagnostic laboratories in the event of an outbreak. This was the case during the Coronavirus pandemic where LRSud provided support to the EOC and promptly developed methodologies to detect SARS-CoV-2 in air, surface and water. The analysis of surfaces and wastewater were useful to SPAAS and the Cantonal Medical Office respectively for an evaluation of the spread of the virus in the environment from an environmental epidemiology perspective. This role will be strengthened in the next four years by intervening more in the development of research projects. In particular, the future institute intends to implement a different perspective in dealing with these issues that takes into account more the ecological vision and the effects on biodiversity, since these aspects are not yet adequately considered.

Antibiotic resistance and micropollutants

The other emerging issue on which the institute will focus its efforts in the future, considering that the health of humans, animals and the environment are closely related, is the uncontrolled release into the environment mainly through sewage treatment networks, but also from diffuse sources (agriculture, settlements, transport) of pathogens and substances dangerous to ecosystems. The main issues arise from the release of antibiotics that affect both human and animal medicine, agriculture and the environment due to the development of antibiotic resistance. The other source of concern is the release into the environment of a whole series of micropollutants, such as plant protection products, biocides, heavy metals that, even at low concentrations, can have negative effects on aquatic organisms or pollute water used for the production of drinking water.

Only a multisectoral and intercorrelated procedure based on the One-Health approach has real prospects of success. The Institute intends to profile itself at the national level in the implementation of the Antibiotic Resistance Strategy (STAR), developed by the federal government in close collaboration with the Federal Offices of Public Health, Food Safety and Veterinary Affairs, Agriculture and Environment as well as the Swiss Conference of Cantonal Health Directors. In addition, further interested parties were involved, in particular universities of applied sciences, professional associations and expert groups, various sectors, associations and private actors. This extensive network is also of central importance for the implementation of STAR. The Institute in this field focuses in particular on the monitoring and determination of the presence of antibiotics and micropollutants in the water cycle (watercourses, lake basins, etc.), where it is already active with some monitoring and research projects. The latter are beginning to have a multi-year base of data that allow tracing evolutions and identifying interesting causal relationships.

Model organisms for the study of anthropogenic impact

An emerging field is represented by aquatic fungi as key organisms of biomass recycling in streams and as model organisms for the study of anthropogenic impact on the environment. Saprophytic fungi (aquatic hyphomycetes) manage important processes in stream ecosystems, in particular as initiators of biomass degradation phases, in woodlands consisting mainly of deciduous leaves, the main resource of food webs in these environments. An area of research that studies these processes, their importance for the biodiversity of food webs, and their sensitivity to environmental changes, including pollution of water bodies. Projects in this research area exploit a combination of molecular (DNA sequencing) and proteomic (MALDI TOF mass spectrometry) approaches, quantification of biomarkers (for enzymes and biomass) up to the cultivation of these fungi and the creation of culture collections for targeted experiments. Again, the goal of the research is to understand the functioning of ecosystems to better assess the impact of humans and their activities. Particular attention is given to the study of the effects on biodiversity to provide a concrete contribution to the conservation and management of these important ecosystems. One of the emerging issues is for example the diffusion of micro- and nanoplastics in aquatic environments and their impact on the trophic chain. In this area, the IM has already launched a series of projects aimed at using aquatic fungi as indicators of the health of the ecosystem as a whole, evaluating in particular the role of the ecomorphology of the lakeshores.

Enhancement of new diagnostic techniques, OSF 2.1⁶

Over the years, the Identification/Typing task has been fundamental in keeping the diagnostic activity updated with the times, introducing and validating increasingly powerful and complex techniques and instrumentation, such as MALDI-TOF mass spectrometry or next-generation sequencing (NGS). It is therefore considered essential to continue with the policy of updating and strengthening the diagnostic infrastructure and skills in the future.

The techniques of molecular biology and genomics have evolved exponentially since the early 2000s, when the human genome was sequenced for the first time and new methods in the field of sequencing are being developed at an increasingly rapid pace. These innovative techniques offer new opportunities for important developments in microbiology and many other fields of application. However, they require constant updating and continuous investment in equipment, instrumentation and development of the skills of our staff. In recent years, our institute has paid particular attention to following this evolution and has always and constantly updated its instrumentation to keep up with technological developments. This effort has already been recognized by the federal government, which has entered into a contract through the Federal Office of Population Protection for funding of 300 kCHF over 3 years (2019-2021) for the scientific conduct of a project for the development of rapid identification methods by mass spectrometry. This leadership allows profiling at the national level and ensures a continuity in the collaboration with the Laboratory of Spiez, another reference in biosafety at the Swiss level, and will be of synergistic support to the task inherent to Biosafety and the activities of LRSud. The Institute of Microbiology intends to continue this development and to strengthen its competencies in new sequencing techniques (Next Generation Sequencing) such as real-time PCR, metabarcoding for eukaryotes, metagenomics of complex environments, etc.. The training and updating of collaborators in new molecular methods called "-omics" such as proteomics and metaproteomics, metagenomics, transcriptomics are some of the areas in which the future Institute intends to further invest and strengthen itself, as the mastery of these new techniques is then spent in favor of other tasks related to biosafety, vectors of infectious diseases and environmental microbiology. Especially in the latter area, the development of analytical techniques allows enormous progress in the study and understanding of different natural or urban ecosystems. The analysis of the large amount of results produced requires the knowledge of bioinformatics and the enhancement of the computer system. In fact, without bioinformatics support to interpret the data coming from sequencing analysis, it would be impossible to manage the huge amount of information coming from modern genomic sequencing techniques. The IM is already developing this area and aims to further strengthen it in the coming years following the technological evolution.

Development of basic and continuing education activities, OSF 2.2⁷

The lack of a specific pathway in Life Sciences within the SUPSI basic training offer in part penalizes the IM in the possibility of developing training activities within it. On the other hand, it can be seen as an opportunity to develop other forms of synergy and interaction within SUPSI. For this reason, collaborations with the Degree and Master Courses of Conservation and Restoration and with the MSE program carried out by the Environmental Biotechnology sector are of fundamental importance.

One of the Institute's next goals is to develop these training activities to the maximum extent possible, providing its contribution through the specific skills of its collaborators. In addition, another training area in which the laboratory sees an important potential for development is that of continuing education, which at the moment is not particularly developed. Also in this case, the transfer to Mendrisio in the new campus of the DACD can prove to be a driving force for the development of basic and continuing education as the infrastructure of its laboratories have been designed to allow the development of lectures and training courses, something that in the current location of Bellinzona can be done only marginally. Furthermore, the collaboration between the professors/researchers active at the degree program and the scientific experts of the IM represents an excellent opportunity for professional growth and synergistic development and is also a great added value for the students

⁶ OSF 2.1, Ricerca e innovazione per il territorio

⁷ OSF 2.2, Sinergie tra i mandati istituzionali

who have the possibility of having at their disposal state-of-the-art specialized and multidisciplinary skills.

In the future, once the activities of the Institute of Microbiology are consolidated, the possibility of creating an innovative Master of Sciences focused on the "One Health" concept, differentiated from the common "Life Sciences" sectors present in the Swiss and international academic landscape, cannot be excluded.

Collaborations within DACD and SUPSI in general, OSF 2.2⁸

The integration strategy of the Institute of Microbiology in SUPSI and the development of the Life Sciences area are an integral part of the strategic directions of the DACD; for example, the relationships between the built environment and biology proper to several projects such as invasive mosquitoes in urban environments, biodeterioration of cultural heritage, indoor mold and air quality, hygiene aspects in the management of construction sites, contamination of water systems, such as Legionella and SARS-CoV-2 to name a few.

The integration plan developed with the DACD direction is based on the will to consolidate and further develop the 4 main research areas: biosafety mainly related to pathogens, hygiene and environment (both built and natural environment), the fight against disease vectors (e.g. mosquitoes) and environmental biotechnology. Biosafety and the Regional Laboratory South, linked to the BSL3 biosafety laboratory infrastructure and the EOC diagnostic microbiology activities, will be strengthened. Thanks to the work carried out in the tasks of biosafety (LR South) and hygiene and environment, virus analysis and genomic and transcriptomic analysis will be increased, representing an important technological leap forward for the IM. Pathogen-related activities will also be strengthened including MALDI-TOF mass spectrometry, in close collaboration with EOC-EOLAB and in particular with the departments of bacteriology (including the National Reference Center for Legionella), hospital hygiene, veterinary, for the rapid identification of pathogenic germs and with the department of biochemistry and clinical pharmacology which uses mass spectrometry extensively.

Another important scientific area in which there is a particular need for specific expertise is virology. In fact, the continuous emergence worldwide of epidemics and pandemics that are transmitted in the environment from animals to humans (zoonoses) at an increasingly rapid pace (in the last twenty years: 2002-2004 SARS, 2005-2006 avian influenza, 2009 influenza A/H1N1, 2012 MERS-CoV, 2014-2015 Ebola, 2015-2016 Zika, 2019-2021 SARS-CoV-2) require a strengthening of the Hygiene and Environment sector, the development of the concept of ampibiental epidemiology and the presence at the laboratory of specific knowledge in virology in order to integrate in a circumstantial way these specific skills and counteract the spread of these viruses that can cause serious environmental, economic, social and of course public health problems. In this regard, in 2021 a research virologist active in the Biosafety sector was hired with the aim of further developing research on viruses carried by mosquitoes. Currently, viral culture techniques are being introduced in close collaboration with the Vector Ecology sector for studies on the vector competence of invasive Asian mosquitoes. In addition, a PhD work on the study and implementation of the CRISPR-Cas system for the development of new rapid diagnostic systems for highly pathogenic viruses and new antiviral strategies has also started in collaboration with Labor Spiez.

Activities in the Vector Ecology, Microbial Ecology and Environmental Biotechnology Sectors will be further enhanced. They are synergistic with the fields of the IST in water biology, sensing and limnology, with the IMC in the field of materials, conservation and restoration (e.g., biological degradation of cultural heritage, biotechnology and biotechnology), and with the IMC in the field of biotechnology. biological degradation of cultural heritage, bio-cleaning and bio-consolidation of works of art) and indoor contamination (microbiology of the built environment) but also with the IDE for the aspects of scientific dissemination very important both for the problem of invasive mosquitoes and for science-society relations related to educational activities in collaboration with the Foundation Alpine Biology Center of Piora.

⁸ OSF 2.2, Sinergie tra i mandati istituzionali

In this field it is foreseen a greater focus on some central themes for the construction sector on one side and the development of biotechnologies on the other. In the first case, the main relationship will be developed directly and primarily with the other institutes and degree courses of the DACD, while in the second case the integration of the BET acts as a driving force for the development of the biotechnology sector and for the collaboration, already quite active, with the DTI.

A great potential for synergistic development within the DACD is foreseen and it is therefore intended to pursue a targeted policy of development of research projects, services and teaching with the other units of the DACD and other departments of SUPSI, such as the DTI.

The transfer of the DACD to Mendrisio, OSF 4.1⁹

This transfer finally allows a physical proximity between IM and all the other institutes and degree programs of the DACD thus favoring a greater intra-departmental interaction and collaboration. The infrastructure of the Institute is enhanced compared to the previous situation (see chapter 9.1.) and the IM intends to make available to the activities of the DACD its specialized equipment to implement in research projects and basic training the topic of microbiology. Particularly important, as indicated above, is the synergy with the Course of Conservation and Restoration, which will be able to carry out part of its practical lessons directly in the microbiology laboratories, and with the IMC within the Center of Competence for Indoor Air Quality, which will thus be able to have instrumentation specifically dedicated to biological analysis that is currently lacking. The transfer to Mendrisio also favors the collaboration at territorial level, in part already started with some regional institutes active in the field of agriculture such as the Professional Center of green Mezzana and the Forest Nursery of Lattecaldo with which the future Institute intends to collaborate actively in the development of research projects.

New Environmental Biotechnology and Biotechnology Development Sector, OSF 2.1¹⁰

In this field we see great potential in the application of innovative microbiological techniques in areas such as the optimization of anaerobic digestion processes, energy production from biomass and its reuse, water treatment, removal of micropollutants from water, etc.. Also in this case, the possibility of combining synergistic disciplinary skills allows to address environmental issues from completely different perspectives and innovative that have no comparison at the national level. In addition, the Energy and Environment specialization of the Master of Science in Engineering, MSE, can be shared and expanded by including the specific skills of the IM in the curriculum currently offered by the DTI.

These complementary and synergistic disciplinary combinations between biotechnology and microbiology are unique in Switzerland and in addition to strengthening the integration in the SUPSI context, they are strategic as they allow to strengthen the positioning of the future Institute in an original and innovative way with a strong interdisciplinary imprinting compared to the national microbiology landscape. This approach will allow to deal with complex issues with a global vision of the problems, strengthening the field of more classical microbiology thanks to the expertise in process optimization and the economy of scale that comes from it.

Strengthening the Built Environment Sector, OSF2.2¹¹

The strengthening of the built environment sector within the DACD is certainly one of the main priorities as a result of the need to develop closer collaborations with its institutes and degree courses. In the future there is a great potential for development in the field of microbiology of the built environment and plant engineering in relation to both biodeterioration and aspects of biosafety related to human, animal and environmental health. In this area, the creation of a center of competence of indoor air quality has been initiated in collaboration with the Institute for Materials and Construction, IMC, and the Institute for Applied Sustainability in the Built Environment, ISAAC. Another area that has become increasingly important is the protection of the built heritage and cultural heritage. In fact, in close contact with the CdL and Master of Conservation and Restoration has been consolidated over the years an intense collaboration to implement in the diagnosis and

⁹ OSF 4.1, Campus aperti e integrati nel territorio

¹⁰ OSF 2.1, Ricerca e innovazione per il territorio

¹¹ OSF 2.2, Sinergie tra i mandati istituzionali

evaluation of damage to cultural heritage aspects related to microbiological degradation. In this field, for many years now, chemical-physical techniques for the diagnosis and restoration of cultural heritage have been established, such as the use of non-invasive diagnostic techniques or new chemical compounds to intervene on cultural heritage to be restored. On the other hand, the study of the phenomenology of biodeterioration of cultural heritage caused by biological agents such as molds, fungi, algae, bacteria and the identification of recovery and conservation interventions is still underdeveloped. Not always microorganisms have a negative impact in the context of cultural heritage, bioremediation also uses bacteria for the conservation of works of art through bio-cleaning and bio-consolidation. This opens a very interesting field of action and potentially promising implications to be addressed in a synergistic way between experts in conservation and restoration and microbiologists, with interdisciplinary skills that no other restoration institute at the national level has.

Strategic collaborations in the territory and scientific community, OSF 1.1¹²

With the recognition through a federal mandate of the FOEN given to the IM as "Coordination Center of the national network of competence for the surveillance of invasive mosquitoes" it can be said to have achieved an important objective that must be maintained and strengthened. This recognition, in fact, places the IM as one of the main actors in the fight against vectors of infectious diseases on a national level. Since 2006, the FOEN and the FOPH have been following the activities carried out in Ticino in the fight against the tiger mosquito. In 2011, this collaboration led to the development of the concept for the control of tiger mosquitoes and associated diseases as well as to the establishment of an informal working group of the federal authorities involved (FOEN, FOPH, FVO and FOCP). This interdepartmental working group for vector problems (Interdepartementelle Arbeitsgruppe Vektoren, IDAV) ensures the exchange of scientifically sound information on the subject.

The IM serves as a hub for information from the regional stations and the Swiss monitoring program, which is passed on to the Swiss Centre for Wildlife Conservation after validation.

Also noteworthy is the constant collaboration with the virology and bacteriology departments of the Spiez Laboratory (Federal Office for Civil Protection, FOCP) for the surveillance of mosquito-borne viruses, the activities of the Regional Biosafety Laboratory and for the field of proteomics and mass spectrometry applied to the detection of protein biomarkers in complex samples. Two projects have also been recently added: one on the detection of biological toxins using state-of-the-art molecular methods and the second linked to a PhD work on the CRISPR-Cas system for the development of new rapid diagnostic systems for highly pathogenic viruses. The IM has been entrusted by the FOPH the direction of the mentioned projects allowing the recruitment of 2 SUPSI collaborators active mostly in the laboratories of Spiez.

The strengthening of the collaboration with the CBA, a specific task of the IM mandate, has been concretized both with the activation of new courses (molecular ecology UNI Geneva and SUPSI degree course in visual culture) and with projects financed by the National Fund for Scientific Research, such as the project "Bioconvection-mediated microbial ecophysiology in aquatic systems" (acronym BIOCAD) on bioconvection and the project "Effects of variation in atmospheric electricity on microbial ecology at Lake Cadagno" on variations in atmospheric electrical potential and their influence on the biology of water and sediments. Above all, the BIOCAD project also makes a substantial contribution to the strengthening of the network of contacts of the future Institute at the Swiss level. The project, for which IM is the first applicant, involves a close collaboration with EAWAG, the leading institute for water research, and the limnological station of the University of Zurich. The prospects for increased scientific activities in Piora in collaboration with CBA are very good, both in competitive research projects and in knowledge transfer. With the limnology station of the University of Zurich (UNIZH), a study has started on particular ciliates from Lake Cadagno that represent key species in the trophic network and interact directly with photosynthetic bacteria and probably also with the bioconvection studied by IM. The project will be the subject of a Master work that will allow to start a close collaboration with UNIZH that is also part of the Foundation Board of

¹² OSF 1.1, Cooperazione attive nelle reti Nord-Sud

the CBA. Possible synergies may arise with USI, which is also a member of the CBA and which intends to increase its activities in the Gotthard area through the planned "House of Sustainability" in Airolo, a project that is expressly devoted to a collaboration with the CBA Foundation. The IM and in general the DACD will also be able to give its important contribution for the realization of an Infopoint at the CBA, a project that has been planned for some years but has not yet really taken off.

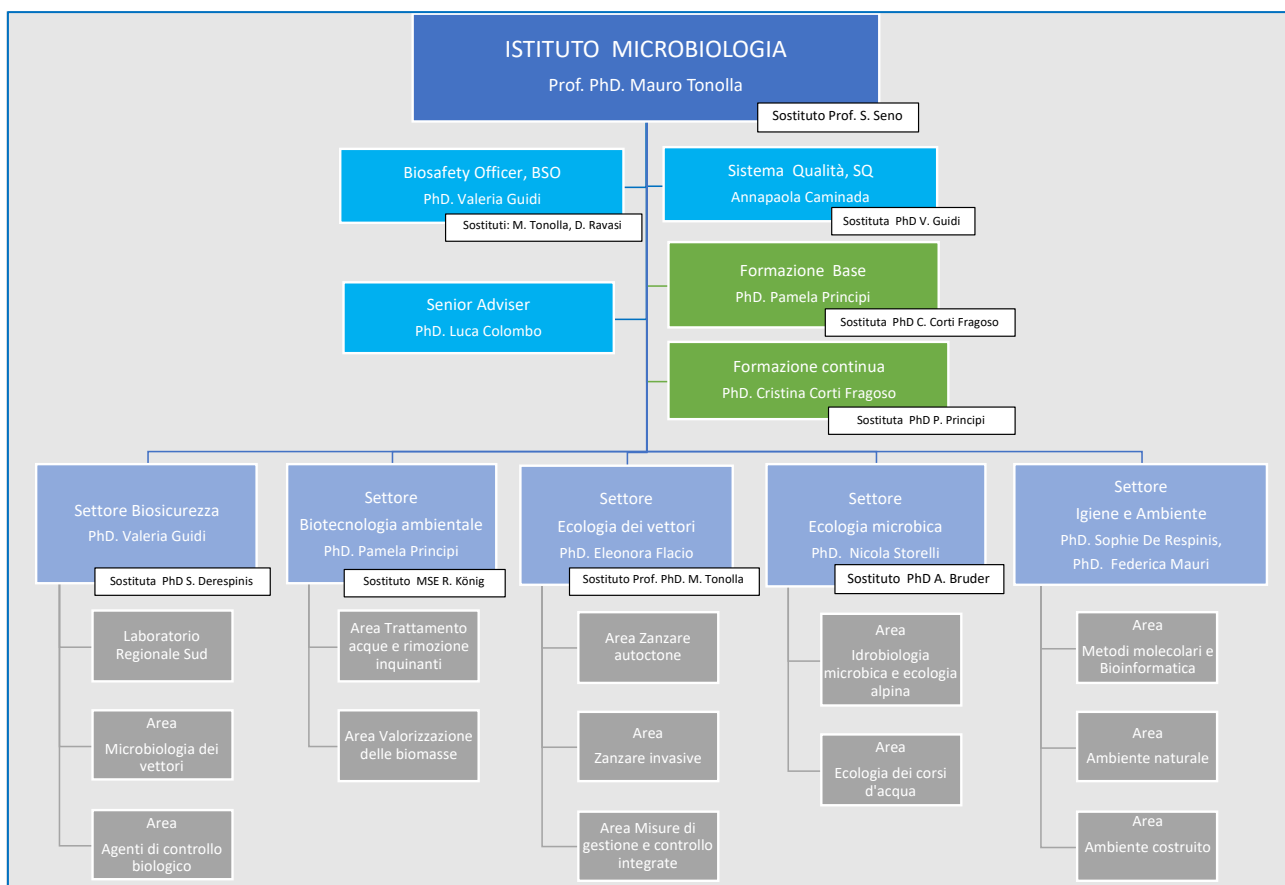
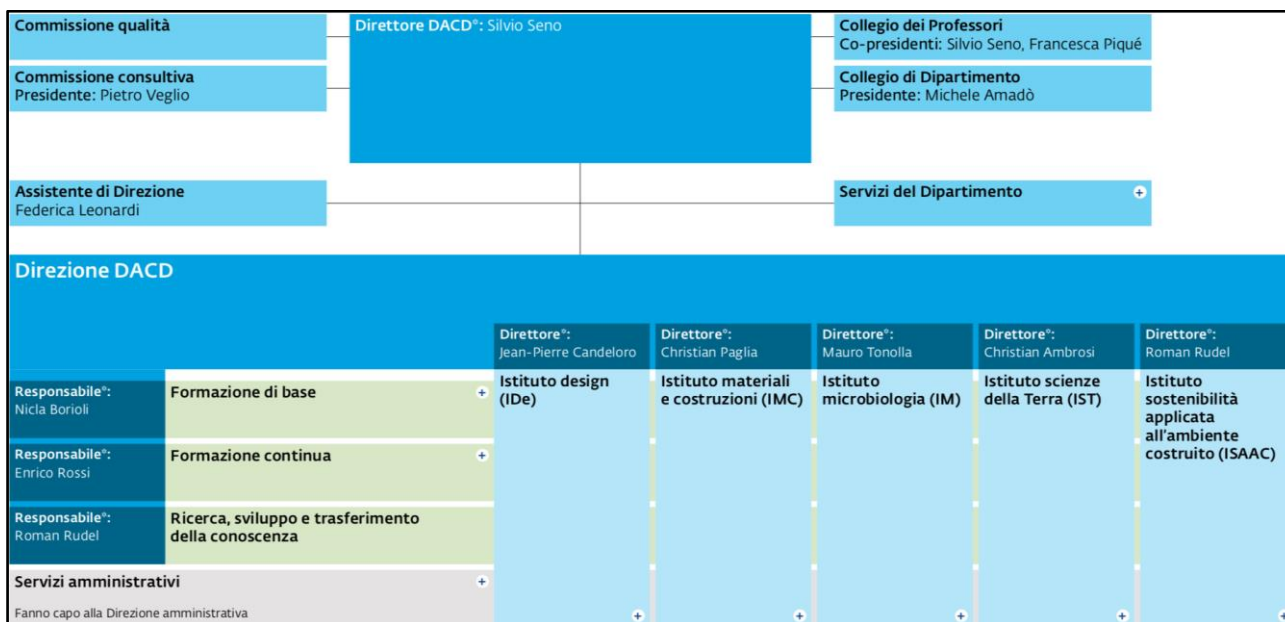
Environmental biotechnology relies on a good national network of contacts that increases the specific weight of the future institute and that brings valuable and synergistic knowledge with both the fields related to environmental microbiology (in particular of the built environment) and those related to health.

The Institute intends to maintain, consolidate and strengthen its position as a relevant player in these scientific areas at national and international level. It is intended to shift the focus of the institute on the acquisition of projects of relevant size (>100 kFr) to ensure the maintenance of this evolution in the composition of funding sources and to maintain a high share of funding through competitive research projects, increasing more European funding.

11. Annexes

1. Organigram
2. Financial planning
3. Representative number of major research projects of the last 4 years, complete with information sheet.
4. SWOT analysis
5. Gender and Diversity: SUPSI Checklist
6. SUPSI research quality indicators
7. Criteria for the sustainability of SUPSI research
8. List of research projects, 2014-2022
9. List of scientific publications, 2014-2022
10. List of scientific presentations, 2014-2022
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12. List of teaching courses

1. Organigram




2. Financial planning; C2015-C2021, P2022, PSF 2023-2024


	C2015	C2016	C2017	C2018	C2019	C2020	C2021	P2022	PSF2023	PSF2024
Research & Services	-1'101'697	-1'584'770	-1'467'308	-1'589'694	-1'891'706	-1'868'001	-2'972'087	-2'905'833	-2'861'545	-2'891'545
Cantonal research funding	-	-111'795	-2'405	-15'000	-73'431	-44'279	-140'697	-40'000	-80'000	-85'000
CTI funding	-0	-	-14'700	-18'300	-17'000	-19'998	-178'239	-221'239	-45'000	-45'000
SNF funding	-	-	38	-20'093	-100'512	-124'339	-333'981	-136'387	-245'000	-250'000
EU european programs funding	-	-	-	-	-1'371	-8'223	-3'221	-6'853	-10'000	-10'000
Other research programs funding & Foundations	-9'781	-96'530	-97'131	-69'409	-87'478	-68'263	-78'320	-61'000	-330'000	-340'000
Other federal research funding	-30'612	-109'881	-35'116	-116'591	-200'892	-190'894	-552'218	-526'451	-235'000	-240'000
Research & Services cantonal Mandate (DSS)	-991'545	-1'231'545	-1'231'545	-1'171'545	-1'151'545	-1'181'545	-1'181'545	-1'181'545	-1'181'545	-1'181'545
Other research revenues	-3'959	10'107	-83'332	-136'468	-189'810	-209'578	-418'892	-642'358	-700'000	-700'000
Services	-65'800	-45'126	-3'117	-42'289	-69'667	-20'883	-84'974	-90'000	-35'000	-40'000

3. Representative number of major research projects of the last 4 years, complete with information sheet.


Bioconvection-mediated microbial ecophysiology in aquatic systems: Multi-scale dynamics in the chemocline of meromictic Lake Cadagno

Sector	Microbial ecology
Keywords	Carbon fixation; <i>Chromatium okenii</i> ; sulfur cycle; Bioconvection; phototrophic sulfur bacteria; meromictic lakes.
Project leader	Nicola Storelli
Duration	2018-2022
Funding Agency	Swiss National Science Foundation (643'000.00 CHF)
Research Partners	Dr. Bouffard Damien, Eawag, Switzerland Prof. Sengupta Anupam, University of Luxemburg, Luxemburg
Abstract	Lake Cadagno presents during the whole year a permanent stratification of its waters, meromixis, the upper water layer containing oxygen is placed over an anoxic layer very rich in dissolved salts such as sulfur compounds. Anaerobic purple sulfur bacteria of the species <i>Chromatium okenii</i> develop at the interface of the two layers where they are able to mix considerable volumes of water, not by agitating it directly with their flagella but by grouping together in search of light in a restricted area near the oxygen diffusion front. As they do so, the density per volume increases and the water begins to fall, taking the microorganisms with it in a process known as bioconvection.
The project	The objective of the project is to understand two fundamental scientific question: (i) What are the environmental drivers influencing bacteria-induced bioconvection? and (ii) does bioconvection influence microbial ecophysiology? We have identified Lake Cadagno as the ideal study system to address these questions, mainly for two reasons: 1) the reported occurrence of bioconvection, reproducible over seasonal time scales, and 2) the extensive research experience during the past 30 years led by our research team. The specific aims are then to a) understand how ecophysiology of microorganisms in Lake Cadagno is coupled to the bio-convective mixing, b) role of bioconvection in shaping the chemocline microenvironment and to evaluate the potential metabolic advantage (e.g., fitness) to <i>C. okenii</i> , and c) to assess the consequences of bioconvection on key biogeochemical cycles at the ecosystem scale. These aims will be supported by a laboratory platform to conduct experiments at the individual and population scale under gradients of light, sulfide, oxygen and density. We will thus apply a combination of field and laboratory experiments to acquire data on the ecophysiology of dominant microorganisms in the chemocline of Lake Cadagno.
The result	Given the interdisciplinary nature of the project, we expect different results derived firstly from in-lake measurements to characterize in detail the abiotic (physical parameters) and biotic (dynamics of the main populations of the bacterial layer) environment, and secondly from laboratory experiments to test different phenotypic traits, including cell volume, motility and density using microfluidic and millifluidic experiments, for each individual species using pure cultures. In addition, we will provide a molecular basis by looking at specific gene expression (transcriptomic) of the <i>C. okenii</i> population before, during and after periods of bioconvection, looking for reference genes linked to this process.
Research domain	Asse 1 - Ambiente costruito, risorse naturali e sicurezza
Picture	


The role of land-use change for detrital food webs in streams – a tropical-temperate comparison

Sector	Microbial Ecology
Keywords	Stream ecosystem functioning, biodiversity, macroinvertebrates, fungi, food-web
Project leader	Andreas Bruder
Duration	2020-2024
Funding Agency	Swiss National Science Foundation and Brazilian National Council for Scientific and Technological Development (344831 CHF)
Research Partners	Prof. Marcelo Moretti, University of Vila Velha, Brazil Prof. Florian Altermatt, University of Zürich, Switzerland
Abstract	Detrital-based food webs in streams govern important ecosystem functions and services. The most important processes include decomposition of leaf litter from the terrestrial vegetation in the catchment (i.e. detritus). This process provides most of the energy to food webs in shaded streams and is governed by specialized fungi and macroinvertebrates. These food-webs and organism groups are increasingly under pressure from environmental change related to changes in land-use in the catchment, e.g. agriculture, which alters water quantity and quality as well as the riparian vegetation of impacted streams. First results suggest strong differences in litter decomposition and macroinvertebrate communities between streams with intact (i.e. forests) and altered riparian vegetation.
The project	Our project is based on replicate field experiments in Brazil (the Atlantic Forest biome) and Switzerland (prealp streams in northern and southern Switzerland). We measured the decomposition of leaf litter of different riparian tree species in mixtures and monocultures, as well as the activity, biomass and diversity of the main decomposer groups (i.e. specialized macroinvertebrates and fungi) and their roles in food webs. Experiments were performed in streams and stream sections impacted by similar reductions in density and diversity of the riparian vegetation and compared to experiments in nearby reference sections. Our project will provide answers to the following questions crucial for ecological management and restoration of streams in both countries: (1) how does degradation of riparian vegetation alter the relative role of decomposer groups for litter decomposition in streams, and (2) what are the consequences of changes in biodiversity at four trophic levels on this key ecosystem process.
The result	In the Swiss streams, the abundance, diversity and biomass of specialized macroinvertebrates was higher in forested sections, which translated into higher litter decomposition rates. Moreover, sensitive macroinvertebrate taxa were less abundant and diverse in sections with altered riparian vegetation. Stable isotope signatures suggest that fungi growing on leaf litter use different carbon sources in forested and open landscape streams, which was then also reflected in the respective macroinvertebrates feeding on these resources. These results indicate shifts in ecosystem functioning caused directly and indirectly by changes in the condition of the riparian vegetation. These findings highlight that landscape management and restoration needs to account for changes in stream ecosystems and their macroinvertebrate and fungal communities.
Research domain	Asse 1 - Ambiente costruito, risorse naturali e sicurezza
Picture	

ACME: Anaerobic digestion with Conductive Material and Electrogenic microorganisms

Sector	Environmental Biotechnologies
Keywords	Anaerobic digestion; electrogenic microorganisms; conductive material
Project leader	Pamela Principi
Duration	2020-2023
Funding Agency	BFE project cost chf 395000
Research Partners	HES-SO (F.Fischer) TBF+Partner AG CDA,CV
Abstract	The project evaluates the use of electrogenic microorganisms attached to conductive carriers to optimize the anaerobic digestion process. The culturability on conductive support (electrodes) in pure culture (e.g. Shewanella spp. and Methanotrix spp.), the biogas production in lab scale conditions, and the ability to maintain the biofilm mode in a real condition digester are evaluated. The microbial community composition is monitored to evaluate the changes during the different phases of the project
The project	In Anaerobic Digestion (AD) process, different trophic groups of microorganisms cooperate in a syntrophy to exploit complex organic matter as source of carbon and energy. This mutualistic metabolism is supported by different electrons exchange mechanisms that are defined as Interspecies Electron Transfer. The Direct Interspecies Electron Transfer (DIET) process foresees the electrons exchange directly and it is enhanced by conductive material. We proved the occurrence of positive effect given by the addition of conductive material in a lab scale project (Direct Interspecies Electron Transfer (DIET) to increase methane production project BFE SI/501716-01), and questions about the real involvement of a DIET mechanism led us to question the fate of DIET-able bacteria in a real anaerobic digester environment.
The result	The present project investigates the possibility to culture specific selected electrogenic microorganisms (e.g. Shewanella spp.) and methanogens (Methanotrix spp.) on conductive support (electrodes) in pure culture to assess their ability to colonize conductive surface in a biofilm mode, and to evaluate biogas production in lab scale conditions. The microbial community composition will be monitored to evaluate the resistance toward the microorganisms present in the anaerobic biomass in normal condition. Given a microbial consortium able to exploit the DIET mechanism, we aim to prove its resistance once in contact with real condition digestate. The biodiversity of the digestate poses a risk to the maintenance of the cultures used as starters, on the other hand the selective pressure and the advantages of DIET exploiting cultures against the indigenous microflora could be the edge guaranteeing their survival and proliferation. It is foreseen that the electrogenic microorganisms, by electron exchange advantage, improve the overall anaerobic digestion process. The benefit would be expressed as shortened lag phase and/or increased steepness and/or maximum methane yield.
Research domain	Environment, renewable energy
Picture : Preparation of biofilm carrier in the laminar flow hood and positioning in the 3.5L-ACME reactors	


CMMF: Combined Micropollutant and Microplastic Filtration as innovative quaternary municipal wastewater treatment

Sector	Environmental Biotechnologies
Keywords	Wastewater Treatment; micropollution ; microplastic; quaternary treatment
Project leader	Roger König
Duration	2020-2023
Funding Agency	Innosuisse: project cost chf 270'000
Research Partners	DrM, CDAM, CSD
Abstract	Micropollutants and microplastics elimination in municipal wastewater treatment plant effluent is approached with an innovative architecture of a powdered activated carbon and filter aid material mix, pre-coated on a cloth filter and operated in a unique process mode.
The project	<p>Water quality plays a key role in the national and international economy and society. 20% of the national drinking water is withdrawn from lake water (SVGW, 2020) and purified in a two or three steps process.</p> <p>The treated and discharged water from municipal and industrial wastewater treatment plants directly effects the surface water quality and consequently the treatment efforts of drinking water plants.</p> <p>Emerging contaminants, so called micropollutants (MPs), are personal care products ingredients, pharmaceutical compounds and industrial agents, and plastic debris or engineered microplastics (<5mm MPLas). Those increasing released pollutants are often poorly degraded or insufficiently eliminated in today's WWTPs. The efforts in Switzerland to upgrade 100 of the 700 biggest treatment plants are addressing the topic of MPs (only pharmaceutical MPs and not the plastics) and cover around 50% of the wastewater released.</p> <p>This project aims to develop a technological solution that adsorbs the MPs and retains at the same time the MPLas, making the technology available (economically and technically) for the small and midsize treatment plants. The project outcomes contributes to an increased ecological water quality and an overall economic impact on drinking water treatment and health. The technology is based on three sequential innovations:</p> <ol style="list-style-type: none"> 1. Powdered activated carbon (PAK) mixed with a filter aid material and conditioned for the downstream cloth filter retention; 2. Diverse layers (pre-coat and bodyfill) deposited on a cloth filter for high solid retention but high flow; 3. Unique process operation to maximize the PAK adsorption and minimize the fouling effects on the filter; by returning the filter cake slurry to the upstream adsorption tank.
The result	<p>The proposed project tackles two major ecological water quality issues with one innovative technology. By the combination of an engineered "PAK mix" loaded on a filter cloth (pre-coated + body fill), the system is operated to reduce solid particles, MP adsorption and MPLas retention in a unique filtration process developed for municipal WWTPs. The major novelty can be summarized with:</p> <ul style="list-style-type: none"> • Conditioned activated carbon for filter cake formation by an engineered mixture of PAK and filter aid material; • Flow scheme and operation mode of the filtration system; • MP Adsorption in filter cake and enhanced MP loading on PAK by partial slurry recycling; • High retention capacity of activated carbon to work as barrier for MPLas and MPs;
Research domain	Energy&Environment
Picture: CMMF-Filter candle for the elimination of micropollutants and microplastics from wastewater treatment plant effluent.	


Sars-Cov-2 monitoring in wastewater treatment plants of Ticino Canton.

Sector	Biosafety
Keywords	Sars-Cov-2, Waste water, surveillance, monitoring
Project leader	Federica Mauri, Valeria Guidi
Duration	December 2022 (possible extension), in progress
Funding Agency	Federal office of public health (BAG). About 130'000 CHF
Research Partners	Ticino Canton, Ufficio del medico cantonale
Abstract	The increase and persistence of cases related to coronavirus disease 2019 (COVID-19) and the need to find methods to estimate the spread of the infection in the population are the main reasons that led to the development of the project. The aim is to test the potential of epidemiology based on wastewater analysis that considers water treatment plants (WTPs) as antennae of the health status of the inhabitants connected to the network. Although the main mode of transmission of SARS-CoV-2 is through respiratory droplets, the virus persists in faeces for several days and is also present in wastewater entering sewage treatment plants.
The project	The presence of SARS-CoV-2 in IDAs correlates with the increase in confirmed clinical cases, therefore, systematic monitoring of Sars-CoV-2 in the main sewage treatment plants located in Ticino could be useful as a rapid control method to obtain information on the degree of spread of COVID-19 in a population, including asymptomatic or pre-symptomatic individuals; and to obtain information on the effectiveness of current interventions to contain the disease.
The result	<ul style="list-style-type: none"> • Five WTPs monitored: Rancate, Vacallo, Giubiasco, Gordola e Locarno • Method development and validation <ul style="list-style-type: none"> ○ RNA extraction ○ Quantification of N1 gene (SARS-CoV-2 molecular marker) • Sample analyses (about 600 sample analyzed until now) • Development of a method to compare wastewater results and clinical cases (in collaboration with Ufficio del medico cantonale).
Research domain	Asse 1

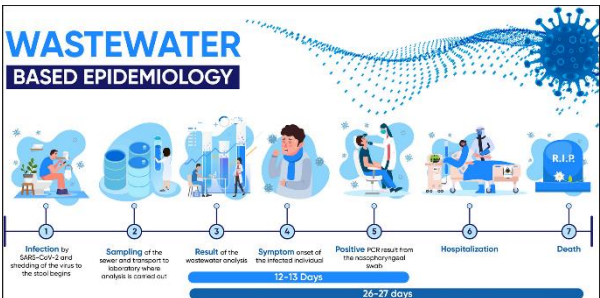
HSGreenTec - Heat shock treatment: green technology for the suppression of biodeteriogens in the treatment of natural and artificial stone monuments

Sector	Hygiene and Environment
Keywords	Heat shock treatment, biodeterioration, green treatment
Project leader	Cristina Corti
Duration	2021-2022
Funding Agency	SUPSI
Research Partners	SUPSI IMC/ IM/ ISAAC Marta Cicardi, Enrico Bura, Tiziano Teruzzi, Cristina Polo, Francesca Pique.
Abstract	Biological colonization of monuments is a constant and damaging process, that is treated with biocides which, when dispersed in the environment, have harmful consequences for humans and biodiversity. Laboratory tests have shown that high temperature and humidity conditions, heat shock treatment, allow the suppression of microorganisms without biocides. This research aims to identify suitable parameters for this treatment of stone monuments and to create eco-sustainable application protocols.
The project	Microorganisms are one of the main factors in the deterioration and alteration of stone monuments. Colonization of outdoor works is constant and there are no effective methods to prevent it. It is currently combated with biocidal products that are then dispersed into the environment. This research aims to develop an eco-sustainable method and avoid the use of biocides that are harmful to humans and the environment. Studies have shown effective elimination of biological colonization by maintaining specific temperature (T 40-60°C) and relative humidity (RH approx. 90%) conditions for a few hours, without the use of chemicals. Although the effectiveness of this treatment has been demonstrated, there is a lack of research into optimizing the parameters required for in situ application. In order to make the removal of microorganisms easier, as well as environmentally friendly from an energy point of view, we want to develop a protocol that can be implemented by all restorers and a prototype of modular equipment, with reusable materials. Promising results will allow an extended research project to be made marketable.
The result	The project produced indications of the minimum conditions necessary to achieve the elimination of microorganisms with the simple use of high temperature and humidity. The solution developed will have a direct impact in conservation and restoration practice but can also be used to intervene on buildings and structures suffering from biological colonization. The project fits into the social fabric by investigating a "green" alternative for a very frequent problem, promoting innovation in the field of cultural and natural heritage protection activities. Due to lack of time and funds, the prototype was not optimized to supply energy to the system through photovoltaic panels.
Research domain	OSF2, OSF3
HST in situ treatment	<p style="display: flex; justify-content: space-around;"> before treatment after treatment </p> 


Monitoring of antibiotic resistance genes and bacteria in water environment (rivers and lake)

Sector	Hygiene and Environment
Keywords	Antibiotic resistance genes, antibiotic resistance bacteria, rivers, Lugano lake
Project leader	Federica Mauri
Duration	2015-in progress
Funding Agency	Commissione internazionale per la protezione delle acque italo-svizzere (CIPAIS); 30'000 CHF per year
Research Partners	Canton Ticino
Abstract	Antibiotic resistance genes (ARGs) are causing increasing problems especially in clinical settings. Nowadays they are considered important environmental contaminants but little is known yet about their fate in the environment or about how they affect the natural microbial populations. In the environment, especially in water affected by anthropic activities (discharge of hospital, urban and industrial waste water treatment plant and agricultural run-off), antibiotic determinants may become part of the environmental gene pool, may spread horizontally, and may move back to humans and animals via contaminated food and drinking water. However, there are scarce information about the presence and distribution of antibiotic resistance genes in aquatic ecosystems.
The project	The aim of this work was to assess if anthropic activities could influence the bacterial populations naturally present in water environments in terms of antibiotic resistance. To reach our objective we investigate the presence of antibiotic resistance determinants in water samples collected from a subalpine lake and some tributary rivers located in the south part of Switzerland. We analysed water samples by PCR, to investigate the presence or absence of integrase gene, and by qPCR to quantify five antibiotics resistance genes that confers resistance to the major classes of antibiotics used in clinical and veterinary.
The result	<ul style="list-style-type: none"> • Long term monitoring of Lugano Lake and rivers <ul style="list-style-type: none"> ◦ Enough data to evaluate trend and distribution of ARGs in Lugano Lake and rivers • ARGs are influenced by human activity (especially wastewater treatment)
Research domain	Asse 1
	<ul style="list-style-type: none"> •  <p>https://waterandhealth.org/safe-drinking-water/drinking-water/antibiotic-resistant-bacteria-and-genes-in-wastewater-and-drinking-water/</p>


Urban water drains as a possible reservoir of Legionella pneumophila

Sector	Hygiene and Environment
Keywords	<i>Legionella pneumophila</i> , manholes, legionnaires disease,
Project leader	Federica Mauri
Duration	2018-2021, ended
Funding Agency	Lega polmonare -Fondazione Pierluigi Crivelli, 30'000 CHF
Research Partners	National reference center of Legionella (EOC)
Abstract	When investigating cases of community legionnaires' disease (LD), it is often difficult to trace the source of the infection. In the presence of a cluster or an outbreak, a cooling tower is generally involved, but in sporadic cases the source often remains unknown. When it is possible to exclude a domestic source, the presence of an urban source may be considered. In the urban environment, the existence of alternative sources such as puddles or manholes has already been described in previous studies. We postulate that water drains could be an important reservoir for legionella. The stagnant rainwater inside these basins could promote the proliferation of <i>Legionella spp.</i> while its evaporation could lead to the formation of aerosols and thus constitute a potential source of LD.
The project	The aim of the project was to monitor the presence of <i>Legionella pneumophila</i> (Lp) and its serogroups in the water drains located in urban residential areas where cases of Legionnaires' disease have been identified among the inhabitants. Isolation and quantification were performed with a rapid identification kit (Legiolert™, IDEXX). The objective was to see if there was a relationship between the presence of cases of Legionnaires' disease and the presence of <i>Legionella</i> in manholes and if the possibility of finding a positive sample varies according to environmental conditions (e.g. rainfall).
The result	<ul style="list-style-type: none"> • Test an easy and specific kit for environmental isolation of <i>Lp</i> • Manholes can be considered a reservoir of <i>Legionella pneumophila</i> • There is a relation between the presence of <i>Legionella pneumophila</i> in manholes and disease incidence. • Precipitations can be associated with presence of <i>Legionella pneumophila</i> in the manholes
Research domain	Asse 1
Research domain	 <p>https://www.nature.com/articles/s41598-021-98653-x/figures/1</p>

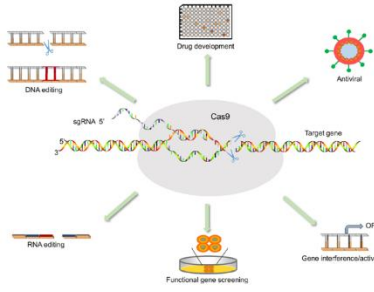
Indoor moulds - Study of the mycobioma in varying indoor environments

Sector	Hygiene and Environment
Keywords	Mould, mycobioma, indoor environment, high throughput sequencing, minion
Project leader	Sophie De Respinis
Duration	2018-2022
Funding Agency	Lega polmonare ticinese – Fondazione Pierluigi Crivelli
Research Partners	
Abstract	<p>For professional, social, or private reasons, people spend more and more time in indoor environments. According to a biosafety perspective, the buildings air quality has become important in terms of health and quality of life. The microbiological content of indoor environments is directly associated to the status of the building. In fact, the type of material used for the construction, the ventilation system installed, the furniture used for interior design, as well as the indoor temperature and moisture levels, can influence the type, survival, and development of indoor microorganisms. Fungi, bacteria, and viruses are brought indoor from humans, animals and outdoor air, and their outliving and growth depend on the indoor conditions. Some of them are infectious, asthma or allergic agents, and human exposure, in some cases, can yield to adverse health outcomes. On the other hand, some studies have demonstrated that a high fungal diversity in house dust is associated with a reduced childhood asthma development.</p> <p>It is well established that people can become sick after exposition to infectious microorganisms (eg. live virus or bacteria, allergenic fungal fragments, mycotoxins), although variations in human response are common. On the other hand, some microorganisms, microbial compounds, or microbial communities can have beneficial health effects. Therefore, it becomes important to have a better overview of the risks and benefits of indoor microorganisms' exposure to human health. To give a contribution to the knowledge of microbes linked to the biosafety of indoor environment, this project aimed to sample different built and inhabited environments in the southern part of Switzerland for one year, and to determine the mycobioma present.</p>
The project	<p>Three types of dwellings were selected: i) one with humidity problems and visible presence of mould; ii) one without visible problems; iii) a "Minergie" type house, with controlled ventilation system. Four dust samplings were carried out over one year (one per season), each comprising: i) a dust extraction at ground level, considering corners where moulds easily grow; ii) a swab sampling on areas with visible mould growth. Mould populations were determined: i) from the dust samples, by high throughput sequencing (ITS metabarcoding), which allowed the identification of DNA from mixed organisms; ii) from the swab samples, by MALDI-TOF mass spectrometry and DNA sequencing for the identification of the visibly growing moulds.</p>
The result	The sampling phase and sequencing are finished, the results are under process.
Research domain	Ambiente costruito, risorse naturali e sicurezza
	


Layer by layer technology to prevent microbiological growth on immovable Cultural Heritage

Sector	Hygiene and Environment
Keywords	Layer by layer technology, biodeterioration, green treatment
Project leader	Cristina Corti, Anna Rita De Corso
Duration	2019-2020
Funding Agency	SUPSI
Research Partners	SUPSI DACD IMC/ IM, SUPSI DTI Marta Cicardi, Francesca Pique, Anna Rita De Corso
Abstract	<p>Any intervention on Cultural Heritage should follow norms and requisites. In this scenario, the general objective of this project is to first assess the potential of LbL to deliver specific antimicrobial properties to cultural heritage surfaces in white marble and second to apply the LbL to a case study.</p> <p>I. Design an antimicrobial LbL formulation specifically engineered for the white marble stone surfaces;</p> <p>II. Parametrization of the LbL application process (i.e. coating mg/m², number of layers, etc.);</p> <p>III. Evaluation of antimicrobial properties under different colonization and climatic conditions;</p> <p>IV. Development of procedures for LbL in situ application, monitoring and maintenance;</p> <p>V. Application of LbL on selected case studies.</p>
The project	<p>The surface of immovable cultural heritage is often subject to microbiological growth (MGB) which cause color alteration and impact the esthetic of sculptures especially when made with light colored stone (such as marble). MBG can penetrate the porous material causing deterioration and can be very difficult to completely remove it without affecting the underling material. Cleaning operations are necessary on a regular basis to remove MBG from monuments and sculptures. Unfortunately, this operation cannot be sustained and typically, in short lapse of time, depending on the climatic condition and the environmental context, recolonization occurs. This in turns requires further cleaning causing, over time, not only a continuous use of resources but also a tremendous impact on the surface of the cultural heritage, which as a result is slowly eroded.</p> <p>The proposed research aims at exploring the so-called LbL (layer by layer) technology to develop a biocide coating to protect immovable Cultural Heritage from microbiological attach.</p> <p>Cultural heritage can be made of many different materials. For this study, marble has been selected as a substrate for this study because it is the most common used stone for monuments and being white any color change easily impact its cultural value. The research will start with a through lab testing on marble samples. Successful LbL formulation will be further tested on real case studies. In collaboration with the Ticino Cultural Heritage Office and the city of Lugano, the Lugano's Monumental Cemetery is proposed as a case study for in situ testing of the LbL for MBG prevention bringing the research from the laboratory to a practical application that can be monitored and assessed over time.</p>
The result	<p>This line of research is very innovative in that it addresses the aspect of prevention after intervention. This approach supports the attempt to reduce the need for direct intervention on the works by trying, after the intervention, to prevent the degradation processes which in this case are the growth of micro-organisms. In fact, there are no products that have an effective preventive effect in the recolonization of stone materials outdoors. This project has brought promising results in laboratory tests and preliminary data from in situ tests.</p> <p>In out tests, the product with the highest biocidal efficacy proved to be Chlorhexidine. The Ag layers were also promising, but tests showed a risk of yellowing of the stone surface, which is not appropriate for application in cultural heritage.</p>
Research domain	OSF1,
Picture: Monument and marble blocks at the end of the layer application.	


Establishment of the CRISPR-Cas system for rapid diagnostics and the development of antiviral strategies

Sector	Biosafety
Keywords	CRISPR-Cas, diagnostic, antiviral, arboviruses, West Nile virus, Crimean Congo Haemorrhagic Fever virus
Project leader	Valeria Guidi (IM) Roland Züst (Labor Spiez)
Duration	2021-2025
Funding Agency	BABS – 320'000 CHF
Research Partners	Labor Spiez
Abstract	Emerging highly pathogenic viruses pose a major threat to humans and society, as tragically illustrated by the catastrophic SARS coronavirus outbreak that is still ongoing. In recent years, the incidence of these highly pathogenic viruses has increased and there is neither a vaccine nor effective drugs against these dangerous pathogens. Fast and reliable diagnostics are of great importance to bring such pandemics under prompt control. This project aims to investigate and develop the CRISPR-Cas system for diagnostics and the discovery and development of antiviral agents against highly pathogenic arboviruses such as West Nile virus and Crimean Congo Hemorrhagic Fever virus. Once established, the CRISPR-Cas system can be modulated for any virus and allows rapid response to future pandemics and epidemics.
The project	<p>In recent years, the incidence of emerging infectious diseases has increased and pose serious threat to public health and society. In order to fight epidemics caused by highly pathogenic viruses, the availability of rapid diagnostic systems as well as therapeutic approaches are crucial. Private diagnostic laboratories do not have the capacity to quickly react to new pathogens, but often have to wait for the manufacturers of diagnostic kits. The joint research project of the Highly Pathogenic Pathogens Research and Analytic Group of the Spiez Laboratory and Biosafety Sector of the Institute of Microbiology aims to investigate and develop new systems for the rapid detection of these highly pathogenic viruses and new effective antiviral strategies. Specifically, with this project we aim to:</p> <ol style="list-style-type: none"> 1. Establish a rapid and sensitive diagnostic system for West Nile virus (WNV) using the CRISPR-Cas technology. Afterwards, it will be tested how fast and easy the system can be adapted to other pathogens. The sensitivity and specificity of the system can then be evaluated in round robin tests. 2. Establish a CRISPR-Cas system for the inhibition of WNV replication. A system for inhibiting viral replication of dengue virus using the CRISPR-Cas has already been described. 3. Generate CRISPR-Cas knockout cells and evaluate cells resistance against Crimean Congo Hemorrhagic Fever virus (CCHFV) infection. The CRISPR-Cas system can be used not only to target and destroy viral RNA or DNA, but also to modify DNA in cell nuclei to produce gene knockout cells. It is possible to create a pool of cells in which every known gene has been knocked out at least once in a cell. The goal is then to infect this pool with CCHFV and isolate resistant cells. The genetic material of the cell can then be used to determine which host proteins are essential for infection. In a second step, molecules are to be found which inhibit this protein and thus also prevent the viral cycle. This system also has the advantage that these findings can be quickly applied to other viruses.
The result	We expect to establish CRISPR-Cas systems to specifically target the highly pathogenic arboviruses West Nile and Crimean Congo Hemorrhagic Fever for a rapid diagnostic and prevention and control strategies. The knowledge gained from this project will help prepare for future pandemics, as the technology can be easily adapted and applied to other viruses.
Research domain	Axis 6 - Social systems and public health
	 <p>Ding R. et al., 2021. <i>Front. Cell. Infect. Microbiol.</i> 11:639108.</p>


Mosquito-borne viruses surveillance in Canton Ticino

Sector	Biosafety, vector ecology
Keywords	<i>Culex</i> mosquitoes, arboviruses, West Nile virus, Usutu virus, surveillance
Project leader	Valeria Guidi
Duration	2020-2025
Funding Agency	BABS, BAG – 215'000 CHF
Research Partners	Labor Spiez
Abstract	In the past 30 years, mosquito-borne viruses have dramatically expanded their distribution range, with more frequent and large epidemics. Factors such as globalization, human activities and climate change favour the spread of vectors and pathogens. Considering the continuous expansion of vector-borne diseases, we set up since 2010 an entomological active surveillance of arboviruses in southern Switzerland. So far, only Usutu virus and other flaviviruses specific for mosquitoes of unknown relevance to humans and animals were identified.
The project	In the last years, the flaviviruses West Nile (WNV) and Usutu (USUV) have become of great interest to several European Countries. Until 2018, WNV outbreaks were commonly predominantly located in the eastern and southern parts of Europe, but recent data showed that this flavivirus has had a geographical expansion northwards. Surveillance for viruses within mosquito populations offers the ability to detect the pathogens prior to their emergence in animal or human populations. Therefore, an entomological surveillance is important for an early detection of these pathogens, helping to prevent human cases and reducing the risk of a possible spread of arbovirus outbreaks in our country. The study aim to survey for the presence of arboviruses in mosquitoes in Switzerland, with a special focus on flaviviruses (West Nile and Usutu viruses). Considering the recent data on the expansion of WNV in Europe and the proximity to the areas with high risk of transmission of WNV and USUV (e.g. Italy), surveillance is carried out in the Canton of Ticino, in a territory where woodlands, agricultural areas and most of the wetlands are closely connected with urbanized areas. Surveillance is performed in the Locarnese, Luganese and Mendrisiotto districts, with a greater attention to border areas with Italy, using CDC traps and Box-Gravid Mosquito traps coupled with honey-baited FTA cards. To increase the possibility of finding WNV or USUV, both the FTA cards and the target mosquito species (<i>Culex pipiens</i> and <i>Culex modestus</i>) retrieved from traps are analysed by semi-nested endpoint PCRs for the detection of flaviviruses (PanFlavi PCR) with subsequent sequencing of the positive amplified product.
The result	During the 2020-2021 surveillance, a total of 130 traps were set in the field, collecting 5669 mosquitoes. The analysis of both FTA cards and mosquitoes confirmed the presence of Usutu virus, while West Nile virus has never been detected so far. The genome of the USUV detected in mosquitoes in 2020 was fully sequenced and was found to be similar to some USUV samples from Italy (lineage 4). The presence of Usutu virus in these areas indicates that there are the conditions that have allowed the cycle of this flavivirus, closely related to WNV, and for this reason is important to continue this surveillance in order to detect the pathogens before their emergence in animal or human populations. Surveillance of arboviruses will continue in the current year and at least until 2025.
Research domain	Axis 1 - Built environment, natural resources and safety
	

Swiss Competence Center for Invasive Mosquitoes

Sector	Vector Ecology																																																																																																																																															
Keywords	Invasive mosquito, Ae. albopictus, Ae. japonicus; Ae. koreicus; surveillance																																																																																																																																															
Project leader	Eleonora Flacio, Lukas Engeler, Klaudia Erndle																																																																																																																																															
Duration	2017-2023																																																																																																																																															
Funding Agency	FOEN																																																																																																																																															
Research Partners	Swiss TPH, City of Zurich, University of Lausanne, Info Fauna																																																																																																																																															
Abstract	The objective of the project is to create a national coordination center for the surveillance and control of invasive mosquitoes to support the cantonal authorities in charge (Art. 52 FrSV). The coordination center will also, within the Reference Network for Invasive Mosquitoes (NRIS), collect and validate all invasive mosquito data, build a dedicated web page and analyze the collected data in order to build distribution and suitability models for invasive mosquitoes and disease transmission risk.																																																																																																																																															
The project	<p>The project aims to:</p> <ul style="list-style-type: none"> • Coordinate activities around surveillance and control of invasive mosquitoes, with focus on Ae. albopictus, at national level • Support the Cantons in building up their own invasive mosquito surveillance programme through direct coaching and free extra traps (location changes every 1 – 2 years) • Provide information material, such as guidelines, SOP's, flyers, images of invasive mosquitoes, literature, action plan for epidemics, etc. • Manage invasive mosquito citizen reports through a dedicated web page • Perform rapid site inspections in case of Ae. albopictus findings in new areas • Central collection of data on invasive mosquitoes coming from citizen reports and surveillance programmes • Forward the collected data to the National Data and Information Centre of Swiss Fauna (info fauna - SZKF / CSCF) 																																																																																																																																															
The result	<table border="1"> <thead> <tr> <th>Nr</th> <th>Canton / Country</th> <th>Managed by</th> <th>Active since</th> <th>Nr. ovitraps (2021)</th> <th>TM Situation</th> </tr> </thead> <tbody> <tr><td>1</td><td>TI</td><td>SUPSI</td><td>2000</td><td>1'355</td><td>TM largely established</td></tr> <tr><td>2</td><td>GR</td><td>SUPSI</td><td>2016</td><td>163</td><td>TM locally established</td></tr> <tr><td>3</td><td>ZH</td><td>SUPSI, RO-NE</td><td>2016</td><td>35</td><td>Isolated TM detection</td></tr> <tr><td>4</td><td>GL</td><td>SUPSI</td><td>2017</td><td>6</td><td>No TM finds till now</td></tr> <tr><td>5</td><td>UR</td><td>SUPSI</td><td>2017</td><td>23</td><td>Isolated TM detection</td></tr> <tr><td>6</td><td>FL</td><td>SUPSI</td><td>2017</td><td>25</td><td>Isolated TM detection</td></tr> <tr><td>7</td><td>BS</td><td>SwissTPH</td><td>2018</td><td>223</td><td>TM locally established</td></tr> <tr><td>8</td><td>BL</td><td>SwissTPH</td><td>2018</td><td>61</td><td>TM locally established</td></tr> <tr><td>9</td><td>AG</td><td>SwissTPH</td><td>2018</td><td>28</td><td>No TM finds till now</td></tr> <tr><td>10</td><td>SZ</td><td>SUPSI</td><td>2019</td><td>48</td><td>No TM finds till now</td></tr> <tr><td>11</td><td>GE</td><td>SUPSI, RO-W</td><td>2019</td><td>6</td><td>TM locally established</td></tr> <tr><td>12</td><td>VS</td><td>SUPSI, RO-W</td><td>2019</td><td>30</td><td>TM locally established</td></tr> <tr><td>13</td><td>VD</td><td>SUPSI, RO-W</td><td>2019</td><td>44</td><td>Isolated TM detection</td></tr> <tr><td>14</td><td>FR</td><td>SUPSI, RO-W</td><td>2019</td><td>6</td><td>Isolated TM detection</td></tr> <tr><td>15</td><td>NE</td><td>SUPSI, RO-W</td><td>2019</td><td>6</td><td>No TM finds till now</td></tr> <tr><td>16</td><td>JU</td><td>SUPSI, RO-W</td><td>2019</td><td>6</td><td>No TM finds till now</td></tr> <tr><td>17</td><td>SH</td><td>SUPSI</td><td>2020</td><td>12</td><td>Isolated TM detection</td></tr> <tr><td>19</td><td>LU</td><td>SwissTPH</td><td>2021</td><td>6</td><td>Isolated TM detection</td></tr> <tr><td>18</td><td>TG</td><td>SUPSI</td><td>2021</td><td>6</td><td>No TM finds till now</td></tr> <tr><td>20</td><td>SO</td><td>SwissTPH</td><td>2021</td><td>12</td><td>Isolated TM finds</td></tr> <tr><td>21</td><td>BE</td><td>SwissTPH</td><td>2021</td><td>12</td><td>Isolated TM finds</td></tr> <tr><td>22</td><td>SG</td><td>SUPSI, RO-NE</td><td>2021</td><td>12</td><td>Isolated TM finds</td></tr> </tbody> </table> <p>TM: Tiger mosquito, RO: Reporting office, Grey: no monitoring in 2021</p> 						Nr	Canton / Country	Managed by	Active since	Nr. ovitraps (2021)	TM Situation	1	TI	SUPSI	2000	1'355	TM largely established	2	GR	SUPSI	2016	163	TM locally established	3	ZH	SUPSI, RO-NE	2016	35	Isolated TM detection	4	GL	SUPSI	2017	6	No TM finds till now	5	UR	SUPSI	2017	23	Isolated TM detection	6	FL	SUPSI	2017	25	Isolated TM detection	7	BS	SwissTPH	2018	223	TM locally established	8	BL	SwissTPH	2018	61	TM locally established	9	AG	SwissTPH	2018	28	No TM finds till now	10	SZ	SUPSI	2019	48	No TM finds till now	11	GE	SUPSI, RO-W	2019	6	TM locally established	12	VS	SUPSI, RO-W	2019	30	TM locally established	13	VD	SUPSI, RO-W	2019	44	Isolated TM detection	14	FR	SUPSI, RO-W	2019	6	Isolated TM detection	15	NE	SUPSI, RO-W	2019	6	No TM finds till now	16	JU	SUPSI, RO-W	2019	6	No TM finds till now	17	SH	SUPSI	2020	12	Isolated TM detection	19	LU	SwissTPH	2021	6	Isolated TM detection	18	TG	SUPSI	2021	6	No TM finds till now	20	SO	SwissTPH	2021	12	Isolated TM finds	21	BE	SwissTPH	2021	12	Isolated TM finds	22	SG	SUPSI, RO-NE	2021	12	Isolated TM finds
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Research domain	Axis 1: Built environment, natural resources and safety; Axis 5: Digital Ecosystems; Axis 6: Social systems and public health																																																																																																																																															

High resolution optical identification of *Aedes albopictus* and *Aedes aegypti* eggs

Sector	Vector Ecology
Keywords	<i>Aedes albopictus</i> , <i>Aedes aegypti</i> , identification, surveillance, arbovirus
Project leader	Nikoleta Anicic, Eleonora Flacio, Lukas Engeler
Duration	2021-2022
Funding Agency	WHO
Research Partners	ECOSUR (Mexico)
Abstract	Invasive mosquito species of the genus <i>Aedes</i> represent a risk to public health due to their ability to transmit viral diseases (e.g. Dengue, Chikungunya, Zika) and for this reason there is a need to monitor and control these species. The objective of this project is to develop a high-resolution optical instrument to identify differences in the chorion structure of eggs of the two main invasive species (<i>Aedes albopictus</i> and <i>Aedes aegypti</i>). This system would allow rapid analysis of field-collected samples and quantification of the abundance of the two species in the event that both are present, thus improving arboviral disease surveillance. In the implementation of this project, researchers from the ECOSUR laboratory (Mexico) will be in charge of egg collection, while the Vector Ecology Sector (SUPSI-DACD-Istituto Microbiologia) will analyze the samples with the optical instrument. The results obtained will be analyzed in parallel by molecular techniques in order to confirm the method.
The project	In 2020-21, the vector ecology department of SUPSI has validated an optical determination method for the distinction of eggs of <i>Ae. albopictus</i> from <i>Ae. japonicus</i> and <i>Ae. koreicus</i> . The surface structure of the chorion (outer surface of the egg) was examined using a high-resolution ZEISS Axio Zoom.V16 microscope. The species were optically identified and the identifications were confirmed via MALDI-TOF mass spectrometry. With this optical identification technique, the operator can reliably distinguish eggs of <i>Ae. albopictus</i> from <i>Ae. japonicus</i> and <i>Ae. koreicus</i> , while for the two latter species the accuracy is less than 95%. The advantages of the optical identification technique are that even eggs in bad condition or already hatched can be analyzed, more or even all the eggs on a sample can be identified, and the eggs do not need to be destroyed and can be reused for further analyses and that it is much less time consuming. With the present study, we will evaluate if this methodology can be also applied to distinguish eggs of <i>Ae. albopictus</i> from eggs of <i>Ae. aegypti</i> . Therefore, we need fresh eggs from the field, because in our experience eggs from laboratory rearing could have altered characteristics that would not reflect the reality in the field. The work group of Pablo Liedo's laboratory (ECOSUR) in Mexico will provide <i>Ae. aegypti</i> and <i>Ae. albopictus</i> eggs collected in the field from at least 20 different sites characterized by the presence of <i>Ae. albopictus</i> (5 sites), <i>Ae. aegypti</i> (5 sites) and both species (10 sites). From each site, we need samples from 2-3 ovitraps and 5 eggs pro sample will be analyzed for a total of 250 eggs. After highlighting morphological differences, the species will be confirmed by PCR.
The result	A validated identification method for eggs of <i>Aedes albopictus</i> and <i>Aedes aegypti</i> using high-resolution microscopy that allows a rapid analysis of the samples collected in the field and a quantification of the abundance of the two species where both are present. A tool (protocol) that can be used by an operator in order to be able to differentiate <i>Ae. aegypti</i> eggs from <i>Ae. albopictus</i> eggs.
Research domain	Axis 3: Innovative products and processes
Picture	

4. SWOT analysis

<p>Strength</p> <ul style="list-style-type: none"> - Unique research unit in Canton Ticino operating in the fields of Biosafety, microbial ecology, environmental hygiene and health, vectors of emerging diseases and biotechnology - Infrastructure, updated equipment, field station - Personal competences multidisciplinary - Link with national and international research networks, RLN for Biosafety - Strong link with UNIGE, UNI ZH, UNI Insubria with the possibility for PhD and Master thesis - Cooperation and co-utilization of devices and space with EOLAB hosted in the same building - BSL3 laboratory managed by IM 	<p>Opportunities</p> <ul style="list-style-type: none"> - Growing awareness in the society for an eco-health view, integrating human, veterinary and environmental fields/habitats (?) (e.g. antibiotic resistances, vector borne diseases, SARS-CoV-2 virus) - The increase of invasive vectors in the future will become a national problem - Increasing requests for identification/typing of microorganisms from environment (natural or built environments, production chains, etc.) - Transfer of part of the staff in the new DACD building in Mendrisio, increasing the collaboration opportunities with IST, IMC, LCV and ISAAC transformation of LMA to Institute - Acquisition of the BET group of DTI for increasing synergies - Development of home office - Thanks to the development of next generation sequencing technology, new opportunities for deeper studies of microbes and microbial populations.
<p>Weaknesses</p> <ul style="list-style-type: none"> - Lack of EU-funding - Lack of teaching activities in SUPSI - Limited logistic space for future expansion - Lack of a Life Sciences curriculum 	<p>Threats</p> <ul style="list-style-type: none"> - Weakness of the region vs. rest of CH - Competition with the big Swiss institutes for financing big long-term projects - Fractionation of the group due to the transfer to the new DACD in Mendrisio (Biosafety separated from the rest) - Risk of losing the network at the national level if there is no constant feeding of relationships - Lack of generational turnover to ensure continuity

5. Gender and Diversity: SUPSI Checklist

1. General aspects and framework conditions	YES	No	Comments
In the strategy of your Research Unit, do you refer to the objectives and apply the measures of the SUPSI Equal Opportunities, Diversity and Inclusion Action Plan ¹³ (P13 Equal Opportunities SUPSI QMS) that allow the development of framework conditions useful to integrate the gender and Diversity dimension in research and service development projects?	Yes		
2. Research and services team			
Do you support the work-life balance of employees in your research unit?	Yes		Home office; Individual organization of work; elasticity for vacation and leisure time
Do you support the achievement of a better gender balance in your teams? Do you adopt such measures in recruitment/selection processes, career development/progression and leadership within your Unit?	Yes		4 of 5 sectors are led by women
Do you favour the development of the skills of those who have a role of responsibility within your Unit, on issues related to the management of a team attentive to Diversity and unconscious gender stereotypes? Do you find out about the possibilities offered at SUPSI in this respect?	Yes		4 of 5 sectors are led by women therefore the management is attentive to these issues
Are equal working conditions guaranteed for female and male employees (including middle management) in research projects and service offerings?	Yes		
Do you allow employees to devote working hours or leave to research activities?	Yes		Home office; Individual organization of work; elasticity for vacation and leisure time
Do you ensure adequate measures to prevent violations of personal integrity such as discrimination, bullying and sexual harassment?	Yes		
3. Research projects and services			
When planning research and service projects, do you check whether and how gender and diversity are relevant to the development and results?			Not pertinent to the scientific field
When planning and designing research and service projects, do you assess the social impact of the respective results (reference objectives 4, 5 and 10 UN 2030 Agenda)?			Not pertinent to the scientific field
Do you check the gender and diversity dimension especially when collecting personal data?			Not pertinent to the scientific field
Do you use non-discriminatory expressions and images in the final project report and mention relevant findings on gender and diversity?	Yes		Gender e Diversity SUPSI directives for text editing are applied
Do you bring issues and research results that have integrated gender and Diversity aspects into teaching so that the whole student body is aware of their importance?			Not pertinent

Reference documents:

- Sustainable Development Goals of the UN AGENDA 2030
- [Gender equality in Horizon Europe](#) SUPSI Equal Opportunities, Diversity and Inclusion Action Plan 2021-2024
- SUPSI QMS Quality Manual
- Process P-8 Evaluation of research and service units and process P13 - Equal opportunities, of the SUPSI quality assurance system
- Directive Flexibility of working time and place of work
- Directive on the protection of personality and personal integrity (in force since 1 January 2022)
- Document "Recommendations for a culture of equal opportunities" drafted in 2012 by the then OPET

¹³ The SUPSI Equal Opportunities, Diversity and Inclusion Action Plan meets the requirements (binding and recommended), which the European Commission requires for the submission of projects to the new Horizon Europe programme with reference to the *Gender Equality Plan*.

6. SUPSI research quality indicators

Categories/ Quantitative Indicators audit evaluation				
results 4 years	2018	2019	2020	2021
Research Output;				
Peer-reviewed scientific publications;	11	20	12	10
Open Access peer-reviewed scientific publications;	6	12	9	7
Scientific publications	9	20	12	10
Non-scientific publications;	2	0	0	0
Scientific presentations;	21	34	15	34
Patents;	0	0	0	0
Start-ups;	0	0	0	0
Artefacts/Innovative software solutions/Industrial prototypes	0	0	0	0
Awards;	0	0	0	0
H-index of citations (average value of professors, researchers, scientific collaborators and doctoral students)	n.a.	n.a.	n.a.	8.7
Research volume;				
Percentage self-financing research (see contabilità analitica AF diretto);	98%	96%	89%	n.a.
Volume acquisitions (total volume and % to total cost)	1'547'405 76.9%	1'822'039 77.5%	1'847'118 69.1%	2'815'833 76.7%
Service volume				
percentage self-financing; (see contabilità analitica AF diretto)	110%	104%	111%	
Volume acquisitions (total volume and % to total cost);	42'289 0.02%	69'667 0.03%	20'883 0.01%	84'974 0.02%
Impact teaching				
Number of new courses;	1	2	1	8
Number of updated courses;	1	2	3	9
Supervision BA-thesis;	1	1	1	3
Supervision MA-thesis;	2	2	3	10
Supervision PhD-thesis;	2	5	5	8
Teaching hours;	242h	363h	363h	977h
Creation of cultural/non-scientific courses;	0	0	0	0
Number of tools developed by the research unit (i.e. learning materials, annotated bibliographies, databases...);	1	1	2	3
Regional impact				
Number and percentage of researchers or teacher-researchers with a teaching qualification	1	1	1	2
Projects with local/regional stakeholders;	11	14	24	32
Cooperations with regional institutions;	11	14	22	29
Executive projects;	0	0	0	0
Satisfaction rate project partners/ by interview end of project;	n.a.	n.a.	n.a.	n.a.
Human Resource Indicators				

Number professors/no titles specified;	1	1	1	1
Number of FT equivalent senior researchers compared to the total number of FT equivalent researchers;	1.8/14.4	2.1/15.8	4.2/19.5	5.1/22.7
Number of research assistants (BA/MA students);	1	1	2	3
Number of doctoral researchers/PhD students;	1	1	2	3
Cooperations				
Internal cooperations SUPSI;	3	4	10	14
Scientific external cooperations;	23	38	55	62
Participation national networks;	11	16	30	38
Participation international networks;	0	3	6	9
Funding; in CHF				
Cantonal funding for the research	15'000	73'431	44'729	140'697
Cantonal research and services Mandate (DSS)	1'171'545	1'151'545	1'181'545	1'181'545
Innosuisse funding	18'300	17'000	19'996	178'239
FNS funding	20'093	100'512	124'339	333'961
Other federal research funding	116'591	200'892	190'894	552'218
EU research program funding	-	1'371	8'223	3'221
Other research program & foundations funding	69'409	87'478	68'263	78'230
Other research funding	136'468	189'810	209'578	418'892
Percentage of successful proposals;	92%	87%	88%	79%

7. Criteria for the sustainability of SUPSI research

Version 12/2021
SUPSI Research Service

Evaluation:

1) given: yes/no

2) evaluation scale, indicate **high-middle-low**

General Indicators: Quantitative/Qualitative	evaluation
General sustainability impacts	
Indicated impacts referring to the 17 sustainability goals – SDGs <ul style="list-style-type: none"> • Ensure healthy lives and promote well-being at all ages (SDG nr.3); • Ensure availability and sustainable management of water and sanitation for all (SDG nr.6) • Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation (SDG nr.9) • Make cities and human settlements inclusive, safe, resilient and sustainable (SDG nr.11) • Take urgent action to combat climate change and its impacts* (SDG nr.13) • Conserve and sustainably use the oceans, seas and marine resources for sustainable development (SDG nr.14) • Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss (SDG nr.15) • Include partnerships at the global, regional, national, and local levels (SDG nr.17). 	Yes
Sustainability of research <i>high/middle/low</i>	
Impact environment: <ul style="list-style-type: none"> • indicate percentage of projects with impact on the environment; • indicate example of impacts; BET, vector ecology 	94% (52/55)
Economic impact: <ul style="list-style-type: none"> • indicate percentage of project with applied results in economic institutions/ vector ecology • effects on environmental issues 	78% (43/55)
Social impact: indicate percentage of projects with <ul style="list-style-type: none"> • social impact/ vector ecology • indicate projects with cultural impact; C+R/ CBA • indicate examples of impact 	78% (43/55)
Cultural impact: <ul style="list-style-type: none"> • indicate percentage projects with cultural impact; 	20% (11/55)
Impact on teaching <ul style="list-style-type: none"> • indicate percentage projects with impact on teaching Bachelor/Master; • Indicate percentage projects with impact on teaching for further education internally; seminars/ green Day • Indicate percentage projects with impact on teaching for further education offers externally; C+R/CBA/MSE 	9% (5/55)
Governance	
Research Strategy	yes
Regular Meetings, Commissions	yes
Annual feedback to researchers;	High
Transparency/Communication policy;	High
Diversity	percentage
Gender aspects unit	yes/no

Other diversity aspects (inclusion, cultural diversity, diversity of age); no gender discrimination	yes/no
Integrated in Research Strategy; not pertinent for the research field	yes/no
Career options	
Number doctorates/total number researchers;	9%
Research assistants/total number of researchers;	6%
Participation conferences; 104 in the last 4 years	High
Transparency career options; see SUPSI career planning internal directive 4B	yes
Career planning; see SUPSI career planning internal directive 4B	yes
Mentoring programme; mandatory according to quality system (check where indicated)	yes
Visibility	
Website; https://www.supsi.ch/im_en.html	indicated
Languages Italian/English /others	yes
Communication research focus	yes
Presentations researchers	yes
Presentations projects	yes
Alumni/Stakeholders presented	no
Affiliate: Visibility SUPSI	yes

8. List of research projects, 2014-2022

Project	Area	Leader	Budget, CHF	Project phase	Start	End	Funding body/scientific partner
Mosquito-borne viruses surveillance in Canton Ticino, phase 2	Biosicurezza	Guidi Valeria	180000	In corso	2022	2025	Confederazione, UFPP / Labor Spiez
MetaPCP - Metagenomics as process control parameter	BET	R König	15000	In corso	2022	2022	Innosuisse
Monitoraggio di determinanti genici di resistenza in alcuni corsi d'acqua a monte e a valle di impianti di depurazione delle acque reflue.	Identificazioni/tipizzazioni	Federica Mauri	30000	in corso	2022		Cantone Ticino, DT
Natural compounds for Biofilm control in a beer manufacturing start up	BET	P.Principi	15000	In corso	2022	2022	Innosuisse
NGTOXDET, Next Generation Toxin Detection	Biosicurezza	Rindlisbacher Jan/Michael Moser	280000	In corso	2021		Confederazione, Armasuisse / Labor Spiez
VectoMax, valutazione efficacia del prodotto VectoMax	Ecologia dei vettori	Flacio Eleonora	25000	In corso	2021	2023	Interno
Monitoraggio del Sars-Cov-2 nelle acque in entrata degli impianti di depurazione del Canton Ticino	Biosicurezza	Mauri Federica	170000	In corso	2021		Confederazione UFSP, Cantone Ticino, DSS
Sviluppo ed implementazione di nuove tecniche per analisi virologiche	Biosicurezza	Guidi Valeria	127000	In corso	2021		Interno SUPSI
Validazione determinazione uova zanzare invasive	Ecologia dei vettori	Flacio Eleonora	10000	In corso	2021	2022	Interno
Multitrophic and multispatial biodiversity-ecosystem functioning relationships	Ecologia microbica	Bruder Andreas	773088	In corso	2021		SNF
Establishment of the CRISPR-Cas system for rapid diagnostics and the development of antiviral strategies	Biosicurezza	Valeria Guidi	320000	In corso	2021	2025	Confederazione, UFPP / Labor Spiez
Sviluppo di Filtri Fotocatalitici porosi per la Disinfezione dell'Aria in ambienti chiusi	Biosicurezza	Guidi Valeria	200000	In corso	2021	2022	Interno SUPSI / DTI-MEMTI
Heat shock treatment using green technology for monuments affected by biodeterioration	Ecologia microbica	Corti Cristina Margarida	50000	Concluso	2021	2022	Interno SUPSI
Identificazione ottica ad alta risoluzione di uova di Aedes albopictus ed Aedes aegypti	Ecologia dei vettori	Anicic Nikoleta	45000	In corso	2021	2022	WHO
Studio sulla presenza di microplastiche nei suoli del Canton Ticino	Ecologia microbica	Bruder Andreas	40000	concluso	2021	2021	Cantone Ticino, DT
Centro Nazionale di Referenza per le malattie trasmesse dalle Zecche	Biosicurezza	Tonolla Mauro	40000	Concluso	2021		Confederazione, UFPP,
Monitoraggio resistenze antibiotiche Lago Ceresio	Igiene e ambiente	Federica Mauri	30000	in corso	2021	2022	Cantone Ticino, DT
OSTEOSEQ-LMA, transcriptomic and molecular dynamics analysis	Ecologia dei vettori	Buetti Antoine	20000	In corso	2021		Interno

Aquatic hyphomycetes in streams of the Swiss National Park	Ecologia microbica	Bruder Andreas	10040	In corso	2021		FK Swiss national Park
Endophytic <i>Cephalotrichum</i> spp. from <i>Solanum tuberosum</i> (potato) in Iran – identification through DNA sequencing and MALDI-TOF MS	Igiene e ambiente	Sophie De Respinis	10000	Concluso	2021	2021	University of Tehran (Iran)
Indoor microorganisms as indicators of air quality	Igiene e ambiente	Sophie De Respinis	10000	In corso	2021		
Use of the new campus from Department for Environment Constructions and Design for a long-term monitoring of indoor airborne microorganisms in dust	Igiene e ambiente	Sophie De Respinis	10000	In corso	2021		
Identification of <i>Wolbachia</i> populations in mosquitoes of Canton Ticino	Biosicurezza	Guidi Valeria	40000	In corso	2020	2023	
Combined micropollutant and microplastic elimination with an innovative PAC-Filtration technology	BET	R. König	269976	In corso	2020		Innosuisse DrM
Layer by layer technology for the prevention of microbiological growth on immovable Cultural Heritage	Ecologia microbica	Corti Cristina Margarida	100000	Concluso	2020	2021	Interno SUPSI
Anaerobic digestion with conductive material and electrogenic microorganisms	BET	Principi Pamela	290000	In corso	2020	2023	Confederazione, UFAM
Development of a biotic index for Karun River, Iran, based on macroinvertebrate and fish assemblages - II	Ecologia microbica	Bruder Andreas	249832	In corso	2020		FNS
Sorveglianza zanzare invasive ZH	Ecologia dei vettori	Engeler Lukas	160000	In corso	2020	2023	Cantone Zurigo
Anaerobic digestion with conductive material and electrogenic microorganisms - 2-	Igiene e ambiente	Mauri Federica	108700	In corso	2020		Confederazione, UFAM
Automatic Device for Mosquitos Viral Screening via DNA-based Biosensors	Biosicurezza	Guidi Valeria	103459	In corso	2020	2023	Innosuisse / TIBIO, CHISER, EPFL, ISEA-SUPSI
Développement de protocoles pour la détection rapide des rejets d'eaux usées dans les eaux claires	Igiene e ambiente	Mauri Federica	69500	Concluso	2020	2021	Città Losanna, servizio protezione acque
Vector competence for dengue and chikungunya viruses of the <i>Aedes albopictus</i> from Canton Ticino	Biosicurezza	Guidi Valeria	68298	In corso	2020	2022	Confederazione, UFAM / UNIZH
Economic feasibility of additive manufactured natural zeolite filters for micropollutant adsorption	BET	R König	50000	In corso	2020	2022	BAFU
Concetto ABC, consulenza e formazione in ambito B	Biosicurezza	Guidi Valeria	50000	In corso	2020	2024	Cantone Ticino, DT / SPAAS
Mosquito-borne viruses surveillance in Canton Ticino	Biosicurezza	Guidi Valeria	35000	Concluso	2020	2021	Confederazione, UFPP, UFSP / Labor Spiez
Monitoraggio resistenze antibiotiche in tre fiumi immissari del Lago di Lugano	Igiene e ambiente	Federica Mauri	30000	Concluso	2020	2021	Cantone Ticino, DT
Molecular description of new aquatic hyphomycete cultures	Ecologia microbica	Bruder Andreas	18750	concluso	2020	2022	Confederazione/BAFU
Preparing freshwater biodiversity monitoring for the next decade	Ecologia microbica	Bruder Andreas	15800	In corso	2020		FNS

Feasibility study on environmental monitoring of SARS-CoV-2 on high-touch surfaces	Biosicurezza	Guidi Valeria	14261	Concluso	2020	2021	Confederazione, UFAM
Corona Immunitas Ticino: studio epidemiologico per valutare l'impatto del coronavirus, la sua diffusione e lo sviluppo dell'immunità nella popolazione ticinese	Igiene e ambiente	Corti Cristina Margarida	300000	In corso	2020		Swiss School of Public Health (SSPH+), Ufficio Federale di Sanità Pubblica, diversi cantoni e numerose aziende.
Sequenziamento spettrometrico di massa per l'identificazione di biomarcatori proteici	Biosicurezza	Tonolla Mauro	312813	Concluso	2019	2021	Confederazione, UFPP, Labor Spiez
Agrochemicals affecting microbial ecology	Ecologia microbica	Bruder Andreas	99100	concluso	2019	2021	FNS
Progetti di ricerca con la CIPALS Sez 3	Ecologia microbica	Bruder Andreas	89606	In corso	2019		Cantone Ticino/CIPALS
Development of a biotic index for Karun River, Iran, based on macroinvertebrate and fish assemblages	Ecologia microbica	Bruder Andreas	60540	In corso	2019		Swiss Leading House for South Asia and Iran/ Iranian Ministry for Research and Technology
Ophthalmologic medical system for Dry Eye Syndrome (DES) treatment	Biosicurezza	Tonolla Mauro	24668	In corso	2019	2023	EUROSTARS / SUPSI-ISIN-ISEA-MEDTECH, BH Swiss, GRINN, ABA Mobile, LDT
Virome determination of endemic and invasive mosquitoes in Ticino	Biosicurezza	Guidi Valeria	16172	Concluso	2019	2022	Swiss School of Public Health / UNIZH
ALBIS2 Microclimate impact on risk scenarios for exotic invasive mosquitoes in Switzerland	Ecologia dei vettori	Ravasi Damiana	12615	In corso	2019		Confederazione, UFAM
Impact of environmental and physiological factors on the mycobioma of alpine cheeses from southern Switzerland	Igiene e ambiente	De Respinis Sophie	5000	Concluso	2019	2021	Cantone Ticino, DFE, Sezione agricoltura
Monitoraggio di determinanti genici di resistenza nel Lago di Lugano e in alcuni fiumi immissari	Ecologia microbica	Demarta Aeschbacher Antonella	48716	Concluso	2019	2020	Cantone Ticino, DT
Identificazione microorganismi endofitici degli alberi	Ecologia microbica	Bruder Andreas	15000	Concluso	2019	2020	InnoSuisse
Sorveglianza zanzare invasive nei cantoni Romandi	Ecologia dei vettori	Engeler Lukas	15214	Concluso	2019	2019	Cantoni Romandi
Sorveglianza di zanzare invasive nel Principato del Liechtenstein	Ecologia dei vettori	Engeler Lukas	9732	Concluso	2019	2019	Principato Liechtenstein
Trattamenti larvicidi contenitivi sui sedimenti della stazione merci FFS di Balema	Ecologia dei vettori	Engeler Lukas	9121	Concluso	2019	2019	FFS
Sorveglianza di zanzare invasive nel Canton Svitto	Ecologia dei vettori	Engeler Lukas	9002	Concluso	2019	2019	Canton Svitto
Sorveglianza zanzare invasive nel Canton Uri	Ecologia dei vettori	Engeler Lukas	7787	Concluso	2019	2019	Canton Uri
Sorveglianza di zanzare invasive nel Canton Glarona	Ecologia dei vettori	Engeler Lukas	6548	Concluso	2019	2019	Canton Glarona
Sorveglianza e misure di controllo per zanzare invasive nel Canton Grigioni (da accorparsi con quello FFS di Francesco Pace?)	Ecologia dei vettori	Flacio Eleonora	1230	Concluso	2019	2019	Cantone Grigioni
Mini Onsite System To valorizzare manure in methane	BET	Principi Pamela	403785	In corso	2018	2022	Innosuisse LaborexSA

BIOCAD - Bioconvection-mediated microbial ecophysiology in aquatic systems	Ecologia microbica	Storelli Nicola	543341	In corso	2018		FNS
Sostegno e analisi nella sorveglianza zanzara tigre Canton Grigioni	Ecologia dei vettori	Engeler Lukas	317344	In corso	2018	2023	Cantone Grigioni
Programma nazionale di sorveglianza della zanzara tigre	Ecologia dei vettori	Flacio Eleonora	86713	In corso	2018		Confederazione, UFAM
Indoor moulds - Study of the mycobioma in varying indoor environments	Igiene e ambiente	De Respinis Sophie	46849	In corso	2018		Lega Polmonare Ticinese
Valutazione di trasmissione locale di arbovirus in Canton Ticino	Ecologia dei vettori	Flacio Eleonora	39540	In corso	2018		Confederazione, UFAM
Tombini come possibile serbatoio di Legionella e ricerca di batteriofagi specifici per Legionella.	Igiene e ambiente	Mauri Federica	28147	Concluso	2018	2021	Cantone Ticino, DSS
Comunità dei funghi acquatici in vari ambienti delle Bolle di Magadino	Ecologia microbica	Bruder Andreas	18406	concluso	2018	2022	Fondazione Bolle Magadino
Trattamenti FFS Balerna	Ecologia dei vettori	Pace Francesco	13581	In corso	2018		FFS
Sorveglianza zanzare invasive Liechtenstein	Ecologia dei vettori	Flacio Eleonora	10879	Concluso	2018	2020	Principato Liechtenstein
Mutagenesi Sprosarcaria pasteurii	Biosicurezza	Ruinelli Michela	14116	Concluso	2018	2019	TiBio
Sorveglianza specie invasive Canton Glarona	Ecologia dei vettori	Flacio Eleonora	10890	Concluso	2018	2019	Cantone Glarona
Zanzara Bolle di Magadino	Ecologia dei vettori	Flacio Eleonora	9410	Concluso	2018	2019	Fondazione Bolle Magadino
Zanzare laghetto di Muzzano	Ecologia dei vettori	Flacio Eleonora	8205	Concluso	2018	2019	Pro Natura Ticino
MALDI-TOF MS analysis of potential plant growth-promoting bacteria, isolated from different arid regions	Igiene e ambiente	Sophie De Respinis	5000	Concluso	2018	2019	King Abdullah University of Science and Technology Saudi Arabia
ALBIS Microclimate impact on risk scenarios for exotic invasive mosquitoes in Switzerland	Ecologia dei vettori	Ravasi Damiana	39862	Concluso	2018	2018	Interno SUPSI
Multi level diversity hyphomycetes ecosystem functionality	Ecologia microbica	Bruder Andreas	18500	Concluso	2018	2018	FNS
Biologia alpina Corsi universitari UNIGE in Piora organizzati da IM-SUPSI	Ecologia microbica	Storelli Nicola	12000	In corso	2017		Uni Genève
Centro CH di competenza per le zanzare invasive	Ecologia dei vettori	Flacio Eleonora	557103	In corso	2017	2023	Confederazione, UFAM
Monitoring and surveillance of fish infection diseases	Igiene e ambiente	Mauri Federica /De Respinis Sophie	45000	In corso	2017		Cantone Ticino, DSS
Two-phase ANaerobic digestion for Aqueous Industrial waStes	BET	Principi Pamela	113487	Concluso	2017	2018	Confederazione, UFE
Microbial ecology at the alpine-lake Catchment	Ecologia microbica	Tonolla Mauro	5600	Concluso	2017		FNS
Programma monitoraggio e analisi dati ambientali e gestione Piora	Ecologia microbica	Tonolla Mauro	172994	In corso	2016		Fondazione CBA

Emerging diseases and health risks	Biosicurezza	Guidi Valeria	155000	Concluso	2016	2019	Confederazione, UFSP, UFFP / Labor Spiez
Eradicazione delle mastiti causate da <i>Staphylococcus aureus</i> genotipo B nel Ticino	Biosicurezza	Guidi Valeria	50000	Concluso	2016	2016	Cantone Ticino, UVC
Pilotprojekt Entwicklung Strategie: Koord Unterstützung der Kantone Bekämpfung Tiger und Buschmücke	Ecologia dei vettori	Engeler Lukas	400000	In corso	2015		Confederazione/UFAM -Cantoni Svizzeri
Concetto di protezione ABC – Consulenza e formazione in ambito biologico	Biosicurezza	Tonolla Mauro	10000	Concluso	2015	2019	Cantone Ticino, DT / SPAAS
Characterization of <i>Saprolegnia</i> at the molecular level in regard to pathological features in fish	Igiene e ambiente	Ravasi Damiana	159330	Concluso	2015		Uni Bern
Investigation of the impact of PAC recycling to the occurrence of ARB in a municipal WWTP	Ecologia microbica	Principi Pamela	55000	Concluso	2015	2016	Confederazione/UFAM
Indagini sulla presenza di determinanti genici di resistenza agli antibiotici nelle acque del lago di Lugano	Ecologia microbica	Demarta Antonella	49200	Concluso	2015	2016	Cantone Ticino/CIPAIS
BAAR, Life/death <i>Mycobacterium tuberculosis</i>	Biosicurezza	Guidi Valeria	40000	Concluso	2014	2018	Fondazione Lega polmonare (Fondazione Crivelli) / EOLAB
Optimierung der Methoden zum Nachweis von Viren in Vektoren	Biosicurezza	Guidi Valeria	155000	Concluso	2014	2017	Confederazione, UFPP / Labor Spiez, STPH
Analysis of <i>Bacillus thuringiensis israelensis</i> spores in the soil of the natural reserve of the Thurauen	Biosicurezza	Guidi Valeria	43583	Concluso	2014	2017	AWEL, Zurigo
Distribution of Antibiotic Resistant microorganisms in municipal wastewater treatment plants (WWTP)	Igiene e ambiente	Demarta Antonella	40100	Concluso	2014	2015	Confederazione
CH Monitoring BAFU	Biosicurezza/Vettori infettivi	Guidi Valeria	27155	Concluso	2014	2017	Confederazione, UFAM / STPH
MALDILEG, creation of a new MALDI-TOF MS database for the identification of <i>Legionella</i> through Vitek MS IVD and RUO systems	Igiene e ambiente	De Respinis Sophie	11950	Concluso	2014	2014	Biomérieux
MALDI_MIC, creation of a new MALDI-TOF MS database for the identification of dermatophyte fungi through Vitek MS IVD and RUO systems	Igiene e ambiente	De Respinis Sophie	28400	Concluso	2014	2014	Biomérieux

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Suter T., Flacio E., Feijoó Fariña B., Engeler L., Tonolla M., Müller P. (2015) First report of the invasive mosquito species <i>Aedes koreicus</i> in the Swiss-Italian border region <i>Parasit. Vectors.</i> 8: 402. Doi: 10.1186/s13071-015-1010-3.
Flacio E., Engeler L., Tonolla M., Lüthy P., Patocchi N. (2015) Strategies of a thirteen year surveillance programme on <i>Aedes albopictus</i> (<i>Stegomyia albopicta</i>) in southern Switzerland. <i>Parasit. Vectors</i> 8: 208.
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De Respinis S., Monnin V., Girard V., Welker W., Arzac M., Cellière B., Durand G., Bosshard P.P., Farina C., Passera M., Van Belkum A., Petrini O., Tonolla M. (2014) Dermatophytes on Solid Cultures for Rapid and Accurate Identification of Spectrometry Using the Vitek MS System-Time of Flight (MALDI-TOF) Mass. <i>J. Clin. Microbiol.</i> 52(12): 4286-4892. doi:10.1128/JCM.02199-14.
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Nicola Storelli, Sandro Peduzzi, Maged M. Saad, Niels-Ulrik Frigaard, Xavier Perret, Mauro Tonolla, CO ₂ assimilation in the chemocline of Lake Cadagno is dominated by a few types of phototrophic purple sulfur bacteria, <i>FEMS Microbiology Ecology</i> , Volume 84, Issue 2, May 2013, Pages 421–432, https://doi.org/10.1111/1574-6941.12074
Storelli N., Saad M., Frigaard N, Perret X. and Tonolla M. (2014) Proteomic analysis of the purple sulfur bacterium <i>Candidatus "Thiodictyon syntrophicum"</i> strain Cad16T isolated from Lake Cadagno. <i>EuPA Open Proteomics</i> 2: 17-30.

10. List of Presentations, 2014-2022

Meeting	Type	Year
Bruder A. 01/2022. Biodiversity and ecosystem functioning in small freshwater ecosystems in forests. Invited presentation at the general assembly of the Swiss Forest Lab (online).	Oral presentation	2022
Camilla Perego, Roger König, Markus Süsser, Pamela Principi Engineered carbon based filtration for the removal of micropollutants and microplastics from municipal wastewater treatment plant effluent 2022: 09 Marzo, Cologne, Filtech presentation and paper https://filtech.de/conference/conference-programme/	poster presentation	2022
PPrincipi Invited speaker Swiss-Canadian Cleantech Innovation Summit, Breakout session B2 Water & Waste management March 17, 2022 https://www.s-ge.com/en/overview/breakout-session-b2-water-waste-water-management	Oral presentation	2022
V. Guidi. Evaluation of the vector competence for dengue and chikungunya viruses of Aedes albopictus from southern Switzerland. EFBS Meeting, 11 May 2022	Oral presentation	2022
Storelli N. Microbial life in the anoxic waters of Lake Cadagno. PELAGICS Meeting (CZ), 2021	Oral presentation	2021
Di Nezio F. Ecophysiological impact of bacterial bioconvection in meromictic Lake Cadagno. SGM/SSM (virtual), 2021	Oral presentation	2021
Fernandes I., Bruder A. & Grossart H.-P. Aquatic fungi: bringing a key freshwater microbial group into the spotlight. SEFS12 (virtual) 2021	Oral presentation	2021
dos Reis Oliveira P., Cardoso I., Moretti M., Bruder A. & Janssen A. Ecocide in river ecosystems. SFS 2021 (virtual)	Oral presentation	2021
R. König Presentation, , 2.9.2021, Verband der Schweizer Gasindustrie, Rapperswil, Titolo: Mini Onsite System To valorize manure in methane, 3. Forschungstag der Schweizer Gaswirtschaft: Auf dem Weg zu einer klimaneutralen Gasversorgung;	poster presentation	2021
R.König Conference online, 26.1.2021, Mikroplastik in der Umwelt, Oekotoxzentrum/Eawag Dübendorf;	Oral presentation	2021

R.König Conference, 21.9.2021, VSA-Fachtagung "Biologische Abwasserbehandlung", Horgen;		2021
	oral presentation	
M. Cuomo, P. Principi, E. Zanardini, R. König Engineered Natural Zeolite Filters For Micropollutant Elimination Poster online (24.5 / 4.6) – IWA 2021 – Digital World Water Congress IWA Digital World Water Congress - International Water Association (iwa-network.org).		2021
	Poster presentation	
Guidi V. Evaluation of the vector competence for dengue and chikungunya viruses of <i>Aedes albopictus</i> from southern Switzerland. Swiss Vector Entomology Group Meeting, Mendrisio (CH), 26 November 2021.	Oral presentation	2021
Cazzin S. Surveillance of Flaviviruses in Southern Switzerland, 2018-2021. Swiss Vector Entomology Group Meeting, Mendrisio (CH), 26 November 2021.	Oral presentation	2021
J. Kubacki, S. Stegmüller, E. Flacio, V. Guidi, M. Tonolla, C. Fraefel. Viral metagenomic analysis of endemic and invasive arthropod vectors. Swiss Vector Entomology Group Meeting, Mendrisio (CH), 26 November 2021.	Oral presentation	2021
P. Müller, L. Engeler, L. Vavassori, T. Suter, V. Guidi, N. Ancicic, M. Gschwind, M. Tonolla and E. Flacio. Monitoring of invasive <i>Aedes</i> mosquitoes along Swiss traffic routes. Swiss Vector Entomology Group Meeting, Mendrisio (CH), 26 November 2021	Poster presentation	2021
Guidi V., Paslaru A., Veronesi E., Mathis A., Flacio E. Evaluation of the vector competence for dengue and chikungunya viruses of <i>Aedes albopictus</i> from southern Switzerland. Xth International EMCA Conference, Vienna (Austria), 3-7 October 2021.	Poster presentation	2021
Cazzin S., Flacio E. Guidi V. Surveillance of Flaviviruses in Southern Switzerland, 2018-2021. Xth International EMCA Conference, Vienna (Austria), 3-7 October 2021.	Poster presentation	2021
P. Müller, L. Engeler, M. Gschwind, L. Vavassori, T. Suter, V. Guidi, N. Anicic, M. Tonolla and E. Flacio. Monitoring of invasive <i>Aedes</i> mosquitoes along Swiss traffic routes. Xth International EMCA Conference, Vienna (Austria), 3-7 October 2021.	Poster presentation	2021
Guidi V. (2021). Evaluation of the vector competence for dengue and chikungunya viruses of the <i>Aedes albopictus</i> from Canton Ticino and estimation of the epidemic risk. Report for the Swiss Expert Committee for Biosafety (SECB).	Scientific report	2021
Rindlisbacher J. (2021). Establishment of a cytotoxicity assay for the determination of the biological activity of abrin. Characterization of CRM abrin EuroBioTox (EURM-113). Report for the Federal office for defence Procurement armasuisse.	Scientific report	2021
Heat shock treatment:green technology to tackle biodeterioration on monuments, 2021, rapporto di progetto, Marta CICARDI, Enrico BURAI, Tiziano TERUZZI, Cristina POLO LOPEZ, Francesca PIQUE, Cristina CORTI	Scientific report	2021

D Ravasi, D Parrondo Monton, M Tanadini, E Flacio "Evaluating the integrated management of Aedes albopictus in southern Switzerland". 3rd AIM-COST Annual Conference, 2-3 September, Istanbul, 2021 (Invited talk)	Oral presentation	2021
E. Flacio, Training school: Field Assessment of Quality in Control Measures (including SIT) against Aedes Invasive Mosquitoes, Valencia, 13-24 September 2021	Oral presentation	2021
E. Flacio, Sampling for quality assessment of AIM control measures – eggs, AIM-COST Training school Valencia, 13-24 September 2021	Oral presentation	2021
D. Ravasi, D. Parrondo Monton, M. Tanadini and E. Flacio. Evaluating the integrated management of Aedes albopictus in southern Switzerland, AIM-COST Training school Valencia, 13-24 September 2021	Oral presentation	2021
D. Ravasi, D. Parrondo Monton, M. Tanadini and E. Flacio. Evaluating the integrated management of Aedes albopictus in southern Switzerland, Xth international EMCA conference, Vienna, 3-4 October 2021	Oral presentation	2021
L. Engeler, P. Müller, D. Chérix, G. Müller and E. Flacio. Swiss Mosquito Network: a national coordination network for the activities on invasive mosquitoes, Xth international EMCA conference, Vienna, 3-4 October 2021	Oral presentation	2021
E. Flacio, Latest challenges and responses in mosquito control, Xth international EMCA conference, Vienna, 3-4 October 2021	Chair	2021
Workshop on control measures, Xth international EMCA conference, Vienna, 3-4 October 2021	Moderator	2021
Swiss Vector Entomology Group, meeting 2021, campus SUPSI, Mendrisio, 25-26 November	Meeting organizer	2021
E. Flacio. Surveillance and control of Invasive Mosquito in Switzerland, SVEG meeting 2021, campus SUPSI, Mendrisio, 25-26 November	Chair	2021
E. Flacio. History of mosquitoes activities in Canton Ticino, SVEG meeting 2021, campus SUPSI, Mendrisio, 25-26 November	Keynote lecture	2021
D. Ravasi, F. Mangili, D. Huber, L. Engeler, M. Tonolla and E. Flacio. Risk-based mapping tools for surveillance and control of invasive mosquito Aedes albopictus in Switzerland, SVEG meeting 2021, campus SUPSI, Mendrisio, 25-26 November	Oral presentation	2021

L. Engeler, P. Müller, D. Cherix, G. Müller and E. Flacio. Swiss Mosquito Network: a national coordination network for the activities on invasive mosquitoes, SVEG meeting 2021, campus SUPSI, Mendrisio, 25-26 November	Oral presentation	2021
S. Flämig, E. Flacio and A. Gander. Inventory of Culicidae in and around the nature reserve "Grande Cariçaie" (Lake Neuchâtel) 2019, SVEG meeting 2021, campus SUPSI, Mendrisio, 25-26 November	Poster	2021
S. Flämig and E. Flacio. Update on wetland mosquito fauna in southern Switzerland (Ticino), SVEG meeting 2021, campus SUPSI, Mendrisio, 25-26 November	Poster	2021
P. Müller, L. Engeler, L. Vavassori, T. Suter, V. Guidi, N. Ancicic, M. Gschwind, M. Tonolla and E. Flacio. Monitoring of invasive Aedes mosquitoes along Swiss traffic routes. (Poster), SVEG meeting 2021, campus SUPSI, Mendrisio, 25-26 November	Poster	2021
Ravasi D., Guidi V. (2021). Feasibility study on environmental monitoring of SARS-CoV-2 on high-touch surfaces. Report for the Federal Office for the Environment (FOEN)	Scientific report	2021
Zare M., Fathi P., Ebrahimi E., Keyvani Y. & Bruder A. The structure of fish and macroinvertebrate communities in the Karun River system, Iran. GEOBON Open Science Meeting (virtual) 2020	Oral presentation	2020
Bruder A, Turak E. Update on the Freshwater Biodiversity Observation Network (FWBON). GEOBON Open Science Meeting (virtual) 2020	Oral presentation	2020
Bruder A., Turak E. The Freshwater Biodiversity Observation Network (FWBON): Current State And Development Goals. WBF2020, Davos 2020	Oral presentation	2020
Bruder A. 01/2020. The food-web perspective in multiple-stressor research and management. Invited presentation at the group of Aquatic Ecosystem Analysis of UFZ Magdeburg, Germany.	Oral presentation	2020
Buetti-Dinh A. Applied bioinformatics in alpine microbial hydrological systems. SIB Bienne, 2020	Poster presentation	2020
Colombo L., Pozzoni M., Bulgheroni M., Capelli C., Scapozza C., Pera S. & Lepori F., Are climate changes affecting the acidification recovery of swiss alpine lakes?, ESA Virtual meeting 2020 Harnessing the ecological data revolution, 3-6.8.2020, 2020	Poster presentation	2020
Colombo L., Bulgheroni M., Capelli C., Pozzoni M., Pera S., Scapozza C. & Lepori F., 2020, Lago Nero observatory – Report of the five-years activities as a contribution to ICP IM, Reports of the Finnish environment institute 31, 2020, 29th Annual Report 2020 Convention on Long-range Transboundary Air Pollution ICP IM, 2020, Uppsala	Poster presentation	2020

De Respinis S., Riva Scettrini P., Petrini L., Tonolla M., Petrini O. 2020, Influsso di fattori ambientali e fisiologici sul microbioma di formaggi tradizionale ticinesi, Fase 1, Studio pilota, 24.11.2020	Scientific report	2020
Ravasi D. 01/2020. Oral presentation at SVEG Meeting, Basel. Mosquito-borne viruses and Public health Risk in southern Switzerland.	Oral presentation	2020
Ricerca e monitoraggio di determinati genici di resistenza agli antibiotici nelle acque di alcuni fiumi immissari al Lago Ceresio, 2020	Scientific report	2020
Tombini di scolo delle acque urbane come possibile serbatoio di <i>Legionella pneumophila</i>	Scientific report	2020
Cazzin S., Guidi V. (2020). Mosquito-borne viruses surveillance in Canton Ticino (MoBoViS). Project report for the Federal office for civil protection (FOCP) and the Federal Office of Public Health (FOPH).	Scientific report	2020
Rindlisbacher J. (2020). SEB bioassay for the characterization of recombinant produced SEB (EURM-110, EuroBioTox). Report for the Federal office for defence Procurement armasuisse.	Scientific report	2020
Layer by layer technology to prevent microbiological growth on immovable Cultural Heritage, 2020, rapporti interno, Cristina Corti, Annarita de Corso, Marta Cicardi, Francesca Pique	Scientific report	2020
Bruder A., Frainer A., Rota T. & Primicerio R. The food-web perspective in multiple-stressor research and management. SEFS 11, Zagreb 2019	Oral presentation	2019
De Respinis S. 2019. MALDI-TOF MS analysis of potential plant growth-promoting bacteria, isolated from different arid regions, January 2019	Scientific report	2019
Andres-Barrao C, Alam IS, De Respinis S, Tonolla M, Hirt H, Saad MM. (2019) A polyphasic strategy incorporating genomics, proteomics and biochemical data for the taxonomic description of endophytic bacteria from family Enterobacteriaceae. SSM Annual Congress, September 3rd/4th 2019, Campus Irchel, University of Zurich (poster).	Poster presentation	2019
Beney C, Storelli N, Danza F, Roman S and Tonolla M. (2019) CO2 and H2S assimilation rate of most important phototrophic sulfur bacteria from the Lake Cadagno chemocline. Swiss microbial ecology meeting, Lausanne, 30 January-01 February 2019 (poster).	Poster presentation	2019
Bruder A. 01/2019 Invited presentation at the Swiss Federal Institute of Forest, Snow and Landscape Research in Birmensdorf, Switzerland: Ecology of aquatic hyphomycetes and the role of biodiversity.	Oral presentation	2019

Bruder A. 04/2019. Invited presentation at the Department of BioNanomaterials of the Adolphe Merckle Institute of the University of Fribourg, Switzerland: Anthropogenic impacts on the ecological roles of aquatic hyphomycetes.	Oral presentation	2019
Bruder A. 06/2019. Invited presentation at ECOLAB of the University of Toulouse III, Toulouse, France. Ecology of aquatic hyphomycetes and the role of biodiversity.	Oral presentation	2019
Bruder A. 09/2019. Oral presentation at SSM19, Zürich: Applying MALDI-TOF MS to explore inter- and intraspecific diversity of aquatic hyphomycetes.	Oral presentation	2019
Bruder A. 10/2019. The food-web perspective in multiple-stressor research and management. Invited presentation at NINA, the Norwegian Institute of Nature Research, Tromsø, Norway.	Oral presentation	2019
Bruder A. 10/2019. Invited presentation at the Freshwater Ecology Group of the Arctic University of Tromsø, Norway: Ecology of saprophytic fungi in streams and the role of biodiversity.	Oral presentation	2019
Bruder A. 04/2019. Ecology of aquatic hyphomycetes and the role of biodiversity. Invited presentation at the Department of Plant Sciences of the University of Geneva, Switzerland	Oral presentation	2019
Bruder A. 03/2019. Bridging the gap between multiple stressor research and freshwater ecosystem conservation. Invited presentation at the Department of Natural Resources of the Isfahan University of Technology, Iran	Oral presentation	2019
Bruder A. 01/2019 Ecology of aquatic hyphomycetes and the role of biodiversity. Invited presentation at the Swiss Federal Institute of Forest, Snow and Landscape Research in Birmensdorf, Switzerland	Oral presentation	2019
Corti C , Cicardi M. , Ruinelli M. , Alamia F. , Pique F., Microbial growth on Cultural Heritage, a methodological approach, 3rd Conference Green Conservation 10-12 novembre 2019, Católica Porto, Portugal.	poster presentation	2019
Corti C , Cicardi M. , Ruinelli M. , Alamia F. , Pique F., Microbial growth on Cultural Heritage, a methodological approach, 3rd Conference Green Conservation 10-12 novembre 2019, Católica Porto, Portugal (poster).	Poster presentation	2019
Di Nezio F, Beney C, Roman S, Danza F, Tonola M and Storelli N. (2019) The physiology of the most important anoxygenic phototrophic sulfur bacteria of Lake Cadagno. SSM Annual meeting, Zurich, 3-4 September 2019 (poster).	Poster presentation	2019
Storelli N. Microbial Ecology of anaerobic phototrophic sulfur bacteria in the meromictic Lake Cadagno. SME19 Lausanne, 2019	Oral presentation	2019

Lüdin S, Brackmann M, Brunisholtz R, Bueche M, Pothier J, Roman S, Storelli N, Wittwer M and Tonolla M. (2019) Proteogenomics for the MALDI-TOF MS TDS-based rapid identification of novel bacterial isolates from the environment. 1st European Top-Down Proteomics Symposium, Paris, February 12-14, 2019 (poster).	Poster presentation	2019
Galli S., Ruinelli M., Mauri F., Demarta A. Characterization of the plasmid content of a multi-resistant <i>A. hydrophila</i> strain of environmental origin. SSM Annual meeting, Zurich, 3-4 September 2019 (poster).	Poster presentation	2019
presence of antibiotic resistance genes and antibiotic resistant bacteria in water environment: lake Lugano and some rivers. SSM Annual meeting, Zurich, 3-4 September 2019 (poster).	Poster presentation	2019
Ricerca e monitoraggio di determinati genici di resistenza agli antibiotici nelle acque del Ceresio e di alcuni immissari; 2019	Scientific report	2019
PPincipi (2019): Direct Interspecies Electron Transfer (DIET) to increase methane production https://www.infothek-biomasse.ch/index.php?option=com_abook&view=category&id=5&Itemid=155&lang=de	Scientific report	2019
Guidi V., Tonolla M. (2019). Vektorsurveillance – Surveillance of mosquito-borne viruses in Canton Ticino and Canton Grubunden. Report for the Federal office for civil protection (FOCP).	Scientific report	2019
Engeler L., Suter T., Flacio E., Tonolla M., Müller P. (2018) Guidelines for the surveillance and control of invasive <i>Aedes</i> mosquitoes in Switzerland. Manifestazione “Ticino +3.5 gradi”, Locarno, 12 febbraio 2019	Poster	2019
Flacio E, Integrated control strategies on invasive mosquitoes in Switzerland, 49th annual conference SOVE, Puerto Rico, 22-26 September,	Oral presentation	2019
E. Flacio, „Überwachung und Kontrolle der Tigermücke im Kanton Tessin“, ETHZ training course, Bellinzona, 24th May 2019	Oral presentation	2019
E. Flacio, “Integrated control strategies on invasive mosquitoes in Switzerland”, SOVE International, 22nd-26th September 2019, Puerto Rico	Oral presentation	2019
E. Flacio, “Tiger mosquito project and applications in the Mendrisiotto region”, 4th Sino-Swiss Symposium of UAS, Mendrisio, 25th October 2019	Oral presentation	2019
E. Flacio, “Swiss mosquito network”, SVEG, Neuchâtel, 18th January 2019	Oral presentation	2019
E. Flacio, “Influenze dei cambiamenti climatici sulla biologia e la diffusione dei vettori di malattie”, EOC, Bellinzona, 10th December 2019	Oral presentation	2019
E. Flacio, “Integrated control strategies on invasive mosquitoes in Switzerland”, Sinergitech meeting, Ravenna, 21st-22nd November 2019	Oral presentation	2019
D. Ravasi & E. Flacio, “A new integrated system for risk-based surveillance of invasive mosquito <i>Aedes albopictus</i> in Switzerland”, EMCA, La Rochelle, 11th-14th March 2019	Oral presentation	2019
E. Flacio, «Technologie génétique! Et vous? Discussons-en». SCNAT meeting, Lausanne, 20th November 2019	Oral presentation	2019
E. Flacio “Les moustiques exotiques invasives en Suisse” Société Neuchâteloise des Sciences Naturelles, 7 th November 2018, Neuchâtel (Switzerland)	Oral presentation	2019
Tonolla M., Ravasi D, Parrondo Monton D, Guidi V., Flacio E. Evaluation of the public health risk for autochthonous transmissions of mosquito-borne viruses in Canton Ticino. EFBS, 2018	oral presentation	2018
Tonolla M. (2018) Tiger mosquito, arboviruses and risk assessment. 12th Applied Biosafety Meeting. August 23rd/24th 2018 Palazzo dei Congressi Lugano	oral presentation	2018
Storelli N. Hydrogen sulfide (H ₂ S) removal: an alternative friendly biological approach. Evonomia circolare SUPSI, 2018	Poster presentation	2018
Storelli N. Understanding the microbial ecosystem of a meromictic alpine lake through genomics and proteomics. ISMSM5 Vienna, 2018	Poster presentation	2018

Tonolla M. (2018) Getting to know microbes: outreach activities in the Cadagno region. Annual congress 2018 Swiss Society for Microbiology CHUV – Lausanne August 28-30	Oral presentation	2018
Flacio E. (2018) One Health 2018, USAV e UFSP, 18th October, Bern (Switzerland)	Oral presentation	2018
Bruder A. Ecology of aquatic hyphomycetes and the role of biodiversity. Invited presentation at the Microbial Ecology Group of the CNR Institute on Water Research in Pallanza, Italy	Oral presentation	2018
Bruder A. Ecology of aquatic hyphomycetes and the role of biodiversity. Keynote presentation at the 2nd International Conference on Fungal Conservation in Ismailia, Egypt.	Oral presentation	2018
Bruder, A. Knowledge flows both ways: Transferring knowledge between applied freshwater ecologists and freshwater ecosystem managers. Invited presentation in the SP21-seminar series at the Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, Switzerland	Oral presentation	2018
Engeler L., Flacio E., Müller P., Tonolla M. (2018) "Invasive Aedes mosquitoes are spreading through Switzerland: situation in 2017" 9th Conference of the European Mosquito Control Association, 5-6 March 2018, Speyer (Germany) (presentazione orale)	Oral presentation	2018
L. Engeler, E. Flacio, M. Abderhalden, P. Müller, M. Tonolla "Invasive vector species: Surveillance & Management Strategies", 21st Euro SOVE conference, 22-26 October, Palermo (Italy) (Poster)	Poster presentation	2018
Mauri F. "Approccio OneHealth nell'antibiotico-resistenza". Novembre 2018, Manno (presentazione orale)	Oral presentation	2018
Mauri F. e Demarta A. Titolo Congresso: Halting Antimicrobial Resistance Dissemination in Aquatic Environments (HEARD2018), organizzato al Monte Verità (Ascona) dal 16 al 19 settembre 2018 da EAWAG. (poster)	Poster presentation	2018
Spread of antibiotic resistance markers in Lake Ceresio and tributary rivers SSM Annual meeting, Basel, 30 August 2018 (oral presentation).	Oral presentation	2018
Tonolla M., Ravasi D, Parrondo Monton D, Guidi V., Flacio E. Evaluation of the public health risk for autochthonous transmissions of mosquito-borne viruses in Canton Ticino. EFBS, 2018	Oral presentation	2018
Ravasi D., Parrondo Monton D., Flacio E., Guidi V. (2018). Evaluation of the public health risk for autochthonous transmissions of mosquito-borne viruses in Canton Ticino. Project report for the Swiss Expert Committee for Biosafety (SECB).	Scientific report	2018
E. Flacio "Swiss Reference Network for invasive mosquitoes" 21 st European Society for Vector Ecology, 22-26 October 2018, Palermo (Italy)	Oral presentation	2018
E. Flacio "Exotische invasive Mücken in der Schweiz" Seminario di formazione continua One Health 2018, USAV e UFSP, 18 th October 2018, Bern (Switzerland)	Oral presentation	2018
E. Flacio, P.Lüthy "Mosquito control in Switzerland, a country divided by the ridge of the Alps" 48 th Annual conference of Society for Vector Ecology, 7-11 October 2018, Yosemite (USA)	Oral presentation	2018
L. Engeler, E. Flacio, P. Müller, M. Tonolla "Invasive Aedes mosquitoes are spreading through Switzerland: situation in 2017" 9 th Conference of the European Mosquito Control Association, 5-6 March 2018, Speyer (Germany)	Oral presentation	2018
E. Flacio, L. Engeler, M. Tonolla "Swiss Reference Network for invasive mosquitoes" 9 th Conference of the European Mosquito Control Association, 5 th -6 th March 2018, Speyer (Germany)	Oral presentation	2018
Fragoso-Corti C. Presentazione + articolo congresso Lecce: Microbiological growth and biodeterioration of wall painting at the UNESCO site Varallo	Oral presentation	2017
Storelli N. TANAIS – Two-phase ANAerobic digestion for Aqueous Industrial waStes. BFE Ittingen, 2017	Poster presentation	2017
Lüdin S., Liechti N., Danza F., Storelli N., (5), Wittwer M., Pothier J. and Tonolla M.. (2017) Proteogenomics for the MALDI-TOF MS-based rapid identification of novel bacterial isolates from a meromictic alpine lake. SAME15 – 15th Symposium on Aquatic Microbial Ecology, September 3.-8. 2017, Zagreb	Poster presentation	2017

Ravasi D., De Respinis S., Tonolla M., Wahli T. (2017) Saprolegnia - Why is it becoming a problem in Swiss rivers? Characterization at the molecular level and in regard to pathological features in affected fish. Poster. Population Genomics of Fungal and Oomycete Diseases of Animals and Plants, 7-11 May 2017, Ascona, Switzerland.	Poster presentation	2017
Solcà, N., Mauri, F.& Demarta Aeschbacher, A. (2017) Lago di Lugano: Ricerca e monitoraggio di determinati genici di resistenza agli antibiotici nelle acque del Ceresio e di alcuni fiumi immissari. Dipartimento del territorio e Laboratorio di microbiologia applicata	Poster presentation	2017
Storelli N, Tenti P., Danza F., Roman S. and Tonolla M.. (2017) Hydrogen sulfide (H ₂ S) removal: an alternative friendly biological approach. poster congresso REGATEC, Verona (maggio 2017)	Poster presentation	2017
Storelli N., Mattogno M. and Principi P.. (2017) Two-phase ANaerobic digestion for Aqueous Industrial waStes (TANAIS). Final report project SI/501264-01, BFE (marzo 2017)	scientific report	2017
Wipf N., Guidi V., Guedes DRD., Barbosa RMR, Tonolla M., Engler O., Muller P. (2017) Surveillance of mosquito-borne viruses with honey-baited nucleic acid preservation cards. Swiss Society of Tropical Medicine and Parasitology (SSTMP) meeting, OneHealth Symposium, Basel (BS), Switzerland, November 30.	Oral presentation	2017
Wipf N., Guidi V., Guedes DRD., Barbosa RMR, Tonolla M., Engler O., Muller P. (2017) Surveillance of mosquito-borne viruses with honey-baited nucleic acid preservation cards in an area of low virus prevalence. 10th European Congress on Tropical Medicine and International Health, Antwerp, Belgium, October 16-20.	Oral presentation	2017
Guidi V. (2017) Sorveglianza dei virus trasmessi dalle zanzare in Canton Ticino. Rapporto per l'Ufficio del medico cantonale.	Scientific report	2017
Guidi V. (2017) Monitoring of viruses transmitted by mosquitoes in Canton Ticino. Report for the Federal office of public health (FOPH).	Scientific report	2017
Guidi V. and Tonolla M. (2017) Optimierung der Methoden zum Nachweis von Viren in Vektoren. Report for the Federal office for civil protection (FOCP).	Scientific report	2017
Guidi V. (2017) Analysis of the Dynamic and Persistence of Bacillus thuringiensis israelensis Spores in the Soil of the Natural Reserve of the Thurauen. Report for the Amt für Abfall, Wasser, Energie und Luft (AWEL), Kanton Zürich.	Scientific report	2017
Biodeterioramento dei dipinti al Sacro Monte di Varallo: identificazione, caratterizzazione e fattori di sviluppo microbico nei dipinti della Cappella 11, 2017, rapporto interno, Marta Cicardi, Francesca Pique, Cristina Corti	Scientific report	2017
Biodeterioramento dei dipinti al Sacro Monte di Varallo: identificazione, caratterizzazione e fattori di sviluppo microbico nei dipinti della Cappella 11, 2017, rapporto interno, Marta Cicardi, Francesca Pique, Cristina Corti	Oral presentation	2017
E. Flacio, L. Engeler, M. Tonolla "Urban mosquito control in Switzerland", 8th Conference of the European Mosquito Control Association, 12-16 March 2017, Bečići (Montenegro)	Oral presentation	2017
P. Müller, L. Engeler, T. Suter, E. Flacio, M. Tonolla „Development of guidelines for the surveillance and control of invasive Aedes mosquitoes in Switzerland“, 8th Conference of the European Mosquito Control Association, 12-16 March 2017, Bečići (Montenegro)	Oral presentation	2017
E. Flacio "Surveillance programme on mosquitoes in southern Switzerland", Joint annual meeting SSP/SSAI & Lymphoid Tissue Meeting 2017, 1-2 June 2017, St. Gallen (Switzerland)	Oral presentation	2017
L. Engeler, T. Suter, E. Flacio, M. Tonolla, P. Müller „Guidelines for the surveillance and control of invasive Aedes mosquitoes in Switzerland“, SVEG annual scientific meeting, 19-20 June 2017, Lausanne (Switzerland)	Oral presentation	2017
E. Flacio "Moustique tigre, une crainte pour demain", Insectes entre fascination et inquiétudes, journée de conférences, La Murithienne, 9-10 Novembre 2017, Sion (Switzerland)	Oral presentation	2017

Wipf N., Guidi V., Engler O., Flacio E., Tonolla M., Guedes DDR., Muller P. (2016) Surveillance of mosquito-borne viruses with honey-baited FTA cards. 20th Swiss Vector Entomology Group meeting, Zurich (ZH), Switzerland, November 18.	Oral presentation	2016
Wipf N., Guidi V., Engler O., Flacio E., Tonolla M., Guedes DDR., Muller P. (2016) Surveillance of mosquito-borne viruses with honey-baited FTA cards. 20th European Society for Vector Ecology (E-SOVE) conference, Lisbon, Portugal, October 3-7.	Oral presentation	2016
Muller P., Vavassori L., Engeler L., Suter T., Flacio E., Guidi V., Tonolla M. (2016) Surveillance of invasive mosquitoes at points of entry in Switzerland. 20th European Society for Vector Ecology (E-SOVE) conference, Lisbon, Portugal, October 3-7.	Oral presentation	2016
Muller P., Suter T., Engeler L., Guidi V., Flacio E., Tonolla M. (2016). Surveillance of the Asian tiger mosquito (<i>Aedes albopictus</i>) in Switzerland. Swiss Society of Tropical Medicine and Parasitology (SSTMP) meeting, Montreux (VD), Switzerland, September 1-2.	Poster presentation	2016
Guidi V. e Baggi Menozzi F. (2016) Studio preliminare: Sviluppo di una tecnica che permetta di distinguere fra cellule vitali e cellule morte di	Scientific report	2016
Micobatteri appartenenti al complesso tubercolare all'esame microscopico nei pazienti durante il trattamento. Rapporto per la Fondazione Pierluigi Crivelli.		
Roditi, I., Imhof, S., Fragoso, C., W., Betzig, F1000 Research, 2016, 5, 682 Flagellar membrane fusion and protein exchange in trypanosomes; a new form of cell-cell communication	Poster presentation	2016
E. Flacio et al. "Surveillance on exotic invasive mosquitoes in southern Switzerland", Regional Workshop to Present Respective Experiences with Invasive Mosquitoes and Activities, 22-26 August 2016, Vienna (Austria)	Oral presentation	2016
E. Flacio et al. "Exotic invasive mosquitoes: introduction pathways into Switzerland", E-SOVE meeting, 3-7 October 2016, Lisbon (Portugal)	Oral presentation	2016
E. Flacio et al. "Strategies and results of a sixteen year <i>Aedes albopictus</i> surveillance program in southern Switzerland", Entomol-6 / SOVE, 25-28 October 2016, Recife (Brazil)	Oral presentation	2016
L. Vavassori, P. Müller, L. Engeler, T. Suter, E. Flacio, V. Guidi, M. Tonolla „Surveillance of invasive mosquitoes in Switzerland“, Facing the invasion of alien arthropods species, 8th November 2016, Trento (Italy)	Oral presentation	2016
E. Flacio et al. "Laboratory of applied microbiology – SUPSI: updated and ongoing activities", SVEG meeting, 18 November 2016, Zurich (Switzerland).	Oral presentation	2016
De Respinis S, Dressler D, Tonolla M, Petrini O. 2015 Discrimination of closely related populations by MALDI-TOF mass spectrometry using the ABOS software: <i>Trichophyton rubrum sensu lato</i> as a model. SSM Annual Congress, May 27th/29th 2015, Palazzo dei Congressi Lugano (poster)	Poster presentation	2015
De Respinis S, Petrini O, Tonolla M. 2015 MALDI-TOF mass spectrometry can discriminate closely related species of filamentous fungi. SSM Annual Congress, May 27th/29th 2015, Palazzo dei Congressi Lugano (poster)	Poster presentation	2015
De Respinis S, Caminada A, Crenna A, Guidi V, Petrini O, Tonolla M. 2015 MALDI-TOF mass spectrometry to study fungal populations in different built environments. SSM Annual Congress, May 27th/29th 2015, Palazzo dei Congressi Lugano (poster)	Poster presentation	2015
De Respinis S. Teruzzi T. 2015 Chemical and mycological assessment of indoor air quality inside a recently constructed flat. SSM Annual Congress, May 27th/29th 2015, Palazzo dei Congressi Lugano (oral presentation)	Oral presentation	2015
Could <i>Aeromonas</i> bacteriophages be involved in horizontal gene transfer? SSM Annual meeting, Lugano 2015, (poster).	Poster presentation	2015
Guidi V., Ravasi D., Caminada AP., Portmann J., Flacio E., Licheri G., Pace F., Engeler L., Tonolla M., Engler O. (2015) Emerging viruses: optimisation of methods for the monitoring of mosquito-borne viruses in Switzerland. 73rd Annual Assembly of the Swiss Society for Microbiology, Lugano (TI), Switzerland, May 28-29.	Poster presentation	2015

Wagner S., Schönenberger A.C., Guidi V., Tuten H.C., Becker S., Veronesi E., Silaghi C., Mathis A. (2015) Vector capacity traits of <i>Aedes japonicus</i> and <i>Culex pipiens</i> for West Nile virus. 73rd Annual Assembly of the Swiss Society for Microbiology, Lugano (TI), Switzerland, May 28-29.	Poster presentation	2015
Role of <i>Aeromonas</i> spp. in the environmental spread of resistance genes International Symposium on <i>Aeromonas</i> and <i>Plesiomonas</i> , Montpellier, 25-27 June 2014 (poster)	Poster presentation	2014
Role of <i>Aeromonas</i> spp. in the environmental spread of resistance genes SSM Annual meeting, Fribourg, 19-20 June 2014 (poster)	Poster presentation	2014
Feijoó Fariña B., Flacio E., Engeler L., Guidi V., Suter T., Pflüger V., Tonolla M. (2014). Application of the new technique of rapid protein profiling (MALDI-TOF MS) in the extensive surveillance system on <i>Aedes albopictus</i> in southern Switzerland. 19th European Society for Vector Ecology (E-SOVE), Thessaloniki, Greece, October 13-17.	Oral presentation	2014
Guidi V. (2014). Persistence of <i>Bacillus thuringiensis</i> va. <i>israelensis</i> (BTI) in soil. BioInfo Seminar, AWEL, Zurich (ZH), Switzerland, September 16.	Oral presentation	2014
Guidi V., Feijoó Fariña B., Flacio E., Engeler L., Lüthy P., Tonolla M. (2014) Fate and mosquitocidal activity of VectoMax CG in the urban environment of the city of Chiasso. Project report	Scientific report	2014

11. List of institute employees, 2021-22

	Employee	Age	Function	H-index	Nr of Citations	Nr of Reads	Degree
1	Anicic Nikoleta	32	Collaboratrice scientifica	2	13		MSc
2	Antognoli Silvia	37	Collaboratrice scientifica				BSc
3	Ackermann Rahel	38	Ricercatrice				PhD
4	Bruder Andreas	42	Ricercatore senior	22	1894		PhD
5	Buetti-Dinh Antoine	37	Ricercatore				PhD
6	Caminada Annapaola	55	Collaboratrice scientifica				
7	Cavalli Flavia	52	Collaboratrice amm.				
8	Cazzin Stefania	38	Collaboratrice scientifica	11	455		MedVet
9	Colombo Luca	58	Docente ricercatore	9	345	3689	PhD
10	Corti Cristina	44	Ricercatrice	10	225		PhD
11	Cuomo Maurizio	31	Dottorando	2	34		MSc
12	Davino Luca	21	Apprendista				
13	De Respinois Sophie	52	Ricercatrice	7	390	5696	PhD
14	Del Biaggio Miriam	60	Collaboratrice amm.				
15	Demarta Antonella	63	Ricercatrice senior	18			PhD
16	Di Nezio Francesco	34	Dottorando	1	4		MSc
17	Engeler Lukas	46	Ricercatore	7	222		MSc
18	Esmaili O'Fogh Ali Reza	35	Ricercatore				MSc
19	Flacio Eleonora	50	Ricercatrice senior	12	550		PhD
20	Frei Giorgia	27	Collaboratrice scientifica				MSc
21	Guidi Valeria	38	Ricercatrice senior	9	242		PhD
22	Erndle Klaudia	40	Collaboratrice scientifica				MSc
23	König Roger	38	Docente ricercatore	4	458	1757	MSc
24	Licheri Giovanni	45	Collaboratore scientifico				MSc
25	Liechti Nicole	30	Ricercatrice				PhD
26	Losa Mattia	25	Collaboratore scientifico				MSc
27	Lötscher Sabrina	33	Assistente BSc				BSc
28	Mauri Federica	37	Ricercatrice	3	117	322	PhD
29	O'Reilly Liam Joseph	28	Collaboratore scientifico				MSc
30	Oester Rebecca	27	Dottoranda				MSc
31	Pace Francesco	46	Collaboratore scientifico				MSc
32	Parrondo Monton Diego	29	Collaboratore scientifico	1	4		BSc
33	Perego Camilla	27	Assistente MSc				BSc
34	Pianta Elisa	26	Collaboratrice scientifica	1	1		MSc
35	Principi Pamela	50	Docente ricercatrice senior	14	708	2808	PhD
36	Ravasi Damiana	43	Ricercatrice	8	283		PhD
37	Rindlisbacher Jan	26	Ricercatore				MSc
38	Roman Samuele	38	Collaboratore scientifico	4	55		
39	Soldati Valentina	30	Collaboratrice scientifica				MSc
40	Storelli Nicola	39	Ricercatore	9	219		PhD
41	Tanadini Emily	17	Apprendista				
42	Tonolla Mauro	61	Professore in microbiologia	35	3323		PhD
43	Torriani Giulia	32	Ricercatrice	13	530		PhD
44	Vogini Letizia	19	Apprendista				
45	Würsch Gea	43	Collaboratrice scientifica				MSc

12. List of teaching courses

Researcher	Mandate	Sektor	Course	Years	Type	ECTS	Hours
A. Bruder; M. Tonolla	UNIGE	Ecologia microbica	Cours 14B026 Ecologie microbienne moléculaire	2014-2022	FB/FC	4	40
N. Storelli; F. Di Nezio; S. Roman; M. Tonolla	UNIGE	Ecologia microbica	Cours 14B041 Hydrobiologie microbienne: Environnement naturel et construit, aspects écologiques, hygiéniques et sanitaires, Hygiene, and Health	2014-2022	FB/FC	3	28
N. Storelli; F. Di Nezio; S. Roman; M. Tonolla	UNIGE	Ecologia microbica	Cours 14B641 Hydrobiologie microbienne: Ecologie microbienne et écologie alpine	2014-2022	FB/FC	4	40
M. Tonolla	UNIGE	Ecologia microbica	Cours 14B053 Microbiologie moléculaire des milieux hydriques	2014-2022	FB/FC	3	28
M. Tonolla	UNIGE	Ecologia microbica	Cours 13B011 Microbiologie générale 1	2014-2022	FB/FC	3	8
M. Tonolla	UNIGE	Biosicurezza	FORMATION SECURITE Bioch / Biolog / ISTE / NCCR Biosécurité: Dangers lies aux produits biologiques	2014-2022	FB/FC		4
A. Buetti-Dinh	HSLU	Ecologia microbica	Applied Machine Learning and Predictive Modelling	2020-2021	FB	3	28
A. Bruder	ZHAW	Ecologia microbica	Modul Gewässerökologie und Revitalisierung	2018-2021	FB		2
C. Corti	SUPSI; DACD	Ecologia microbica	Biopulitura e Bioconsolidamento di pitture murali e materiali lapidei	2018-2021	FB	2	4
C. Corti	SUPSI; DACD	Ecologia microbica	Bio-deterioramento (CN 2.1.1)	2018-2021	FB	3	24
C. Corti	SUPSI; DACD	Ecologia microbica	Consulenza didattica in cantieri (biodeteriogeni)	2018-2021	FB		4
C. Corti; F. Mauri	SUPSI; DACD	Ecologia microbica	Tesi master e bachelor CR,LCV, DTI	2018-2021	FB	6	24
P. Principi	MSE; DTI	BET	MSE Energy & Environment, EnEn	2020-2021	FB	90	2700
R. König	MSE; DTI	BET	Environmental Technologies: Wastewater Treatment	2015-2021	FB	3	24
P. Principi	MSE; DTI	BET	Environmental Remediation Technologies: soil, groundwater and atmosphere	2015-2021	FB	3	24
C. Corti	SUPSI; DFA	Ecologia microbica	DFA Diploma SMS	2018-2021	FB	6	18
C. Corti	SUPSI; DFA	Ecologia microbica	Seminario di didattica disciplinare in Biologia	2018-2021	FC	1	6
C. Corti	SUPSI; DFA	Ecologia microbica	DFA 073 Alla scoperta di un mondo nascosto tra Ritom e Alpe Piora	2018-2021	FC	1	16
C. Corti	SUPSI; DFA	Ecologia microbica	DFA 517 Biologia: dalla Teoria alla Pratica Corsi BiOutils	2018-2021	FC	6	8
C. Corti	SUPSI; DFA	Ecologia microbica	DFA 530 Microbiologia nel laboratorio di scienze naturali contestualizzata al Piano di studio	2018-2021	FC	3	32
C. Corti; A. Caminada	SPAI	IM	Biologia Molecolare	2018-2021	FB		72
C. Corti	SPAI	IM	Metodi rapidi per analisi della carica microbica	2018-2021	FB		6
A. Demarta; C. Corti	SSMT Locarno	IM	Stage allievi TAB	2018-2021	FB		630
C. Corti; A. Caminada; A. Demarta	SPAI	IM	Apprendisti in formazione	2018-2021	FB		3y
S. De Respinis, A. Bruder ; M. Tonolla	SUPSI	IgAmb	MALDI-TOF mass spectrometry in clinical and environmental microbiology	2019	FC	1	19
M. Tonolla	SUPSI	IM	CAS Direzione dei lavori nell'ambito dell'edilizia e del genio civile	2019-2021	FC		2