Leibniz
INFECTIONS'21

Infectious diseases such as tuberculosis, AIDS and influenza are among the prime causes of death globally. How can we improve prevention and control of infections?

Leibniz Research Alliance
INFECTIONS'21

Leibniz Research Alliance INFECTIONS´21

Transmission Control of Infections in the 21th Century

Improved hygiene and better prevention and treatment have reduced the incidence of infectious diseases in the past, particularly in industrialised countries. However, increasing antibiotic resistance and emergence of new pathogens, together with changes in pathogen distribution due to climate changes and mobility are global challenges.

Infectious diseases can be spread and transferred to humans in many ways. A holistic approach is required to better understand transmission and to achieve optimal infection control strategies. Biomedical, ecological, socio-economic and political aspects all need to be considered.

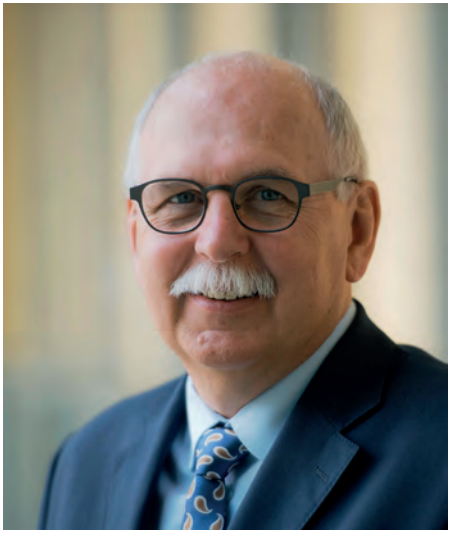
To address these aspects the Leibniz Research Alliance “INFECTIONS´21” was founded in 2015. The aim of this interdisciplinary project is the establishment of new communication paths across disciplines to develop new strategies and methods for early warning and outbreak management systems to control the spread of pathogens. This effort will also include public involvement through citizen science projects.

Greetings

Globalization, climate change and individual mobility present new challenges for societies, especially for health care systems. For example, animal diseases from distant areas suddenly appear in Germany or infectious diseases from known pathogens are becoming a fatal threat to humans because of their resistance to commonly used antibiotics.

The Leibniz Research Alliance INFECTIONS'21 places these current challenges at the center of its research interests and develops new strategies for an early warning system and successful treatments. The Leibniz Research Alliance therefore uses the interdisciplinary competencies of the 14 Leibniz Institutes involved by combining biomedical, ecological, climatic, socio-economic and political aspects. Also, in a particularly exemplary way, the Research Alliance focuses on the transfer of knowledge into society by involving the public in its diverse activities.

Thus the Leibniz Research Alliance INFECTIONS'21 and the application-oriented basic research of its members are an example of the excellent cooperative science within the Leibniz-Association and of the instrument of the Leibniz Research Alliances.



I would like to thank the colleagues of the Leibniz Research Alliance for their commitment and wish them every success! I am looking forward to their further results and joint activities.

Prof. Dr. Matthias Kleiner
President of the Leibniz Association

Short interview

How did the project start?

In 2014, the opportunity arose to apply for Research Alliances between different Leibniz institutes in order to foster cooperative research across scientific disciplines. In view of globally changing living and environmental conditions, we considered transmission and distribution of infectious diseases to be determined by distinct factors. To study these factors, we realized that an integrated and interdisciplinary approach is needed which closely links biomedicine with social, environmental and climate research. Thereby, we were able to strategically employ the interdisciplinary portfolio of the Leibniz Association to generate an added value.

14 institutes from 3 sections – How does the cooperation work?

I have to say, the cooperation already worked surprisingly well from the beginning. During preparation of the application, all partners brought together the different pieces of the puzzle in order to design the projects. Nevertheless, it quickly became clear that we were locked in different scientific idioms. Indeed, the biggest challenge for us, is the mutual understanding across the disciplinary boarders. During our meetings and presentations, we make an effort to use a more general scientific language and to clearly explain specific idioms. In order to find out how interdisciplinary cooperation works within the alliance, whether we generate an added value, where problems arise, and what we can improve, we hooked up with interdisciplinary research specialists from Wuppertal University to monitors our activities. We basically are an experimental rabbit.

How did this interdisciplinary cooperation change your research approach?

Tremendously. Deliberating on projects in my research topic, tuberculosis, I often now consider aspects from other disciplines. For example, whether patients will also benefit economically from new treatment strategies, and how we can study it using social science approaches, or whether analytical physics can foster our infection biology research questions.

Prof. Dr. Ulrich Schaible,
Speaker of INFECTIONS´21

What are infectious diseases?

Infectious diseases are defined as illnesses that are caused by invading microorganisms. These pathogens, such as viruses, bacteria, fungi, parasites or prions can enter the body in several ways, for example through the respiratory system, the direct contact of skin or mucous membranes, but also via wounds and bites.

The period between infection and onset of the first symptoms is called incubation time. This period can vary between few hours and several years, depending on the infection and the proliferation rate of the pathogen. Besides the pathogen, the health status of each individual plays an important role in the progression of the symptoms. While some infections remain asymptomatic for a lifetime or heal without any medical treatment, other pathogenic agents pose a high risk.

Infectious diseases in the 21st century

The major epidemics

Within the last centuries the human population was repeatedly afflicted by dangerous epidemics. In the 14th century, the plague claimed the lives of an estimated 25 million people in Europe, which represented one third of the population at that time. Similarly, pandemics such as cholera, smallpox or typhoid fever killed millions of people. It was not until the end of the 19th century that the direct link between a disease and a pathogen was established. Since then, and thanks to the discovery of antibiotics and vaccines, numerous infectious diseases are defeated or brought under control.

Infectious diseases in the 21st century

Despite all medical advances and improved hygiene levels, the threat posed by infectious diseases has not been banished until today.
Worldwide, infectious diseases such as pneumonia, diarrhea, AIDS, tuberculosis and malaria are amongst the most frequent causes of death. Current events, like the Ebola outbreak in 2012 clearly show how difficult it is to stem an epidemic despite international cooperation.

Which factors affect the spread of diseases?

The reason why infectious diseases are spreading are complex and multilayered: Due to globalization and increasing mobility, pathogens have the opportunity to spread around the globe within very short time periods.
Additionally, climate change and global warming facilitate the spread of vector animals and harmful pathogens into new areas. Furthermore, antibiotic resistance is a factor, which can promote further the spread of infectious diseases. Already, this most important therapeutic tool against pathogenic bacteria is not any longer effective in many infections.

This global challenge can only be addressed through international and interdisciplinary cooperation.


Product 6
Product 7
Product 8
68
95
25
67
86
89
68
35
42
45
68
75
24
45
28

Objectives & Tasks

The Leibniz Research Alliance “INFECTIONS´21” aims to establish an interdisciplinary research agenda and to open up new avenues of communication across disciplines.
New strategies and methods for early warning and outbreak management systems will be developed to control the spread of pathogens.

In order to achieve this objective, 14 Leibniz institutes and selected partners pooled their expertise to work on four prototypical cooperative research projects.

These four research projects investigate the transmission paths of pathogens and focus on

- human-2-human-transmission
- aerosol transmission of pathogens through the air
- open waters as hubs for pathogen spread and
- vectors as potential carriers of pathogens

Human-2-human transmission: Preventing tuberculosis transmission in times of high migration

Since 2014 Germany has seen an increasing number of new TB cases that can be traced back to migrants from high prevalence countries. According to the Robert Koch-Institute, 5.915 new cases of tuberculosis were recorded in 2016. Nearly three-quarters of these patients were born abroad.

The aim of this project is to identify potential improvements in the prevention of human-2-human transmission of tuberculosis in times of high migration.

The project is divided into two studies, both using empirical methods of social sciences. In both studies, intervention measures and prevention strategies are developed via problem-centered interviews and standardized surveys, respectively. The objective of the first part of this project is to investigate problems and possibilities for improving the prevention of the human-2-human transmission in the sectors of diagnosis and therapy. For this reason interviews with doctors, employees of public health offices and with Tb-patients, who have come to Germany as refugees, will be conducted.

In the second part, the efficacy of training measures for Tb-infected asylum seekers will be analyzed. Relying on a standardized questionnaire, patients from two specialist clinics for pulmonary diseases will be asked about their knowledge of tuberculosis and their attitude regarding the upcoming medication intake.

Tuberculosis

Tuberculosis, formerly also referred to as consumption or white death, is an infectious disease caused by the bacterium *Mycobacterium tuberculosis.* In most cases this infection affects the lung and causes severe damage of the lung tissue. The pathogen is transmitted via aerosol droplet transmission from patients with active TB to healthy people. An infection with *M. tuberculosis* is not always accompanied with an outbreak of the disease: it is assumed that one third of the world population is carrying the pathogen without developing any symptoms.
Worldwide, 9 million newly infected TB cases were reported in 2014, 1,5 million people died as a result of this infection. Especially in Eastern Europe, the numbers of multiresistant (MDR) and extensiv resistant tuberculosis (XDT-TB) are increasing. These resistant pathogens can only be treated by a cost-effective and long term therapy with a number of adverse side effects.

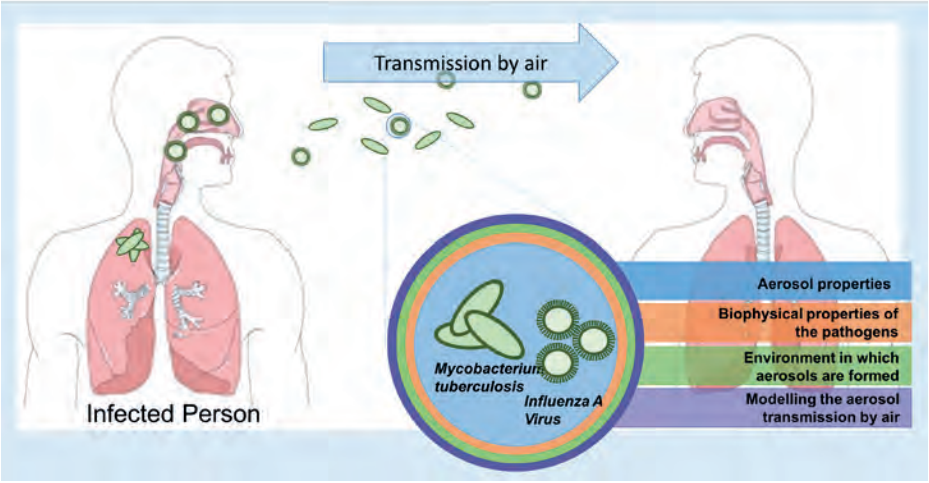
As a social scientist, interdisciplinary work has so far only consisted of joint projects of sociologists and politologists. In this project, I have the feeling of doing "real" interdisciplinary science - and it is enormously exciting and beneficial

Dr. Sven Stadtmüller

Project participants:

Trainee:	Dr. Sven Stadtmüller (GESIS)
Supervision:	S. Ehlers (FZB), J. Schröder (GESIS), N. Menold (GESIS)
Partner:	FZB, GESIS, GIGA, HKI

Air:
Characterization of pathogen-carrying aerosols



Airway pathogens, like *Mycabacterium tuberculosis* or the influenza A virus can be transmitted in various ways: through direct contact with an infected individual, by touching contaminated surfaces or via inhalation.

So far, little is known about how the pathogen is transmitted by air and how pathogen-carrying aerosols are composed. Aerosols are suspensions of solid or liquid particles able to float in the air for an extended period of time. Therefore, they are optimal carriers for pathogens.

The aim of this project is to investigate this transmission path in greater detail and to model the transport of pathogens through the air.

Biophysical characteristics of particles are important determinants for air transport. Therefore, we examine the size, surface property, morphology and hygroscopicity, which is the capacity of an object to absorb water from the air, of pathogen containing aerosols. In a second step, aerosols from the surrounding air and the respiratory tract of infected hosts are being collected and characterized.

These results will help to identify infection risks and to establish protection measures.

Influenza

Influenza, or real flu, is an infectious disease caused by the influenza virus leading to a disease that differs considerably from a normal cold in terms of duration and severity. There are three types of influenza viruses, called type A, B and C, whereby the influenza A virus is the most common type. The influenza virus undergoes constant changes and shows a high genetic variability. Thus, it is nearly impossible for the human immune system to produce effective antibodies, and vaccines have to be adjusted to new strains every year. Influenza strains are characterized by differences in two major virus surface proteins, hemagglutinin and neuraminidase. While some virus subtypes are transmitted particularly well from human to human, the avian subtype – also known as avian flu - can only be transmitted through the direct contact of humans and birds. However, studies have shown that it would only take a few mutations to enable human-2-human transmission.

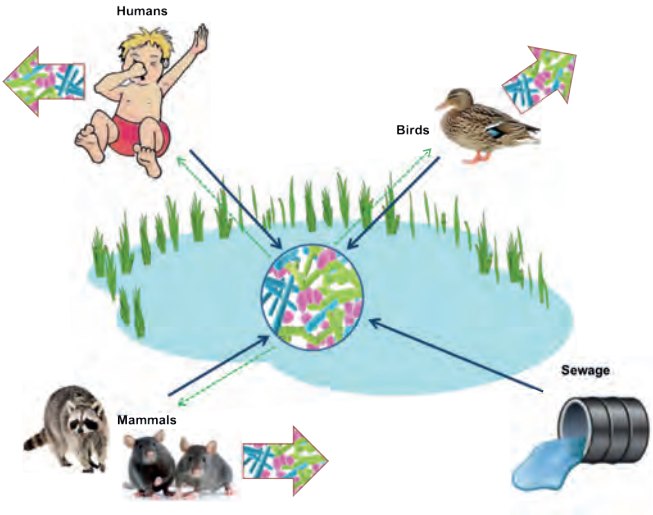
"There is lots of talk about interdisciplinarity and the calls for it are getting louder. However, it is difficult for many scientists to get out of their beaten tracks of thinking. My doctoral thesis is like no other, because I have the opportunity to combine microbiology, biophysics and meteorology, and to use all these sciences to work on my own question. INFECTION'S 21 allows me to find new access to scientific questions."

Elisabeth Pfrommer

Project participants:

Trainee:	Elisabeth Pfrommer
Supervision:	K. Schepanski (TROPOS), G. Gabriel (HPI), T. Gutsmann (FZB), U.E. Schaible (FZB)
Partner:	ATB, FLI, FZB, GESIS, GIGA, HPI, PIK

Water:
Water as a reservoir of pathogens



Water is essential to all living beings, but at the same time, it is also a habitat for a wide range of microorganisms. Among them are pathogens that are transmitted to humans or to animals through the water.

Therefore, lakes, rivers and ponds can be central reservoirs for pathogens. Pathogens can enter the aquatic environment via wastewater or are shed by animals or humans. Contaminated water bodies could thus be a source of infection for other individuals and could disseminate pathogens over distances.

Small water bodies in particular could serve as hotspots, because they are mostly rich in nutrients and serve as gathering places for waterfowl. Furthermore, they are a preferred habitat for blood-sucking insects and their larvae. The aim of this research project is to examine the presence and distribution of pathogens such as Clostridium difficile and (avian) influenza A viruses.

For these studies, various water sources in the Berlin area were selected, including five lakes, the Berlin Tierpark and a wastewater treatment plant. In order to detect seasonal dynamics or changes, these sites are sampled every three months. In addition to water, sediment samples are taken from the lakes and environmental parameters such as temperature, pH-values and nutrient concentrations are documented. Furthermore, molecular-genetic methods will be used to characterize the microbiom representing the entire bacterial population of a sampling site.

Clostridium difficile

Clostridium difficile is a gram-positive rod bacterium, which can be found all over the world in the environment as well as in the intestinal tract of humans and animals. *C. difficile* comprises of pathogenic strains, which produce powerful toxins and harmless non-pathogenic strains. Very often diseases in humans are associated with antibiotic treatment and/or occur when humans are suffering from an immunodeficiency. Whereas in most cases diarrheal disorders and intestinal inflammation occur, in severe cases an infection can even be fatal. In 2014 according to Bundesamt für Statistik (German Federal Statistical Office) about 2,499 deaths were caused by *C. difficile*. Yet this bacterium is mostly known as a hospital pathogen. However, there is increasing evidence that humans might also be infected by food, contact with animals or through the environment. As a spore-forming bacterium it can persist in the environment for a long time and is very robust against environmental factors. This pathogen could find its way into the environment through hospital sewage water and infected humans or animals. Is *C. difficile* also an inhabitant of Berlin's bodies of water? We are looking for an answer to this question.

"Still waters run deep – a journey into microcosm. Water is a habitat for a plethora of microorganisms. While most of them are harmless and have an important function for the ecosystem, some of them can cause diseases."

Daniela Numberger

Project participants:

Trainee:	Daniela Numberger
Supervision:	A Greenwood (IZW), H.-P. Grossart (IGB)
Partner:	DSMZ, HPI, IGB, IZW, ZALF, ZMT

Vectors:
Studies on the ecology and the vector potential of native mosquitoes

Vectors are living organisms with the ability to transmit infectious diseases between humans or from animals to humans. The most important vectors are arthropods and rodents. Well known examples are mosquitos, lice, ticks as well as bank voles, carrying the pathogens causing malaria, lyme disease or hantavirus infection, respectively.

In recent years mosquitoes gained increasing attention as vector for the rampant Zika virus in Central and South America.

Globalization and climate change promote the spread of vectors and thus, the sources of infections. Domestic bloodsuckers can encounter new pathogens and new vectors can become carriers for foreign pathogens.

Currently, adequate risk assessments are insufficient due to lack of knowledge of ecology and vector competence of native species in Germany. Here the work of the vector group will contribute to our understanding. We investigate breeding sites and host preferences and analyse mosquito specimen for pathogens.

Zoological gardens are ideal sampling areas for our studies, because the health of zoo animals is monitored very closely and therefore infections with pathogens are quickly detected. Moreover, wild animals – for example migratory bird – are also visiting zoological gardens that may introduce pathogens to domestic vectors. Thus pathogens may be transferred from wild reservoir animals to zoo animals.

Malaria

Malaria is a common infectious disease in tropical and subtropical countries caused by eukaryotic parasites of the genus plasmodium. These pathogens are spread to humans through the bite of the anopheles mosquito. In infected humans the parasites invade the liver, where they multiply and infect red blood cells. As a consequence of the replication, the infected blood cells burst and cause severe fever. The cyclic pattern of malaria symptoms in humans is due to the life cycle of malaria parasites as they develop, reproduce, and are released from the red blood and liver cells. Malaria tropicana is the most prevalent but also the most dangerous malaria type. According to the Robert Koch-Institute 40% of the world's population are living in malaria-endemic areas. In 2015 roughly 200 million malaria cases and an estimated 600 000 malaria deaths were reported worldwide, 75% of which were children under 5 years of age.

"The INFECTIONS'21 research alliance gives me the opportunity to work on the ecology of mosquitoes outdoors as well as in the laboratory searching for pathogens and blood-hosts. Looking at a research topic from different point of views is what fascinates me most in the project."

Eva Heym

Project participants:

Trainee:	Eva Heym
Supervision:	H. Kampen (FLI), D. Walther (ZALF)
Partner:	BNITM, FLI, IGB, IZW, PIK, ZALF

Science Dialogue

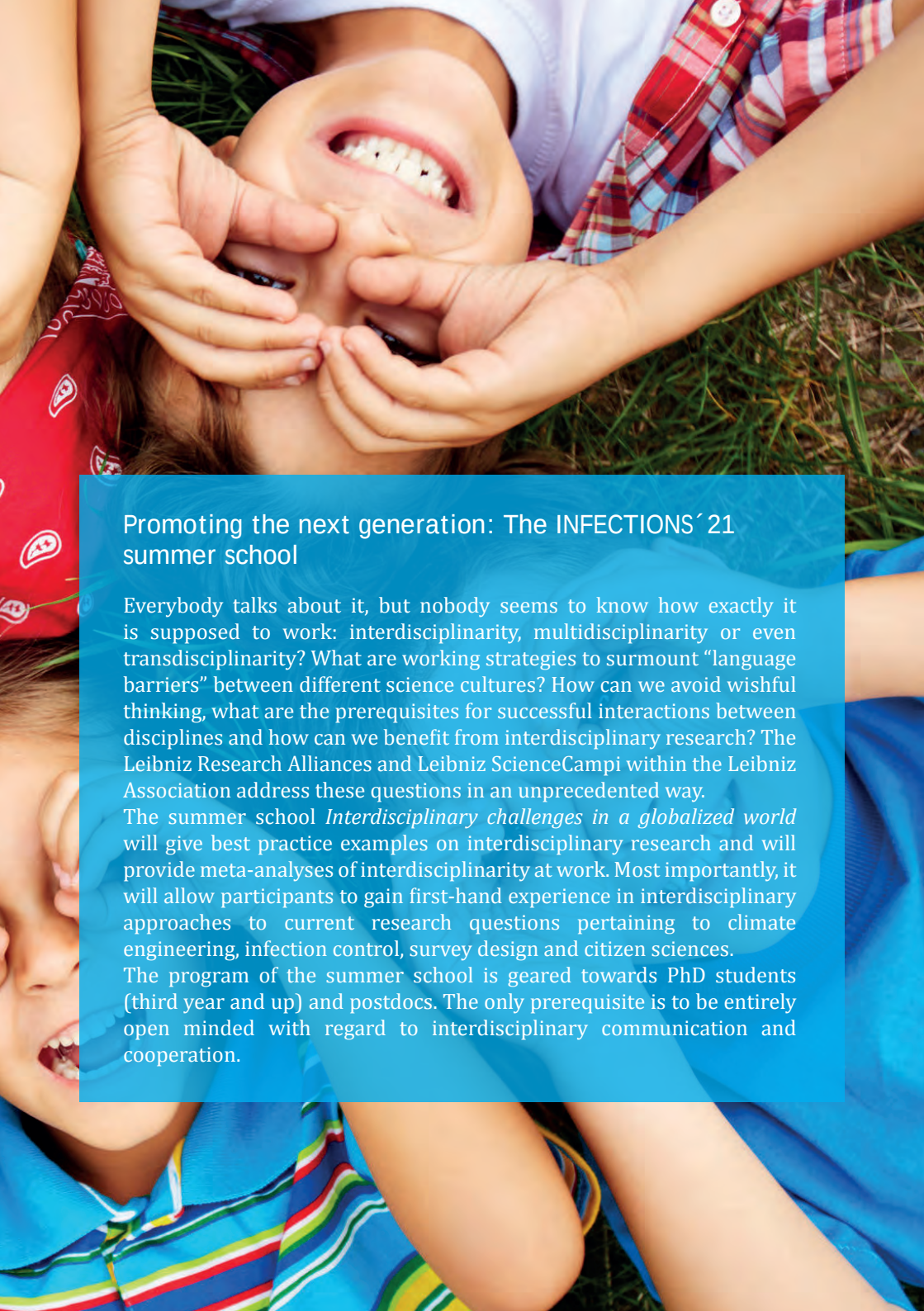
In order to inform the public of and attract their attention to the widespread aspects of infection research, the Leibniz Research Alliance INFECTIONS´21 developed a series of events with periodic lectures and panel discussions entitled “Zu Land, zu Wasser und durch die Luft: Wie sich Infektionsserreger ausbreiten”. The general public is invited to join and discuss these topics with scientists of our alliance – all across Germany and on a regular basis!

Science Dialogue

In Germany, research projects with active participation of citizens are gaining increasing importance. This voluntary work presents a great opportunity for science, opening up the opportunity for a wider range of data collection. Furthermore, it is a key step to render scientific work more transparent and attract the general public's attention to these topics.

The "Mückenatlas" (mosquito atlas) is an extraordinarily successful citizen science project which went online in April 2012. Citizens are asked to collect culicid mosquitoes in their private neighborhoods and send them to the research institutions involved in the survey. This way, citizens are actively involved by collecting important scientific data. In return, they receive detailed information about the biodiversity, the ecology and the biology of the bloodsucking insects. The Leibniz Centre for Agricultural Landscape Research (ZALF) is one cooperation partner of this project.

For further information, please visit: www.mueckenaltas.de

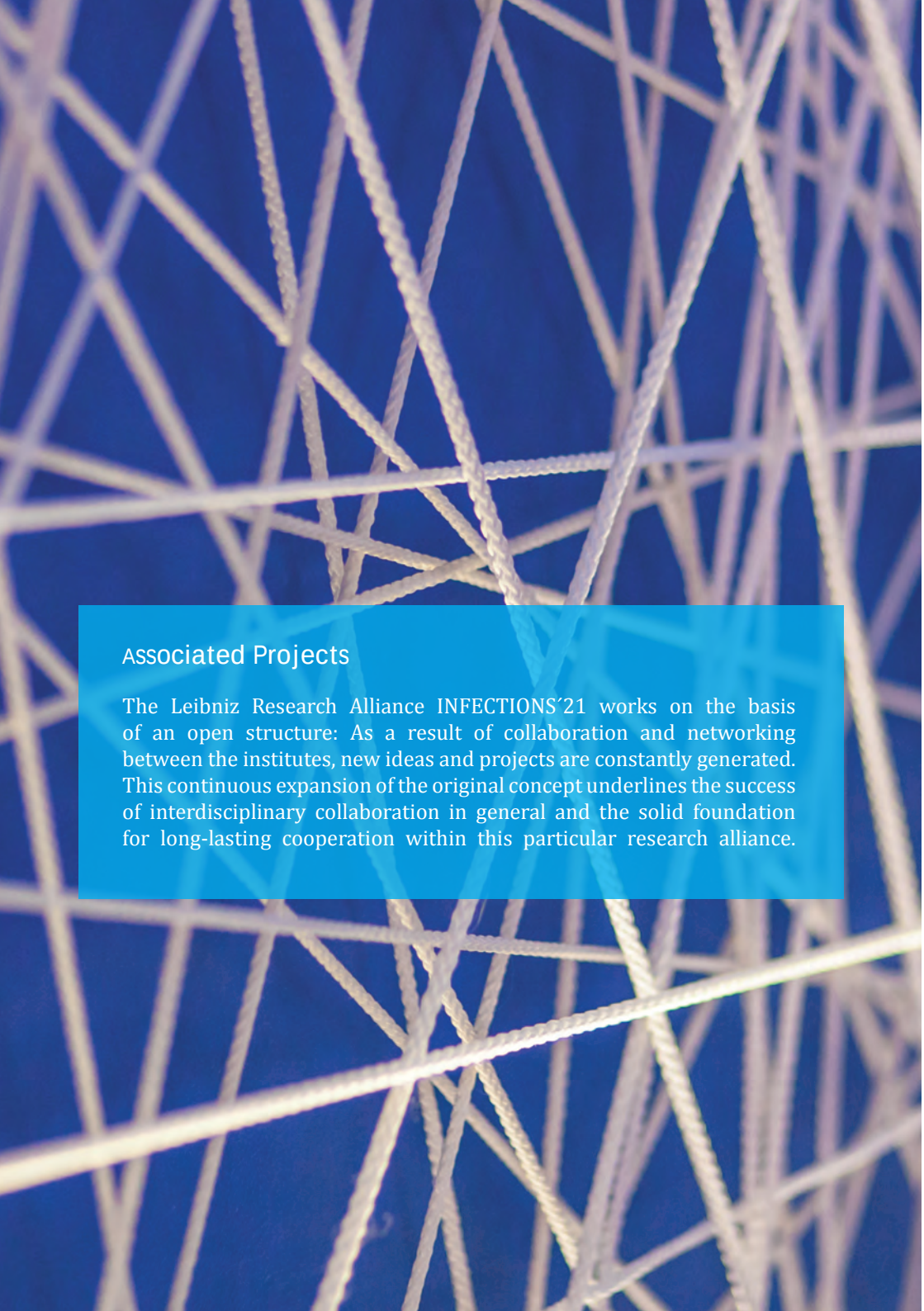


Promoting the next generation: The INFECTIONS´21 summer school

Everybody talks about it, but nobody seems to know how exactly it is supposed to work: interdisciplinarity, multidisciplinarity or even transdisciplinarity? What are working strategies to surmount "language barriers" between different science cultures? How can we avoid wishful thinking, what are the prerequisites for successful interactions between disciplines and how can we benefit from interdisciplinary research? The Leibniz Research Alliances and Leibniz ScienceCampi within the Leibniz Association address these questions in an unprecedented way.

The summer school *Interdisciplinary challenges in a globalized world* will give best practice examples on interdisciplinary research and will provide meta-analyses of interdisciplinarity at work. Most importantly, it will allow participants to gain first-hand experience in interdisciplinary approaches to current research questions pertaining to climate engineering, infection control, survey design and citizen sciences.

The program of the summer school is geared towards PhD students (third year and up) and postdocs. The only prerequisite is to be entirely open minded with regard to interdisciplinary communication and cooperation.



Associated Projects

The Leibniz Research Alliance INFECTIONS´21 works on the basis of an open structure: As a result of collaboration and networking between the institutes, new ideas and projects are constantly generated. This continuous expansion of the original concept underlines the success of interdisciplinary collaboration in general and the solid foundation for long-lasting cooperation within this particular research alliance.

Aquavir
In climatic zones with seasonally limited precipitation animals congregate at high densities at scarce water sources. We hypothesise that viruses shed in water in this ecological setting would gain a fitness advantage if they evolve traits permitting both the retention of their infectivity in water and a reduction of host specificity. Aquavir - Water as an aquatic vector for newly emerging diseases will determine if water is a significant viral vector, how viruses behave mechanistically in such settings and to develop mathematical models for the phenomenon.

CuliMo
The project CuliMo - Monitoring of mosquitoes in Germany deals with the recording of the geographic and seasonal occurrence of culicid species and the human and animal pathogenic disease agents they may transmit in Germany.

CuliFo
The project CuliFo - Mosquitoes and mosquito-borne zoonoses in Germany is intended to produce data which enable a risk assessment of the occurrence of mosquito borne diseases in Germany in the future.

ACUTE
Aquaculture sites, in particular open fish cage practices in tropical countries, are characterised by high bacterial abundances and potential pathogens, harmful algae blooms, and organic matter-rich particles which can cause extensive economic and ecological damage. Pathogen-laden particles pose great risk for human health and may be implemented in the field of disease ecology. Aquaculture practice in tropical coastal ecosystems - Understanding ecological and socio-economic consequences (ACUTE) will help to improve current drawbacks in aquaculture practices in tropical countries. The outcomes will provide a solid basis for management strategies and risk assessment for human livelihoods, e.g. outbreak of diseases through aquaculture derived pathogens.

BIBS
Focusing on rapid transitions of ecological systems as one of the most pressing challenges in biodiversity research, Bridging in Biodiversity Science (BIBS) will conduct studies at key interfaces commonly neglected in conventional biodiversity research and evaluate the added value and limitations of the bridging concept.

SOARIAL
In SOARiAL - Spread of antibiotic resistance in an agrarian landscape we investigate and quantify dust-associated emissions of antibiotic-resistant, pathogenic bacteria from fertilized agricultural fields. We will elucidate how emissions are determined by soil properties and agricultural management. Our data will allow modelling of bacterial emission fluxes and dispersal and assessing the risk of wind-borne transmission.

Participating Institutes

14 Institutes from the Leibniz Association and 3 external partners are involved in the Leibniz Research Alliance INFECTIONS´21. The research areas of the participating institutions are very diverse, ranging from economic and social sciences through life sciences to environmental sciences.

The Research Center Borstel - Leibniz-Center for Medicine and Biosciences (RCB) is the lung research center of the Leibniz Association. The focus is on chronic inflammatory lung diseases such as asthma and allergies, chronic obstructive pulmonary disease (COPD) as well as tuberculosis and other infection-induced inflammations of the lung. The overall aim of the interdisciplinary research activities is to elucidate the causes and mechanisms of chronic inflammatory and degenerative diseases of the lungs in order to derive new innovative concepts for their diagnosis, prevention and therapy.

www. fz-borstel.de

The Bernhard Nocht Institute for tropical Medicine (BNITM) is Germany's largest institution for research, services and training in the field of tropical diseases and emerging infections. The institute operates laboratories of the highest biosafety level, a safety insectary and – together with its Ghanaian partners – a modern research and training centre in West Africa. It focuses on research on malaria and hemorrhagic fevers and on diagnostics development, comprising the National Reference Centre for Tropical Infections and WHO Collaborating Centre for Arboviruses and Hemorrhagic Fevers.

www. bnitm.de

As the largest German infrastruture institute for the social scieces, GESIS – Leibniz-Institute for the Social Sciences, with its expertise and services, stands ready to advise researchers at all levels to answer socially relevant questions on the basis of the newest scientific methods, high quality data and research information. GESIS do this with essential research-based services and consulting, covering all levels of the scientific processes. The work of GESIS is characterized by its independence, long-term sustainability, quality and competence.

www. gesis.org

The Heinrich Pette Institute, Leibniz Institute for Experimental Virology (HPI) investigates the biology of human pathogenic viruses with the aim of unraveling the molecular mechanisms that control viral life cycles and virus induced pathogenesis. The institute applies basic experimental research to develop new approaches for contemporary treatments of viral infections such as AIDS, influenza and hepatitis but also of emerging viral diseases. The HPI was established by the philanthropist Philipp F. Reemtsma and the neurologist Heinrich Pette in 1948. The institute is a non-profit, independent research foundation that is part of the Leibniz Association.

www. hpi-hamburg.de

The Leibniz Institute DSMZ-German Collection of Microorganisms and Cell Cultures is one of the largest biological resource centers worldwide. The unique diversity of resources, its extensive scientific services and the professional quality management make the DSMZ an international supplier for science, diagnostic laboratories, national reference centers, as well as for industrial partners of high renown. Research at the DSMZ focuses on microbial diversity, molecular mechanisms of biological interactions and tumor genesis.

www. dsmz.de

Leibniz Centre for
Agricultural Landscape Research
(ZALF)

The mission of the Leibniz Center for Agricultural Landscape Research (ZALF) is to explain causal relationships in agricultural landscapes and to provide society with sound information for the sustainable use of agricultural landscapes through excellent interdisciplinary research. Agricultural landscapes in comparison to natural landscapes are shaped by their use and their users. The research at ZALF therefore also covers societal demands on agricultural landscapes and the effect of their use. In its research, ZALF increasingly addresses major societal challenges in the context of agricultural landscapes including climate change, food and nutrition security and biodiversity.

www. zalf.de

The Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB) is a European research centre for agricultural engineering with an interdisciplinary field of activities at the nexus of biology and technology. ATB develops sustainable technologies for the resource efficient utilization of biological systems to produce food, raw materials, and energy. Solutions developed in the context of biorefinery concepts and cascade utilization of biomass for improving the environmental compatibility, efficiency and sustainability of relevant processes will contribute to enhance a knowledge based bio-economy. and therapy.

www. atb-potsdam.de

Leibniz-Institute of
Freshwater Ecology
and Inland Fisheries

"Research for the Future of our Freshwaters" is the mission of the Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB). Its key research activities include the long-term development of lakes, rivers and wetlands under rapidly changing global, regional and local environmental conditions, the development of coupled ecological and socio-economic models, the renaturation of ecosystems, and the biodiversity of aquatic habitats. The research findings should enable society and decision-makers to face a changing environment and to manage and conserve water-based resources and ecosystems for the welfare of mankind and nature.

www. igb-berlin.de

The GIGA German Institute of Global and Area Studies is an independent social-science research institute based in Hamburg. It analyses political, social and economic developments in Africa, Asia, Latin America and the Middle East and combines this analysis with innovative comparative research on international relations, development and globalisation, violence and security, and political systems. On the basis of this research, the GIGA advises political, economic and social decision-makers. Through its Berlin office, the institute is also represented in the German capital.

www. giga-hamburg.de

The Potsdam Institute for Climate Impact Reserach (PIK) addresses crucial scientific questions in the fields of global change, climate impacts and sustainable development. Researchers from the natural and social sciences work together to generate interdisciplinary insights and to provide society with sound information for decision making. The main methodologies are systems and scenarios analysis, modelling, computer simulation, and data integration.

www. pik-potsdam.de

Since 1991 the Leibniz Centre for Tropical Marine Research (ZMT) has dedicated its training and research to the better understanding of coastal ecosystems in the tropics. The ZMT focuses on the structure and functioning of these habitats, their response to anthropogenic and natural influences and the use of resources. In close cooperation with partners in the tropics, the ZMT leads interdisciplinary projects combining natural and social sciences. Scientists at the ZMT also support the development of expertise and structures in its partner countries to allow for sustainable coastal zone management.

www.leibniz-zmt.de

Microbial natural products serving as mediators of biological communication are essential for our lives. They do play an ambivalent role: on the one hand, they contribute to the generation of many infectious diseases; on the other hand, they belong to the most important sources provided in drugs such as antibiotics. The Leibniz Institute for Natural Product Research and Infection Biology - Hans Knöll Institute (HKI) investigates the communication between micro-organisms to be able to make use of the acquired know-how to develop innovative components for the diagnosis and therapy of diseases.

www.leibniz-hki.de

In 1992 the Leibniz Institute for Tropospheric Research was founded for research on physical and chemical processes in the polluted troposphere. Meanwhile, a well-defined and globally unique research profile of the Leibniz Institute for Tropospheric Research (TROPOS) emerged, with a focus on aerosols, i.e. small airborne particles, and clouds. Despite their minute absolute amount, aerosols and clouds are essential parts of the atmosphere because they control the budgets of energy, water and trace substances of the Earth System.

www.tropos.de

The Leibniz Institute for Zoo and Wildlife Research (IZW) was founded in 1992 and performs basic and applied research on wildlife to provide the scientific underpinnings for worldwide conservation of wildlife species and natural processes. The institute studies the diversity of life histories and evolutionary adaptations and their limits of free-ranging and captive wildlife species, and their interactions with people and their environment in Germany, Europe and worldwide. The IZW conducts research into genetic, physiological, veterinary, behavioural, ecological and evolutionary mechanisms and incorporates theoretical and applied as well as mechanism-oriented and functional research to develop the scientific basis for novel approaches to conservation of wildlife.

www. izw-berlin.de

Universität Hamburg
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Universität Hamburg is the largest institution for research and education in the north of Germany. As one of the country's largest universities, we offer a diverse course spectrum and excellent research opportunities. The University boasts numerous interdisciplinary projects in a broad range of subjects and an extensive partner network with leading institutions on a regional, national and international scale. Besides Climate, Earth, Environment, further successful key research areas include: Matter and the Universe, Neurosciences, Multilingualism, Governance, Infection Research, Structural Biology as well as Heterogeneity and Education.

www.uni-hamburg.de

FRIEDRICH-LOEFFLER-INSTITUT
FLI
Bundesforschungsinstitut für Tiergesundheit
Federal Research Institute for Animal Health

As Federal Research Institute for Animal Health, the Friedrich-Loeffler-Institut (FLI) addresses farm animal health and welfare. The work aims at the prevention, diagnostics and control of animal diseases, the improvement of animal welfare and animal nutrition as well as the preservation and use of farm animal genetic resources.

www.fli.de

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

The London School of Hygiene & Tropical Medicine is a world-leading centre for research and postgraduate education in public and global health, with an annual research income of more than £110 million. Our depth and breadth of expertise encompasses many disciplines, and we are one of the highest-rated research institutions in the UK.

www.lshtm.ac.uk

Imprint:

Leibniz Research Alliance
INFECTIONS`21- Transmission Control of Infections in the 21th Century

Speaker:
Prof. Dr. Ulrich E. Schaible
Research Center Borstel -
Leibniz-Center for Medicine and Biosciences (FZB)
Tel.: 04537/188 6000
Mail: uschaible@fz-borstel.de

Coordinator:
Dr. Susanne Paetzold
Research Center Borstel -
Leibniz-Center for Medicine and Biosciences (FZB)
Tel.: 04537/188 5840
Mail: spaetzold@fz-borstel.de

Press contact:
Britta Weller
Research Center Borstel -
Leibniz-Center for Medicine and Biosciences (FZB)
Tel.: 04537/188 2870
Mail: bweller@fz-borstel.de

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