Helmholtz Space Life Sciences Research School – SpaceLife

An Interdisciplinary Doctoral Candidate Program

Institute of Aerospace Medicine, Cologne, Germany
Contents

Introduction 3
Scientific Program 4
Topics and Doctoral Theses 6
  Radiation Biology 6
  Gravitational Biology 12
  Astrobiology 19
  Space Physiology 23
Professional Training Program 32
  Thesis Supervision 32
  Curriculum 33
Management Structure 47
Members 49
  DLR Institute of Aerospace Medicine 50
  Partner Universities 51
  Associated Partners 52
  Faculty Member Profiles 56
  Profiles of the SpaceLife Associated Partners 94
  Member Group Locations 110
Application 111
Contact 112
Introduction

The Helmholtz Space Life Sciences Research School (SpaceLife) offers excellent and interdisciplinary training for doctoral students from different fields (biology, physics, psychology, veterinary medicine, nutrition or sports sciences) and all countries.

In each generation, up to 25 students can participate in the three-year program. At the DLR, up to 13 doctoral students will participate in SpaceLife. Up to twelve doctoral students at the partner universities can be admitted to SpaceLife.

Students will learn to develop integrated concepts to solve health issues in human spaceflight and in related disease patterns on Earth, and to further explore the requirements for life in extreme environments, enabling a better understanding of the ecosystem Earth and the search for life on other planets in unmanned and manned missions.

Thesis supervision is close meshed by two specialist Supervisors from DLR and the partner university, and a Mentor, as well as annual progress reports by the doctoral student in a Students’ Workshop.

All students attend lectures in different subfields of space life sciences to attain an overview of the field: radiation and gravitational biology, astrobiology and space physiology, including psychological aspects of short and long term space missions. Seminars, advanced lectures, laboratory courses and stays at labs at the partner institutions or abroad are offered as elective course and will provide in-depth knowledge of the chosen subfield or will allow to appropriate innovative methods. In Journal Clubs of the participating working groups, doctoral students will learn critical reading of scientific literature, first steps in peer review, scientific writing during preparation of their own publication, and writing of the thesis. The training of soft skills will be offered as block course in cooperation with other Helmholtz Research Schools.

The spokesperson bears responsibility for SpaceLife. SpaceLife is organized by the coordinator and the secretary. The scientific members of SpaceLife form the Faculty which meets annually. The Faculty elects a Faculty Panel who assists the coordinator and the spokesperson in the student selection process and in formation of the curriculum. The doctoral students elect a Doctoral Spokesperson who participates in meetings of the Faculty and the Faculty Panel.

Doctoral students from Kiel, Zurich and Regensburg attend the lectures using teleconference tools, or block courses will be offered. Some elective courses take place at the University of Bonn and the DSHS Cologne.

The whole program encompasses 303 hours and is organized in semester terms. Most of the lectures will take place in Cologne at the Institute of Aerospace Medicine.
The mission of the Helmholtz Space Life Sciences Research School (SpaceLife) is to contribute to understanding the space frontier and the opportunities, capabilities, and limitations of humans living and working on that frontier and of the spread of life in the universe. The program’s objective is to investigate the complex inter-actions of space environmental factors and humans or other organisms. To accomplish its mission, SpaceLife implements a broad range of applied and basic scientific research. Thereby it links theoretical and practical approaches of radiation dosimetry, microbiology, basic molecular and cellular research in radiation and gravitational biology with translational and clinical studies. This research is accomplished using ground-based laboratories, microgravity environments, space-analog simulation facilities and if available, space flight opportunities. The long-term goal is to contribute to the “safe, sustained, affordable exploration of the Moon, Mars, and beyond...”. The European Space Agency’s Aurora program and the US Vision for Space Exploration aim ultimately to land people on Mars, although it seems certain that the Moon will be an earlier target.

In the short term, Aurora features robotic missions while at the same time preparing for future human exploration missions. Humans bring speed, agility, versatility and intelligence to exploration in a way that robots cannot. Although it is true that humans will face many dangers and obstacles operating on other planets, mostly due to their physiological limitations when compared to robots, the potential scientific returns is more than sufficient to justify employing astronauts as field scientists on other planets. However, prior to manned missions to Mars, appropriate guidelines and methods need to be developed to protect the planet from human activities that may be harmful to its environment; this includes preventing the introduction of terrestrial biochemical compounds and microorganisms that could interfere with the search for indigenous Martian life, to protect the Earth from potentially harmful agents brought back from Mars or even sample return missions upon return of the explorers. Answers to these planetary protection issues need to be available well ahead of manned missions to Mars, e.g. by testing planetary protection protocols and guidelines during precursor missions and by investigating the extraordinary capability of terrestrial microorganisms to adapt to and live under extreme environmental conditions.

A key priority of European human spaceflight activities remains the effective use of the International Space Station (ISS) in the next 10 years in order to maximize the return on European investment. This aligns well with the current German Space Life Sciences Program, in which three main scientific fields have been identified in collaboration with the scientific community: integrative human physiology, biotechnological applications of the microgravity environment, and fundamental biology of gravity and radiation responses. In view of planning long-duration human exploration missions it is imperative that the ISS is used for the preparation of these new endeavors.

The ISS is ideally suited for testing hardware developments, and to perform long-term medical studies, related to future exploration missions to Moon and Mars. These medical studies on humans will be focused on the long-term effects of microgravity, radiation biology, and the psychological effects of long duration flight.
The European Columbus laboratory has been successfully launched on February 7, 2008 and paves the way for the implementation of a significant ISS utilization program which will further advance technical and scientific progress in human spaceflight.

Space life science research embraces the whole range of studies from molecular and cellular biology to whole-organism physiology. In the important area of human physiology and medicine, research in the space environment has demonstrated the potential to provide unique insights into such areas as gene expression, immunological function, bone physiology, and neurovestibular and cardio-vascular function. These areas are important for understanding age-related phenomena and a range of terrestrial disease processes (e.g. osteoporosis, muscle atrophy, cardiac impairment, and balance and co-ordination defects), and as such have potential medical applications in prevention, diagnosis, and therapy here on Earth. Moreover, research in space physiology provides a stimulus for the development of innovative medical technology, much of which is directly applicable to terrestrial medicine.

In fundamental biology, questions on the understanding of the effects of cosmic radiation and of altered gravity (microgravity and hypergravity) on living systems as well as on the origin and distribution of life and its evolution, are tackled. Radiation is an acknowledged primary concern for manned spaceflight and is a potentially limiting factor for long term orbital and interplanetary missions. Results from numerous space probes demonstrate heightened radiation levels compared to the Earth's surface and a change in the nature of the radiation field - particularly the presence of high energy heavy ions. The biological effects of this extraordinary radiation quality and the depths dose distributions in the human body have to be assessed for risk estimation and countermeasure development. Of central importance is also the elucidation of the mechanisms of gravity perception and signal transduction. While there is an increase in knowledge of the biological and physiological consequences of short-term microgravity, the biological effects of prolonged exposure to low, but non-zero, gravity are largely unknown. For example, more or less open questions are adaptation phenomena to a long-term microgravity environment, the existence of sensitive windows in the development of organisms as well as thresholds of graviperception. There is particular interest in the long-term effects of reduced gravity on the human body as well as on multi-generation experiments with cells and multicellular systems. Of special importance is to determine potential gravity thresholds for different body functions, in particular with regard to loss of muscle and bone mass, reduced cardiovascular capacity, functioning of the central nervous system, and immune system deficiencies.

With respect to future long-term human space missions to Moon and Mars it is of utmost importance to enlarge our knowledge about life in extreme environments, to develop, not only adequate countermeasures to reduce the effects of low gravity, but also to perform research into the effects of space radiation on the human body. Therefore, the Institute of Aerospace Medicine at the DLR establishes the Helmholtz Space Life Sciences Research School (SpaceLife) in order to provide training at the highest level for excellent young scientists.
SpaceLife

Scientific Program

Radiation Biology

Space Radiation Biology seeks to understand the biological effects of cosmic radiation by applying advanced methods of radiation dosimetry and cell biology. For proper risk assessment and amelioration of the effects of radiation encountered in space the knowledge of the radiation distribution throughout the body and hence on the body dose, of the relative biological effectiveness of cosmic radiation, of the effects of other spaceflight factors on the expression of radiation damage, and of the underlying biological responses are necessary.

Radiation Protection and Space Radiation Measurements

In order to obtain precise data on radiation distribution throughout the body during an Extra Vehicular Activity (EVA), MATROSHKA - an ESA multi-user facility - was developed by the German Aerospace Centre (DLR), Institute of Aerospace Medicine. The key part of the facility is a human phantom upper torso, equipped with numerous radiation detectors. MATROSHKA was mounted on the exterior of the Russian Service Module of the International Space Station (ISS) in February 2004. After an exposure of about 18 month it was brought back inside the ISS and equipped with new detector sets and is still operating. The data gathered - in cooperation with 19 institutes worldwide - are used to reduce uncertainties in risk estimates for radiation-induced cancer, and for the refinement of the shielding needs for vehicles used for future long duration missions. They serve as benchmarks for space radiation models and radiation transport calculations and have important implications for ISS crew health and mission planning.

Topics and Doctoral Theses

Besides the MATROSHKA experiment, the group is in charge – as contractor for ESA – for the personal dosimetry of European Astronauts. Of special importance are the experiments - in cooperation with CAU - for the long term monitoring of the radiation environment in- and outside the ISS. This started with measurements inside the US Lab in 2001 (DOSMAP) and was followed by long term spatial and temporal measurements in the Columbus Module starting with the DOSIS (2009 – 11) experiment and followed by the DOSIS 3D experiment (2012 – 15). The development of active radiation detectors in cooperation with the University of Kiel for the US MSL Mission, as well as the determination of the radiation exposure on aircrew are further fields of study. All space studies are accompanied by an extensive ground based calibration program. The detection efficiency of various passive (thermoluminescence detectors, nuclear track etch detectors) and active (silicon detectors, tissue equivalent proportional counters and scintillators) radiation detectors is investigated in various heavy ion and neutron fields.
Accurate knowledge of the physical characteristics of the space radiation field in dependence on the solar activity, the orbital parameters and the different shielding configurations of the International Space Station ISS is therefore needed. Although considerable data has been accumulated from several spaceflights, it is not yet possible to provide a full quantitative description of the radiation field, especially at the edge of the radiation belt, because of its highly complex composition regarding the particles present and their energy spectra. Data comparison is also hampered by uncertain angular distribution of the single radiation components, by missing knowledge on the angular response of instruments and missing information about shielding distributions of the locations were the different instruments are mounted. Further on the radiation environment inside the ISS has changed over the years, especially due to the extension of the space station, adding new modules and thereby changing the overall shielding properties of the station but also due to the heliospheric modulation and particle transport in a dynamic magnetosphere.

In the frame of the PhD thesis data from radiation experiments onboard the International Space Station shall be analysed to provide documentation of the actual nature and distribution of the radiation environment throughout the whole International Space Station. The baseline data should be from the joint DLR and CAU experiments as DOSMAP (2001), DOSIS (2009 – 2011) and the upcoming DOSIS-3D (2012 – 2015) experiment. In order to take into account the variable “primary” radiation field due to heliospheric modulation existing models (e.g. PLANETOCOSMICS) will to be applied.

The active part of the DOSIS experiment (2009 – 11) onboard the ISS inside the European Columbus Laboratory

Measured count rate with the active DOSTEL during the DOSIS experiment onboard the ISS
The Radiation Assessment Detector (RAD) instrument aboard MSL has been measuring the radiation environment which an astronaut would experience on his way to Mars since early December 2011. RAD is an energetic particle analyser designed to characterize the full spectrum of energetic particle radiation at the surface of Mars, including galactic cosmic rays (GCRs), solar energetic particles (SEPs), secondary neutral radiation and other particles created both in the atmosphere and in the Martian regolith.

The RAD instrument will operate throughout the whole mission, including a substantial part of the cruise phase, to characterize the radiation environment of MSL, both on its way to and on the surface of Mars. RAD’s primary science objectives are to characterize the energetic particle spectrum at the surface of Mars and to determine the radiation dose for humans. Further on it should enable validation of Mars atmospheric transmission models and radiation transport codes.

This thesis will focus mainly on the determination of the radiation dose for humans on the surface of Mars and on their way to Mars. It will analyse measurements from the cruise phase and on the surface to derive from them not only the dose an astronaut would have accumulated if he had flown with MSL, but also to give, for the first time, measurement-based ranges for this important quantity for the various phases of a future manned mission to our neighbouring planet, Mars. Thus, this thesis entails a combination of data analysis and detailed modelling.
### Scientific Program

**Radiation Biology**

#### Cellular Radiation Effects and Bystander Effects

During space travel astronauts face many acute risks; however, after safe return to Earth a lifetime risk persists for cancer and cataracts as a result from exposure to galactic cosmic rays (GCR) and in rare cases to solar particle events (SPE). When comparing terrestrial low-linear energy transfer (LET) radiation (X-rays or γ-rays) to high-LET space radiation qualities (heavy ions and secondary neutrons), differences in the patterns of energy deposition in biomolecules, cells and tissues occur, which on cellular level are only poorly understood and on organ level information is still incomplete.

Exposure to ionizing radiation modifies the cellular division processes as well as other cell functions required for healthy living organisms. Cells have the ability to repair themselves; when that repair is successful, the tissues and organisms return to their normal state. When the repair is not successful, cells may die, mutate or differentiate along their lineage. If a sufficiently large number of cells are killed, tissue integrity and function may be impaired, as occurs in acute radiation effects. Repair may be successful from the point of view of cell survival, but may contain latent errors that only manifest in subsequent generations of dividing cells. Such errors may contribute to radiation induced cancerogenesis and cataractogenesis. The active cellular response to radiation exposure involves triggering of many signaling pathways and the activation of transcription factors. For risk assessment and countermeasure development, the role of such pathways in radiation induced cancerogenesis and cataractogenesis has to be understood. In view of its tumor-promoting capacity, Nuclear Factor κB (NF-κB) is an important factor involved in the modulation of environment-induced gene expression, especially in the interplay of the pro-apoptotic p53 pathway and the pro-survival NF-κB pathway after low and high dose radiation. The transcription factor p53 plays a central role as a principal regulator of the G1 cell cycle checkpoint in maintaining the integrity of genome after exposure to DNA-damaging agents, thereby acting as a tumor suppressor.

p53 protein regulates the expression of specific genes involved in growth regulation and apoptosis, while NF-κB regulates the expression of specific anti-apoptotic genes involved in innate and adaptive immunity and in oncogenesis. Activation of the NF-κB pathway gives transformed cells a growth and survival advantage and further renders tumor cells resistant to chemo- and radiation therapy.

At the Institute of Aerospace Medicine, the biological effects of cosmic radiation are analyzed by several approaches: Different radiation qualities (sparsely ionizing X-rays, densely ionizing α-particles and accelerated heavy ions as well as neutrons) are supposed to have different induction potencies for stress-induced pathways. Their effect on the biological outcome (alterations in gene expression, cell cycle arrest, apoptosis and other types of cell death, DNA repair) are analyzed e.g. by microarrays, real-time quantitative Reverse Transcriptase Polymerase Chain Reaction (qRT-PCR), translocation vectors with fluorescent marker proteins and immunofluorescence (confocal microscopy), promoter-reporter vectors, pulsed field gel electrophoresis, inhibitor and RNA interference studies, apoptosis assays and flow cytometric cell cycle analysis.
Radiation Biology

Cellular Radiation Effects and Bystander Effects

**Topic of Doctoral Thesis**
Survival pathways in the cellular response to space-relevant radiation qualities

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**Thesis Description**
Radiation is a potentially limiting factor for long-term orbital and interplanetary missions. For better risk estimation and development of appropriate countermeasures, the study of the cellular radiation response is necessary. This active response of the cell to DNA damage involves the activation of several signaling pathways, resulting in the activation of transcription factors. The interplay of pro-survival and death-promoting pathways is essential for the cell-fate responses (cellular senescence or premature differentiation, and different types of cell death: apoptosis, necrosis, mitotic catastrophe). Previous experiments with space relevant radiation qualities have shown that the pro-survival NF-κB pathway is activated by fluences of heavy ions that can be reached during long-term missions. The role of another cytoprotective pathway leading to activation of the transcription factor Nuclear Factor-E2-related factor 2 (Nrf2) in the cellular response to heavy ions with medium to high linear energy transfer (LET) is unknown.

For UV and low-LET radiation, it has been shown that Nrf2 is activated dose-dependently and that the induction of cytoprotective genes can confer a higher radioresistance. Therefore, activation of Nrf2 pathway and the induction of target genes by space-relevant radiation qualities will be studied in this work, and compared to the effects of known activators of the pathway such as pro- and anti-oxidants, UV and low-LET radiation. The contribution of the Nrf2 pathway to different cellular outcomes after radiation exposure will be analyzed by functional knockout of Nrf2 using an RNA interference approach.

**Relative Biological Effectiveness (RBE)** of energetic ions of different LET in activating NF-κB dependent d2EGFP gene expression. 150 kV X-rays were used as reference radiation (Hellweg et al., 2012, IJRB, 87:954-963)

Possible means for regulation of cell survival and other cell-fate responses to DNA damage and reactive oxygen species (ROS) and oxidative stress through interactions of Nrf2 with NF-κB, p53, and Notch1 cell-signaling pathways.
Radiation Biology

**Cellular Radiation Effects and Bystander Effects**

**Topic of Doctoral Thesis**
Response of mammalian lenses to space radiation qualities *in vitro* and in organ culture

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**Thesis Description**
The exact mechanisms leading to radiation-induced cataract formation are not precisely known; they are supposed to initiate from genetic damage in lens epithelial cells, including conflicts in cell cycle controls, apoptosis, abnormal differentiation, and cellular disorganization, or other pathways guiding to abnormal lens protein fibers.

Radiation-induced cataracts have been studied in radiotherapy patients, the survivors of the atomic bombings in Japan, and patients undergoing computer tomography (CT) scans. These epidemiological studies indicate that there is an increased incidence of lens opacities at doses below 1 Gy of sparsely ionizing radiation. Although the causative factors of cataract are many, and its etiology is still unclear, it has been linked to oxidative stress. It plays a major role, not only in age related cataract, but also in radiation-induced cataract.

In contrast to other human organs, most mammalian lenses are small enough to be cultivated as a whole organ *ex vivo* over a longer period of time.

The mammalian lens is composed of a single layer of nucleated cuboidal epithelial cells which differentiate at the bow region into elongated lens fiber cells which at maturity lack nuclei and organelles.

With a diameter of ~10 mm porcine lenses could be viable for several weeks in culture and this allows for a systemic investigation of the so far only hypothesized correlation of DNA damage response in epithelial cells and repair insufficiencies during differentiation to lens fiber cells and their emerging opacification.

Cross section of an adult mammalian lens [modified from Danysh and Duncan, 2009, Experimental Eye Research 88: 151-164]
Gravitational Biology

The evolution of life on Earth occurred under the persistent influence of gravity. As gravity is constant with respect to its direction and magnitude, the vectorial information of gravitational acceleration is a most reliable reference point for orientation. Sensors for the gravity stimulus, specialized organelles for gravity sensing and mechanisms for active responses have been found in unicellular organisms as well as in multicellular animal and plant systems. Recent studies support the hypothesis that gravity is perceived either by intracellular receptors (statocyst-like organelles), heavy cell organelles (such as nucleus) and/or by sensing the cell mass by means of ion channels located in the cell membrane. Consequently the question arises about a general gravisensitivity of cells including mammalian cells.

Scientific Program

Though severe effects of microgravity on cells (e.g. lymphocytes) have been stated, the development of complex organisms occurs more or less undisturbed under this condition. However, a systematic approach and multi-generation experiments with animals and plants in microgravity are necessary as they are the key players in life support systems which are necessary for long-term manned space missions.

In addition to rather exclusive experiments under real microgravity conditions, different ground-based methods have been developed to achieve either the status of simulated microgravity (this term has been adopted by international convention) or hypergravity (artificial gravity) conditions.

The DLR Institute of Aerospace Medicine has a long-term experience in developing and using space simulation facilities: so-called clinostats enable the rotation of a sample perpendicular to the gravitational field assuming that a continuously reoriented biological system does not perceive the gravitational stimulus. The results of some experiments also performed in real microgravity conditions support this hypothesis.

Topics and Doctoral Theses

Various clinostat devices have been constructed enabling a broad variety of experimental performances (e.g. microscopic observation of the sample during rotation in a clinostat).

Combination with our irradiation facilities (see section Radiation Biology) enables the investigation of the combined effect of functional weightlessness and radiation. Correspondingly, different centrifuge devices – such as centrifuge microscope (NIZEMI = Niedergeschwindigkeits-Zentrifugenmikroskop) - complete our experimental scenario.

Furthermore, the Institute of Aerospace Medicine is the facility responsible centre for Biolab, a laboratory facility on the ISS. Biolab provides the possibility to investigate various cell types and small biological systems (plants and animals) under microgravity conditions.

DLR short arm human centrifuge (SAHC)
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**Thesis Description**

Space conditions have been found to have various effects on the whole organism as well as on single cells. The planned thesis aims to increase the information about the impact of gravity on human chondrocytes. In vitro reconstitution of organs is a modern task in tissue engineering. If chondrocytes are exposed to altered gravity conditions, simulated or real microgravity (µg) or hypergravity, 3D cartilage will be formed, characterized and may be potentially used for implantation in human or animal bodies.

The aim of this thesis is to investigate the underlying molecular pathways and to focus on the gravisensitive molecular mechanisms in chondrocytes to identify the biological interface between the gravity force and cellular functions. The bone morphogenetic protein (BMP)-SMAD pathway has been reported to play an important role in chondrocyte differentiation and function maintenance. Thus, the integrin internalization and subsequent signaling pathways of chondrocytes under altered gravity conditions – including a parabolic flight experiment - will be investigated.

75 % of the thesis is performed at Magdeburg, 25 % at DLR, Cologne. Therefore it is recommended to live in Magdeburg.

Integrin internalization and downstream signaling pathway. The low elastic modulus of the extracellular matrix (ECM) promotes the integrin internalization. The promoted internalization of integrin via caveolae on soft substrate is shown to affect the membrane location of bone morphogenetic protein receptor type IA (BMPR1A) which is essential for the bone morphogenetic protein (BMP) signaling.
**Scientific Program**

The main goal of this project is to understand and how T lymphocytes respond to microgravity at the molecular level and which molecular pathways are altered initially and rapidly after onset of microgravity. Previous experiments of our team investigated early signaling mechanisms (MASER-12) and rapid alterations in gene expression (16th DLR PFC) in T cells exposed to microgravity, which revealed potential gravity-sensitive mechanism and structures in the cell. In the doctoral thesis project we will focus on the role of specific ion channels, cytoskeletal alterations and chromatin-associated mechanisms in gravitational cell sensitivity. Experiments will be performed during the TEXUS-50/51 sounding rocket mission, during parabolic flight campaigns and in simulated weightlessness provided by a 2D clinostat. The major part of the thesis will be performed in Zurich, minor parts in Cologne, Magdeburg, Bordeaux and Kiruna. Therefore it is recommended to live in Zurich.

**Thesis Description**

Sensitivity of cells of the human immune system to reduced gravity has been supposed since the first Apollo missions and was demonstrated during several space missions in the past. However, it is not understood if and how human cells respond rapidly to reduced gravity and how reduced gravity is sensed by a human cell. However, their sensitivity to altered gravity renders cells of the immune system an ideal model system to understand if and how gravity on Earth is required for normal mammalian cell function.

**Lift-Off of TEXUS-49 on March 29th, 2011, 06:01 (Picture: Adrian Mettauer)**
**Gravitational Biology**

**Bioregenerative Life Support Systems**

**Topic of Doctoral Thesis**
Living in extreme habitats: The potential role of freshwater ostracods in life support systems

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**Thesis Description**
Bioregenerative life support systems will play an important role in future space missions by providing astronauts with food and also by recycling organic waste.

However, bioregenerative life support systems resemble artificial ecosystems, where populations naturally undergo frequent oscillations evoked by changing environmental conditions.

Since bioregenerative life support systems can be regarded as harsh, unfavorable and instable habitats, organisms inhabiting these systems must exhibit a high plasticity to adapt to frequently changing environmental conditions.

Ostracods are extremely well suited to face these challenges as they are tolerant to a wide range of environmental factors and could therefore be key organisms in bioregenerative life support systems for the enduring protein production in space or explorations and life in extreme environments. The proposed project thus aims to establish ostracods in aquatic based bioregenerative life support systems.

As a first step suitable species will be selected and their tolerance to common space mission generated debris such as high ammonium and phosphate levels will be tested.

In addition, ground based experiments to study short- and long-term effects of altered gravity on selected ostracod species will be performed and their specific gravisensing mechanisms and sensitive phases to gravity in their ontogeny will be analyzed. The outcome will add a robust and reliable species to future aquatic based live support systems.

75% of the thesis is performed at Munich, 25% at DLR Cologne. Therefore it is recommended to live in Munich.

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*Freshwater ostracods Eucypsis virens seen from their right body sides. Carapace length ca 1,5 mm. Photo: R. Matzke-Karasz*
The planned thesis will centre on the molecular identification and characterization of gravitaxis-relevant genes/proteins. It will be based on the transcriptom data and the already identified gravitaxis-relevant components. The known components will be used for a yeast two-hybrid screen to identify up- and downstream components.

Potential candidates will be knocked down by RNAi. Knockdown mutants will be characterized physiologically. On success (i.e. impairment of gravitaxis and/or phototaxis (the light controlled orientational movement)) will be used again in two-hybrid screens.

Sign and precision of gravitaxis are changing during culture development. Recent qPCR results indicate a change in expression of gravitaxis-relevant genes during culture development. This approach will be extended by the newly identified components. In an ambitious upcoming space experiment an automatic qPCR will be used. The newly developed system will be validated by the comparison to ‘normal’ qPCR results and will allow for an in-depth analysis in growing cultures.

75 % of the thesis is performed at Erlangen, 25 % at DLR, Cologne. Therefore it is recommended to live in Erlangen.
Gravitational Biology

Bioregenerative Life Support Systems

Topic of Doctoral Thesis
Comparison of gravisensing organs in different planktonic organisms – from evolution to life support systems

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Thesis Description
The high reproductive output and the essential role in aquatic food webs suggest especially aquatic zooplankton species to be suitable for life support systems.

Considering the broad range of gravity-perception systems - from sensilla based structures up to statocyst systems - there is still a considerable lack of knowledge regarding the gravit sensing organs in marine and freshwater zooplankton species. Hence, this thesis aims to develop a highly representative comparison of gravity-perception systems in selected zooplankton organisms with special emphasis on their evolutionary history.

In addition, the thesis will address sensitive windows for graviperception in ontogeny as well as thresholds of graviperception in selected organisms. Moreover, ground based studies will be performed to investigate the effects of altered gravity on the life history of the selected zooplankton species. The outcome will foster the selection of zooplankton species for future life support systems. Furthermore, it will significantly increase our knowledge on the evolution of graviperception in aquatic ecosystems where gravity is often the only reliable cue for orientation, and may therefore elucidate general gravity-related mechanisms valid for other organisms as well.

75 % of the thesis is performed in Munich, 25 % at DLR, Cologne. Therefore it is recommended to live in Munich.
Gravitational Biology

Plant Physiology

**Topic of Doctoral Thesis**
Influence of altered gravity on cellular signaling demonstrated with *Arabidopsis*

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**Thesis Description**
Space conditions have been found to have various effects on the whole organism as well as on single cells. The planned thesis aims to analyze responses of *Arabidopsis thaliana* under altered gravitational stimulation. Players of the plants gravitropism have been already identified; however, their role in the signaling cascade in perception and response is unclear. It has to be tested whether protein expression (up/down-regulation) and posttranslational modifications (phosphorylation etc.) contribute to plants’ adaption to altered gravitational stimuli.

**Scientific Program**

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Clinostat Microscope for online observation of samples in simulated microgravity

**Doctoral Theses**

Thus, the impact of altered gravity (simulated microgravity provided by clinostats, hypergravity by means of centrifuge; all facilities located at DLR) will be tested on the plant model system *Arabidopsis*. The results are expected to provide information on gravity-related pathways in plant systems but might also elucidate general gravity-related mechanisms valid for other systems. In the frame of the thesis, a proposal for a student microgravity experiment will be elaborated, submitted and - in case of positive evaluation – will be performed.
Astrobiology

Astrobiology is the study of the origin, evolution and distribution of life in the universe. This interdisciplinary field encompasses the search for habitable environments in our Solar System and beyond, investigations in the field of prebiotic chemistry, the search for extinct or extant life on Mars and other bodies in our Solar System, laboratory and field research into the origin and early evolution of life on Earth, and studies of the potential of life to adapt to environmental challenges on Earth and in outer space.

Viable microorganisms from Earth might be transported either intentionally or unintentionally to other planets by natural events such as meteorite impacts or by robotic spacecraft, but they most certainly will accompany humans in future space missions. In extraterrestrial environments these terrestrial life forms will be challenged by extremes, e.g. in temperature, pressure, radiation and the availability of water and nutrients.

In the last decades the number of organisms discovered at locations, which would have been classified still recently as 'life-hostile', has increased immensely. Examples of such 'extremophile' terrestrial organisms are microorganisms from hot springs, hydrothermal vents, deserts, permafrost, salt crystals, very acid or basic water. The increasing knowledge of the adaptability and its fundamental molecular mechanisms enable the estimation of the hypothetical viability on other planets in our solar system, e.g. on Mars.

This research field is the main topic of the Research Group Astrobiology of the Radiation Biology Department in the DLR-Institute of Aerospace Medicine. General questions at DLR are:

(i) What are the physicochemical boundary conditions for habitability?
(ii) How do organisms survive extreme environments?
(iii) How resilient is life in extreme environments to environmental change?
(iv) What are the responses to different stressors, how do they cause adaptation and evolution?
(v) Are there unique/common paths for responses to stresses?

The Lehrstuhl für Mikrobiologie and the Archaea Centre of the University of Regensburg have a long-lasting expertise in isolating, growing and characterizing extremophilic Bacteria and Archaea. They are a rich resource of model organisms also for studying the effect of conditions in outer space or on other planets.

The Laboratory for Molecular Microbiology at the Philipps-Universität Marburg is investigating the stress response of *Bacillus subtilis*. This soil bacterium can form highly resistant endospores. The investigations are focused on the physiological and molecular mechanisms by which bacteria respond to changes in the environmental osmolarity.

The Lehrstuhl für Mikrobiologie and the Archaea Centre of the University of Regensburg have a long-lasting expertise in isolating, growing and characterizing extremophilic Bacteria and Archaea. They are a rich resource of model organisms also for studying the effect of conditions in outer space or on other planets.

The Research School SpaceLife provides the unique opportunity to join the biological resources of the Regensburg Archaea Centre with the equipment and expertise of the DLR research group Astrobiology, where laboratory and space experiments concerning research on viability and adaptability to space as well as to simulated Martian conditions are accomplished and the experiences of the Philipps-Universität Marburg in the investigation of molecular and cellular mechanisms in bacteria as a response to high salt concentrations.

Studies of survival and adaptation will indicate not only whether microbial life can expand its evolutionary trajectories beyond Earth but also how it can play key supporting roles in human exploration.
Astrobiology

Topic of Doctoral Thesis
Investigation of the resistance of typical bacterial isolates from spacecraft assembly cleanrooms and confined manned habitats on different antimicrobial surfaces

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Thesis Description
Microorganisms are an integral component of the terrestrial biosphere and can be found at almost all locations ranging from environments regarded as life-friendly from the anthropocentric point of view to those described as extreme or hostile. Future space exploration is based on unmanned and manned missions to other planets and moons of our solar system.

One of the major driving forces is the search for signs of either extinct or extant extraterrestrial life forms. For such missions initially based on robotics it is absolutely necessary to avoid any unintended harmful contamination of other planets with terrestrial microorganisms. In manned mission it is unavoidable to carry microorganisms from Earth to space because many microorganisms are associated with humans. Several of them are living in a commensal relationship with their human hosts, others are human pathogens. During prolonged human confinement in isolated habitats like spacecraft microorganisms, especially those related to the crew, will populate the habitat, e.g., surfaces in form of biofilms. This can have deleterious effects with respect to material damage by biocorrosion and biofouling, but also to humans by the potential accumulation of pathogens. Both processes are critical for mission success.

Antimicrobial surfaces, e.g. with metalorganic materials like Sterions (from: sterione)

This astrobiological doctoral thesis in the frame of the Helmholtz Space Life Sciences Research School (SpaceLife) will comprise investigations on the resistance of microbial isolates from spacecraft assembly cleanrooms and from the Mars 500 isolation facility which was used to simulate a manned mission to Mars. One focus of these investigations will be the examination of different types of antimicrobial surfaces and their suitability in the context of exploratory missions. In addition, the physiological potential with respect to different inactivating and sterilising agents and procedures of these bacteria will be determined.

The new insights obtained from these investigations will support the development of measures to assure crew health and safety during long-term space missions and to prevent or counteract excessive microbial contamination and dissemination.

Fungi on a communication device on the space station MIR (from: IBMP)
Astrobiology

**Topic of Doctoral Thesis**
Investigation of the tolerance of microorganisms against extreme physical and chemical environmental parameters of astrobiological relevance

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**Thesis Description**
In the last decades the number of organisms discovered at locations, which would have been classified still recently as ‘life-hostile’, has increased immensely. Examples of such extremophilic terrestrial organisms are microorganisms from hot springs, hydrothermal vents, deserts, permafrost, salt crystals, spacecraft assembly clean rooms, and very acid or basic water.

The hyperthermophilic archaeon *Ignicoccus hospitalis* with its symbiont *Nanoarchaeum equitans*  
(from: Stetter & Rachel)

The increasing knowledge of the microbial adaptability and its fundamental molecular mechanisms enable the estimation of their hypothetical viability on other planets in our solar system, e.g. on Mars. The ability of life to move beyond Earth will depend upon the potential for microorganisms to utilize resources and to adapt and evolve in extraterrestrial environments. Studies of adaptation and survival will indicate not only whether microbial life can expand its evolutionary trajectories beyond Earth but also how it can play key supporting roles in human exploration and are therefore in the interest of Planetary Protection considerations.

This astrobiological doctoral thesis in the frame of the Helmholtz Space Life Sciences Research School (SpaceLife) will comprise investigations on the tolerance of microorganisms against extreme physical and chemical environmental factors as they occur on other planets and moons of our solar system and in space. From the variety of Bacteria and Archaea which already proofed to be of astrobiological interest in previous investigations as well as from new isolates from different extreme terrestrial environments a subset will be chosen for further analysis. In addition, the occurrence of microorganisms in special environments of astrobiological interest will be detected by molecular methods. Selected thermophilic and hyperthermophilic microorganisms, first of all four species of *Ignicoccus*, will be characterised in detail with respect to their radiation and desiccation resistance. The main focus of these investigations will be on the analysis of cellular damage, the identification of enzymatic repair pathways and on the determination of repair kinetics and the expression of DNA repair genes. Molecular methods to be adapted and applied are amongst others pulsed field gel electrophoresis and/or RTqPCR, fluorescence staining techniques, microarrays, 2D-gel electrophoresis.
Astrobiology

**Topic of Doctoral Thesis**
Salt stress response during spore germination: implications for search for microbial life on Mars

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**Thesis Description**
Liquid water is one of the most important prerequisites for life on Earth, and its search has driven the exploration of Mars for the past 30 years. Geomorphological and mineralogical evidence supports the idea that liquid water was stable on the Martian surface in the past, but under current environmental conditions liquid water is not stable on the surface at large scales. However, there are local processes that could allow for the occurrence of liquid water at smaller scales, at least transiently.

*Bacillus subtilis* as a soil bacterium is subject to changes in the supply of water and to the concomitant alterations in salinity and osmolality resulting from frequent drought and flooding of its natural habitat. This threatens the cell with dehydration under hypertonic conditions or with rupture under hypotonic conditions. *B. subtilis* avoids these devastating alternatives by actively modulating its ion and organic solute pool to retain a suitable level of cytoplasmic water and turgor. Under conditions where the salt stress is so strong that growth is no longer permitted, a nonspecific and preemptive general stress response system is engaged to ensure the survival of *B. subtilis*. In addition, *B. subtilis* can efficiently scavenge a wide variety of preformed compatible solutes from environmental sources. High salinity exerts pleiotropic effects on the physiology of *B. subtilis*. Increases in salinity affect the phospholipid composition of the cytoplasmic membrane and the properties of the cell wall.

In the context of planetary protection, bacterial spores have been identified as major candidates of concern in the forward contamination of Mars. *B. subtilis* is a highly suitable model organism for this research field for studying spore resistance to artificial and environmental stressors, e.g. UV and ionizing radiation. Many frequently used techniques, standardized experimental protocols (for preparation and analyses) are already established for *B. subtilis* and a variety of different knock-out strains are available.

Within this astrobiological doctoral thesis in the frame of the Helmholtz Space Life Sciences Research School (SpaceLife) a broad spectrum of methods could be applied. The approaches cover proteomics (e.g. SDS PAGE gel electrophoresis, Western blotting) and genome-wide expression analyses studies (microarrays, PCR, RT-PCR, dot blotting). The analyses aim at gathering sufficient molecular information to be able to put together an initial framework for dynamic modeling of spore germination and outgrowth behavior under salt stress.

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**False-color transmission electron micrograph of a spore-forming *B. subtilis* cell.**

**NASA Phoenix lander site with layers of hydrated minerals (from: NASA).**
Bone and muscle loss in space

Microgravity is a challenging environment for the human organism. In particular, the mechanical loading of muscles and bones in the back, the hip area, and the legs is severely reduced in microgravity compared to earthbound conditions. This leads to sarcopenia and osteoporosis. For long-term spaceflight, the deconditioning of the musculo-skeletal system belongs to the most risky physiological changes observed in response to microgravity. To obtain health and effectiveness of astronauts especially for planned long-duration space flights, it is mandatory to develop efficient countermeasures. Current countermeasures are either less effective or too time-consuming for application during long-term mission. New developments are mandatory in order to keep muscle and bone function during the astronauts’ long-term flight. However, the observed changes are comparable to processes observed during ageing or in handicapped people with inborn or chronic diseases of the neuro-musculo-skeletal system. Insofar, the foreseen projects will aim at astronauts, ageing people and patients. Under consideration are special training measurements and nutraceuticals with a postulated positive effect on muscle and/or bone mass and function. To conduct research in this field on Earth, methods using 6° head-down tilt bed rest (HDTBR) as a simulation model for muscle and bone unloading (immobilization) are utilized.

The adequate stimulus for muscle growth keeping or increasing muscle trophy and strength is given by a combination of high intense muscle contraction and passive stretches. These stimuli are e.g. provided by concentric-eccentric resistive exercise or by jumps and landings. Bone growth is locally triggered by strain and the best strain pattern in a bone is naturally generated by high intense muscle work or by impacts like the heel impact on ground during running.

A most time efficient training of all leg muscles is given by a leg press like apparatus. In microgravity, heavy weights cannot provide counter forces for muscle training. Existing, even newly developed training devices do not fulfill the required efficiency of a training method for microgravity. We therefore intend to verify and apply a Sensodrive-leg press as an upgrade and technological progress of the current flywheel device. Robotic controlled Sensodrives have originally been developed for ultra light weight robotic arms on the ISS. This novel technology combined with a leg press allows the application of various patterns of force and velocity at any angle of the hips, the knees, or the ankles during leg movement. During training the subject must not adapt to the physical properties of the device, but like a physiotherapist the device with its one intelligent robotic motor control also adapts to the needs of the subject. Time optimized and variable training stimuli and protocols can be developed, that provide optimum intense and maximum save stimuli for all groups of leg muscles and bones. The simulation of naturally earth bound situations like hopping or trampoline jumping will potentially also keep up motor control and balance. Little is known about the interrelations between muscle fatigue and the growth stimulus of training. The combination of the Sensodrive leg press and a lower body negative pressure device will be built to study the effects of alterations in muscle perfusion by gravity independent simulation of various levels of orthostasis.
Space Physiology

Bone and muscle loss in space

Topic of Doctoral Thesis
Influence of vibration training on glycemic control

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Thesis Description
The present project explores in which way vibration training can lead to enhanced glucose uptake of the muscle cells and if it has the potential to preserve metabolic disorders induced by physical inactivity. We hypothesize that vibration training enhances the glucose transporter 4 (GLUT-4) translocation via neuronal mechanisms and improves glucose uptake of the muscle cells leading to improved insulin sensitivity.

In order to achieve these goals, it is planned to do an acute study testing the effects of whole body vibration or muscle electro-stimulation superposed to resistive exercise on glycemic control on a molecular basis and a long-term training study testing the potential of vibration training to enhance insulin sensitivity.

Pathway of GLUT4 translocation

Glucose transporter 4 (GLUT 4) translocation muscle cell

Vibration platform
GALILEO, Novotec, Pforzheim
Space Physiology

Bone and muscle loss in space

Topic of Doctoral Thesis
Kinematics and musculoskeletal loading under conditions of reduced gravity

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Thesis Description
The present project explores in which ways reductions in gravity affect human locomotion and the musculoskeletal loading involved in it. We hypothesize that the relationship between gravity and musculoskeletal loading magnitude is essentially non-linear.

Scientific Program
The proposed work will inform us about joints kinematics and kinetics involved in locomotion under different gravitational conditions, e.g. on the Mars and on the Moon.

In order to achieve these goals, it is planned to assess ground reaction forces, and whole-body kinetics and kinematics during parabolic flights with 0.38 g and also with 0.16 g.

Walking, running, and hopping will be assessed, and hypogravity locomotion during parabolic flights will be compared to locomotion under normogravity conditions. The greatest part of the data shall be collected during ground-based research, and it is envisaged to also collect data during parabolic flights campaigns.

Doctoral Theses

The ‘enhanced zero-gravity loading system’ (eZLS) at the Glenn Space Center (Cleveland, Ohio)

Gangway set-up for the study of locomotion in parabolic flight.
**Space Physiology**

**Bone and muscle loss in space**

**Topic of Doctoral Thesis**
Calculating muscle forces in lower limb in relation to tibia deformation via inverse FE-modelling

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**Thesis Description**
Muscle-force induced strains in bone may be the key to bone-remodelling. But since it proofs to be very difficult to measure these forces directly in vivo, modelling has been the key to answers ever since.

**Scientific Program**

The aim of this work is to create a model that can calculate the forces generated by predefined muscle groups in respect to a given bone deformation. To achieve this, the model will make use of CT-data of the bone, measured bone deformation from an earlier on project and combine these to an inverse dynamics simulation of the lower limb.

**Doctoral Theses**

Thereby, the activated muscle-groups for certain activities can be determined, the occurring strain allotted to these and as a result a strain – activity – force – pattern is created. This data can then be used for further research in the field of bone-remodelling.
Scientific Program

Cardiovascular effects

Topic of Doctoral Thesis
A model based exploration of the cardiovascular regulatory mechanism for the prevention of orthostatic intolerance

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Thesis Description
Orthostatic intolerance remains a problem upon return to Earth from the microgravity environment of spaceflight. To improve astronaut’s countermeasure programs, a better understanding of the response of the cardiovascular system to changes in hydrostatic pressure is crucial. The objective of this project is to assess the regulatory mechanisms of the cardiovascular system in response to hydrostatic pressure by combining in vivo experiments and cardiovascular model as blood pressure wave propagation model. The in vivo experiments will be performed using a tilt table and a Lower Body Negative Pressure (LBNP) facility at the DLR to generate a step and linear increases in the hydrostatic pressure. In a second stage, the response to rapid transition from hypergravity to microgravity will be assessed during parabolic flight campaign. Finally, quadratic increases in hydrostatic pressure will be generated with a Short Arm Human Centrifuge at the Space Physiology division. Abnormal hydrostatic loads (step and quadratic increases) from a linear gradient in hydrostatic pressure normally felt on Earth. High resolution ultrasound imaging techniques will be used to measure hemodynamic parameters of large vessels. Concurrently, the theoretical effects of hydrostatic pressure will be implemented in a 1D wave propagation model of blood flow and pressure to simulate the cardiovascular response to the in vivo protocols described above. Furthermore, a fitting process between in vivo data and simulated data will provide physiological parameters describing the specific vasoconstriction responses of the peripheral bed to the different hydrostatic loads. Combining these three protocols will allow us to differentiate responses to abnormal hydrostatic loads (step and quadratic increases) from a linear gradient in hydrostatic pressure normally felt on earth. High resolution ultrasound imaging techniques will be used to measure hemodynamic parameters of large vessels. The results of this project will bring new insights into the response of the cardiovascular system to changes in hydrostatic pressure which are essential to improve astronaut’s training programs and resolve crucial issues in hypotension and peripheral vascular diseases.

Doctoral Theses

Crew training during a simulated landing phase of the ESA’s Mars500 experiment (ESA multimedia gallery, Mars500).

Ultrasound Doppler measurement of blood flow velocity in the common carotid artery.
Cardiovascular effects

**Topic of Doctoral Thesis**
Cardiovascular limitations to resistive exercise tolerance during centrifugation in humans

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**Thesis Description**
This project explores the cardiovascular limitations to resistive exercise that humans face during centrifugation, both on short-arm, as well as on-long arm human centrifuges (SAHC and LAHC, respectively).

The underlying rationale for this proposal is to scrutinize resistive exercise in a hyper-gravity field as a training modality.

However, it is anticipated that exercise tolerance will be hampered by the anatomical constraints of the human cardiovascular system. We therefore aim to counteract these constraints by application of anti-g suits, as for example worn by pilots.

Three studies will be performed within this project. Firstly, a framework shall be established to compare exercise tolerance at different g-levels on SAHC and LAHC.

Second, exercise tolerance and g-suit efficacy shall be tested on the DLR SAHC, and in a third study this approach shall be taken to an LAHC.

The results of this study will help to design an optimized exercise regimen for Space and Earth.
SpaceLife

Scientific Program

A short arm centrifuge on board the space ship is an option for providing efficient countermeasures.

Doctoral Theses

This work will provide in depth investigation on possible use of an SAHC on a long-duration space flight and propose a powerful training program for that purpose.

Space Physiology

Countermeasures

Topic of Doctoral Thesis
Development of a countermeasure training program on a short arm human centrifuge

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Thesis Description
During sojourns under microgravity, already of modest duration, measurable reduction of muscle and bone mass can be observed.
For future long-duration missions to Mars with projected durations of distinctly more than one year we must expect severe complications.

Short Arm Human Centrifuge (SAHC) of the Institute of Aerospace Medicine

6° head down tilt bed rest
Furthermore, we are also considering the ‘high-pressure’ breathing technique used by many people during weight lifting. The present project will investigate the effects of 1) weight lifting, 2) high-pressure breathing, and 3) acute and 4) chronic head-ward fluid shift upon intra-cranial and intra-ocular pressure.

Head-ward fluid shifts shall be induced by head-down tilt (HDT), a recognized ground-based model of simulated microgravity. If opportune and possible, a study shall also be performed under real microgravity conditions during parabolic flights.

Astronaut using the advanced resistance exercise device (aRED) on board the international space station (ISS).

Astronaut on Earth (left) and while in Space (right), depicting the typical ‘puffy face’ that is seen in many, but probably not all astronauts.
Muscle loss in space

Topic of Doctoral Thesis
Effects of alterations in muscle blood supply and oxygenation at a given muscle loading on muscle growths and differentiation and on muscle capillary density

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Thesis Description
In microgravity the absence of hydrostatic pressure severely affects blood supply of leg muscles during training. These effects may contribute to the reduced efficiency of training measures in space performed as countermeasures against muscle loss. It is generally assumed that muscle contraction and passive stretching determine growth and strength whereas the processes of fatigue determined muscle endurance parameters. However, the complex mechanisms of the interrelations between muscle perfusion and the processes of peripheral fatigue with the growth and differentiation stimuli of training are still under intensive research. In conventional training these two stimuli cannot be independently altered which hampers studies on growth control and differentiation in human muscle. The combination of a robotic controlled leg press and a lower body negative pressure device allows an independent variation of muscle loading and perfusion. In a long term study subjects will perform an 8 weeks long training a given strength level and two different levels of muscle blood perfusion. Before and after training we will examine acute effects of perfusion on muscle performance and hormonal growth control and the long term training effects on muscle performance, fibre type composition, and capillary density by means of non-invasive methods and the analysis of blood and muscle biopsy samples.

Robotic-controlled leg press (RBL) for free programmable load profiles in a lower body negative pressure chamber altering blood supply in the legs

Simplified overview of factors controlling the growth and differentiation of muscle fibers
The three-year program reflects the increasing importance of interdisciplinarity in life science research and provides comprehensive training for scientific, methodological and transferable skills.

The program will provide training and translational research towards a career in life sciences and space research. It consists of a three-year research project as well as introductory and advanced lectures, student workshops, journal clubs, the active attendance of congresses, participation in laboratory and transferable skill courses.

**Thesis supervision**

Expert supervision throughout the research activities leading towards a doctoral degree within three years is regarded of the utmost importance. In addition to the day-to-day supervision, each doctoral student has a Thesis Advisory Committee (TAC). The main task of the TAC is to guide the doctoral students throughout their thesis work and to monitor and evaluate the progress of the research project and the individual development of the doctoral student.

The TAC consists of three faculty members:

First and second Supervisors are chosen on the basis of their research specialty in order to provide as far as possible the complete scientific expertise required to realize the proposed thesis project.

The DLR Supervisor is a scientist at the Institute of Aerospace Medicine working at the laboratory where the research is being performed.

At least one member of each TAC must be a university professor.

The Mentor is a scientist from a different scientific field and gives general advise to the doctoral student, e.g. for career planning.

The TAC will help to design and monitor the trainee’s thesis work and will help the trainee to establish contacts inside and outside the institution.

Following the submission of a project proposal after one month, and an initial report meeting after 3 to 6 months, TAC meetings are scheduled on an annual basis. TAC meetings include a written report and an oral presentation which covers the theoretical background, research progress, results obtained so far and experiments to be done in the future.

The Initial Report focuses on the detailed outline of the thesis project and planning for future experiments.

The 3rd Annual Report meeting defines the work to be done prior to writing and submitting the thesis, and the time frame for obtaining the doctorate.

TAC meetings can be integrated in the Students’ Workshop or organized separately.
The three-year doctoral program is divided into six semesters (half-years). In addition to the laboratory-based experimental thesis work, doctoral students participate in a structured training program, which consists of 303 hours of practical courses, workshops, lectures, seminars, and journal clubs.

The curriculum of training is composed of mandatory and elective modules:

- Introductory Lectures during the 1st and 2nd semester (mandatory)
- Advanced Lectures during the 3rd semester (elective)
- Students’ Workshop during the 1st, 4th and 6th semester (mandatory)
- Seminars, Workshops and Experimental Courses (elective, 40 h during the program)
- Journal Club during the 2nd, 3rd, 5th and 6th semester (mandatory)
- 2 ½ days soft skill training per year (mandatory)
- Additional soft skill training based on individual needs (DLR education program), e.g. project management (optional)
- Active participation in a Workshop or Conference (mandatory)
- Internal Seminars (optional)

**Students’ Workshop**

In the 1st semester, each student is given a valuable opportunity to present his/her research project including the hypothesis, methods to be applied and the work schedule. During the 4th Semester, students are once again given the opportunity to present the current findings of their research projects in front of the class and TAC, giving the student valuable feedback on how they are progressing. This enables the student not only to develop his/her presentation skills but to critically analyze their own findings and those of others. During the last term, the students present the final report on their thesis.

**Journal Clubs**

Journal Clubs are held during the second, third, fifth and sixth semester in the working groups of the Institute of Aerospace Medicine and the Partner Universities. They offer the opportunity to read papers together and to discuss them with members of the working group. Each student is required to present an original paper and review. The topic of the original paper is always related to the general field of the student’s research project, requiring the student to research and subsequently present the topic in a succinct and critical way.

**Internal Seminars**

Doctoral students will familiarize with critical reading, preparation of manuscripts and scientific figures, and designing of a doctoral thesis and a research proposal in the Journal Clubs.

**Conferences/Symposia**

Participation in national as well as international conferences will be encouraged. The trainee will have to present her/his work at least during one conference either by a poster or an oral presentation, which will be financially supported.
Professional Training Program

Career Day
During the third year of the program, the doctoral students attend or organize and chair a Career Day, for example during a conference organized by members of the Institute of Aerospace Medicine, during which invited speakers from academia, industry, scientific journals and funding bodies present career paths to the students.

Optional lab rotations
Optional lab rotations will be encouraged on an individual basis, especially if:

- the graduate training is conducted in a research area different from the undergraduate studies
- the thesis work is interdisciplinary
- the thesis requires methods which are not established in the hosting lab.

External work of trainees
If appropriate, the trainees will have the opportunity of a short-term stay in a partner institute or organization, in industry, or in a specialized laboratory to complement her/his skills or to carry out work that cannot be done within the partnering institutions. This might also be abroad. The trainees can apply for support through SpaceLife.

Final examination
The doctoral examination can comprise a public presentation of the trainee in which she/he will present the results of her/his doctoral work which will subsequently be discussed with the auditorium, depending on the regulations of the university.

SpaceLife curriculum

Overview of the SpaceLife curriculum
Introductory Lectures
As the doctoral program is open to candidates from diverse backgrounds, the 1st semester, as well as part of the 2nd, concentrates on the basics of Space Life Sciences. Doctoral students participate in a mandatory lecture covering the topics space medicine, radiobiology, astrobiology and gravitational biology. The lectures introduce the space life sciences research program and the theoretical background of the topic and provide the scientific background of the applied methods. The learning success is controlled by a written exam.

Space Life Sciences
Semester
1st
Duration
2 h
Subjects
Introduction to Space Life Sciences (Gerzer, Anken)
Space Life Sciences Research Program (Hemmersbach, Ruyters)
Learning Objectives
Getting a glimpse of the fascination of human spaceflight and the unsolved questions for long-term manned missions

Space Medicine
Semester
1st
Duration
6 h
Subjects
History of Space Medicine, Atmosphere, Radiation, Space Weather
Space Transport Systems, Space Station
Human Physiology in Space I: Short and mid-term adaptation
Human Physiology in Space II: Long-term adaptation, Countermeasure Development
Astronaut Selection, Training, Work Schedule in Space, EVA, Medical Problems
Future Plans for Human Spaceflight
(Gerzer)
Learning Objectives
Basic Information on Space Physiology and Medicine - medical problems during short-term and long-term manned space missions and their solutions available currently.

Radiation Biology
Semester
1st
Duration
6 h
Subjects
Interplanetary radiation field (Heber)
Radiation Environments on Planets & other Celestial Bodies (Wimmer-Schweingruber)
Earth Radiation Environment and Space Radiation - Quantities and Measurements (Berger)
Radiation Exposure during Space Missions (Reitz, Berger)
Biological Effects of Space Radiation (Hellweg), Acute & Chronic Radiation Effects in Humans (Baumstark-Khan)
Learning Objectives
Overview of the space radiation environment, with emphasis on energetic particle environment in interplanetary space & planetary magnetospheres; Introduction to dose quantities for radiation protection in space, comprehensive survey of space radiation measurements with view to future human mission to Mars, radiation exposure during space missions & biological risks for humans.

Prerequisites for the Course
None
SpaceLife

Professional Training Program

Curriculum

Introductory Lectures

Astrobiology

Semester 2nd

Duration 6 h

Subjects
1. Steps to Life (Horneck)
2. History of Life on Earth (Rabbow)
3. Life under Extreme Conditions (Huber)
4. Looking for Life, Searching the Inner Solar System (Rettberg)
5. Interplanetary Transfer of Life (Panitz)
6. Astrobiological Space Experiments - Past and Present (Rabbow)

Learning Objectives (continued)
ad 3. Understanding the adaptation of specialized extremophiles to high and low temperatures, to high salinity, to high pressure, to low water activity.
ad 4. Understanding the prerequisites of habitability, the habitable zone of our solar system; learning astrobiological aspects of Mars, its history of water, results from past and ongoing missions to Mars, planned missions to Mars.
ad 5. Learning the hypothesis of "Panspermia" and "Lithopanspermia", experimental tests of those and conclusions from the results.
ad 6. Knowing the ongoing and planned astrobiological space experiments

Gravitational Biology

Semester 2nd

Duration 6 h

Subjects
1. Methods on ground and in space (flight opportunities)
2. Graviperception in unicellular systems
3. Gravity related signal transduction pathways
4. Graviperception in multicellular systems (plants, animals)
5. Life Support Systems, Exploration

Learning Objectives
Fundamental aspects and experimental approaches in gravitational biology.

Prerequisites for the Course
None
Advanced Lectures
During the 3rd semester, doctoral students participate in an advanced lecture in a topic of their interest. They elect at least one advanced lecture from one of the following topics:
- Space Physiology
- Radiation Biology
- Gravitational Biology
- Astrobiology
- Aerospace Dosimetry
- Extraterrestrial Physics
- The Interplanetary Medium

Space Physiology

Semester
3rd

Duration
10 h

Subjects
Cardiovascular System, Fluid & Salt balance (Guest Speaker)
Skeletal System & Muscles (Zange)
Neurosensory & Vestibular System (Balance & Motion Sickness) (Guest speaker)
Immunological & Hormonal Response (Guest speaker)
Medical Research aboard the ISS (Ruyters)
Current Countermeasure Developments (Zange)
Psycho-Sociological Aspects (Johannes)
Human Health Concerns for Lunar & Martian Exploration (Gerzer)

Learning Objectives
Detailed Insight into Space Physiology, including ground based research, space analogs (bed rest etc.), and development of countermeasures. Refreshing of knowledge from introductory course.

Prerequisites for the Course
Introductory Lectures
"Space Life Sciences", "Space Medicine"
Subjects (continued)
Characteristics of cell survival curves - interpretive models based on target theory or repair theory; radiosensitivity of various tissues. Role of oxygen in modifying the chemistry of radiation damage and cellular radio sensitivity; mammalian cell radio sensitivity: interphase, reproductive and apoptotic cell death; Cellular factors that modify radiation response: The role of the cell cycle in influencing radiation response (Baumstark-Khan)
Use of radiation for cancer therapy: Deficient vascularisation, high interstitial pressure and hypoxia in solid tumors; Significance of tumor physiology for radiation treatment; Tumor regrowth and tumor cure assays. (Baumstark-Khan)
Low dose effects on humans: The mechanisms of radiation-induced mutagenesis and carcinogenesis; Oncogenes and suppressor genes; susceptibility of various organs; Risks of developing cancers from present-day sources; The hereditary effects of radiation; Effects on the embryo and fetus (Baumstark-Khan)
Whole body irradiation - acute effects of high doses: Prodromal syndromes; cerebro-vascular, gastrointestinal and hematopoietic syndromes; Mean lethal doses; Treatments for whole body exposure. (Baumstark-Khan)
Lessons from Hiroshima, Nagasaki and Chernobyl: acute & chronic health effects on those exposed; Assessment of exposure doses; Assessment of present-day risks, & radiation protection standards (Baumstark-Khan)

Learning Objectives
The course RADIATION BIOLOGY will focus on the biological changes which follow the interaction of ionizing and non-ionizing radiation with living matter from molecular interactions to whole body responses. Particular emphasis will be placed on the role of ionizing radiation in the treatment of cancer, mechanisms of radiation-induced carcinogenesis, and changes in normal and tumor cells at the molecular, cellular and tissue level. The course includes the biological aspects of environmental radiation exposure.

Prerequisites for the Course
Introductory Lecture
"Radiation Biology"
Advanced Lectures

**Gravitational Biology**

**Semester**
3rd

**Duration**
4 x 1.5 h

**Subjects**
1. Gravity Effects on Cells
2. Gravity Effects on Animals
3. Space Biological Experiment Design. Graviperception in Unicellular Systems
4. Graviperception in Multicellular Systems (Plants, Animals)
5. Life Support Systems, Exploration

**Learning Objectives**
Enhanced aspects and experimental approaches in gravitational biology; dedicated examples from experiments under altered space conditions

**Prerequisites for the Course**
Introductory Lecture "Gravitational Biology"

**Astrobiology**

**Semester**
3rd

**Duration**
6 x 1 h

**Subjects**
1. *Bacillus subtilis* - a Model Organism for Space Research (Möller)
2. Pitfalls of Detecting Life (Rabbow)
3. Planetary Protection (Rettberg)
4. Hyperthermophile Archaea tbc (Huber)
5. Robotic Solar System Exploration - Europa, Titan, Enceladus (Panitz)
6. Human Missions (Horneck tbc)

**Learning Objectives (continued)**
ad 1. Understanding the microorganisms *B. subtilis*, spore formation, adaptation strategies to extreme environmental conditions, knowing space experiments with *B. subtilis*, understanding results.
ad 2. Understanding the obstacles for detecting life, implications for past and present experiments for detecting life.

**Prerequisites for the Course**
Introductory Lecture "Astrobiology"
Advanced Lectures

**Aerospace Dosimetry (CAU Kiel 060374)**
- **Semester**: 3rd or 5th
- **Duration**: 30 h
- **Subjects**
  - Radiation environment, including the origin and composition of primary particles, interaction of these primaries with matter (e.g. ionization, electromagnetic and hadronic interactions, secondary particle production)
  - Methods for measurements
  - Characterization and analysis of radiation in space
  - Physical and medical parameters in dosimetry like LET; dose; effective dose and quality factor (Heber)

**Learning Objectives**
The students learn the basic principles and applications of experimental measurements and interaction of radiation with matter as well as properties of different radiation environments important to humans in space

**Prerequisites for the Course**
Introductory Lecture "Radiation Biology"

**Extraterrestrial Physics (CAU Kiel 060346)**
- **Semester**: 1st or 3rd
- **Duration**: 30 h
- **Subjects**
  - The course gives a solid introduction to the Earth's space environment starting with the atmosphere, ionosphere, magnetosphere, and continuing with the origin of the solar wind, its interaction with planetary bodies and the overall structure of the heliosphere. (Heber, Wimmer-Schweingruber)

**Learning Objectives**
Understanding of the Earth's space environment
Understanding of particle propagation and acceleration

**Prerequisites for the Course**
Introductory Lecture "Radiation Biology"

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The Interplanetary Medium (CAU Kiel)

- **Semester**: 2nd or 4th or 6th
- **Duration**: 30 h
- **Subjects**
  - The interplanetary medium (Heliosphere) fills the space between the planets. It has its origin in the solar wind emanating from the Sun and interacting with the interstellar medium. Several properties of the interplanetary medium are important for our understanding of radiation exposure of astronauts and, in some cases, of aircraft crews. The interplanetary medium and its boundary region with the interstellar medium modulate galactic cosmic rays; it is also the medium through which solar energetic particles propagate (Heber, Wimmer-Schweingruber)

**Learning Objectives**
Understanding of the large-scale structure & origins of the heliosphere; Capability to interpret real-time space weather data & knowledge of data sources

**Prerequisites for the Course**
Introductory Lecture "Radiation Biology"
Seminars, Workshops and Experimental Courses

Elective Seminars, Workshops and Experimental Courses are offered in the first, third and fifth semester of the program. During the three year period, Doctoral students should participate in 30 hours of electives courses. The participation in each course must be discussed with the primary Supervisor. The workshop “Biomathematics” combines lectures and exercises, and provides skills towards the quantitative analysis of experimental data and experiment configuration and study design. Experimental Courses cover different methods in space life science research. A series of laboratory courses that have already been installed by the partner institutions will offer the trainees a special training in specific areas including laboratory as well as theoretical work.

Seminars

Structure and function of adaptation processes; Performance and ageing; Performance diagnostics (DSHS Köln)

Semester 2\textsuperscript{nd} or 4\textsuperscript{th} or 6\textsuperscript{th}

Duration 15 x 1 h

Subjects General physiological mechanisms of adaptation
Definition of metabolic and mechanical stimuli between micro- and ultra-loading
Biological response to stimuli at organ- and cell-level
Age depending adaptation
Empirical approaches to adaptation (time course)
(Mester)

Learning Objectives
Establish an understanding of adaptation between stimulus and molecular mechanisms
Tuning of stimuli under various conditions (from microgravity to bedrest to ultrahigh loads)

Prerequisites for the Course
Introductory Lecture
"Space Medicine"

Gravitational Biology (RFWU Bonn)

Semester 2\textsuperscript{nd} or 3\textsuperscript{rd}

Duration 15 h

Subjects Enhanced Background in Gravitational Biology:
1. Methods on ground and in space (flight opportunities)
2. Gravipeception in unicellular systems
3. Graviperception in multicellular systems (plants, animals)
5. Life Support Systems, Exploration (Hemmersbach, Braun)

Learning Objectives
Enhanced aspects and experimental approaches in gravitational biology; dedicated examples from experiments under altered space conditions

Prerequisites for the Course
None
Seminars

Heliospherical Astroparticle Physics & Dosimetry (CAU Kiel)

**Semester**
3rd or 5th

**Duration**
30 h

**Subjects**
During the seminar student will present recent research in the following topics: Structure of the heliosphere, planetary magneto- and atmospheres; processes and stability. The composition, acceleration and propagation of charged particles in magnetized plasmas including scattering, drifts, magneto-spheric transmission and secondary particle production in matter; dependence on solar activity. Spectral measurements of particle radiation and standards for space dosimetry measurements (e.g. LET, (effective) dose).

(Heber, Wimmer-Schweingruber)

**Learning Objectives**
Students learn how to work out and present fundamental and recent research topics in heliospheric astroparticle physics, with emphasis on acceleration and transport of energetic particles and galactic cosmic rays in the heliosphere, planetary magneto- and atmospheres, as well as basic principles and methods in space dosimetry.

**Prerequisites for the Course**
Introductory Lectures "Radiation Biology"
Aerospace Dosimetry (CAU Kiel 060374) or The Interplanetary Medium or Extraterrestrial Physics (CAU Kiel 060346)

Current Topics in Space Physics (CAU Kiel)

**Semester**
2nd, 3rd, 4th, 5th or 6th

**Duration**
30 h

**Subjects**
The students read and present two papers from the recent space physics literature. During the course of the seminar, a broad range of current space physics is covered. Thus, the students are exposed to current problems in the subject as well as a real-life presentation atmosphere (Heber, Wimmer-Schweingruber).

**Learning Objectives**
Presentation skills
Use of presentation software
Overview of current topics in space physics

**Prerequisites for the Course**
Introductory Lecture "Radiation Biology"
Extraterrestrial Physics (CAU Kiel 060346)
Workshop

**Biomathematics**  
*(Universität zu Köln)*

**Semester**  
2nd, 3rd, 4th, 5th or 6th

**Duration**  
30 h

**Subjects**  
Theory of Probabilities  
Descriptive and Inferring Statistics  
Confidence Intervals  
Significance Tests  
Non-parametric Tests  
Correlation, Regression  
Epidemiology  
Clinical Study and Experimental Design  
Variance Analysis, Crossover (Lehmacher).

**Learning Objectives**  
Acquire statistical tools for data interpretation in doctoral thesis

**Prerequisites for the Course**  
None
Practical Training

**Microgravity Simulation and Hyper-g Stimulation**

**Semester**
1st, 2nd, 3rd, 4th, 5th or 6th

**Duration**
10 h

**Subjects**
- Types of Clinostats
- Centrifuges
- Experiment Preparation and Implementation (Hemmersbach, Ivanova)

**Learning Objectives**
- Overview of Altered Gravity Experimental Methods (for Beginners)
- Safe and Efficient Working with the Microgravity Simulation and Centrifuges Facilities at the Institute of Aerospace Medicine (for Advanced Students)

**Prerequisites for the Course**
- For Beginners: None
- For Advanced Students (Planning to use the Experimental Facilities in their Thesis): Knowledge About Mammalian Cells and Cell Culture Techniques

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**Microscopic and Analytic Techniques**

**Semester**
1st, 2nd, 3rd, 4th, 5th or 6th

**Duration**
10 h

**Subjects**
- Light Microscopy, Phase Contrast Microscopy (Baumstark-Khan)
- Fluorescence Microscopy (Hellweg)
- Digital Photography and Image Analysis (Axiovision) (Hellweg)
- Confocal Microscopy (Hemmersbach)

**Learning Objectives**
- Safe and Efficient Working with the Microscopes at the Institute of Aerospace Medicine for Documentation and Analysis of Living or Fixed Cells with or without Immunological Staining

**Prerequisites for the Course**
- Basic Microscopy Experience

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**Cell Culture Techniques**

**Semester**
1st, 2nd, 3rd, 4th, 5th or 6th

**Duration**
10 h

**Subjects**
- Preparation of Buffer and Media
- Sterile Working Techniques
- Routine Culturing (Medium Change, Passages, Phase Contrast Microscopy, Freezing and Thawing of Cells, Counting of Cells)
- Preparation of Cells for Experiments
- Mycoplasma Detection
- Genetically Altered Cell Lines (Baumstark-Khan, Hellweg)

**Learning Objectives**
- Safe and Efficient Working with Cell Cultures without Contaminations
- Working with Genetically Altered Organisms According to German Laws

**Prerequisites for the Course**
- Basic Laboratory Experience
Practical Training

Flow Cytometry

Semester
1st, 2nd, 3rd, 4th, 5th or 6th

Duration
10 h

Subjects
Parameters, Probes and Labels (Hellweg)
Data Analysis (Hellweg)  
Troubleshooting (Hellweg)
DNA Content / Cell Cycle Analysis (Baumstark-Khan)
Reporter Protein Analysis (Hellweg)
Antibody Staining: Cell Surface and Intracellular Antigens (Lau)

Learning Objectives
Safe and Efficient Working with the Fluorescent Activated Cell Scanner (FACScan) at the Institute of Aerospace Medicine for Analysis of Mammalian Cells

Prerequisites for the Course
Basic Knowledge of the Principles of Flow Cytometry

Thermoluminescence Dosimetry and Nuclear Track Etch Detectors

Semester
1st, 2nd, 3rd, 4th, 5th or 6th

Duration
10 h

Subjects
Introduction to passive radiation detectors
Thermoluminescence detectors - Principles and Data evaluation procedures
Nuclear Track Etch Detectors - Principles and Data evaluation procedures
Thermoluminescence detectors for space applications - practical examples of detector evaluation based on experiments performed in space and at heavy ion medical accelerators.
Nuclear Track Etch Detectors - practical examples of detector evaluation based on experiments performed in space and at heavy ion medical accelerators (Berger)

Learning Objectives
The course focuses on the principle of passive radiation dosimetry, introduces thermoluminescence and nuclear track etch detectors, gives an overview of their application for space radiation dosimetry and will enable the students to work on laboratory data evaluation systems, including evaluation of detectors exposed in space.

Prerequisites for the Course
Introductory Lectures "Radiation Biology"
Practical Training

Non-invasive & Invasive Methods in Physiology

Semester
1st, 2nd, 3rd, 4th, 5th or 6th

Duration
10 h

Subjects
Muscle: Performance tests, MRI and ultrasound, EMG, MRS, blood parameter and microdialysis, taking, conserving and analysing biopsies
Cardio-vascular system: Test scenarios: tilt table, LBNP, ergometer, centrifuge; measurements: ECG, porta press, impedance, rebreathing (Zange)

Learning Objectives
Measurement of physical and chemical parameters and their validity in interpretation as physiological variables
Statistical reliability of measure outcomes
Phenomena and their precise recording in quantity and time course.
How to analyze the mechanism behind a phenomenon?

Prerequisites for the Course
Lectures “Space Medicine” and “Space Physiology”

Research in Extraterrestrial Physics

Semester
1st, 2nd, 3rd, 4th, 5th or 6th

Duration
30 h

Subjects
Methods for the characterization and analysis of radiation in space: Basic principles of the measurements by particle detectors using different methods (e.g. dEx/dx-E-method, dE/dx-dE/dx-method, dE/dx-v-method) including the determination of important radiation parameters & variation of these parameters with the solar cycle and the position in space (Heber, Wimmer-Schweingruber, Boettcher)

Learning Objectives
Basic principles & applications of experimental & analysis methods for characterization of the radiation and its modulation in the heliosphere, planetary magnetosphere and atmospheres.

Practical Exercises in Instrument Development

Semester
2nd, 4th, or 6th

Duration
30 h

Subjects
The course begins with a summary of nuclear physics & electronics which is required to understand the operating principles of particle or radiation detection instruments. Various types of detection techniques are introduced, as are relevant electronics concepts such as pulse shaping etc. Additional topics are Monte-Carlo & other numerical techniques (Wimmer-Schweingruber, Boettcher, and Steigies).

Learning Objectives
Understanding of the underlying nuclear physics and relevant electronics
Knowledge of key detection technologies
Capability to interpret “raw” radiation measurements

Prerequisites for the Course
Introductory Lectures “Radiation Biology”, “Aerospace Dosimetry” or “The Interplanetary Medium” or “Extraterrestrial Physics”

Introductory Physics & Electronics Classes
The Spokesperson of SpaceLife is PD Dr. C. Hellweg, head of the radiation biology department at the Institute of Aerospace Medicine. The former spokesperson, Prof. Dr. R. Gerzer, is now Honor Spokesperson (Figure).

The Coordinator Dr. L.F. Spitta, scientist in the Radiobiology department of the Institute, coordinates the activities of SpaceLife (applicants’ selection, curriculum, evaluation, public relations).

The Secretary, Mrs. Claudia Schmitz assists the coordinator in all administrative processes of SpaceLife, including setup of the Research School webpage, organization of the curriculum, and support for the doctoral students (visa application, living space).

The thesis Supervisors at the DLR and the partner universities and scientists who conduct courses in the Research School form the SpaceLife Faculty. All faculty members are invited for a kick-off meeting before start of the Research School and for subsequent annual meetings.
Management Structure

During the kick-off meeting in 2009, a **Faculty Panel** of six members was elected, and the curriculum of SpaceLife was determined. The Faculty Panel forms the **Selection Committee** during the interview week and assists the Spokesperson and the Coordinator in the selection process.

The **doctoral candidates** in SpaceLife will have an employment or scholarship contract with the partner universities or a SpaceLife scholarship contract with the DLR. The Doctoral Candidates will enroll at the respective university and apply for admission to doctoral studies. The doctoral candidate writes together with the supervisors a synopsis of the doctoral thesis containing the name of the student, the names and institutions of the Supervisors and of the **Mentor**, title and description of the thesis, start of the thesis, and a work plan including milestones, risk assessment and alternatives. The approval of the University Supervisor to accept the candidate as doctoral student will be forwarded to the SpaceLife Coordinator.

The **TAC** will be formed as described above. The doctoral students invite the TAC for their thesis presentations in the Students’ Workshop (1st, 4th and 6th semester) and arrange an independent meeting with the TAC during the first month of the thesis to discuss the subject and approach.

The doctoral students elect a **Doctoral Spokesperson** during the first Students’ Workshop. The Doctoral Spokesperson participates in meetings of the Faculty Panel or the full SpaceLife Faculty. In conflict situations, the Mentor and the Doctoral Spokesperson develop a solution together with the doctoral student and the Supervisors.

SpaceLife can make use of the infrastructure of the Institute of Aerospace Medicine, including the laboratories and meeting rooms of different sizes for the lectures and workshops. The internal communication is facilitated by means of an **extranet teamsite** accessible to all members of SpaceLife, which is operated by the Coordinator and the Secretary. The lectures and workshops will be transmitted online to the partners in Regensburg, Kiel and Magdeburg, using teleconference tools (webcam, microphone and loudspeaker).

Doctoral students from the universities of Bonn and Cologne can attend the courses personally.

SpaceLife will be **evaluated** by questionnaires to the doctoral students, the Supervisors and the lecturers. Results of the evaluation will be discussed in SpaceLife Faculty meetings and the curriculum will be adapted accordingly.
Members

Deutsches Zentrum für Luft- und Raumfahrt

Institut für Luft- und Raumfahrtmedizin

Strahlenbiologie
Prof. Dr. Christa Baumstark-Khan
Dr. Thomas Berger
PD Dr. Christine Hellweg
Dr. Patrick Lau
Dr. Ralf Möller
Dr. Elke Rabbow
Dr. Petra Rettberg
Dr. Günther Reitz
Dr. Luis Spitta

Weltraumphysiologie
Prof. Jörn Rittweger
PD Dr. Jochen Zange
Dr. Carole Leguy
Dr. Edwin Mulder
Dr. Uwe Mittag
Dr. Krassimira Ivanova
Dr. Petra Frings-Meuthen
Dr. Luis Beck
Dr. Bergita Ganse

Biomedizinische Forschung
Prof. Dr. Ralf H. Anken
PD Dr. Ruth Hemmersbach
Dr. Jens Hauslage

Christian-Albrechts-Universität (CAU) zu Kiel

Institut für Experimentelle und Angewandte Physik
Extraterrestrische Physik
Prof. Robert F. Wimmer-Schweingruber
Dr. Jan Köhler

Heliosphärische Astroteilchenphysik
Prof. Bernd Heber
Dr. Andreas Klassen

Universität Regensburg
Lehrstuhl für Mikrobiologie und Archäologie
Dr. Harald Huber
Prof. Dr. Reinhard Rachel
Prof. Dr. Michael Thomm
Prof. Dr. Reinhard Wirth

Deutsche Sporthochschule (DSHS), Köln

Institute for Training Science and Sports Informatics
Prof. Dr. paed. Dr. h.c. mult. Joachim Mester

Institute for Circulation Research and Sports Medicine
Prof. Dr. Wilhelm Bloch

Institute for Biomechanics and Orthopedics
Prof. Dr. Gert-P. Brüggemann

Rheinisch-Westfälische Technische Hochschule (RWTH) Aachen

Institut für Flugmedizin, Zentrum für Medizin & Mobilität
Dr. rer. nat. Corinna Panitz

Rheinische Friedrich-Wilhelms-Universität Bonn

Life & Medical Sciences (LIMES) Institute
Prof. Dr. Waldemar Kolanus

Institut für Molekulare Physiologie und Biotechnologie der Pflanzen (IM-BIO)
Gravitationsbiologie
PD Dr. Markus Braun

Otto-von-Guericke-Universität Magdeburg

Fakultät für Maschinenbau
Institut für Maschinenkonstruktion
Prof. Dr. Dr. Oliver Ullrich

Freie Universität Berlin
Charité Universitätsmedizin Berlin
Zentrum für Weltraummedizin
Prof. Dr. Hanns-Christian Gunga
Within the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt e.V., DLR), the Institute of Aerospace Medicine is the only research institution that primarily deals with life science problems concerning traffic, aviation, and space flight.

The Institute’s research activities are focused on the central task of providing for the health and performance of the persons involved (pilot, crew, passenger, astronaut, motorist, resident etc.).

Furthermore, from a medical point of view the development of countermeasures to protect humans from the effects of weightlessness, like the loss of bone and muscle mass is one of our main tasks to enable long-term stays of humans in space for example.

At the same time, when conducting research under microgravity conditions basic functions of the human body are examined by eliminating the interfering influence of gravity in a system-physiological approach.

In the field of psychology the selection of qualified personnel (pilots, astronauts, air traffic controllers) and the development of suitable scientific instruments for the selection procedure are another main task of the Institute. Finally, we also deal with the problem of adaptation of life to extreme environments and take part in projects that are concerned with the search for life in space.

Just opposite to the building shown below, a new research facility called :envihab is currently constructed. It is a new modularly designed analogue research facility for large-scale complex medical, physiological, psychological, biological research and technology developmental campaigns.
Since many years, a main focus at the Institute for Molecular Physiology and Biotechnology of Plants (IMBIO) at the University of Bonn, Germany, is gravitational biology. A main focus of the SpaceLife partners at the Life & Medical Sciences (LIMES) institute is immunology.

The Institute for Experimental and Applied Physics at the CAU in Kiel has a long-lasting experience in extraterrestrial physics and heliospherical astroparticle physics.

Institute for Biomechanics and Orthopedics

The Institute for Training Science and Sports Informatics of the DSHS Köln, Germany, contributes excellent expertise in the development and evaluation of efficient countermeasures to muscle and bone degradation during space missions.

The DSHS Institute for Circulation Research and Sports Medicine

The Institute for Biomechanics and Orthopedics has long-lasting experience in the two fields mentioned in its name.

The Institute of Mechanical Engineering of the Faculty of Mechanical Engineering at the Otto-von-Guericke-University Magdeburg, Germany, contributes excellent expertise in space biotechnology.

Expertise in Astrobiology is contributed by the Institute of Aerospaces Medicine at the RWTH Aachen.

The Lehrstuhl für Mikrobiologie and the Archaea Centre of the University of Regensburg stand for excellent expertise in isolating, growing and characterizing extremophilic Bacteria and Archaea into the Astrobiology field of SpaceLife.

The Center for Space Medicine Berlin (ZWMB) at the Charité-University Clinics in Berlin, Germany, investigates the anatomical, physiological and psychological adaptation of humans to microgravity.
SpaceLife

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70599 Stuttgart
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SpaceLife

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Prof. Jörg Stülke
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Dr. David Andrew Green
King’s College London
Centre of Human & Aerospace Physiological Sciences (CHAPS)
Department of Physiology,
School of Biomedical Sciences
London, UK

Prof. Dr. med. Daniela Gabriele Grimm
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Pharmacology
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Dr. Cora Thiel
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XueYuan Road No. 37
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International Associated Partners

SpaceLife
Profiles of the Members
Scientific Career
1991 Diploma in Biology
1995 PhD in Natural Sciences (Zoology)
1999 Habilitation (Zoology)
2008 Professorship (apl)

Professional Experience
1992 Scientific Employee,
2008 Zoological Institute, University of Hohenheim, Germany
2008 Scientific Employee,
2010 Biomedical Science Support Center (BSSC), Institute of Aerospace Medicine, German Aerospace Center, Cologne, Germany
Since Head of Biomedical Research (BMR, formerly BSSC), Institute of Aerospace Medicine, German Aerospace Center, Cologne, Germany

Research Topics
Biology, inner ear otolith calcification in fish, fish as model system in understanding motion sickness susceptibility, neuroscience, neurovestibular behavior, sensorimotoric disorders, aquatic life support systems.

Space Related Activities

Selected Publications


Gravisensor of vertebrates
Prof. Dr. Christa Baumstark-Khan

Institute of Aerospace Medicine
Radiation Biology
Cellular Biodiagnostics

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Website: http://www.dlr.de/me/

Scientific Career
1978 Diploma in Biology
1985 PhD in Radiobiology
2004 Lecturer at University of Applied Sciences Bonn-Rhein-Sieg

Professional Experience
1982 Research scientist,
1991 Experimental Radiology & Radiation Biology, Radiologic University Clinics,
Medical Faculty, University of Bonn, Germany
1991 Project scientist,
1993 Preparation of KINETICS experiment, NASA Spacelab
mission IML-2
1995 Research scientist, DLR,
1998 Institute of Aerospace Medicine, Radiation Biology
1998 Group Leader of the
2000 Project Group Human Radiation Risk, Aerospace Medicine,
University Clinics, RWTH Aachen
Since 2000 Group Leader, DLR
Institute of Aerospace Medicine, Cellular Biodiagnostics

Research Topics
Biological effects of different environmental stressors at the cellular & molecular level
(radiation, esp. heavy & light ion exposure, nanoparticles, mechanical stress) - Gene expression & signal transduction in mammalian cells, Apoptosis and cell cycle control

Bacterial cyto- & genotoxicity assays
Molecular bone metabolism under conditions of space flight

Space related activities
Co-Investigator:
IML-2: Cellular Repair of Radiation Damage (KINETICS)
Genotoxic effects of space environment (TRIPLE-LUX C)

Principal Investigator:
‘Cellular Responses to Radiation in Space (CellRad): The effects of single and combined space flight conditions on mammalian cells’ - to be flown.

Selected Publications

Heavy Ion exposure of human cells at GANIL, Caen, France
Dr. Thomas Berger

Institute of Aerospace Medicine
Radiobiology
Biophysics

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Website: http://www.dlr.de/me/

Scientific Career
1998  Diploma in Physics
2003  PhD in Radiation Physics

Professional Experience
2003- Postdoc, Institute of Aerospace Medicine, DLR, Cologne, Germany
Since  Scientific Employee, Institute of Aerospace Medicine, DLR, Cologne, Germany

Research Topics
Radiation protection and dosimetry for human space flight and for aircrew

Development and investigation of the radiation detection properties of active and passive radiation detectors

Organization of ground based radiation intercalibration campaigns

Space Related Activities
Co-Investigator in the space experiments:
MATROSHKA, DOSIS, ExoMARS, ALTEINO, BRADOS – Space ICCHIBAN.

Ground-based radiation detector studies at the Heavy Ion Medical Accelerator HIMAC, Chiba, Japan; the CERF High Energy Neutron Field, CERN, Switzerland, the iThemba Neutron Field, Capetown, South Africa

Selected Publications

Berger T, Hajek M (2008), TL-efficiency-Overview and experimental results over the years. Radiation Measurements, 43(2-6): 146-156.


MATROSHKA on the International Space Station (ISS)
**Prof. Dr. Wilhelm Bloch**

**Professional Experience**
Since 2004 Head of the Department for Molecular and Cellular Sports Medicine, and of the Institute of Cardiovascular Research and Sport Medicine, DSHS, Cologne, Germany

**Honors**
Member of the Scientific Committee of the European College of Sports Sciences
Member of the Board of Directors of “momentum” (“Das Deutsche Zentrum für Leistungssport Köln”) at the DSHS
Vice President Research and Teaching, “Deutsche Gesellschaft für Sportmedizin und Prävention e.V. (DGSP)”

**Research Topics**
Regulation pathways and cellular and extracellular mechanisms of functional and structural adaptation to mechanical and metabolic stress under (patho)physiological conditions in different tissues (heart and skeletal muscle, blood vessels, blood, bone, cartilage, tendons). Dependence of tissue regeneration from stem and precursor cells and influence of physical activity on mobilization and activation of these cells.

**Space Related Activities**
Development and evaluation of countermeasures for muscle and bone loss during long-term space missions

**Selected Publications**


Scientific Career
1991 Diploma in Biology
1994 PhD in Natural Sciences (Botany)
1999 Habilitation (Botany)

Professional Experience
1995- DFG Fellowship, University Canberra, Australia
1999- Professor (C3), University Bonn, Germany
2001- Senior Scientist, University Erlangen, Germany
Since- Project Coordinator, IMBIO, University of Bonn, Germany
Since- Project Manager at DLR Space Agency, Germany

Awards
1991 Heinrich-Hörlein Award, University Bonn
2002 Thora Halstead Young Investigator Award, American Society of Gravitational & Space Biology (ASGSB)

Research Topics
Biology, Plant signal transduction, tip growth, gravity perception, plant cytoskeleton, biosensors, experimentation microgravity

Space Related Activities
Experiments flown on Space-Shuttles:
STS-55 (2nd German Spacelab Mission D2, 1993)
STS-65 (1994)
STS-81 (1997)
TEXUS Sounding rockets: 21, 25, 28, 29, 30, 37, 43
MAXUS 3 & 5
Parabolic Plane Flight Campaigns (7)

Selected Publications


Scientific Career
University studies in Münster and Frankfurt/Main
Doctoral Degree at the University of Frankfurt/Main in Biomechanics
Professor of Biomechanics at the DSHS Köln

Professional Experience
Director of the Institute of Biomechanics and Orthopedics of the DSHS Köln

Research Topics
Clinical biomechanics, occupational biomechanics and sports biomechanics with the goal of an increased understanding of the macroscopic and molecular response of biological tissue (e.g. bone, cartilage, muscle, tendon) to mechanical stimuli in exercise, sport and daily activities.

Influence of technical devices (footwear, braces, orthosis, prostheses) to the tissue loading in sport, exercise and daily life activities.

Selected Publications


Dr. Petra Frings-Meuthen

Institute of Aerospace Medicine
Space Physiology

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51147 Cologne
Germany

Phone: +49 2203 601 3034
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Website: http://www.dlr.de/me/

Scientific Career
2003 Diploma in Nutrition Science
2008 PhD in Nutrition Science

Professional Experience
since 2008 Scientific Employee at the Institute of Aerospace Medicine, DLR, Cologne

Scholarships & Awards
2004 PhD scholarship (Wernher von Braun Foundation)
2008 Science Award of DLR
2008 ESA Young Researcher Award

Research Topics
Influence of nutritional factors on bone and muscle metabolism under microgravity and immobilized conditions.

Development and investigation of countermeasure against immobilization induced bone and muscle losses.

Organization of ground based campaigns.

Space Related Activities:

Principal Investigator:

ISS experiment SOLO: “Sodium retention in microgravity”

ESA bed rest studies “Changes in acid-base balance and its effect on bone metabolism during HDT bed rest”

Project Scientist:

ESA “Nutritional Countermeasure” (NUC) bed rest study

ESA “Evaluation of the use of Artificial Gravity, induced by short-arm centrifugation or the Application of definite combined Training program to counteract effects of bed rest” (SAG study)

Co-investigator:

ISS Experiment PREBL “Post-reentry bone loss”

Publications:


Dr. Bergita Ganse

Scientific Career
2007 Approbation as Medical Doctor (University of Lübeck)
2007 Dissertation, Dr. med.

Professional Experience
2008- Charité – Universitätsmedizin Berlin, ZWMB, Department Physiology
2009- Department of Orthopedic and Trauma Surgery, University of Cologne, surgical training
2011- Emergency Physician (Notarzt)
Since- DLR, Institute of Aerospace Medicine, Department Space Physiology

Research Topics
Bone deformation; Bone density in space, during ageing and in osteoporosis.
Musculoskeletal interaction.
Injuries in athletics.
Two-stage hip revision arthroplasty.

Space Related Activities
Head Medical Doctor:
ESA bed rest study „Medium-term-bedrest Whey Protein“ (MEP)

Co-Investigator:
ISS experiment SARCOLAB

Medical Expert in the commission for manned spaceflight of the extraterrestrial physics group, German Physical Society (DPG, Deutsche Physikalische Gesellschaft)

Selected Publications


Bone deformation measurements with motion capturing
Prof. Dr. Rupert Gerzer

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Skolkovo Innovation Center
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E-mail: r.gerzer@skoltech.ru
Website: http://faculty.skoltech.ru/people/rupertgerzer

Scientific Career
1977 Dr. med., Univ. of Munich
1987 Habilitation, University of Munich
1992 Head, Institute of Aerospace Medicine, DLR Cologne and Head, Institute of Aerospace Medicine, RWTH Aachen
Since 2015 Director Space Center, Skoltech, Moscow, Russia

Professional Experience
1978- DFG Fellow, University of Heidelberg, Germany
1980- DFG Fellow abroad, Vanderbilt University, Nashville, TN, USA
1983 Resident Internal Medicine, University of Munich, Germany
1984-1998 DFG Hessenberg Fellowship
1992- Founder, DFG Clinical Research Group, University of Munich, Germany
2005- Space Life Sciences Award, International Academy of Astronautics
Since 2007 Head, University Council, University of Applied Sciences Bonn

Research Topics
Signal transduction pathways, esp. cyclic GMP, Space Physiology, Telemedicine

Space Related Activities
Participation in many space missions as a scientist and in the present function
Member, Board of Trustees, International Academy of Astronautics since 1999
President, German Society for Aerospace Medicine, 1999-2001
Editor-in-Chief, Acta Astronautica 2008-2011

Selected Publications

Prof. Dr. Hanns-Christian Gunga

Zentrum für Weltraummedizin Berlin (ZWMB)
c/o Institut für Physiologie
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Germany
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Website: http://www.zwmb.de/

Scientific Career
1980 Diploma in Geology-Palaeontology
1987 State examen in Medicine
1989 Dissertation Dr. med. (Berlin)
1997 Habilitation/PhD (Physiology), Free University Berlin, Berlin
2004 Professorship, Charité University Medicine Berlin, Berlin

Professional Experience
1980 Scientific Assistant, Department of Physiology, Free University Berlin Germany
1996 Visiting Researcher, Santiago de Chile
2000 Speaker of the Center of Space Medicine
Since 2008 Vice Director of the Department of Physiology, Charite University Medicine Berlin, Campus Benjamin Franklin

Research Topics
Space medicine, blood physiology, cardiovascular physiology, renal physiology, comparative physiology in extreme environments

Space Related Activities
Principal Investigator
EUROMIR’94 (Principal Investigator, CVP-Erythropoietin)
ESA-CNES L-TBR’94 (Principal Investigator, Erythropoietin)
MIR’97 (Principal Investigator, Erythropoietin-Serum Transferrin Receptor)
Neurolab 2000 (Principal Investigator, Psycho-Physiology)

Co-investigator:
ISEMSI’90, EXEMSI’92, MIR’92, D-2, ALTAIR, EUROMIR’94, HUBES’94
Several Parabolic Flight Campaigns and Bed Rest Studies

Selected Publications

Dr. Jens Hauslage

Institute of Aerospace Medicine Biomedical Science Support Center (BSSC), Interdisciplinary Gravity Research
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Website: http://www.dlr.de/me/

Scientific Career
2005 Diploma in Biology
2008 Dr. rer. nat. in Biology – Plant Physiology

Professional Experience
2005- Postgraduate und scientific assistant at the Institute of Molecular Physiology und Biotechnology of plants (IMBIO), Bonn, Germany
2007 Assessor for Life Science and Physics, Evangelisches Studienwerk e.V. Villigst
Since- Postdoc, Institute of Aerospace Medicine, DLR, Cologne, Germany

Awards
2008 ESA – Young Researcher Award for outstanding Science
2008 1. Poster Award, 10th ESA Symposium “Life in Space for Life on Earth”, Angers, France

Research Topics
Gravitropism, Simulation of Weightlessness, Development of Clinostats, Bioregenerative Life Support
Head of the DLR Project :envihab – Lebenserhaltungssysteme
PI of the DLR Mission Eu:CROPIS

Space Related Activities
2006 Sounding-Rocket Mission TEXUS 43 at ESRANGE, North of Sweden
2006 Co-Pl during the 8th DLR-Parabolic -flight-campaign, Köln/Bonn
2006 Pl during the 9th DLR-Parabolic -flight-campaign, Bordeaux, France
2007 Pl during the 10th DLR-Parabolic -flight-campaign, Köln/Bonn
2003 Over 600 performed parabolas during 13 parabolic plane flights campaigns

Selected Publications

Clinostat for rotation of biological samples, resulting in continuous reorientation of the gravity vector
Prof. Dr. Bernd Heber

Scientific Career
1991 Diploma in Physics Christian-Albrechts-Universität Kiel, Germany
1997 Dr. rer. nat./PhD, Christian-Albrechts-Universität Kiel, Germany
2004 Habilitation, Universität Osnabrück, Germany

Professional Experience
1991- Research Associate, Christian-Albrechts-Universität Kiel, Germany
1998- Research Associate, Centre Etude Atomique, Saclay, France
1999- Research Scientist, Max-Planck-Institute for Aeronomie, Kiel, Germany
2001 Assistant, Universität Osnabrück, Germany
2005 Assistant: Universität Stuttgart, Germany
Since Full Professor, Christian-Albrechts-Universität Kiel, Germany, Institute for Experimental and Applied Physics

Awards
1992 Group Achievement Award “Ulysses Jupiter Flyby”

Research Topics
- Sun and heliosphere
- Cosmic radiation
- Interaction of cosmic radiation with the atmosphere

Space Related Activities
Since Co-I: Ulysses/ Kiel Electron Telescope
Since P-I: Ulysses/ Kiel Electron Telescope
Since P-I: Proton Helium Instrument
Since Co-I: STEREO/ Electron Telescope

Selected Publications


Rover for the US Mars Science Laboratory (MSL) Mission
PD Dr. Christine Hellweg

Scientific Career
1996 Approbation as Veterinarian
2001 PhD in Veterinary Medicine
2012 Habilitation (Immunology)

Professional Experience
2001- Postdoc, Dermatology, University of Cologne, Germany
2004- Scientific Employee, Institute of Aerospace Medicine, DLR, Cologne
2015- Head of Department, Institute of Aerospace Medicine, DLR, Cologne

Research Topics
Biological effects of different environmental stressors at the cellular and molecular level (radiation, especially heavy and light ion exposure, nanoparticles, mechanical stress) - Gene expression and signal transduction in mammalian cells, Apoptosis and cell cycle control Molecular bone metabolism under conditions of space flight

Space Related Activities
Coordinator of SpaceLife
Co-Investigator in the space experiment CellRad (formerly CERASP)

Ground-based radiobiological studies at the heavy ion accelerators GANIL (Caen, France) and GSI (Darmstadt, Germany), at the neutron reactor FRMII (Garching, Germany) and the PTB microbeam (Braunschweig, Germany)

Selected Publications


Heavy ion exposure campaign at GANIL, Caen, France
PD Dr. Ruth Hemmersbach

**Scientific Career**
- 1985 Diplom in Biology
- 1988 PhD in Natural Sciences (Zoology)
- 1998 Habilitation (Zoology)

**Professional Experience**
- 1985-1992 Doctoral grant, PostDoc at the Institute of Aerospace Medicine, DLR, Cologne, Germany
- 1992-2005 Scientific Employee at the Institute of Aerospace Medicine, DLR, Cologne
- Since 2005 Head of the group Interdisciplinary Gravity Research at the BSSC, Institute of Aerospace Medicine, DLR, Cologne
- Since 2015 Head of Department Gravitational Biology, Institute of Aerospace Medicine, DLR, Cologne

**Awards**
- 1991 Junior Scientist Award of the DLR
- 1992 Zeldovich Award of the Cospar Life Sciences behaviour, sensorimotoric disorders, aquatic life support systems.

**Research Topics**
Gravitational biology; perception of gravity on the cellular level; gravisensors in unicellular systems; experiments under altered gravitational stimulation; simulation of functional weightlessness; scientific user support

**Space Related Activities**
- TEXUS 27 (1990); TEXUS 28 (1991)
- MAXUS 2 (1995)
- Shuttle-Mission SMM06 (1997)
- TEXUS 39 (2001)

**Selected Publications**
Dr. Harald Huber

Scientific Career
1982 Diploma in Biology
1987 PhD in natural sciences (Microbiology)

Professional Experience
1987- PostDoc at the Institute for Microbiology, University of Regensburg, Germany
1990 Permanent position (Akad. Oberrat) at the Institute for Microbiology, University of Regensburg, Germany; Work group leader for microbial research projects
Since- Permanent position (Akad. Oberrat) at the Institute for Microbiology, University of Regensburg, Germany

Research Topics
Isolation and characterization of novel hyperthermophilic Archaea and Bacteria;
Physiology and molecular biology of extremophilic microorganisms;
Optimization of fermentation processes in biogas plants.
Bacterial leaching of sulfidic ores by Archaea and Bacteria.

Space Related Activities
Ground-based studies on the resistance of extremophilic microorganisms to radiation, desiccation and high vacuum conditions (collaboration with the DLR in Cologne, Germany, group of Dr. Petra Rettberg).

Selected Publications


Electron micrographs and fluorescence image of the Nanoarchaeum equitans - Ignicoccus hospitalis Co-culture
Scientific Career
1971 Diploma in Chemistry, University of Technology, Dresden
1984 PhD (Biology), Sofia
1990 Habilitation (Biochemistry), Med. University, Varna
1998 PhD, Medical Faculty, University of Amsterdam

Professional Experience
1979- DAAD Fellow, University of Heidelberg, Germany
1980 DAAD Fellow, University of Munich, Germany
1972- Assistant & Assoc. Professor of Pharmacology & Biochemistry, Med. University, Varna
1991- Research Scientist, Departments of Pharmacology & Biochemistry, Med. University, Varna
1993- Clinical Pharmacology, University of Munich
Since- Research Scientist, Head of Cell- & Molecular Biology Subdivision, Space Physiology, Institute of Aerospace Medicine, DLR
Since 2000 Adjunct Research Scientist Department of Pathology, University of Amsterdam

Research Topics and Space Related Activities
Signal transduction pathways, esp. nitric oxide, natriuretic peptides, guanylyl cyclases, cyclic GMP, melanocyte (patho)physiology, space physiology

Selected Publications:
Dr. Andreas Klassen

Scientific Career
1980 Graduation in Astronomy, Kazan State University, Kazan, USSR
1988 Ph.D. in Astrophysics, Main Astronomical Observatory Pulkovo/Leningrad, USSR

Professional Experience
1980- Research Scientist, Institute of Ionosphere, Alma-Ata, USSR
1992- Research Scientist, Astrophysical Institute Potsdam, Potsdam, Germany
1994- Research Scientist, Astrophysical Institute Potsdam, Potsdam, Germany
Since- Research Scientist, IEAP, Christian-Albrechts-Universität Kiel, Germany

Space Related Activities
Team member of several space missions:
Kiel Electron Telescope (KET), part of the Ulysses Cosmic Ray and Solar Particle Investigation (CO-SPIN) experiment
Solar Electron and Proton Telescope (SEPT) on Solar Terrestrial Observatory (SEPT/STEREO)
Comprehensive Suprathermal and Energetic Particle Analyzer on the Solar and Heliospheric Observatory (COSTEP/SOHO)

Research Topics
Astro-particle physics, solar physics, radio emission from the Sun, acceleration of particles by shock waves and other processes, propagation of solar particles and planetary particles

Selected Publications

The Solar Electron and Proton Telescope (SEPT) on the two space-based observatories STEREO consist of 16 particle telescopes which collect energetic ions and electrons (IEAP, CAU Kiel).
Dr. Jan Köhler

\[\text{Scientific Career}\]
2008 Diploma in Physics, Christian-Albrechts-Universität (CAU) Kiel, Germany
2012 Dr. rer. nat./PhD, CAU Kiel, Germany

\[\text{Professional Experience}\]
2005- SFB 654, Plasticity and Sleep – Project A8 Developing computational models of cortical neuronal networks, CAU Kiel
2008 DLR Project - Lunar Exploration Orbiter (LEO) Developing instruments for the Lunar Exploration Orbiter
2008- PhD student, Christian-Albrechts-Universität Kiel, Germany
2012- Research Scientist, Christian-Albrechts-Universität Kiel, Germany

\[\text{Awards}\]

\[\text{Space Related Activities}\]
SpaceLife Alumnus
Member of the MSL-RAD Science Team

\[\text{Research Topics}\]
Cosmic radiation
Martian radiation environment
Dosimetry
Interaction of cosmic radiation with the atmosphere

\[\text{Selected Publications}\]


The Payload deck of the Mars rover “Curiosity” of the US Mars Science Laboratory (MSL) Mission. The Radiation Assessment Detector (RAD) is right below the dark round entrance window on the left side of the image.
Profs. Dr. Waldemar Kolanus

Scientific Career
1978-1984: Undergraduate studies in Biology and Chemistry, University of Hannover, Germany
1987: PhD in Molecular Biology, University of Hannover
1988-1994: Postdoctoral positions at Clinical Immunology, Hannover Medical School and at Harvard Medical School/Massachusetts General Hospital, Department of Molecular Biology, Boston, USA.

Professional Experience
1994-1999: Independent group leader, Gene Center, Munich, Germany
1999: Professor of Biochemistry, University of Munich
2002: Full Professor and Chair of Immuno- and Cell Biology, Life & Medical Sciences (LIMES) Institute, University of Bonn, Germany

Research Topics
Signal transduction processes which are either regulating cell adhesion, or those which are the consequences of cell-cell interactions:

a) control of lymphocyte adhesion and
b) intracellular signals which turn on cytokine gene expression

Development of new areas:
Live cell imaging for the visualization of signaling processes, as well as mouse transgenic and knock-out technologies in the investigation of gene function at the organismic level.

Selected Publications


**Dr. Patrick Lau**

**Institute of Aerospace Medicine**  
**Space Physiology**

**Linder Höhe**  
51147 Cologne  
Germany

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Website:  
http://www.dlr.de/me/

**Scientific Career**

2003  Graduation in Biology  
2004  Diploma thesis  
2008  Dr. rer. nat.

**Professional Experience**

2003- Diploma student,  
2004  Institute of Aerospace Medicine, DLR, Cologne, Germany  
2004- PhD student,  
2008  Institute of Aerospace Medicine, DLR, Cologne, Germany  
Since- Research scientist,  
2009  Institute of Aerospace Medicine, Radiation Biology/Space Physiology, DLR, Cologne, Germany

**Awards:**

2004  Education grant European Space Agency (35th CO-SPAR Scientific Assembly in Paris)  
2005  Poster award, Gravitational Physiology Meeting, Cologne, “Three dimensional culture of the murine osteoblastic cell line OCT-1 on collagen coated microcarriers”.

**Research Topics**

Differentiation and regulation of osteoblast and osteoclastic cell formation.

Bone specific gene expression pattern in the differentiation pathway after exposure to ionizing radiation.  
Cellular effects after heavy charged particle exposure on bone cells.  
Induction of DNA strand breaks and premature differentiation of bone cells exposed to high-energy heavy ions.

**Space Related Activities:**

Since-  
2008  Co-Investigator of OSIRIS  
Ground based research at the heavy ion accelerator GSI, Darmstadt, Germany  
Co-Investigator “Interrelation between cellular differentiation and DNA damage of murine pre-osteoblastic cell lines in response to High LET radiation”.  
Ground based research at the heavy ion accelerator GANIL (Grand Accélérateur National d’Ions Lourds), Caen, France

**Selected Publications:**


**DNA damage response in bone cells**

Heavy ion exposure of bone cells
Dr. Ing. Carole Leguy

Scientific Career
2005  Master of Science in Biomedical Engineering
2010  PhD in Biomedical Engineering

Professional Experience
2011- Guest researcher at the Institute of Aerospace Medicine, DLR, Cologne
2012  Post doc, Laboratory for Aero and Hydrodynamics, Delft University of Technology, The Netherlands
2010-  PhD student at the Dept. of Biomedical Engineering, Eindhoven University of Technology, The Netherlands

Research grants
Marie Curie Early Stage Research fellowship (2005-2009), Eindhoven University, the Netherlands
Marie Curie International Outgoing Fellowship, Simon Fraser University, Canada(2012-2014) / DLR (2014-2015)

Research Topics
Cardiovascular space physiology.
Exploration of the regulatory mechanism of the cardiovascular system involved in orthostatic Intolerance.


Space Related Activities
Tilt-table and Lower Body Under pressure in vivo experiment.
Ultrasound assessment of blood flow velocity during tilt-table experiment at DLR
In vivo study on ESA/DLR Short Arm Human Centrifuge study.

Selected Publications:


Leguy CAD, Bosboom EMH, Hoeks APG, van de Vosse FN (2009)
Scientific Career
1974  State examination in Sports Science, University of Bochum
1978  PhD (Motoric Learning, Movement Coordination)
1984  Habilitation (Diagnostics of Sense Organs, Motor Learning, Training)

Professional Experience
1974-  Scientific Assistant at the Institute of Sports Medicine, Ruhr University Bochum
1985-  Appointment as Professor at the DSHS, Head of the Institute of Training Science and Mechanics

Awards
1984  Carl-Diem-Plakette (Deutscher Sportbund) for the Habilitation thesis
1994  Dr. h.c. Sportuniversität Budapest
2004  Dr. h.c. Universität Jyväskylä, Finnland

Research Topics
Analysis of human adaptation to training
Scientific support in top performance sport: national teams in alpine skiing, tennis, ski-jumping, fencing, rowing, track and field

Space Related Activities:
Empirical Modeling of human performance and adaptation under normal conditions and µg Research cooperation with DLR

Selected Publications:
Dr. Uwe Mittag

German Aerospace Center (DLR)

Institute of Aerospace Medicine
Space Physiology
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Website: http://www.dlr.de/me/

Scientific Career
1983 Diploma in Chemistry
1988 PhD in Physical Chemistry
2002 Master in Space Systems Engineering

Professional Experience
1989- Scientific Employee, DLR, Cologne
1989- Space Operations and Astronaut Training Department, Software (S/W) development for crew training and ground operations support
2003- Institute for Aerospace Medicine
2003- Data system design for medical applications
2005- Head of Biomedical Science Support Center
2010- Head of numerical simulations group

Research Topics
Computational modeling of physiological systems in space physiology with focus on bone mechanics and bone remodeling

Space Related Activities:
Software development and operations of the Spacelab Training Assembly at Cologne in support of D-2 project (German Spacelab Mission)

Selected Publications:


Dr. Ralf Möller

Institute of Aerospace Medicine
Radiation Biology
Space Microbiology

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Germany

Phone: +49 2203 601 3145
E-mail: Ralf.Moeller@dlr.de
Website: http://www.dlr.de/me/

Scientific Career
2003 Diploma in Biology
2007 PhD in Natural Sciences (Microbiology, Biochemistry)

Professional Experience
2003-2007 PhD student, German Collection of Microorganisms and Cell Cultures (DSMZ), Braunschweig, Germany and DLR, Cologne, Germany
2007-2015 Scientific Employee, Radiation Biology, Astrobiology Group, DLR, Cologne
Since 2015 Head of the Group, Space Microbiology, DLR, Cologne

Research Topics
Microbiology, Astrobiology, Radiation biology, DNA repair, DNA protection, Gene expression analyses, Regulation networks on microbial model systems

Space Related Activities
Visiting scientist at NASA KSC, USA; ISRL NIRS, Japan; MPI-IB, Germany; Co-investigator of DFG-"Meteorite ejection and life", ESA/DR-"ADAPT" und "PROTECT"

Selected Publications:


Integrated genomic (e.g. microarrays) and proteomic (e.g. Western Blots) approach to study the response of germinating and outgrowing spores (e.g. fluorescence microscopy).
Dr. Edwin Mulder

Institute of Aerospace Medicine
Space Physiology

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Germany

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E-mail: edwin.mulder@dlr.de
Website: http://www.dlr.de

Scientific Career
2001 MSc. in Human Movement sciences
2007 PhD in Human Movement Sciences

Professional Experience
2007 Postdoctoral fellow VU University Amsterdam
2009 Postdoctoral fellow UMCN Nijmegen Department of Neurology
2010- Researcher at DLR, Space Physiology

Research Topics
Development and testing of exercise-related countermeasures for the protection against the adaptations occurring under microgravity conditions for the neuromuscular and the cardiovascular system using ground-based simulation models

Space Related Activities
Member of the Dutch Investigator Support Team during the 2004 DELTA Mission of Dutch Astronaut Andre Kuipers
Member of the founding of the Platform Microgravity Nederland
Projects scientist for the 2010 - 2011 ESA-funded DLR-held short-term bed rest study

Co-investigator during the 2011-2012 ESA-funded DLR-held medium-term bed rest study
Co-investigator during the MARS500 confinement and isolation study
Co-investigator during the DLR-funded Short-Arm Human Centrifuge study

Selected Publications


**Dr. Corinna Panitz**

**Universitätsklinikum Aachen**
Institut für Flugmedizin, Zentrum für Medizin & Mobilität
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Website: http://www.ukaachen.de/content/institution/4125624

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**Scientific Career**

1989  Diploma in Biology
1993  PhD in Biology

**Professional Experience**

1994-  Educational work - two
2000- children
2000-  Scientific employee at the
2005- German Aerospace Center,
       Cologne, Germany
2005-  Scientific employee at the
       present RWTH Aachen

**Research Topics**

Exo/Astrobiology, Photobiology, Microbiology, Genetics, space experiments.

**Space Related Activities:**

PI for ESA Ground experiment
SSIOUX Candy
Co-Investigator of Space experiments:
MARSTOX I and II on BIOPAN IV, V and VI

ADAPT and PROTECT on EXPOSE-E
TRIPLE-LUX in Biolab, Columbus on ISS
Coordinator for Ground Simulation of all EXPOSE-R space experiments
Coordinator for of Rose Consortium and EVT and EST Program for EXPOSE-R space experiments

**SPORES on EXPOSE-R Selected Publications:**


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Biological samples accommodated for EXPOSE-R EST
Dr. Elke Rabbow

German Aerospace Center (DLR)

Institute of Aerospace Medicine Radiation Biology
Astro-/ Exobiology

Linder Höhe
51147 Cologne
Germany

Phone: +49 2203 601 3146
E-mail: elke.rabbow@dlr.de
Website: http://www.dlr.de/me/

Scientific Career
1993 Diploma in Biology
2000 PhD in Biology

Professional Experience
1999-2000 Project Management at DLR
2000-2005 Scientific employee at the RWTH Aachen
Since 2005 Scientific employee at the German Aerospace Center Cologne, Germany

Research Topics
Exo/Astrobiology, Photobiology, Microbiology, Genetics, space experiments.

Space Related Activities:
ESA Point of Contact/coordination of EXPOSE on ISS
PI for DFG-Project Impact II
Co-Investigator of Space experiments:
SURVIVAL I on BIOPAN III
MARSTOX I and II on BIOPAN IV, V and VI
SPORES on EXPOSE-R
TARDIS on BIOPAN VI
ADAPT and PROTECT on EXPOSE-E
TRIPLE-LUX in Biolab, Columbus on ISS

Coordinator for ESA Ground experiment SSIOUX
Coordinator for Ground Simulation of all above space experiments
DFG-Project UV radiation and Deinococcus radiodurans
Coordinator for DLR :envihab

Selected Publications:


STS 122 lift off on February 7th, 2008

External payloads EuTET and SO-LAR in the cargo bay of STS 122
Scientific Career
1982 Diploma in Biology, University of Düsseldorf
1987 PhD at the Technical University of Munich

Professional Experience
1987- PostDoc at the MPI for Biochemistry, Munich
1989- PostDoc at the MRC-LMB in Cambridge, England
since- Permanent position at the Institute for Microbiology, University of Regensburg, Germany; group leader for Ultrastructure and Electron Microscopy in Microbiology
since- Head of the Centre of Electron Microscopy

Research Topics
Structural characterization of hyperthermophilic Archaea and Bacteria
Cell surface, membrane proteins and Surface layer of extremophilic microorganisms
Cell-cell and cell-surface interaction of Archaea

Selected Publications:


Electron micrograph of an ultrathin section of Ignicoccus hospitalis
Dr. Günther Reitz

Scientific Career
1972 Diploma in Physics
1990 PhD in Biophysics

Professional Experience
1975- Scientific Employee, Institute of Aerospace Medicine, DLR, Cologne
Since- Head of the Radiation Biology Section

Awards:
Scientific Award of DGLRM

Research Topics
Radiation Protection and Dosimetry for human space flight and for aircrew. Development and investigation of the radiation detection properties of active and passive radiation detectors. Organization of ground based radiation inter-calibration campaigns.

Space Related Activities:
Project manager:
SL1 experiment Microorganisms
Free Flyer Biostack on LDEF
Payload element Radiation on D2
Dosimetry Mapping in US Lab

Principal Investigator:
Dosimetric Mapping Experiments on EURECA I, D2, IML 1 & 2, Biosmos 9 & 10 missions, BIOPAN flights, MIR92, EUROMIR94 & EUROMIR 95 & on BIORACK Missions on STS 76, 81 and 84
Biostack Experiments on IML2 and D2 and BIOPAN

Co-investigator:
Biostack Experiments I, II, & III, in “Advanced Biostack” Experiment on SL1 & IML1 & in “Free Flyer Biostack” on EURECA; SL1 & D2 Experiments “Microorganisms”; Dosimetric Mapping & “Carausius” in BIORACK in SL-D1, IML1

Selected Publications:

Dr. Petra Rettberg

Institute of Aerospace Medicine
Radiation Biology
Astro-/Exobiology

Linder Höhe
51147 Cologne
Germany

Phone: +49 2203 601 4637
E-mail: petra.rettberg@dlr.de
Website: http://www.dlr.de/me/

Scientific Career
1977- Study of Chemistry, Ruhr-Universität Bochum, Germany
1983- Dissertation (Dr. rer. nat.), Ruhr-Universität Bochum, Germany
1988 Scholar of the Max Planck-Society
1988- Head of the research group ‘Radiation Biology’, Max-Planck-Institute for Radiation Chemistry, Mülheim, Germany
1992 Junior research scientist, DLR, Institute of Aerospace Medicine, Radiation Biology, Köln, Germany
1996 Head of the research group present ‘Photo- & Exobiology’, DLR, Institute of Aerospace Medicine, Radiation Biology, Köln, Germany

Professional Experience
1988- Head of the research group ‘Radiation Biology’, Max-Planck-Institute for Radiation Chemistry, Mülheim, Germany
1992- Junior research scientist, DLR, Institute of Aerospace Medicine, Radiation Biology, Köln, Germany
1995- Head of the research group present ‘Photo- & Exobiology’, DLR, Institute of Aerospace Medicine, Radiation Biology, Köln, Germany

Awards:
2001 DLR-Competition of Visions, 2. Place

Research Topics
Exo/Astrobiology, Photobiology, Microbiology, Genetics, space experiments.

Space Related Activities:
Co-Investigator of the following international space experiments:
SURVIVAL II on BIOPAN I and II
SURVIVAL I on BIOPAN III, UVRAD of the mission D-2
REPAIR of the mission IML-2
KINETICS of the mission IML-2
UVE of the mission Mir’97
EXOBIOLGIE of the mission PERSEUS, HighRad of the FOTON M-3 mission, Lithopanspermia of the FOTON M-3 mission, PROTECT since 2008 on the ISS, SPORES (2008 on the ISS), UREY (2013, ExoMars)

Principal Investigator of the following international space experiments:
MARSTOX I of the mission FOTON M-2, MARSTOX II on the FOTON M-3 mission, ADAPT since 2008 on the ISS
TRIPLELUX (2009 on the ISS)

Selected Publications


Prof. Dr. Jörn Rittweger

Scientific career
1990 Graduation in Medicine
1992 Medical Thesis
2000 Approbation
2005 Habilitation

Professional Experience
1991- Postdoc, Institute of Physiology, Free University Berlin, Germany
1996- University assistant (C1), Institute of Physiology, Free University Berlin, Germany
2001- Principle Investigator in the Long-Term Bed Rest Study, Toulouse, France
2003- Scientific coordinator in Institute of Physiology, the 1st Berlin Bed Rest study
2003- Reader in Human Physiology, IRM Research Institute, Manchester Metropolitan University, United Kingdom
2006- Professor in Clinical Physiology, IRM Research Institute, Manchester Metropolitan University, United Kingdom

Awards:
1999 Supervisor of best medical thesis, Free University Berlin

Research Topics:
Effects of training, immobilization and ageing upon the human musculoskeletal system
Vibration exercise
Gravitational physiology
Biomechanics of the muscle-bone unit & Skeletal maturation

Space related activities
Berlin Bed Rest study (2002-2004)
Unilateral Lower Limb Suspension study, Manchester (2005)
Valdoltra Bed Rest studies, Slovenia (2007 & 2008)

Selected Publications
Dr. Luis Fernando Spitta

Institute of Aerospace Medicine
Radiation Biology
Cellular Biodiagnostics

Linder Höhe
51147 Cologne
Germany

Phone: +49 2203 601 3177
E-mail: luis.spitta@dlr.de
Website: http://www.dlr.de/me/

Scientific Career
2006- MSc. in Biology with biomedical applies at the University of Applied Sciences Bonn-Rhein-Sieg
2012 PhD in molecular biomedicine (University of Bonn)

Professional Experience
2007- Scientific employee in the Life & Medical Sciences Institute of the University of Bonn – Membrane Biochemistry Laboratory
Since- DLR, Institute of Aerospace Medicine, Department Radiation Biology, Cologne, Germany

Research Topics
Plasma membrane (PM) of cells, ionizing radiation effects, heavy ion radiation, reorganization (of proteins) on PM upon different irradiation; repair mechanisms of the plasma membrane after irradiation; visualization/micros-copy of the changes after irradiation of PM

Space Related Activities
Ground-based radiobiological studies at the heavy ion accelerators GANIL (Caen, France) and at the Physikalisch-Technische Bundesanstalt (PTB) microbeam (Braunschweig, Germany)

Deputy Coordinator of SpaceLife

Selected Publications


Spitta L (2012) Phosphatidylcholine is organized in long-lived platforms in native membranes. Membrane Biochemistry Laboratory. Life and Medical Sciences Institute (LIMES) and Department of Natural Sciences of the University of Bonn. Thesis for the doctoral degree (Dr. rer. nat.).

Preparation of plasma membrane sheets and microscopic analysis
University of Regensburg

Prof. Dr. Michael Thomm

Scientific Career
1980 Dipl.-Biol. (Master of Science), Univ. of Munich
1983 Dr. rer. nat. (Ph.D.), Univ. of Regensburg (Microbiology)
1988 Dr. rer. nat. habil., Univ. of Regensburg (Microbiology)

Professional Experience
1983 Postdoctoral fellow at the University of Regensburg (Prof. Dr. Karl O. Stetter)
1988 Research assistant at the Department of Microbiology
1991-2002 Christian-Albrechts-University of Kiel: Full professor of Microbiology, Head of the Institute of General Microbiology
2002 Germany: Full professor of Microbiology, Head of the Department of Microbiology & Archaeencenter

Research Topics
Mechanism of transcription in Archaea;
Regulation of transcription in Archaea and Eukarya;
Microbiology of methanogenes and of hyperthermophiles;
Head of fermentation facility (11 fermenters - Archaeencenter Regensburg)

Space Related Activities:
Cultivation of chemolithotrophic microorganisms which are only dependent upon the presence of water and volcanic gases like hydrogen, CO₂ and H₂S

Selected Publications:
Prof. Hon.-Prof. Dr. Dr. Oliver Ullrich

Otto-von-Guericke University (OvGU) Magdeburg and University of Zurich, Switzerland

Institute of Mechanical Engineering, OvGU Magdeburg
Universitätsplatz 2
39106 Magdeburg, Germany
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Fax: +49 391 67 12595
E-mail: oliver.ullrich@ovgu.de

Institute of Anatomy, Faculty of Medicine, University of Zurich
Winterthurerstrasse 190
8057 Zurich, Switzerland
Phone: +41 44 63 55310
E-mail: oliver.ullrich@anatom.uzh.ch

Scientific Career
1989 Study of Medicine, Free University Berlin, Germany
1996 University Berlin, Germany
1990 Study of Biochemistry, Free University Berlin, Germany
1994 University Berlin, Germany
1996 Fellow of the Ernst-Schering Foundation & Junior House Officer, Medical Faculty Charité, Humboldt-University Berlin, Germany
1998 Doctor of Medicine (Dr. med.), Humboldt-University Berlin, Germany
1998 Doctor of Biochemistry (Dr. rer. nat.), Free University Berlin, Germany
2002 Habilitation (Anatomy and Cell Biology)

Professional Experience
1998- Research Associate, Dept. Cell- and Neurobiology, Institute of Anatomy, Medical Faculty Charité, Humboldt-University Berlin
1999 Cell- and Neurobiology, Institute of Anatomy, Medical Faculty Charité, Humboldt-University Berlin
2000- Research Group Leader, Institute of Anatomy, Medical Faculty Charité, Humboldt-University Berlin
2002- Assistant Professor, Medical Faculty Charité, Humboldt-University Berlin
2002- University Professor of Molecular Immunology & Vice Director of the Institute of Immunology, Medical Faculty, OvGU Magdeburg, Germany
Since- Full Professor & Chair, Faculty of Medicine, University of Zurich, Switzerland & Adjunct Full Professor of Space Biotechnology, OvGU Magdeburg
2002- Assistant Professor, Medical Faculty Charité, Humboldt-University Berlin
2003- University Professor of Molecular Immunology & Vice Director of the Institute of Immunology, Medical Faculty, OvGU Magdeburg, Germany
Since- Full Professor & Chair, Faculty of Medicine, University of Zurich, Switzerland & Adjunct Full Professor of Space Biotechnology, OvGU Magdeburg

Research Topics
Immunology, Neuroimmunology, Gravitational Biology, Signal Transduction

Space Related Activities
Academician of the International Academy of Astronautics (IAA)
Head of Space Medicine / Space Life Sciences, German Society for Aerospace Medicine
Principal Investigator: ISS-projects TRIPLE LUX A and FARAGIS
Sounding rocket missions TEXUS-49, MASER-12 and TEXUS-50/51
12 Parabolic Flight Projects during 10 Parabolic Flight Campaigns German-Chinese SIM-BOX/SHENZOU-8 space mission
Scientific Advisor ISS Project IMMUNOLAB (DLR)
ESA Topical Team Member “Large Radius Human Centrifuge”
Advisor GoSpace Industrial Program (DLR), responsible for the Life Sciences
Editorial Board Member “Flugmedizin Tropenmedizin Reisemedizin”

Selected Publications


Scientific Career
1983 Studies in Physics, University of Bern, Switzerland
1991 Diploma in Theoretical Physics
1994 PhD in Experimental Physics
2001 Habilitation in Experimental Physics

Professional Experience
1995- Postdoc, University of Maryland, College Park, MD, USA
1996- Research Fellow, University of Bern, Switzerland
2001- Senior Scientist (Oberassistent), University of Bern, Switzerland, teaching at university level
Since 2002 University professor at the IEAP, University of Kiel, Germany
2004-2006 2-year term as executive director of the IEAP

Research Topics
Solar and heliospheric physics, planetology, radiation detection

Space Related Activities
Co-Investigator of instruments on numerous space missions
Co-Principal Investigator for Solar Orbiter / EPD
Principal Investigator for LEO/RadMo

Selected Publications


DOSTEL on EuTEFF in STS-122 Cargo Bay
Prof. Dr. Reinhard Wirth

Scientific Career
1976 Dipl.-Biol., University of Regensburg
1980 Dr. rer. nat., University of Regensburg
1989 Dr. rer. nat. habil., University of Munich

Professional Experience
1980- Postdoctoral fellow at the University of Munich, Germany
1983- Postdoctoral fellow at the University of Michigan, Ann Arbor, USA, Prof. Don Clewell
1985- Research assistant at the University of Munich, Germany
Since- Professor (C3) at the University of Regensburg, Germany

Research Topics
Cell surface appendages (flagellae, fimbriae and pili) of Archaeae and their role in adhesion, motility, biofilm formation, etc.

Space Related Activities
ESA project „Communities of archaeae and specific bacterial communities on spacecrafts and in their clean room environment“

Selected Publications


Pyrococcus furiosus binds by flagella to grains of sand in its biotop...
PD Dr. Jochen Zange

Institute of Aerospace Medicine
Space Physiology

Linder Höhe
51147 Cologne
Germany

Phone: +49 2203 601 3456
E-mail: jochen.zange@dlr.de
Website: http://www.dlr.de/me/

Scientific Career
1985 Diploma in Biology
1990 PhD in Natural Sciences (Biology)
2006 Habilitation in Human Physiology

Professional Experience
1988- Postdoc, Max-Planck-Institute for System Physiology, Dortmund, Germany
1990- Postdoc, Institute of Animal Physiology, Heinrich-Heine-Universität Düsseldorf, Germany
1991- Postdoc, Institute of Aerospace Medicine, Cologne, current position: Head of subdivision 'Integrative Muscle Physiology'

Research Topics
Physiology and pathophysiology of human skeletal muscle. Development and testing of countermeasures and therapies against muscle weakness.

Space Related Activities
PI: EuroMir ’94, ’95, ’95E, and MIR ’97, ’97E.
Col ESA-MAP-Med30
ESA Topical Team Member: "Skeletal Muscle" and "Artificial Gravity"

Selected Publications


Development of non-invasive methods for research in applied human physiology and for diagnosis of muscle diseases.


Dr. Maik Böhmer

Institute for Biology and Biotechnology of Plants
Schlossplatz 4
48149 Münster
Germany

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E-mail: m.boehmer@uni-muenster.de
Website: www.uni-muenster.de/Biologie.IBBP/agboehmer/

Scientific Career
2002 Diploma in Biology, Philipps Universität, Marburg
2005 PhD in Biology, MPI for Plant Breeding Research, Cologne

Professional Experience
2006 Postdoctoral fellow, MPI for Plant Breeding Research, Cologne
2006 Postdoctoral fellow, Univ. of California, San Diego
2011- Independent Group leader, Westfälische Wilhelms-Universität, Münster

Research Topics
Our primary research focus is to understand how plant signaling is regulated in response to unfavorable environments, including microgravity, drought and pathogens. We measure quantitative changes in the proteome, transcriptome and metabolome of Arabidopsis thaliana. The goal of these projects is to understand how these stresses are perceived and what the nature of the early signaling processes is.

Selected Publications


Univ.-Prof. Dr. Erhard Bremer

Scientific Career
1980 Diplom in Biology, University of Tübingen, Germany
1982 Dr. rer. nat (Biology), University of Tübingen, Germany
1989 Habilitation in Microbiology and Genetics, University of Konstanz, Germany

Professional Experience
1990- Assistant Professor (C-2; Microbiology), University of Konstanz, Germany
1992- Head (C-3) of the group "Osmoregulation" at the Max Planck Institute for Terrestrial Microbiology, Marburg, Germany
1993- Adjunct Professor (Microbiology) at the Dept. of Biology, University of Marburg, Germany
Since 1995- Full professor (C-4) of Microbiology and Head of the Laboratory for Molecular Microbiology at the Dept. of Biology, University of Marburg, Germany

Honors
2000- Speaker of the Collaborative Research Center for "Soil Microbiology" (SFB 395)
2009- Vice-Dean of the Department of Biology, University of Marburg, Germany
2011 Elected as member of the "European Academy of Microbiology" (EAM)

Research Topics
Stress responses of the soil bacterium Bacillus subtilis to changing osmolarity
Biosynthetic pathway for the compatible solutes ectoin and hydroxyectoine in Bacilli
Transcriptional profiling of Bacillus subtilis in response to salt- and chill-stress
X-Ray crystallographic studies of ligand-binding proteins for compatible solutes and enzymes involved in compatible solute synthesis

Selected Publications
Research Topics
Pathogenesis and Therapy of Osteoarthritis in Dogs
Experimental Surgery
Neurosurgery: Herniated Vertebral Disc
Orthopedics: New methods of fracture care

Selected Publications

Dr. Fabian M. Commichau

Institute for Microbiology and Genetics
Department of General Microbiology
Grisebachstr. 8
37077 Göttingen
Germany

Phone: ++49 551 39 33796
E-mail: fcommic1@gwdg.de
Website: http://genmibio.uni-goettingen.de

Scientific Career
2003 Diploma in Biology
2006 PhD in Microbiology

Professional Experience
2006-2008 PostDoc Göttingen University
2008-2009 PostDoc Basel University
2009-2011 R&D strain development DSM Kaiseraugst (CH)
2011- Research group leader, Göttingen Universitry

Awards
2004, Springorum-Denkmünze, RWTH Aachen
2007, Price for outstanding achievement in science, 14th Int. Conf. of Gram+ bacteria, Pisa
2014, Max-Buchner-Forschungsstiftung, Dechema e.V.

Research Topics
Protein complexes, protein-protein interactions, gene regulation, DNA repair mechanisms, essential genes, minimal genome, glutamate homeostasis, pathogenesis of Listeria, physiology, biotechnology, microbial evolution

Space Related Activities
Collaboration with Dr. Ralf

Moeller, DLR, Cologne, Germany
Principal Investigator
Control of glutamate metabolism in the model bacterium Bacillus subtilis
Molecular mechanisms underlying genome instability in bacteria
The function of the novel second messenger cyclic di-AMP in the human pathogen Listeria monocytogenes

Co-investigator
Minibacillus: construction of a minimal organism on the basis of Bacillus subtilis

Selected Publications


Commichau et al. (2014) Overexpression of a non-native deoxyxylulose-dependent vitamin B6 pathway in Bacillus subtilis for the production of pyridoxine. Metab Eng

Scientific Career
1985 Diploma in Microbiology, Heinrich-Heine-University in Düsseldorf, Germany
1989 Dr. rer. nat. (Microbiology), Heinrich-Heine-University in Düsseldorf, Germany
1998 Habilitation in Microbiology, Heinrich-Heine-University in Düsseldorf, Germany

Professional Experience
1989- Postdoc, Massachusetts Institute of Technology, (Dr. A. Varshavsky), Cell Biology
1992- Research Fellow in Biology, California Institute of Technology (Dr. A. Varshavsky), Cell Biology
1994- Group leader in BMBF priority program, Heinrich-Heine-Universität Düsseldorf, Cell Biology, Biotechnology
Since- Professor of Genetics, University of Cologne, Genetics, Cell Biology

Research Topics
Selective Ubiquitin-mediated proteolysis
Assembly and maturation of the proteasome
Protein modification by conjugation of the small ubiquitin-related modifier SUMO
Ubiquitin-dependent proteolytic control of SUMO conjugates

Selected Publications
Scientific Career
1988: State Examination and License to practice medicine
1989: MD (University of Würzburg)
2004: Habilitation (Internal Medicine)
2008: Associate Professorship
2011: Professor for Space Medicine

Professional Experience
1989–: Scientific Employee, Institute of Pathology, University of Regensburg
1992–1999: Clinic and Polyclinic for Internal Medicine II, senior scientist
1999–2011: Group leader, Institute of Clinical Pharmacology and Toxicology, Charité-Universitätsmedizin Berlin
2008–2011: Associate Professor, Department of Pharmacology, Aarhus University, Denmark

Since- Professorat Space Medicine 9/2011 at the Institute of Biomedicine, Aarhus University, Denmark

Research Topics
Space Medicine, Tissue engineering, Molecular and Cellular Biology, Pharmacology, Cardiovascular Medicine, Endocrinology

Space related activities
Experiment 14 flown on Shenzhou-8 2011, 4 DLR Parabolic flight Campaign (no. 5 accepted for 9/2012) and ground based facility experiments (RPM, clinostat, centrifuge)

Selected Publications


A: Phase contrast microscopy of a 3D aggregate of chondrocytes
B: Vimentin IIF of tissue-engineered cartilage.

Aarhus University

Prof. Dr. med. Daniela Gabriele Grimm

Institute of Biomedicine, Pharmacology
Wilhelm Meyers Allé 4
8000 Aarhus C
Denmark
Phone: +45 87167693
E-mail: daniela.grimm@farm.au.dk
Website: http://www.grimm-space-research.com

SpaceLife | 100
Research Topics

- Basic neurobiological adaptation mechanisms of fish to altered gravity conditions
- Artificial ecosystems
- Space biology

Selected Publications

PD Dr. Christian Laforsch

Scientific Career
1999 Diploma in Biology
2003 PhD in Natural Sciences (Biology)
2009 Habilitation (Zoology, Ecology)
WS 2009 (substitute) Professor
SS 2011 Aquatic Ecology, Department of Biology II, LMU Munich and head of the Field Research Station for Limnology, Seeon
WS 2011 Akademischer Oberrat, SS 2012 Department of Biology II, LMU Munich
WS 2012 Chair (W3) Animal Ecology I, University of Bayreuth

Professional Experience
2003 Postdoc (guest researcher)
2004 at the Institute for Experimental Physics, University of Leipzig
2004 Research Associate
2005 (Postdoc), Biological Sciences Department, I.E.N.S., Lancaster University, UK
2005 Assistant Professor (C1)
2009 Department of Biology II, LMU Munich

Research Topics
Evolutionary Ecology, Limnology, Marine Ecology, Multiple Stressor Ecology, Molecular Ecology, Environmental Science, Integrative Zoology, Systems Biology

Space related activities
Parabolic Aircraft and Drop-Tower Flights, experiments at simulated microgravity (clinostat) and hypergravity (centrifuge).

Selected Publications
**Scientific Career**
1987  Diploma in Biology (University of Marburg)
1991  PhD in Natural Sciences (MPI for Biochemistry)
2000  Habilitation (Botany, University of Erlangen)

**Professional Experience**
1991  Postdoc, Pullman, WA, USA
Since  Senior scientist, FAU Erlangen, Erlangen, Germany

**Research Topics**
Biology, gravity/light perception and integration, protist (Euglena gracilis) as model system, aquatic life support systems.

**Space related activities**
Since 1993 numerous missions on parabolic flights, TEXUS, MAXUS, FOTON, Space Shuttle and ISS.

This includes hardware and software development for FOTON missions.

**Selected Publications**


PD Dr. med. Detlef Moka

Scientific career
1990 State examination in Medicine
1994 Dr. med., University of Cologne
2001 Habilitation, University of Cologne, Germany
2002 Diploma in health economics (Oec.med.)

Professional Experience
1990 Visiting Researcher in the Institute for Nuclear Chemistry in the Nuclear Research Facility Jülich, Germany
1997 Medical Specialist for Nuclear Medicine
1997- Head of the task group: radiation biology and nuclear molecular biology in the Department of Nuclear Medicine, University of Cologne, Germany
1998 Technical qualification for radiation protection in medicine
2002 Technical qualification for magnetic resonance tomography and spectroscopy in medicine
1999- Assistant medical director in the department of nuclear medicine, University of Cologne, Germany
2004 Partner in the clinic for nuclear medicine, Essen, Germany
2011- Federal chairman of the professional association of German nuclear medicine
2012 Chairman of the medical office for radiation protection, medical association Nordrhein, Germany

Awards:
2001 Young Investigator Award of the SNM Cardiovascular Council

Research Topics:
Molecular Imaging
Influence of radiation on cell metabolism
Radiation protection by exposure of radionuclides
Nuclear magnetic resonance spectroscopy
Vitamin D deficiency

Space related activities
Molecular effects of radiation on cancer cell
Influence of chemical protection on radiation therapy of cancer

Selected Publications
Scientific Career
1993 Diploma in Biology (FAU Erlangen-Nürnberg)
2000 PhD (Ecophysiology, FAU Erlangen-Nürnberg)

Professional Experience
Since Senior scientist, 2000 FAU Erlangen, Department of Biology, Cell Biology, Erlangen, Germany

Research Topics
Investigation of gravi- and phototaxis in *Euglena gracilis*.
Support of a project dealing with photodynamic destruction of parasites and fish diseases as well as support of a PhD-project in biomonitoring.

Space related activities
Experiments in the field of bioregenerative life support systems.
DLR project on microgravity research

Selected Publications


Scientific Career
1991 Diploma in Biology
1995 PhD in Natural Sciences, University of Erlangen-Nürnberg
2004 Habilitation (Molecular Radiation Biology)

Professional Experience
1991 Scientific Employee, Institute for Microbiology, University of Erlangen-Nürnberg, Germany
1995 Scientific Project Leader, Medicon Publisher, Munich, Germany
1997 Seminar Project Management, Grundig Academy Nürnberg, Germany
1997 Scientific Employee, Radiotherapy Clinic, University of Erlangen-Nürnberg, Germany
Since Group Leader, Radiotherapy Clinic, University of Frankfurt, Germany

Awards
2000 Günther-von-Pannewitz-Award
2004 Hermann-Holthusen-Award

Research Topics

Development of new vectors with Selected Publications


Freie Universität (FU) Berlin

Univ.-Prof. Dr. Michael F.G. Schmidt

Fachbereich Veterinärmedizin
Institut für Immunologie und Molekularbiologie

Philippstr. 13
10115 Berlin
Germany

Phone: +49 30 2093 6468
E-mail: schmidt.mfg@vetmed.fu-berlin.de
Website: http://www.vetmed.fu-berlin.de/einrichtungen/institute/we06/index.html

Scientific Career
1973 Diploma in Biology
1975 Dr. rer. nat. in Biochemistry, Virology, Genetics
1987 Habilitation (Biochemistry and Virology)
1986 Professorship

Professional Experience
1972 Teaching Assistant, Faculty of Vet. Med., Giessen, Germany
1973 Research Assistant, Faculty of Vet. Med., Giessen University, Germany
1974 Post Doc, Faculty of Vet. Med., Giessen University
1977 Research Fellow, Dept. of Microbiology & Immunology, Washington University, School of Medicine, USA
1980 Senior Researcher, Faculty of Vet. Med., Giessen University
1982 Research Associate (C1), Virology Department, Faculty of Vet. Med., Giessen
1986 Associate Professor, Dept. of Biochemistry, Faculty of Medicine, Kuwait University
1990 Full Professor, Dept. of Virology, Faculty of Vet. Med., FU Berlin, Germany
1993 Full Professor and Chairman Dept. of Immunology and Molecular Biology, Faculty of Veterinary Medicine, FU Berlin, Germany

Research Topics
Enveloped viruses (emphasis influenza virus); membrane biochemistry (vesicular transport, secretion); protein modifications (glycosylation, fatty acylation); intestinal immunity; osteoarthritis, gene therapy; inflammation

Selected Publications


Scientific Career
1990 Diploma in Biology
1994 PhD in Microbiology

Professional Experience
1994- Postdoc, Institut Pasteur, Paris
1996- Group leader, Microbiology,
2003 University of Erlangen
Since Head of the Department
2003 for General Microbiology

Awards:
Thesis Award of the Ernst-Moritz-
Arndt-University Greifswald

Research Topics
Signalling by second messengers, control of central metabolism, protein-protein interactions, gene regulation, essential genes, minimal genome, biofilm formation, pathogenesis of Mycoplasma pneumoniae, RNA degradation, development of annotation databases and apps,

Space Related Activities
Collaboration with Dr. Ralf Moeller, German Aerospace center, Cologne, Germany

Principal Investigator
Control of biofilm in the model bacterium Bacillus subtilis
Molecular mechanisms underlying genome instability in bacteria
Signalling by the novel second messenger cyclic di-AMP in Bacillus subtilis and Mycoplasma pneumoniae
Protein complexes in RNA degradation in B. subtilis
Co-investigator
Minibacillus: construction of a minimal organism on the basis of Bacillus subtilis

Selected Publications


A structured colony of Bacillus subtilis
Dr. Cora Thiel

Institute of Anatomy
Faculty of Medicine
University of Zurich

Winterthurerstrasse 190
8057 Zurich, Switzerland
Phone: +41 44 635 5361
E-mail: cora.thiel@anatom.uzh.ch
Website: http://www.anatom.uzh.ch/index.html

Scientific Career
1997  Diploma in Biology
2002  PhD in Biology

Professional Experience
Up to  Scientific Employee
2009  Max Planck Institute for Biophysical Chemistry, Department of Membrane Biophysics, Göttingen, Germany
2011  Institute for Medical Physics and Biophysics, Working Group Cellular Biophysics, Westfälische Wilhelms-Universität (WWU) Münster, Germany
Since  Scientific Employee
2012  Institute of Anatomy, Division of Cell Biology, University of Zürich, Switzerland

Research Topics
Gravitational Biology, Astrobiology

Space Related Activities:
Ground-based studies on 2D clinostat and hyper-G centrifuge

Selected Publications

Principal Investigator or Co-investigator on the following missions:
- Several DLR and ESA parabolic flight campaigns
- Sounding rocket campaigns (TEXUS-49, TEXUS-51, TEXUS-52)
- Space experiments (Shenzhou-8, CELLBOX, TRIPLELUX, ISS)


Prof. Dr. Edda Tobiasch

Hochschule Bonn-Rhein-Sieg (H-BRS)

Scientific Career
1987 Diploma in Biology, University of Kaiserslautern
1992 Dr. rer. nat. PhD in Biology, University of Kaiserslautern

Professional Experience
since 2004 Professor (C3) for Genetic Engineering and Cell Culture, H-BRS, Rheinbach
2002 Professor (C2) for Virology and Cell Culture, H-BRS, Rheinbach, Germany
2002 Substitute Professor for Virology and Cell Culture, H-BRS, Rheinbach
1999 Instructor, Harvard Medical School, Boston, USA
1998 Postdoctoral Fellow,
1999 Department of Virology, University Heidelberg, Heidelberg, Germany
1996 Postdoctoral Fellow,
1988 Department of Genetics, Research Center Karlsruhe, Karlsruhe, Germany
1992 Postdoctoral Fellow,
1996 Department of Tumor Virology, German Cancer Research Center, Heidelberg, Germany

Research Topics
Osteogenic and adipogenic stem cell differentiation of primary human, bovine, porcine MSCs;
signal transduction pathways and apoptosis.

Selected Publications
Prof. Fengyuan Zhuang

Scientific Career
1962 Diploma in Physics

Professional Experience
1962 Teaching Assistant
1980 Lecturer, Physics Dept. Beijing University
1980 Visiting Scholar,
1983 Applied Mechanics & Engineering, University of California, San Diego, USA
1983 Lecturer, Physics Dept.,
1984 Beijing University
1984 Associate Prof.
2001 Prof. Director, Dept. of Biomechanics & Biorheology, Beijing University of Aeronautics & Astronautics (BUAA)
2001 Director of Bioscience

Research Topics
Effects of gravity on the cardiovascular system, remodeling of cardiovascular vessels.
Effects of microgravity on immune cells and endothelial cells.
Mechanobiology studies on gravitaxis of mammalian cells
Cell biomechanics

Space Related Activities
General Secretary for the 16th IAA Humans in Space Symposium, May 21-24, 2007 Beijing
Co-Chair of 2nd Sino-German Symposium on Space Life Sciences, Oct. 13-18, 2008, Beijing
Co-investigator - 10th DLR parabolic flight campaign (effects of microgravity on migration- and adhesion-regulating signal pathways in cells of the immune system, Co- logne, Germany (2007)

Selected Publications
SpaceLife

Member Group Locations
SpaceLife is open to highly qualified and motivated applicants from all countries, and it is committed to an equal opportunity policy.

Applicants should hold a Master’s or other degree with excellent grades comparable to a German University Master (or Diploma) in biology, human biology, biochemistry, physiology, anatomy, biotechnology, microbiology, physics, chemistry, veterinary medicine, biomechanical engineering, nutrition or sports sciences or related subjects.

SpaceLife gives the opportunity to carry out a full-time doctoral thesis at the end of which the doctoral students will receive a “German PhD”: Dr. rer. nat., Dr. hum. biol., Dr. oec. troph., Dr. med. vet., Dr. rer. medic. or Dr. Sports Sciences. Per age-group, up to 14 doctoral students at the DLR and up to 11 from the partner universities can participate in the program. Furthermore, doctoral students who have already started their thesis at the DLR or the partner universities can apply for admission to SpaceLife and are also subjected to the selection process described below.

Please visit the SpaceLife Webpage for more information and for download of the application forms:
http://www.dlr.de/me/SpaceLife

Applications are invited to send
- their curriculum vitae,
- list of publications,
- copy of their diploma/master theses (as pdf),
- past and present research interests,
- copies of masters/diploma certificates (with translation if not in German, English or French) and
- addresses of two referees.

The two referees have to be asked by the applicant to submit confidential letters of recommendation.

Linguistic proficiency in English can be demonstrated by taking a standardized test (e.g., the TOEFL).

Selected applicants will be invited for an interview with faculty members. The partners of SpaceLife jointly conduct the central selection procedure. The applications will be subjected to a competitive multi-step evaluation procedure.

**Evaluation of applications**
The first evaluation takes into account the applicants’ national education system, and is carried out by experts on the respective educational system. Applicants will be contacted by phone for assessment of proficiency in English.

Applications of candidates which meet the requirements of SpaceLife are recommended for further assessment by the faculty members, who jointly short-list the candidates to be invited for the interview days in Cologne. Invitations are sent approximately three to four weeks in advance.

During the interview days, each candidate conducts several interviews with faculty members to discuss research experience, motivation and interests. The interviews with group leaders result in a first assessment of candidates. All applicants proceed to a final interview with a Selection Committee, which consists of five faculty members. Taking the assessment of the interviewing faculty members into account, the Selection Committee evaluates the overall qualification of the candidate, and recommends to the spokesperson and the coordinator of SpaceLife whom to admit to the program.

**Offers of admission**
Offers of admission to SpaceLife are made by the end of the selection week. The offers include in general the affiliation to the SpaceLife program and to a research group. The individual starting date will be agreed with the primary Supervisor.
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