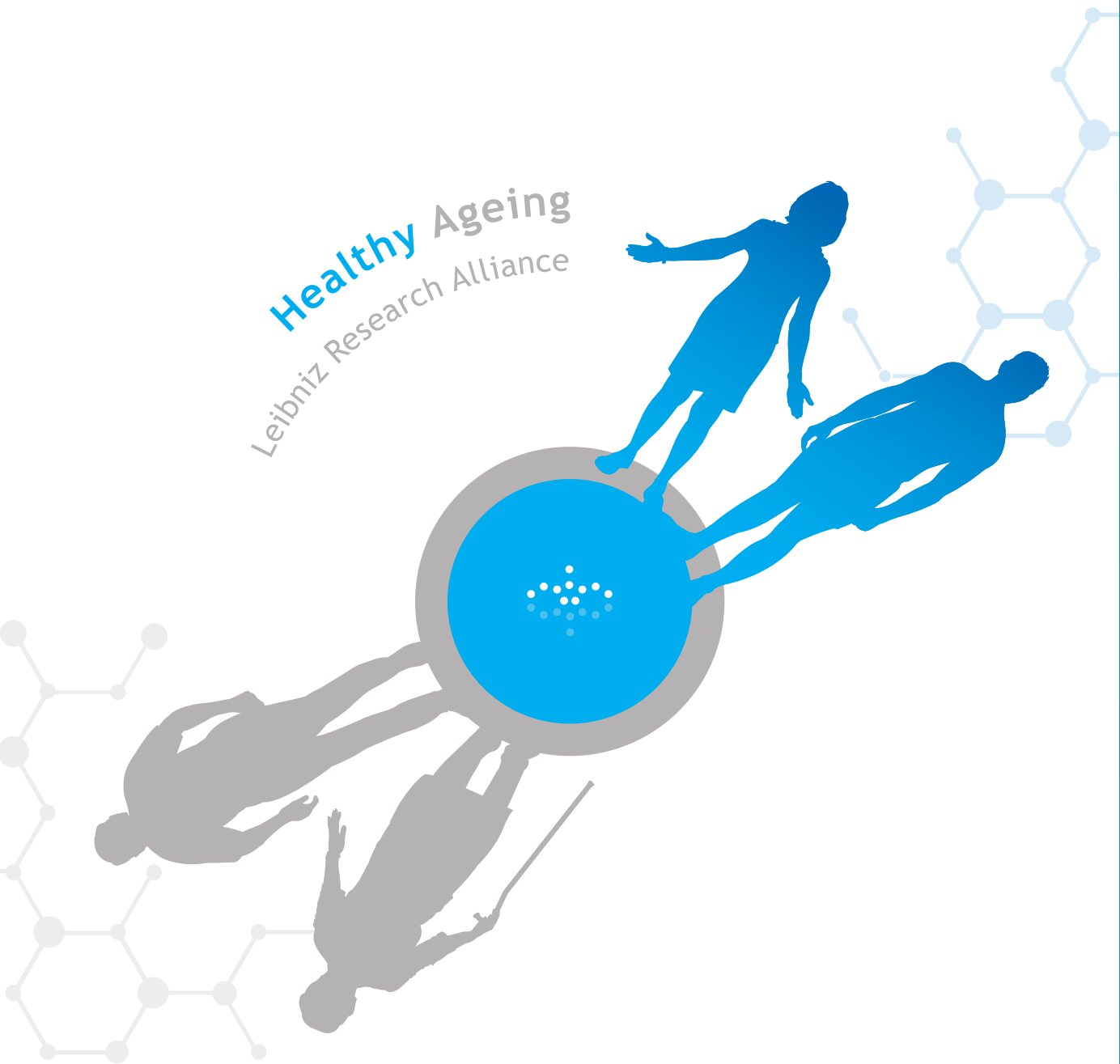




**Healthy Ageing**  
Leibniz Research Alliance



## Healthy Ageing

The average life expectancy in Germany has doubled over the last 120 years. However, in advanced age our organs begin to suffer from functional impairments and we can develop serious diseases. We therefore need to keep the period in which we are restricted by ageing as short as possible so that we can enjoy the additional lifetime we have gained.

With this goal in mind, 20 scientific institutes in the Leibniz Association came together to form the Leibniz Research Alliance Healthy Ageing. Their interdisciplinary projects aim to shed light on the biological and social mechanisms of ageing. This kind of interdisciplinary approach, which is unique in the German research landscape, allows participants to analyse the interrelationships between biological and medical aspects and social and economic factors. The work will culminate in the development of new intervention and adaptation strategies for promoting healthy ageing over the long term.

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# Welcome remarks

Prof. Matthias Kleiner,  
President of the Leibniz Association



The Leibniz Association is different. It stands for research with relevance, and it is built on excellence, as only excellent research can have genuine relevance. The “certain something” of the Leibniz Association is the research-accompanying attentiveness. Our research is attentive because it is firmly rooted in society and in far-reaching scientific networks. Leibniz research picks up on questions, asks questions, and answers questions that are important for us all – for people, for society, for the world and for our environment.

Another “certain something” that the Leibniz Association has is its ability and willingness to make versatile, flexible connections within its own networks and beyond. These connections are built on the scientific strengths and the achievements of every member of the Leibniz Association. Leibniz facilities are very often engaged in interdisciplinary work and, in the pursuit of their goals, they dare to situate their research activities close to the borders of their disciplines and at productive interfaces.

The questions put forward in science and research are becoming increasingly complex. Finding the answers will depend on precisely these kinds of co-operative skills. So it is a good thing that instead of keeping its expertise locked up in its 89 institutes, the Leibniz Association has developed an overarching format for cooperation: the Leibniz Research Alliances.

Twelve Leibniz Research Alliances are addressing questions relevant to our present and our future – without ignoring the past and the developments that have been achieved to date. Their names speak of their timeliness and relevance: Bioactive Compounds and Biotechnology; Biodiversity; Crises in a Globalised World; Education Research; Energy Transition; Historical Authenticity; Medical Technology: Diagnosis, Monitoring and Therapy; Nanosafety; Science 2.0; Sustainable Food Production and Healthy Nutrition; INFECTIONS’21 and, of course, Healthy Ageing. You are currently holding a copy of the brochure about the LRA Healthy Ageing. It is up to you to find out how the projects and findings of this alliance concern you as an individual, and all of us as a society. You will find some answers here, of course, but you will also find forward-looking questions – because being attentive to the future is another task that unites the partners in the Leibniz Research Alliance.

*I wish the Leibniz Research Alliance Healthy Ageing all the best for its continued success and ongoing impact.*



## Prof. Krutmann and Prof. Rudolph, Speakers of the LRA Healthy Ageing

**Dear Readers,** Networking offers opportunities for scientists to cooperate beyond their fields of expertise and across discipline lines. That enables them to better understand and solve problems which would not be achieved by a single researcher alone but needs cooperative teamwork. This also holds true for the interdisciplinary field of research on ageing – a multifactorial process with different layers of complexity affecting almost all research areas. To cover this high level of complexity, 20 institutes within the Leibniz Association have joined together in the Leibniz Research Alliance (LRA) Healthy Ageing. Their interdisciplinary research focuses on a key social question: How do we want to age in the future?

Other questions concern policymakers and each and every one of us: Can our pension system cope with demographic change? Will better therapies be available to treat major age-related diseases such as diabetes, cancer and dementia? Can physical dysfunctions that develop as we age be alleviated? Can urban and spatial planning create healthy environments that will allow us to stay mobile in old age? What will our social and educational requirements be when we reach old age? How should we challenge our cognitive capacities to make sure that we can fulfil the requirements of the labour market in our old age and ensure we have the resources we need to enjoy an active retirement?

The questions that are arising as a result of longer life expectancies and demographic change are as diverse as the disciplines that are working on them. Biomedical health research, economics, psychology, neurological and cognition research, sociology and educational science are all looking for answers and solutions. All of these disciplines have come together in the LRA Healthy Ageing to collaborate on interdisciplinary projects, share findings, and develop new research approaches. Their goal is to help society find answers to the challenges of ageing and demographic change.

This brochure about the LRA Healthy Ageing is our way of introducing ourselves to you – of presenting the questions that the alliance is addressing, the institutes involved in the alliance, and the projects on which the researchers are working. It is an invitation to think around corners and look beyond the boundaries of disciplines, issues and institutes. This kind of approach ensures that a network is worth more than the sum of its parts.

*We wish you an informative and insightful read.*

# Healthy ageing – An interdisciplinary challenge for science, medicine and society

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[www.leibniz-healthy-ageing.de](http://www.leibniz-healthy-ageing.de)

**Does a healthy lifestyle promote better cognitive performance in old age? What new therapeutic approaches will keep us healthier during ageing? What kind of environment will allow us to stay healthy and happy as we age? These are just a few examples of the pressing questions that society and policymakers are currently asking scientists. The LRA Healthy Ageing, a new interdisciplinary alliance in the Leibniz Association, aims to provide answers to these questions.**

The average life expectancy for men and women has doubled over the past 200 years worldwide. In Germany it doubled within 120 years. There are many reasons for this positive development: living and working conditions have changed, medical care has improved, and we have better and secured access to food and pay more attention to hygiene. However, although longer life expectancy is one of the great achievements of mankind, it also comes with downsides including ageing-associated disease as well as social and economic burden that are associated with ageing societies. Only if we solve some of the problems of this demographic change, positive aspects of longevity will become dominant and will outweigh the negative ones.

For example, if scientists can find a way of keeping people healthy for longer and of reducing periods of illness, it will be possible to emphasise the positive aspects of ageing. Scientists believe that humans are biologically set up to live for a maximum of 120 years. However, our biological configuration is not the only measure determining how long we live and how successful (healthy) we age. The way we age is also affected by our lifestyle and external influences.

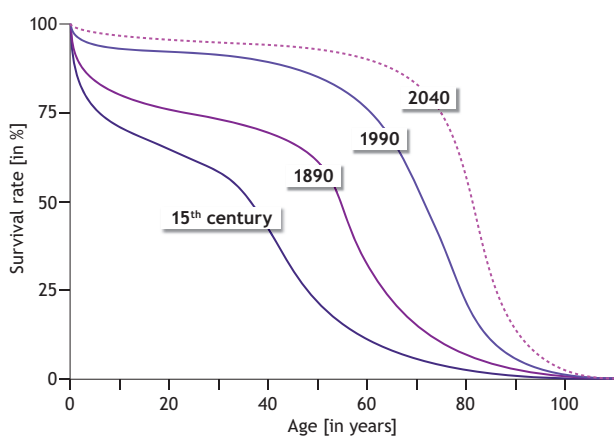


Fig. 1: Over the last century, the maximum lifespan has remained more or less constant at around 120 years. However, our average life expectancy has changed, almost doubling for both men and women. Data from Nikolaus T (1992): *Demographische Entwicklung*. In: Kruse W, Nikolaus T (eds.): *Geriatric*. Springer, Berlin Heidelberg New York. Diagram: pigurdesign.

### Chronic diseases accumulate in old age

Diseases and physical impairments are the main problems associated with ageing. Among the most frequent ageing associated diseases are cardiovascular diseases, diabetes, chronic joint pain, impaired movement, cancer, and neurodegenerative processes including Parkinson's and Alzheimer's disease. Many people over 65 have multiple morbidities, which means they suffer from several of the aforementioned diseases at once.

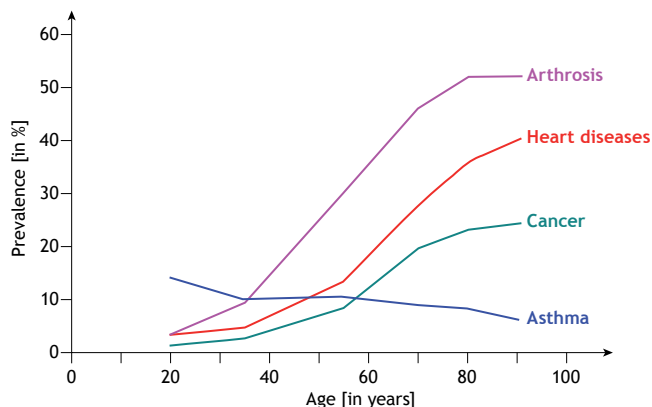


Fig. 2: We become increasingly susceptible to diseases from about the age of 60. Patients often suffer from several serious illnesses at once. This significantly reduces their quality of life. Data from the National Center for Health Statistics, Data Warehouse on Trends in Health and Aging (<http://www.cdc.gov/nchs/>). Diagram: pigurdesign.

### Ageing research aims to keep us healthy for longer

If researchers succeed in deciphering the biological mechanisms of ageing, they will also be able to understand how age-related physical impairments and diseases evolve. This mechanistic knowledge could then be used to develop prevention strategies and therapies that aim to effectively push back diseases, keep us healthier for longer, and improve the quality of life in the elderly (Fig. 3). This would also reduce financial costs for the nursing and healthcare sector. Furthermore, healthy ageing is a prerequisite for ensuring that older people can remain active members of our society.

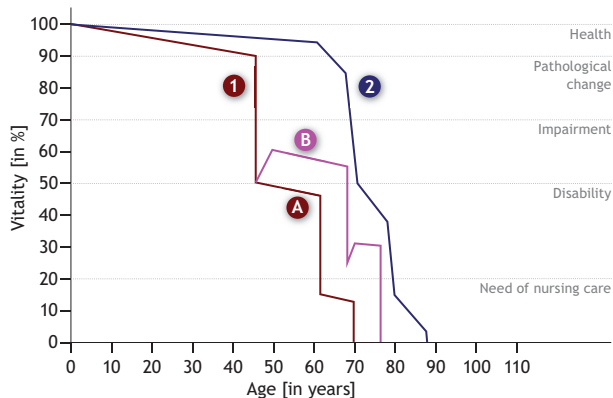


Fig. 3: Biomedical age research aims to substantially shorten the phase of multiple morbidities that many people experience in their final years. The figure shows examples of the different courses ageing can take: 1) Ageing causes an exponential increase in physical dysfunctions and diseases. 1a) Quality of life decreases after a disease or acute event (such as a stroke or heart attack). 1b) Therapeutic measures administered after an acute event can stabilise quality of life at a lower level than before. 2) If new therapies allow us to avoid developing diseases and physical dysfunctions in old age, people will be able to live for longer without any impairments. The final stage of life (morbid phase) will thus be shorter. Image from Schmidt RF, Lang F, Thews G (2005): *Physiologie des Menschen*, Springer Verlag, p. 945. Diagram: pigurdesign.



*“Our research aims to extend the period in which people remain in good health as they age. This will allow them to lead independent, self-determined lives for longer.”*

*Prof. K. Lenhard Rudolph, Leibniz Institute for Age Research, Jena*

### **Ageing is also affected by external factors**

A person's life expectancy and state of health in old age do not only depend on intrinsic biological processes alone. They are also affected by the environment. Environmental factors can have both direct and indirect effects on health and disease. For instance, studies show that a good education and higher income are directly linked to longer life expectancy. Conversely, unfavourable living and poor environmental conditions – such as heavy exposure to harmful substances and noise – have a negative effect on health and life expectancy. Persistent stress, social isolation and loneliness also impact health and wellbeing in old age. Maintaining cognitive skills and physical fitness has a positive effect. Psychological resilience and a wide repertoire of behavioural strategies for overcoming difficult situations also promote wellbeing and can prevent illnesses such as depression, which often develops in advanced age. Older people also benefit from being part of a family and of social networks outside the family. For instance, taking on meaningful tasks in the family or as a volunteer in society can help people retain skills and abilities for longer.



Fig. 4: Questionnaires can gather information on the lifestyle, living conditions and state of health of older people. These kinds of studies provide valuable data for research. Source: DIFE/Till Budde.

### Interdisciplinary age research aims to develop prevention and adaptation strategies

Our society can benefit in many different ways if older people retain the capacity to lead active and independent lives. Therefore, one of the main aims is to develop preventive and interventional strategies that promote healthy ageing. To achieve this, researchers of different disciplines work together within the LRA Healthy Ageing bearing the following premises in mind:

1. Insights into the molecular mechanisms of ageing are crucial to develop new therapies and prevention strategies to improve health in the elderly. Once identified, molecular components of the ageing process can become targets for new types of treatment. The components can also serve as biomarkers for evaluating preventive measures and treatment strategies.
2. Age-related cognitive and psychological changes can be influenced by the individual, but also by his or her environment. Education, physical and cognitive activity, type of work, psychosocial environment and, in particular, social integration and meaningful work all play a crucial role. Once we understand the circumstances that impede cognitive abilities and other skills, we can develop new therapeutic approaches and interventions for counteracting these kinds of impairment.
3. Spatial development, especially at the urban and regional level, is closely linked to the health and wellbeing of older people. Future urban and spatial planning must therefore pay greater attention to issues of mobility in old age, healthy living environments, and age-appropriate residential areas. All planning measures should be scientifically founded.

*“The environment has a considerable impact on biological ageing. Noise, pollutants and radiation, for instance, trigger ageing processes in the lungs and skin. This causes the tissue and organs to lose function and leads to premature ageing.”*

*Prof. Jean Krutmann, Leibniz Research Institute for Environmental Medicine, Düsseldorf*

4. The growing number of elder people is creating major challenges for society and the economy. Analyses of the labour market, health economics, and population economics are needed to work out what the impact of this demographic change will be. Beyond that, studies need to investigate the form that economic policies should take and the working conditions that companies should offer in order to increase the number of older people who are employed and earn enough to support themselves.

#### **Healthy ageing: An overarching research concept**

Ageing research cannot remain limited to a single research field alone. Many different areas of research must work together to address the full complexity of “ageing” and to create the conditions necessary for “healthy ageing” and all the opportunities that come with it. To make this possible, the Leibniz Association created this interdisciplinary LRA Healthy Ageing. It is made up of 20 institutes within the Leibniz Association, as well as associate members from renowned research facilities in Germany and abroad.

The goal of the new research alliance is to shed light on the biological and social mechanisms of the ageing process, and how it relates to various inter-related aspects. Biomedical researchers and psychologists, cognition and neurological scientists, spatial planners and economic researchers are all working together to achieve this. The findings and overall picture produced by their research activities will help to develop adaptation strategies that will facilitate “healthy ageing”.

# German Institute for Adult Education - Leibniz Centre for Lifelong Learning (DIE)

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www.die-bonn.de

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The German Institute for Adult Education – Leibniz Centre for Lifelong Learning (DIE) is a central institution in the fields of research and practice of continuing education in Germany. The DIE is cooperation partner, e.g., in the Adult Education Survey (AES), which is an Europe-wide survey for analysing continuing education behaviour within the demographic change. The monitoring of continuing education participation among the elderly is a permanent task at the DIE. The DIE project “Competencies in Later Life - CiLL” focuses on generating data on basic competences of people between the age of 66 and 80. CiLL is an accompanying study of the OECD programme PIAAC, which



DIE in Bonn. Source: DIE/Brandt.

*The DIE is a competent academic service partner for all institutions in the field of adult education and lifelong learning. The institute's research activities contribute to the development and networking in adult education on a national and international scale.*

investigates everyday adult competences in 25 countries. The project "CiLL" extends the research programme to the German people at the age between 66 and 80. It also includes qualitative research on the competences of the elderly in the context of their individual life situation. The project "Improving Adults' Health Information Literacy", which was launched recently, focuses on improving the information competence of adults as a contribution to "healthy ageing". The project is conducted by the DIE in cooperation with the Leibniz Institute for Psychology Information (ZPID) in Trier. The DIE is also a partner in the PIAAC Leibniz Network, which develops the PIAAC-survey for the next round of surveys.

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Centre for Lifelong Learning DIE. Source: DIE/Lichtenscheidt.

# Leibniz Institute for Psychology Information (ZPID)

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ZPID is the psychology information center for the German-speaking countries. Its mission is to provide scientists and psychology professionals with current and comprehensive information on literature, tests, audiovisual media, primary research data, and quality web resources in the field of psychology. The web portal [www.zpid.de](http://www.zpid.de) offers a wide range of relevant databases, directories, news services, archives, and blogs. In the reference database PSYINDEX, the ZPID indexes scholarly publications from psychology and related disciplines (e.g., social sciences, educational sciences, medicine). Related to ageing research, the database contains references from the fields of educational psychology and gerontopsychology, clinical psychology, health psychology and medical psychology. The database of psychological tests, PSYINDEX Tests, contains a large number of assessment tools which may be used in ageing research (e.g., for the assessment of cognitive functioning or subjective well-being). ZPID's Test Archive is an Open Access collection of assessment tools (mainly in German language) which may be used for research purposes.



The ZPID in Trier. Source: ZPID/Anne-Kathrin Mayer.

*The ZPID supports research on healthy ageing by providing a wide range of scholarly psychology information resources. In its research it is concerned with the impact of psychological factors on processes of ageing.*

In addition, ZPID conducts applied basic research in the fields of psychology and information technology. Studies are concerned with information processing, transmission, and evaluation, as well as information behavior and information literacy across the life span. E.g., research explores the effects of cognitive and emotional-motivational ageing on the search for and evaluation of health-related information in conventional as well as digital media. The results of these studies are used to develop and evaluate interventions designed to foster adequate information behaviors. These behaviors are, in turn, assumed to contribute to autonomy in older adulthood (e.g., regarding health-related or financial decisions).

Further studies deal with psychological factors influencing healthy ageing, quality of life, and coping with strains in old age. On the one hand, this research considers individual resources of older adults (e.g., cognitive functioning, resilience, control beliefs). On the other hand, the impact of social resources (e.g., quantity and quality of intra- and intergenerational social networks, receiving and giving social support) on health status is explored and discussed.

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# Academy for Spatial Research and Planning (ARL), Leibniz Forum for Spatial Sciences

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Healthy and livable cities are a key component of sustainable spatial development. Health promotion has always been a central concern of spatial planning and its tools. However, the capacity of planning instruments is still not completely utilized for the development of healthy living conditions. Current challenges are discussed nationally and internationally, e.g., in the concepts of environmental justice and urban health. Urban planning and health promotion move towards each other in research as well as in practice: Health science increasingly identifies conditions of residential environments as important determinants of health whilst urban planners consider healthy living and working conditions for all residents as an important task, especially due to increasing social inequality and demographic changes.

Particularly vulnerable population groups suffer from processes of disadvantage which are reflected not only in higher disease rates but also in a lower expectancy of life.

There is a need to discuss existing health-related research findings and planning instruments as well as to develop new approaches of spatial planning.



Urban open spaces play an important role in health promoting urban development. Source: Ritzinger.



*The Academy for Spatial Research and Planning (ARL), Leibniz Forum for Spatial Sciences, is doing research and facilitates knowledge transfer in the field of spatial sciences and spatial development. The ARL investigates space both in terms of its physical structure and as a part of societal processes, and analyses the possibilities for sustainable spatial development. The institution provides a platform for inter- and transdisciplinary cooperation between research and practice on all important spatial issues.*

The ARL-working group “Planning for health promoting city regions / Planung für gesundheitsfördernde Stadtregionen” considers the periurban, the city and the neighborhood level. The objective is to provide professional and service-based research and scientific consulting for policy and administration.

Members of this working group deal with selected problem- and practice-oriented questions and develop their research inter- and transdisciplinary. The ARL-research group “Planning for health promoting city regions / Planung für gesundheitsfördernde Stadtregionen” mainly deals with the following topics:

1. The concept of equal health opportunities in urban areas
2. Multiple stressors
3. Subjectively perceived health
4. Spatial instruments of health promotion in urban development
5. Integrated administrative actions
6. Promotion of participation and empowerment



Headquarter of the Academy for Spatial Research and Planning in Hanover. Source: ARL.

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# Leibniz Institute of Ecological Urban and Regional Development (IOER)

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The Leibniz Institute of Ecological Urban and Regional Development (IOER) in Dresden investigates the scientific basis for the sustainable development of cities and regions in the national and international context. The focus of this spatially-oriented research is on ecological aspects of sustainable development. The IOER explores interactions between the natural environment and society, as well as ways to influence these.

One particular line of research pursued by the IOER is age-sensitive urban and regional development.

For many years the Institute has studied questions of demographic change and the repercussions for cities and regions. Regarding age-sensitive urban and regional development, the IOER examines issues around independent



How is it possible to build "ageing-sensitive" cities - cities which meet the needs of all generations?  
Source: pixelio.de/Angelina S.

*“The concept of ‘ageing-sensitive urban development’ is fundamental to the research undertaken at the IOER. While an ageing population is one element of this concept, the primary focus is on an urban environment that meets the needs of all generations.”* Prof. Dr. Bernhard Müller, Executive Director of the IOER

living for the elderly as well as appropriate designs for the residential environment of older citizens.

In the research field *housing and independent living for the elderly* the IOER looks at ways of attaining secure and independent living for the elderly in private accommodation. The Institute investigates future demand for housing for older people and how this housing can be best designed. Together with the Research Institute for Regional and Urban Development (ILS) in Dortmund, the IOER has carried out surveys in a number of German cities on the housing needs of older citizens. From the gathered data it has been possible to make forecasts regarding housing requirements for the elderly as well as the appropriate changes that must be made to the building stock.

Regarding the *residential environment* of older citizens, the focus of research is on the appropriate design of green and open spaces, such as ensuring easy access to parks and other green recreational areas for elderly residents. At the same time such green spaces must accommodate the specific requirements of an ageing population. Urban greenery also plays a vital role in mitigating the impacts of climate change. In heavily built-up residential areas, the increased frequency of unusually hot days is endangering the health of older people. Here the IOER is creating methods to identify unusually sensitive settlement areas and individual buildings, as well as developing measures to adapt to the impacts of climate change.

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# ILS – Research Institute for Regional and Urban Development

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Core research subjects at the ILS include:

1. Research into *residential and urban development* requirements aimed at improving older people's health and the quality of life;
2. Research into the *mobility* needs of older people, including mobility options and tailor-made services;
3. Research into *integrated neighbourhood-related concepts* for older people.

Demographic and climate change, together with the wish of older people to stay independent as long as possible, constitute major urban and spatial planning challenges. What will the future city look like – a city in tune with the needs of the older generation, a city actively promoting the health of its older citizens, a city enabling its older residents to stay living and supporting themselves in their accustomed neighbourhood as long as possible?

At the centre of the *autonomMOBIL* research project is the wide range of interactions between the environment (building/spatial aspects related to the climate, noise and air quality) and the mobility needs and options of older people with regard to their accustomed neighbourhood and their mobility – prerequisites for an independent life and for continuing good health and well-being. The Fritz and Hildegard Berg Foundation is funding an interdisciplinary junior research group that is developing concepts catering for the needs



Age-appropriate residential areas promote social contacts and offer the chance to live as long as possible independently and autonomously. Source: ILS/Volker Beushausen.

*Within its focus on “New urbanisation processes in a European context - Urban futures”, the ILS – Research Institute for Regional and Urban Development is exploring the causes and effects of new urbanisation processes and concepts from an interdisciplinary and comparative international perspective.*

of the older generation and promoting their physical activity and mobility. In doing so, innovative processes and methods for investigating people-environment interactions are being tried out. These can be expected to provide us with new insights into the interrelationship between causes and effects and into the different factors determining the mobility of older people.

Another project – *neighbourhood accessibility* – is exploring the interrelationship between everyday mobility and neighbourhood development, with the aim of improving existing small-scale accessibility modelling and developing an accessibility index going beyond an investigation based on a single means of transport and including indicators for different means of transport. In addition, the local infrastructure of a neighbourhood and its accessibility with regard to these different means of transport will be assessed, looking at the importance of mobility behaviour of younger and older residents.

A further empirical study – *60+ residential forms* – being conducted jointly by the two research institutes, IÖR and ILS, is using surveys conducted in Dresden, Dortmund, Döbeln and Arnsberg to gain information on the structure of apartments and their facilities, on the importance of services and on the residential forms desired by the older generation.



The living together of different generations promotes mutual understanding.  
Source: ILS/Volker Beushausen.

#### PUBLICATIONS

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# Centre for European Economic Research (ZEW)

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Ageing research at ZEW focuses on the different dimensions of employability of older workers, as well as on the concomitant changes at the firm or region level. ZEW researchers merge macro and micro economic data in order to isolate the impact of changing age ratios at the macro level on individual level outcomes, and the demands made on workers by technological change.

Recent research projects have estimated age-productivity profiles of workers using firm-level data and have studied the duration of employment of elderly jobholders in response to sectorial conditions and the quality of age-oriented corporate working environments. The results indicate that a higher productivity of older workers correlates with the adaptation of job requirements and workplaces to their specific needs by employers. Furthermore, the employment of elderly jobholders lasts longer in companies that make use of mixed-age work teams.

Other current research at ZEW takes a more macroeconomic perspective and examines differences in regional employment outcomes as a consequence of variation in the age composition of the local workforce. It has gathered empirical evidence supporting the view that the high share of young labour in certain metropolitan areas in the West and South of Germany has helped promote innovation. In contrast, the weakly populated rural regions in the East of Germany have apparently suffered from their rather old workforce in terms of considerably weakened innovation intensity. In addition, the findings



ZEW in Mannheim. Source: ZEW.

*The Centre for European Economic Research (ZEW) brings together the perspectives of quantitative economics and business administration research as well as the problems associated with ageing which affect workers, businesses and the economy. Our studies contribute to a better understanding of how demographic change creates challenges and opportunities for the functioning of markets, regulatory institutions, and governance.*

suggest a self-reinforcing polarization process: areas in which the economy is weakened by demographic ageing further lose young workers, making it even harder for these regions to counter the negative economic development.

In another line of research, ZEW is investigating the consequences for older workers of the introduction of new technologies in the workplace. A core research question is whether elderly jobholders utilize and adapt innovative technology differently within the same enterprise. In addition, the impact of the newly introduced technologies on individual health, job satisfaction, as well as employment opportunities and unemployment risk, are being examined. Finally, this research is aimed at clarifying how active human resource management, such as specific on-the-job training measures, may attenuate any negative consequences for older workers.



Age-oriented workplaces enhance the productivity of elderly workers. Source: peopleimages.com.

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# German Institute for Economic Research (DIW Berlin)

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DIW Berlin examines the ageing of society and individuals from an economic perspective. In the coming decades, demographic change will alter the financial conditions of the welfare state in many respects. The wage-centered system of social security is faced with the challenge of maintaining its effectiveness with a shrinking labor force. Welfare state reforms in recent years have more strongly individualized many life risks that are age-related (e.g., care, health, and pensions), and have consequently strengthened the financial basis of social security but at the cost of a lower level of benefits.

In our research, we study how these policies affect individual behavior, for instance, employment, savings, retirement decisions, or the uptake of informal care activities, and the welfare of individuals and households. Our focus here is on the interplay between individual risk factors and institutional framework conditions.



Source: DIW Berlin/Aperto.



*DIW Berlin's strengths lie in the wide range of topics it covers in its academic research, its interdisciplinarity, and its access to excellent empirical data. Our research is aimed at advancing economic policy debates. It contributes to policy decisions being taken on an informed basis.*

We use a variety of datasets, such as household surveys like the Socio-Economic Panel (SOEP) study at DIW Berlin and also process-produced datasets, such as data from Deutsche Rentenversicherung (German Pension Fund) which has been accessible for some years now. DIW Berlin is also involved with the SOEP in the second Berlin Ageing Study (BASE II), a special panel survey designed to identify the factors of successful ageing from an interdisciplinary perspective. Also involved in the study, which looks at the genetic and environmental factors of ageing, are the Charité Berlin, the Max Planck Institute for Molecular Genetics, the Max Planck Institute for Human Development, and the University of Tübingen.

We use various microeconomic evaluation methods for the empirical analyses and are working on developing them further, combining methods of microsimulation with modern methods of program evaluation (quasi-experiments), and theory-based structural life-cycle models. DIW Berlin also has a number of projection models that allow it, for example, to model assumptions about demographic trends and their implications. The combination of different empirical methods is essential in order to increase the significance of policy simulations.

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# Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI)

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Research on ageing is an important field of study at RWI. Key research areas are mental and physical health, caregiver relations, and market-related issues. Along with ongoing basic research, several major gerontology projects are currently being carried out.

A current joint project with the Institut für Europäische Gesundheits- und Sozialwirtschaft GmbH (IEGUS) addresses economic challenges related to elderly care. The aim of this project is to thoroughly analyze the economic challenges that long-term care faces to derive policy-relevant action. Methodologically it is based mainly on secondary data analyses, supplementary expert interviews as well as internet- and literature research. Furthermore, a simple forecasting model to estimate future trends in demand for different kinds of nursing will be developed. To evaluate the economic situation of the care services sector as a whole the project analyzes the trends of demand and supply both within the previous ten years and forecasts trends up to 2030. These trends within the nursing care market will be used as a basis to examine financial challenges for nursing services.



RWI is a leading centre for economic research and evidence-based policy advice in Germany. Source: RWI.

*Research with impact: the Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI) is a leading centre for economic research and evidence-based policy advice in Germany. The research work of RWI ranges from the individual to the world economy and is structured along four competence areas.*

A research project on demographic change in the EU, the oldest-old and the need for innovative models of more efficient elderly care is being carried out in cooperation with Prof. Martin Karlsson from the University of Duisburg-Essen with support provided by the European Investment Bank (EIB) Institute. The project seeks to answer the following questions that are fundamental to societal challenges for long-term care:

1. How will demand for long-term care in European countries develop in the future and how much will it cost?
2. What are the consequences of political reforms with respect to care and what can other European countries learn from it?, and
3. What are the determinants of demand for formal and informal long-term care benefits and how will the ageing population affect benefit supply?

Other topics covered by RWI research include the cost of care in institutional settings. For instance, the “Faktenbuch Pflege” studies the market relevance of private providers in both outpatient and inpatient settings. It explores concerns that the realization of an interest yield on capital employed by private providers is not compatible with the care of elderly.

The “Pflegeheim Rating Report” helps to clarify the strengths and weaknesses of the German care market as well as the opportunities and threats that it faces.

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# German Diabetes Center (DDZ)

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The German Diabetes Center (DDZ) works on various topics which contribute to the aims of the LRA Healthy Ageing.

One focus lies on the research on the mechanisms of the development of type 2 diabetes and its age-related complications. These mechanisms include dysfunctions of the individual mitochondria whose role is analyzed during the ageing process. Furthermore, local and systemic inflammatory processes as well as cellular impairments of the energy metabolism (e.g., abnormal mitochondrial function, oxidative stress) play a crucial role not only in states of high risk of diabetes (pre-diabetes) but also in overt type 2 diabetes and the incidence of diabetes-related comorbidities.

Based on national studies on prevalence and incidence of type 2 diabetes among the population, public health relevant risk factors that contribute to the onset and progression of diabetes and its age-related complications are identified. In particular, it is our aim to develop effective methods to identify target groups for type 2 diabetes prevention programs. This includes the evaluation of the relevance of genetic factors and novel biomarkers for risk prediction.



The German Diabetes Center (DDZ) is an interdisciplinary research center which combines molecular, clinical, and epidemiological work. Source: DDZ.

*The superior mission of the DDZ is to contribute to the reduction of the individual and societal burden of diabetes mellitus by interdisciplinary research. The characteristic feature resides in the cross linking of molecular and cell biological basic research with clinical and epidemiological research approaches.*

In the field of health services research prevention and healthcare outcomes as well as their determinants are analyzed with specific emphasis on the patients' perspective. Based on disease cost studies the costs of type 2 diabetes and early prediabetic stages are estimated in the field of health economics. The cost effectiveness of intervention studies is investigated in the context of health economic evaluation. Furthermore, models to evaluate diabetes progression and clinical as well as economic effects of interventions are developed.

Molecular studies of the interaction between gene variants and environmental factors (e.g., nutrition, physical activity, stress) are particularly important because of their substantial influence on the prediction, prevention and therapy of type 2 diabetes. At the DDZ new polygenic mouse models are investigated to unravel the molecular basis of diabetes prevention by environmental and lifestyle factors.



Physician and patient discuss together. Source: fotolia.com/bankatekic.

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# German Institute of Human Nutrition Potsdam-Rehbruecke (DIfE)

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Demographic change is confronting our society with increasing challenges. While birth rates are decreasing, the proportion of older people is rising constantly. Among other measures, science is therefore called upon to develop new nutrition strategies that will help as many people as possible to remain healthy and fit into old age.

The German Institute of Human Nutrition Potsdam-Rehbruecke (DIfE) contributes to this endeavour by investigating the relationships between nutrition and health. Through interdisciplinary collaborations, scientists working at the institute use a broad spectrum of experimental, clinical, and epidemiological methods to identify, for example, nutritional factors that stabilize health in old age. Among other aspects, DIfE is focusing on the causes and consequences of the metabolic syndrome and its secondary complications. The metabolic syndrome is a combination of obesity, high blood pressure, an insensitivity of body cells to the hormone insulin and impaired fat metabolism. Secondary complications include type 2 diabetes, also known as adult-onset diabetes, cardiovascular diseases, certain forms of cancer, and many more diseases.



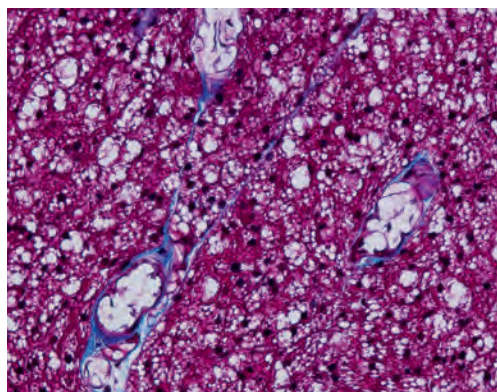
DIfE Potsdam-Rehbruecke. Source: Till Budde/ZAB GmbH supported by ERDF.

*DIfE is studying the causes of nutrition-related diseases in order to develop new strategies for prevention, therapy and dietary recommendations.*

*The scientists at DIfE focus on:*

- 1. the causes and consequences of the metabolic syndrome*
- 2. the role of nutrition in healthy ageing*
- 3. the biological basis of food choice and nutritional behaviour.*

To study the relationships between nutrition and lifestyle factors, physiological variables and the risk of age-related diseases, DIfE epidemiologists are making use of the data from the European Prospective Investigation into Cancer and Nutrition (EPIC Study). This large-scale, prospective and long-term population study involves more than 500,000 women and men from ten European countries. Since 1994, more than 27,000 adults from the Potsdam area alone have participated in this observational study. Based on these data, DIfE developed the German Diabetes Risk Score (DIfE - DEUTSCHER DIABETES-RISIKO-TEST®) that allows any adult to determine his/her own risk of developing type 2 diabetes within the next five years. DIfE scientists are also taking an in depth look at ageing processes at molecular and cellular levels. For example, they are studying how ageing cells and tissues deal with proteins that have been modified or damaged by oxidation and how nutrition can favourably influence these processes. In addition, they are investigating the molecular mechanisms that lead to a decrease of brown adipose tissue in old age and thus promote the onset of obesity.



Histological image of native brown fat after trichrome staining to highlight structural tissue components: extracellular matrix (blue) and intracellular structures (red: cytoplasm, brown: cell nuclei). Source: DIfE.

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# German Primate Center (DPZ) Leibniz Institute for Primate Research

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Scientists of the German Primate Center (Deutsches Primatenzentrum, DPZ) address questions in the fields of infectious diseases, neuroscience and primate biology. The DPZ houses and breeds a variety of non-human primate species used both for research at the institute and at other scientific institutions and maintains three field stations in the tropics. Currently, the sections neuroscience and ethology are conducting research in order to get a better understanding of the principles of ageing.

The social rank of non-human primates, their well-being and stress level with regard to group and age structure is in the focus of behavioural research. Scientists test various psychological theories about social ageing to find out how ageing affects the life of individuals in a group.

Fundamental research in the field of neuroscience at the DPZ aims to identify and describe mechanisms affecting ageing and impacting lifespan. Several comparative studies are concerned with age-related changes in the brain of rhesus macaques as well as with age-related responses to psychosocial stress.



Rhesus macaques in outdoor enclosure. Source: DPZ/Anton Säckel.

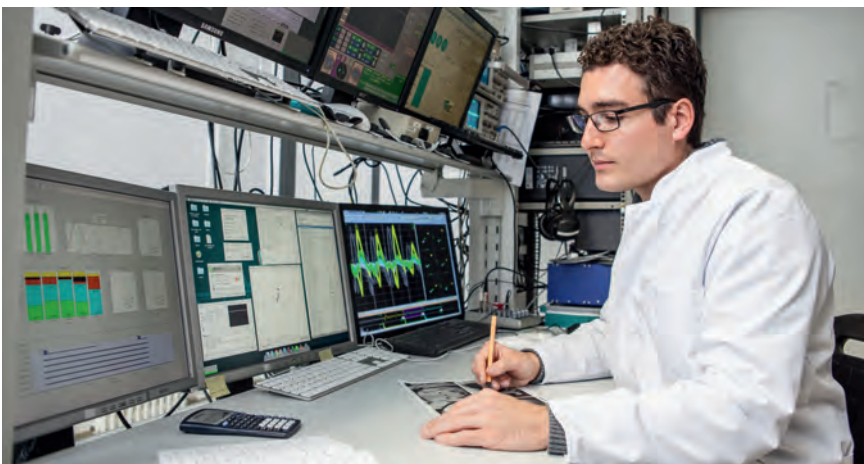


*Scientists of the German Primate Center – Leibniz Institute for Primate Research – research basic biological and biomedical questions about the functioning of the body and about evolution and behaviour by studying non-human primates. As they are biologically closely related to humans, non-human primates provide ideal models to explore biological mechanisms influencing ageing processes in humans.*

The neuroscientists identify stable markers for ageing processes to determine pathological conditions related to age such as cardiovascular and renal diseases or cancer.

The DPZ offers extensive infrastructure for ageing research. The department of primate husbandry houses approximately 1,400 non-human primates of eight different species. Rhesus macaques and common marmosets of different age classes are kept. They serve as models in ageing research and allow exploring developments and changes in different stages of life.

Since 2015, the DPZ applies magnetic resonance tomography for imaging of the structure and function of internal organs and tissues: a 3-tesla scanner for larger non-human primates and humans as well as a 9.4-tesla scanner for small non-human primates and rodents. The scanners will primarily be used for the functional imaging of brain activity and are also available for cooperative projects.



Cognitive Neuroscience Laboratory at the German Primate Center. Source: DPZ/Thomas Steuer.

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# German Rheumatism Research Centre Berlin (DRFZ)

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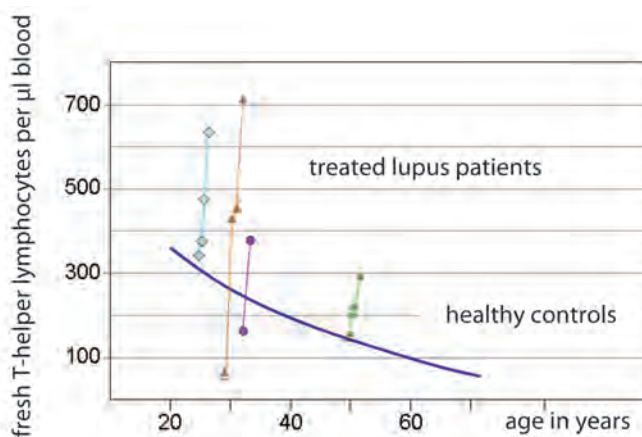
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DRFZ researches rheumatic diseases. More than 200 different types of rheumatic diseases are caused by wear-and-tear, such as Osteoarthritis, and others by chronic infections, such as Rheumatoid Arthritis or Systemic Lupus Erythematoses. In the context of the LRA Healthy Ageing, we are investigating how to repair worn-out joints biologically, how infectious rheumatic diseases can cause premature ageing of the immune system and contribute to the ageing process in general, and how to improve treatments of rheumatic diseases in old age.

Rheumatic diseases caused by wear-and-tear unavoidably occur at a higher incidence in old age. At the DRFZ, we are seeking how to compensate for degeneration via natural regeneration, i.e. via a rejuvenation of affected tissue.

Rheumatic inflammations are caused by the immune system itself by attacking the own body. In the process, aggressive lymphocytes develop and the immune system is affected. This particular cell type mimics the cells that impart an “immunological memory” after an illness. Especially important are the memory plasma cells that were discovered at the DRFZ. We investigate

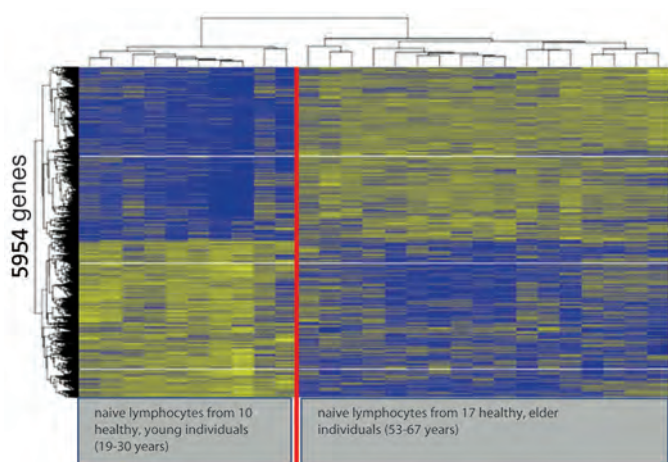


Autologous stem cell transplantations in patients with Systemic Lupus Erythematoses (SLE) lead to a “rejuvenation of the immune system”, resembling the one of newborns. Source: DRFZ.

how this memory changes with age, how pathogenic and protective memory differs and why many rheumatic diseases emerge predominantly in certain age groups. Could rheumatic diseases possibly be a consequence of the ageing immune system?

A rheumatic inflammation has an “ageing” effect on the patients, especially on the immune system, but also on many other organs. Interestingly, the immune system can be regenerated and infections halted as a result of experimental stem cell therapies, as discovered by DRFZ and Charité scientists. This is a novel therapeutic approach!

Finally, the epidemiological aspects of rheumatic diseases are researched. As a result, we know at what age certain rheumatic diseases develop, and how young and old patients respond to current treatments.



T-helper lymphocytes in aged (green) and young (blue) humans differ in their functions. Source: DRFZ.

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# Leibniz Institute for Age Research – Fritz Lipmann Institute (FLI)

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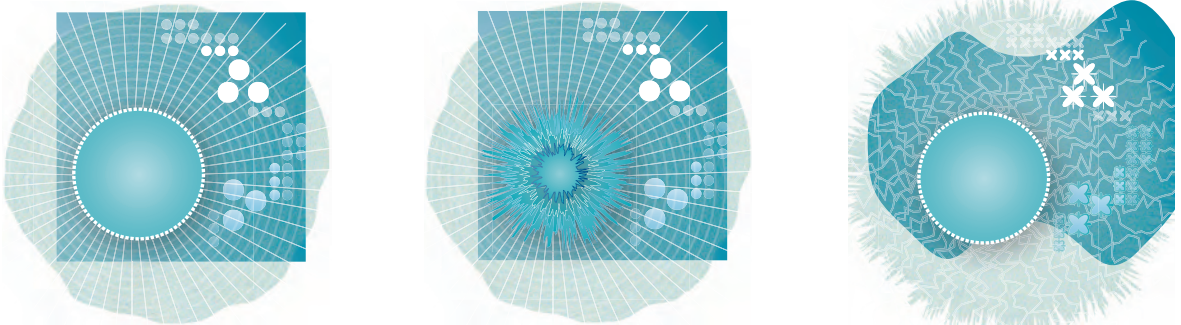
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A dramatic demographic change – the doubling of average life expectancy – has occurred in industrialised countries over the last two hundred years due to improvements in medical therapies, housing, working conditions, food supply, among other factors. As a downside, the number of age-related diseases strongly increased.

The reduced ability to preserve organs and tissues represents a main reason for decreases in tissue function in later life. Furthermore, there is an exponential increase in diseases and cancer development during ageing. Adult stem cells are important for lifelong tissue maintenance and regeneration but the functionality of stem cells decreases during ageing. The development of therapies that aim to improve stem cell function and tissue maintenance represents a promising approach to increase health in the elderly.

The main goal of the Leibniz Institute for Age Research – Fritz Lipmann Institute (FLI) is to make major contribution to the understanding of ageing-induced molecular mechanisms that impair cellular and organismal function during ageing. The FLI focuses on two main programme areas:

1. Ageing-induced impairments in stem cells and regeneration
2. Accumulation of molecular damages and genetic/epigenetic causes of ageing



Ageing changes the stem cells (middle) resp. the stem cell niche (right). Source: FLI/Maren Blaschke.

*Human ageing is a multifactorial process controlled by both environmental and genetic factors. Our mission is to understand the molecular mechanisms that underlie the ageing process and that lead to age-related diseases. We hope that eventually this knowledge can contribute to a more healthy ageing of people.*

Efficient therapies for the treatment/prevention of aging-induced dysfunction and diseases are currently lacking. Therefore, FLI's main goal is to delineate molecular mechanisms underlying the ageing process and its negative impact on tissue function and disease development. Systems biology and bioinformatics analyses are employed to compare research results from model organisms with human ageing and to develop models and predictions for causative key regulatory pathways and mechanisms that impact human ageing. This cooperation between biologists, physicians and mathematicians, can ultimately provide a rational basis for the development of therapies aiming to improve health in the elderly.



FLI's new laboratory building in Jena. Source: FLI/Jörg Hempel.

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Due to its strong orientation towards life sciences and health research, ISAS regularly addresses problems of ageing research. For instance, the institute's Biomedical Research department tries to clarify the (bio-)chemical and biomolecular processes leading to diseases such as Alzheimer's, which is the most common form of senile dementia. This research is based on the hypothesis that the first pathologic processes in Alzheimer's start at an early age, long before a patient shows symptoms of the disease.

In this context, the group investigates the role of autoantibodies in Alzheimer progression. Those antibodies attack and destroy structures of the own body and can therefore lead to neuronal death in the long-term. The group aims to identify the respective autoantigens to uncouple this autoimmune mechanism of Alzheimer's disease.

Moreover, the Biomedical Research department is concerned with biomarker identification to enable an early diagnosis before the first symptoms arise and irreparable damage is caused. In this context, the influence of extracellular vesicles from blood on several neurodegenerative diseases is investigated: These vesicles contain large amounts of the amyloid precursor protein (APP), the main component of senile plaques in the brains of Alzheimer patients, suggesting a neurotoxic quality of blood-derived vesicles.

A project group in the Bioanalytics department at ISAS focuses on Parkinson's, another neurodegenerative disease that is characterized by a degeneration of dopamine-producing neurons in the midbrain. This results in reduced cerebral cortex activity. The Tissue Omics project group therefore aims to clarify the expression and the functional contribution of different folding proteins (chaperones and co-chaperones) to the genesis and development of Parkinson's disease. In this context, the group especially focuses on pathologic Lewy bodies, abnormal protein aggregates.

*ISAS is dedicated to advancing analytical technologies as a driver of scientific, social and economic progress. Our research focuses on providing methods for the multi-parameter analysis of bio-materials. With our innovations we aim to enable an earlier detection of diseases and their associated risk factors, and a faster and more precise therapy.*

Fat metabolism is another important topic in Bioanalytics research at ISAS. The increasing prevalence of adipositas, especially in developed nations, has become a serious challenge for healthy life and active ageing: There are already more people worldwide suffering from obesity than from malnourishment. The Lipidomics group at ISAS studies the quantitative composition as well as the age- and metabolism-induced changes of the platelet lipidome. In this context, the influence of extracellular ageing effects such as obesity or diabetes on platelets is also investigated.

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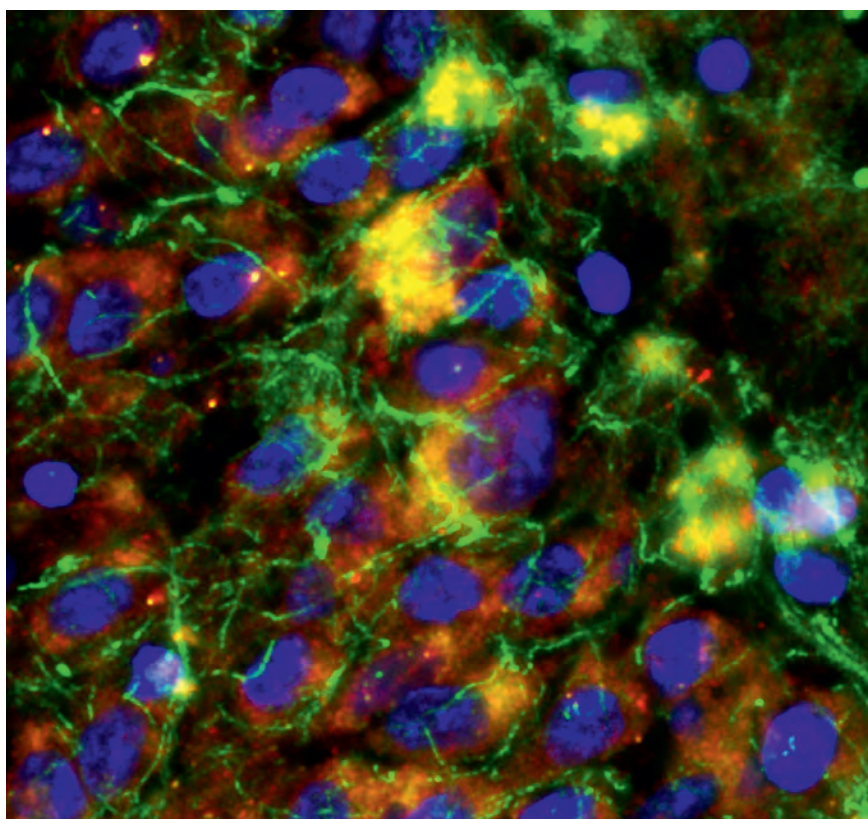
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The picture shows neurons (nerve cells) from the hippocampus, a brain area that helps transferring information from short-term memory to long-term memory and plays an important role in Alzheimer's disease. The image was taken with a fluorescence microscope. Source: ISAS.

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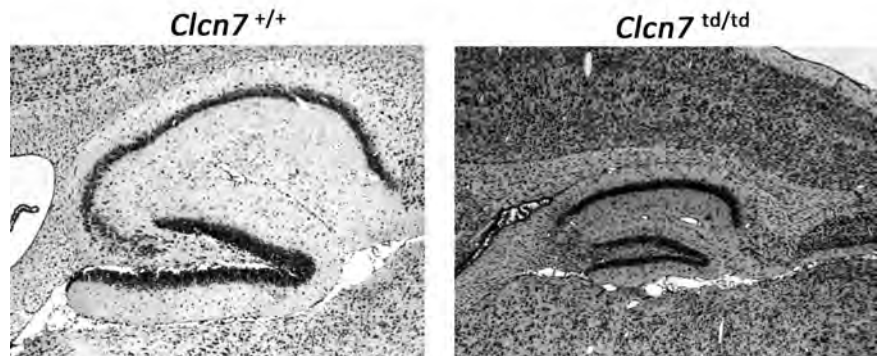
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The health of eukaryotic cells and in turn of organisms depends on a functional proteome. Disturbances in the protein homeostasis (proteostasis) due to a misregulation in expression or the accumulation of non-functional proteins and protein aggregates is intimately linked to cellular damage and to diseases and disorders including metabolic disease, cancer, immunodeficiency, and neurodegenerative disorders like Alzheimer's or Parkinson's disease, many of which show remarkably increased incidences with ageing.

Ageing-related research at the FMP is based on the hypothesis that ageing-related disorders are linked to an imbalance in proteostasis. The identification and characterization of molecular alterations causing disease therefore should reveal options for pharmacological interference. Such research will be performed in collaboration with other institutes and in combining *in vivo*-studies, biochemical and structural studies, and high-throughput small molecule screening.

Ageing-related topics include uncovering mechanisms regulating the proteostasis network that consists of molecular chaperones and proteolytic machines to maintain the fold of proteins and elucidating its role in response to proteotoxic stress such as provoked by the accumulation of disease-asso-



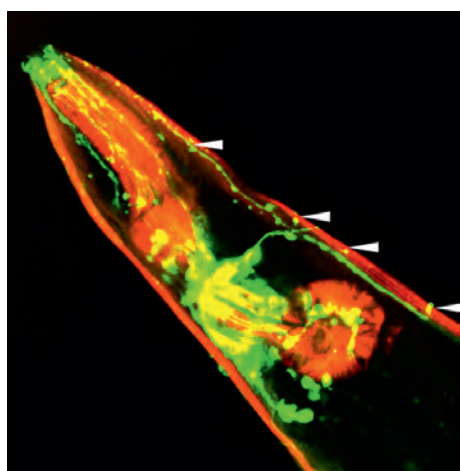
Light-microscopic images of Nissl-stained paraffin sections of the brain show a loss of pyramidal neurons (arrows) in the CA3 region of the hippocampus of *Clcn7*<sup>td/td</sup> mice at the age of 10 month. Modified from Weinert et al., EMBO Reports 2014.



*The FMP approaches ageing with an integrated, interdisciplinary research program based on the hypothesis that alterations in protein homeostasis underlie ageing-related disorders.*

ciated amyloidogenic proteins and the progression of ageing (Kirstein), a dissection of the role of presynaptic protein turnover including autophagy in maintaining neuronal function (Haucke), employing genetic and chemical perturbations to manipulate lysosomal function, particularly by targeting the lysosomal chloride / proton exchanger *ClC-7* in cells and *in vivo* (Jentsch), and developing and applying NMR-based methods to study structural aspects of aggregated proteins and metabolic alterations in lysosomes and autophagosomes in ageing (Oschkinat). The Chemical Biology Platform of the FMP provides crucial support in identifying and generating tools to pharmacologically influence the cellular processes studied (von Kries/Nazaré).

The projects aim at unraveling mechanisms of cellular proteostasis and their contribution to ageing-related disorders ranging from ageing-induced memory loss and neurodegenerative diseases to osteoporosis.



Firefly luciferase employed as a sensor for protein folding reveals a reduced chaperone capacity for preventing the accumulation of misfolded proteins in the ageing nematode *C. elegans*. White triangles mark aggregates of luciferase-GFP (green) in neurons of nematodes at the age of 4 days (young adults). Muscles (red) have been stained with phalloidin. Source: FMP/J. Kirstein.

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# Leibniz Institute for Neurobiology (LIN)

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The Leibniz Institute for Neurobiology (LIN) in Magdeburg is an internationally renowned centre for learning and memory research. Neurobiologists, medics, psychologists, biochemists, and physicists work in interdisciplinary groups to decode the brain mechanisms of learning and memory processes on all organisational levels – from molecular and cellular processes or neural networks to the analysis of complex patterns of human and animal behaviour. According to Leibniz' maxim "Theoria cum Praxi" the LIN is committed to the fundamental research of functions in the healthy brain as well as to a causal understanding of its diseases.

Within the LRA Healthy Ageing, the LIN puts its focus on mechanisms underlying ageing in synapses, neurons, or neural networks. The scientists explore for example causes for the decrease of cognitive functions during normal ageing. They study learning and memory performances in subjects at different ages: Why have elderly people difficulties in remembering and why it is harder for them to learn new items? Which influence does the messenger



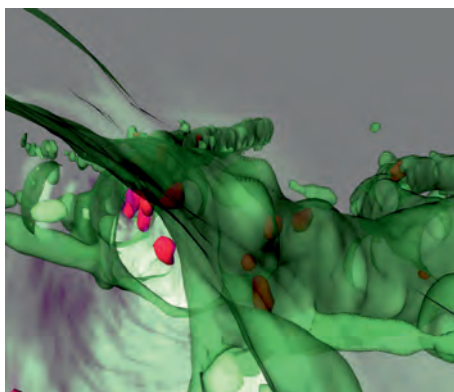
LIN scientists study learning behavior in the elderly. They want to understand how attentional and motivational processes contribute to memory. Source: LIN/Reinhard Blumenstein.

*Modern biological ageing research shall not concentrate on the continuing increase of the achievable age but on the extension of a healthy phase of life. That includes the life-long preservation of learning and memory abilities.*

dopamine have on the reward system – quasi on the motivation to learn and the learning efficiency? Studies indicate that elderly people have a lower reward expectancy making it more difficult for them to keep new things in mind.

Further studies suggest that insulin, a hormone of the metabolism, and some related messengers are important signal transmitters for memory formation. Disordered metabolic processes, as for example the metabolic syndrome or insulin resistance caused by diabetes mellitus type 2, limit the plasticity of synapses and lead to cognitive dysfunctions. This indicates that our lifestyle in terms of food, physical exercises, mental activities but also chronic inflammation has a strong influence on our memory system when we grow older.

Consequently, LIN scientists study causes of pathological ageing changes to the brain like senile dementia. Their efforts aim on discovering molecular causes and influencing factors for dementia. The knowledge of pathomechanisms is a precondition for the development of new drugs and causal treatment strategies.



What happens in an active neuron? LIN researchers have shown that the Jacob protein is an important mediator between active synapses and the cell nucleus. In ageing neurons, the synapse-nucleus communication is disturbed thus impairing adaptation of gene expression to the cell's activity – the network is less plastic and the elderly have memory problems. Source: LIN/Anna Karpova.

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# Leibniz Institute for Prevention Research and Epidemiology – BIPS

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[www.bips-institute.eu](http://www.bips-institute.eu)

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The mission of the Leibniz Institute for Prevention Research and Epidemiology – BIPS is to inform the general public about potential health risks and to contribute to a healthy living environment. Specific intervention and prevention measures for the target group “senior citizens” can potentially strengthen their health and postpone, if not prevent, age related diseases. In future, particularly the demographic change will demand the development of more quality assured measures. Thus, age related research poses an important branch of the institute.

Including the living environment and conditions of senior citizens and raising their individual motivation by utilizing new media is one goal of the comprehensive research of the departments and units of BIPS. Currently, the emphasis lies on promoting physical activity in the so called third stage of life, the transition into retirement age. The enhancement of physical activity does not only improve the health of senior citizens, it also enables them to maintain their independence and participation in social life.

Scientists from the BIPS’ department of “Prevention and Evaluation” coordinate the research network AEQUIPA (Physical activity and health equity: primary prevention for healthy ageing), which is grant-aided by the German Federal Ministry of Education and Research (BMBF). This network investigates behavioral and conditional prevention measures promoting physical activity of senior citizens. Additionally, the pharmacoepidemiological study PhaSiNag, which is mainly carried out by the BIPS’ department of “Clinical Epidemiology”, investigates the safety of neuroleptics and antidepressants in the area of geriatric psychiatrics.

*“With the results from our scientific projects, we strive to detect health risks for senior citizens and to strengthen their resources for a healthy life style.”* Prof. Dr. Hajo Zeeb, Leibniz Institute for Prevention Research and Epidemiology – BIPS

The commitment of BIPS to the LRA Healthy Ageing and the cooperation with different renowned Leibniz institutes as well as other organizations allow to practically integrate latest results from basic research into new intervention measures and to investigate their effectiveness.



The BMBF funded project AEQUIPA investigates behavioral and conditional prevention measures promoting physical activity of senior citizens. Source: iStock/BIPS.

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# Leibniz Institute for Zoo and Wildlife Research (IZW)

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The IZW investigates the mechanisms underlying evolutionary adaptations and explores the factors influencing the ability of species to adjust to environmental change. These insights form the basis for developing suitable concepts and methods to increase the resistance and resilience of wildlife populations and species to anthropogenic global change. To achieve these goals researchers from biology and veterinary medicine work together in five departments at the IZW: Evolutionary Ecology, Evolutionary Genetics, Wildlife Diseases, Reproduction Biology and Reproduction Management. The IZW has special methodological competence for example in imaging techniques (ultrasound and x-ray diagnostics, computed tomography), in the analysis of “ancient DNA” as well as in statistical simulation and modelling.

Wildlife research has enormous potential to identify currently unknown biological processes. In the context of ageing research the IZW investigates physiological and evolutionary mechanisms as well as ecological and social factors influencing ageing processes in different wildlife species with the following emphasis:



Elephants (here: *Loxodonta africana*) show early reproductive ageing (asymmetric ageing) due to long breeding pauses. Source: IZW/Thomas Hildebrandt.

*The IZW is an interdisciplinary research institute dedicated to investigating the ability of wild animals to adapt to global change and developing the scientific basis for novel approaches to wildlife conservation.*

1. The biochemical, hormonal, immunological and genetic mechanisms underlying ageing processes: intraspecific and interspecific comparisons can yield innovative insights not accessible when working with classical model organisms. Examples are the study of naked mole rats, which may become very old whilst in good health, or the comparison between long-lived and short-lived species.

2. Environmental factors (e.g., living conditions during early development, social status, physiological stress and infection status) and their influence on lifespan and life-history strategies.

3. The mutual interdependence of reproduction and ageing. For instance, the lifespan of naked mole-rats depends on being a member of either the reproductive or non-reproductive caste. For conservation breeding of long-lived wild animals such as rhinoceroses and elephants it is crucial to understand the fast, asymmetric ageing of reproductive organs, apparently a consequence of extended breeding pauses.



The naked mole-rat (*Heterocephalus glaber*) – being as small and light as a mouse – has a maximum lifespan of more than 30 years. Source: IZW/ Susanne Holtze.

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# Leibniz Research Centre for Working Environment and Human Factors (IfADo)

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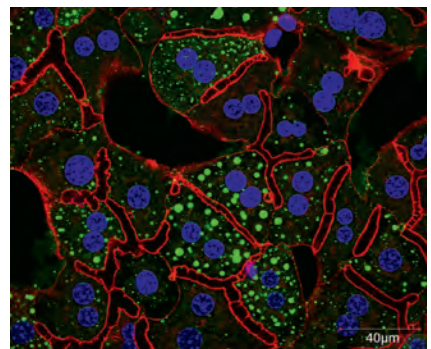
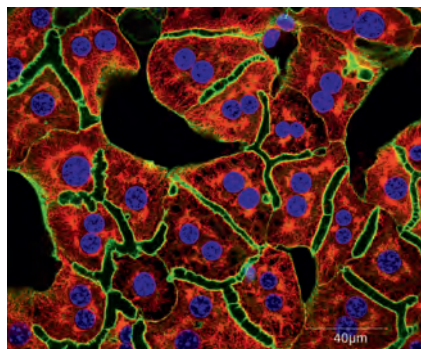
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The proportion of older employees increases continuously in Germany and other European countries. At the same time there is a tendency towards early retirement. The combination of both developments results in a crises of social security systems and in difficulties to cover the need of certain sectors for qualified and efficient labour. Preserving the potential of older workforce as well as developing and deploying of age-differentiated work systems therefore represent an important challenge for the future.

The IfADo examines relevant processes and functions at different levels – from the biochemical and cellular to the behaviour level. The groups “Systems Toxicology” and “Cellular Toxicology” investigate factors that potentially lead to premature or accelerated ageing in liver cells, including lipid accumulation. Research results suggests that intracellular excess of lipids influences key processes involved in maintenance of cellular homeostasis such as autophagy or the detoxification capacity of hepatocytes. This has important implications in the context of exposure to chemicals and toxic compounds. The networking group “Neurobehavioural Toxicology and Chemosensation“ analyses the functionality of neurons and neuronal networks as well as their ageing-related functional alterations, including the loss of capacity to generate action potentials. This allows to understand the effect of neurotoxic chemicals and enables the identification of neuroprotective factors for treatment purposes.



Liver cells. Source: IfADo project groups “Systems Toxicology” and “Cellular Toxicology”.



*The Leibniz Research Centre for Working Environment and Human Factors (IfADo) investigates potentials and risks of modern work on the basis of behavioural and life sciences. The results lead to principles of beneficial and healthy design of the working environment.*

The research field of ergonomics (leading networking group “Ageing”) investigates sensory, motor, and cognitive functions and their changes with increasing age. Age-related changes such as in attentional functions as well as motivation and fatigue are studied with modern neurophysiological methods, both in the laboratory and in real working environments. A further research topic examines beneficial effects of different training activities (e.g., sports, cognitive training, stress management training) for the improvement of cognitive and emotional skills of older employees. An interdisciplinary research network also focus on challenges and opportunities of the networked working environment.



EEG registration. Source: IfADo project group “Ageing”.

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# Leibniz Research Institute for Environmental Medicine (IUF)

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The IUF – Leibniz Research Institute for Environmental Medicine – has as one major research focus ageing processes that are induced by environmental factors. It focuses on airborne particles, nanoparticles, non-ionizing radiation and chemicals as extrinsic inducers of ageing processes in skin, lung, the cardiovascular system and the central nervous system. Key aspects within this research are the relevance of

1. Environmentally induced mitochondrial malfunctions for skin and cardiovascular ageing,
2. Extrinsically induced changes of the cell core architecture and neuronal differentiation processes for brain ageing as well as neurodegenerative diseases,
3. Environmentally triggered ageing of the connective tissues for human organ ageing, and
4. The innate immune system in extrinsic ageing.



The roundworm *C. elegans* as model system of environmentally induced ageing.  
Source: IUF/Katharina Beyen.

*The research mission of the IUF is the prevention of environmentally induced damage to human health by elucidating causal mechanisms in the effects of environmental toxicants of global relevance. The main focus is on environmentally induced ageing, adverse immune reactions and neurotoxicity.*

The IUF works with different model systems. The roundworm *C. elegans* is used in a primary high-throughput process of active substances for the prevention of environmentally induced, mitochondria mediated ageing processes. Based on the generation and characterization of genetic mouse models it is possible to evaluate the effect of specific molecular mechanisms (e.g., telomere dysfunction, and mitochondrial dysfunction) on ageing. Studies in different model organisms are complemented by human studies employing human three dimensional organoid model systems of the skin and the central nervous system as well as clinical studies on human volunteers and epidemiological studies in the genuine IUF cohort SALIA, the Heinz-Nixdorf Recall cohort and the Taizhou cohort in China. The SALIA cohort is a nationally unique age cohort that consists of 80-year-old women, who have been systematically characterized during the last 25 years for their exposure to selected environmental pollutants such as industry and traffic related ambient airborne particles in the Ruhr area.

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Analysis of molecular mechanisms in environmentally induced ageing. Source: IUF/Katharina Beyen.

# Funded Projects

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the Federal Ministry of Education and Research (BMBF),  
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and the European Union (EU)

Funded institutes	Leibniz Association
<b>FLI</b> Jena University Hospital, Friedrich Schiller University Jena	<a href="#">Leibniz ScienceCampus Regenerative Ageing</a> Funding period 2015-2019 Funding line <i>Strategic networks, ScienceCampi</i>
<b>FLI</b>	<a href="#">Leibniz PostdocNetwork: Aging induced impairments of regeneration and stem cell functionality – RegenerAging</a> Funding period 2015-2017 Funded by the Leibniz Competition, funding line <i>Promotion of junior researchers</i>
<b>FLI, FMP, LIN</b>	<a href="#">Role of proteostasis in cellular aging</a> <a href="#">DNA damage response in aging</a> <a href="#">The decline of cognitive function in normal aging</a> Funding period 2014-2016 Funded by the Leibniz Competition, funding line <i>National and international networking</i>
<b>IUF</b>	<a href="#">Investigation of the role of the innate immune system in extrinsic ageing processes</a> Funding period 2013-2016 Funded by the Leibniz Competition, funding line <i>Quality assurance</i>
<b>FLI, IZW</b>	<a href="#">Exploring natural ways to an exceptional long healthspan – the naked mole-rat case</a> Funding period 2012-2014 Funded by the Leibniz Competition, funding line <i>Particularly innovative and high-risk projects</i>
	<b>BMBF</b>
<b>FMP</b> Charité-Universitätsmedizin Berlin, Freie Universität Berlin (FU)	<a href="#">Smartage – Neurobiological basis of poymine protection from age-induced memory decline</a> Funding period 2015-2020
<b>IUF</b>	<a href="#">KAUVIR – Combination instead of addition: UV and IR radiation in the development of cancer and aging</a> Funding period 2015-2018
<b>LIN</b> MPI for Education Research Berlin, German Center for Neurodegenerative Diseases, University of Würzburg	<a href="#">Energl – Energizing the Hippocampus in Aging Individuals</a> Funding period 2015-2018
<b>BIPS</b> Prevention research network in the Metropolitan Region of Bremen/Oldenburg	<a href="#">AEQUIPA – Physical activity and health equity: primary prevention for healthy ageing</a> Funded since 2015
<b>IOER</b> TU Dresden, Verband Sächsischer Wohnungs- genossenschaften e.V.	<a href="#">People-Architecture-Technology Interaction for Demographic Sustainability (MATI) – Analysis of Best-Practice Models</a> Funding period 2014-2015
<b>DIE</b> Ludwig-Maximilians- University Munich (LMU)	<a href="#">Competencies in Later Life (CiLL)</a> Funding Period 2011-2014
	<b>DFG</b>
<b>DDZ, IUF</b> Heinrich Heine University Düsseldorf, University of Duisburg-Essen	<a href="#">Master switches in cardiac ischemia</a> Funding period 2015-2018 Collaborative Research Center of the German Research Foundation SFB 1116



Identification of molecular mechanisms of carbon nanoparticle-induced senescence and aging *ex vivo* and *in vivo*. The role of reactive oxygen species  
Funding period 2015-2017

IUF

Bimodal adaption responses to mitochondria stress induced by extrinsic interventions to delay neuromuscular aging and extend healthy lifespan  
Funding period 2015-2017

IUF

Environmentally induced cardiovascular degeneration  
Funding period 2014-2018, Heisenberg professorship

IUF  
Heinrich Heine University  
Düsseldorf

Analyzes of Muscle Regeneration  
Funding period 2013-2018, Emmy Noether Program, Dr. Julia von Maltzahn

FLI

Differentiation of telomere independent functions of nuclear and mitochondrial telomerase reverse transcriptase *ex vivo* and *in vivo*  
Funding period 2013-2016

IUF

Retrograde signaling processes in extrinsic skin aging  
Funding period 2012-2015

IUF

## EU

FRAILOMIC – Identification of biomarkers to determine the factors that turn frailty into disability  
Funding period 2013-2017  
Funded under the European fp7 framework

DIFE  
Together with 20 partners  
within the EU

Active Ageing with Type 2 Diabetes as Model in the Development and Implementation of Innovative Chronic Care Management Models in Europe  
Funding period 2013-2017  
Funded under the European fp7 framework

DDZ  
Together with 20 partners  
within the EU

## Other Institutions

RegenerAging – Aging induced impairments in organ regeneration and homeostasis  
Funding period 2015-2019  
Funded by the “ProExcellenz Initiative II” of the State of Thuringia

FLI  
Jena University Hospital,  
Friedrich Schiller University  
Jena, Carl Zeiss Jena

Demographic change in the EU, the oldest-old and the need for innovative models  
Funding period 2015-2017  
Funded by the European Investment Bank (EIB) Institute

RWI  
University of Duisburg-  
Essen

Age-friendly City – Autonomy and Sustainable Mobility in the Context of Climate Change – autonomMOBIL  
Funding period 2014-2017  
Funded by the Fritz and Hildegard Berg Foundation

ILS  
University of Stuttgart,  
Goethe University Frankfurt,  
Robert Bosch Krankenhaus  
Stuttgart

Economic Challenges for the Care of Elderly  
Funding period 2014-2015  
Funded by the BMWi

RWI  
IEGUS Institut für  
Europäische Gesundheits-  
und Sozialwirtschaft

Health-information literacy in old age  
Funding period 2014-2015

DIE, ZPID

Demography and pension: The effect of higher gainful employment of older people on the contribution rates of pension fund  
Funded since 2013 by the “Initiative Soziale Marktwirtschaft”

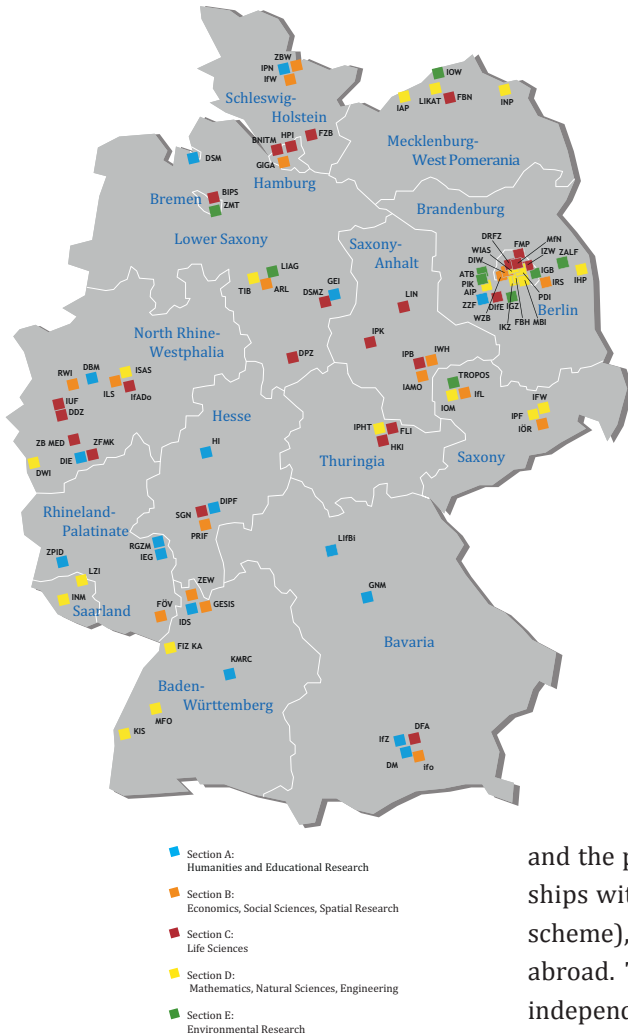
RWI  
Institute for the World Econ-  
omy (IfW), University of  
Duisburg-Essen

Pflegeheim Rating Report  
Funded since 2006

RWI  
Accenture, hcb

# Research Alliances in the Leibniz Association

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In view of their importance for Germany as a whole, the Leibniz Association's institutes receive joint funding from the country's federal and state governments. The institutes employ about 18,100 staff, 9,200 of whom are researchers. The total budget is approximately € 1.64 billion.

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