

CECAD Cluster of Excellence

At a glance



Facts & Figures: An Overview

- CECAD Cluster of Excellence at the University of Cologne: supported by the Faculty of Mathematics and Natural Sciences and the Faculty of Medicine
- Funded by the DFG as part of the federal and state Excellence Initiative since November 1, 2007
- Second five-year funding period began in November 2012
- May 2013: new CECAD Research Center opened
- Central office for scientific administration
- Three central platforms to support research:
 - Technology Platform with 5 facilities
 - Translational Platform
 - Platform for career development, training, equality, PR & Marketing

Research at CECAD

Scientists approx. 440 from the University of Cologne, the University Hospital, the Max Planck Institutes of Metabolism Research and the Biology of Aging, and the Center for Neurodegenerative Diseases (DZNE)

Research areas 6

Principal Investigators 48

Technology facilities 5



The Cluster's Vision

In an aging society, the CECAD cluster of excellence explores the causes of aging processes and aging-associated disorders such as neurodegenerative diseases (Alzheimer's, Parkinson's), diabetes, strokes, kidney failure, chronic inflammation or cancer at the molecular level. The cluster's vision is to understand the common causes of aging and define novel therapeutic approaches for the entire spectrum of aging-associated disorders. This involves identifying the processes that fail as we age and can therefore trigger aging-associated diseases.

Visible Vitality

With CECAD, the Cologne Life Science Campus has developed a highly dynamic and productive scientific network. Specialized laboratories have been created that reflect the vitality of the cluster in the cityscape as well.

05/2009 CECAD Animal Facility Interim

2013 Max Planck Institute for the Biology of Aging

2013 CECAD Research Center

2014 Restructuring of Max Planck Institute for Metabolism Research (formerly Neurological Research)

These research facilities are in CECAD's immediate vicinity and together create an internationally recognized competence center for aging research.

Hightech for Research

Five facilities offer CECAD scientists an exceptional environment and state-of-the-art technology:

- Proteomics Facility
- Lipidomics Facility
- Imaging Facility
- Bioinformatics Facility
- *InVivo* Research Facility

The CECAD Technology Platform's strategic mission is to promote close cooperation between systemically and molecularly oriented research groups.

Career Development

Exceptional research requires exceptional education: Educating and training young scientific talents is one of CECAD's central focuses. The cluster offers a structured three-year doctorate program in cooperation with the 'Cologne Aging Research Graduate School' on campus that has merged with the MPIs, along with an extensive range of CECAD career development support: numerous seminars, conferences and workshops – also in 'soft skills' – promote sustainable careers.

Equal opportunities for women and men are another of CECAD's important objectives. The vertical 'CECAD Female Faculty Club' network provides female scientists with information about special development opportunities. The cluster also cooperates closely with additional university facilities on equality and family support. The new 'Paramecium' childcare center assists CECAD scientists with small children with their childcare needs.

High Potential

Strategic development of new appointments in the institutions involved promote CECAD's goals

- Since 2007: 17 new appointments of internationally successful scientists and the recruitment of new research groups
- Of these
 - 6 W3 professorships confirmed through the University of Cologne
 - 7 new junior research groups set up

Construction of the CECAD Research Center

Principals The University of Cologne and the University Hospital of Cologne

Financing Federal government and the State of NRW

Construction volume 100 mil. EUR

Specifications

- A research center, centrally located on the hospital campus – for short communication channels and efficient working processes
- Central service facilities, equipped with state-of-the-art technology, to support scientists in the cluster
- Identical construction of all laboratory floors to promote intensive communication as a key prerequisite for interdisciplinary research
- Equipment that allows for close collaboration between clinical and basic research groups
- Modern laboratory equipment with short distances and divided into laboratory and documentation zones



Technical Data

Area Total floor space: 25,000 m²; Useable space: 10,600 m²; Floors: 7 upper floors, 3 basement floors

Realization medfacilities GmbH with architects from von gmp Gerkan, Marg und Partner, Aachen

Ground breaking September 2009

Commencement End 2009

Roofing ceremony September 2011

Completed Spring 2013

Opened May 2013

Start-up operation Until Autumn 2014

Occupied As of October 2014





Research into Aging: CECAD's strong vision

Dementia, diabetes, chronic inflammation, cancer, infections, chronic kidney disorders, arterial sclerosis... the prevalence of all these diseases increases with age. In a society in which people are living longer and longer, aging research is of high social relevance. More than 400 international scientists from the University of Cologne, University Hospital Cologne, and the Max Planck institutes for Metabolism Research and the Biology of Aging explore the molecular basis of the aging process and age-associated diseases at the CECAD Excellence Cluster.

Developing new therapies for treating aging-associated diseases requires basic research.

Only if we recognise the molecular processes that trigger the pathogenesis of a disease, we can possibly find research approaches that will give us a new understanding of age-associated disorders.

CECAD's vision is to develop new conjoint therapies for aging-associated diseases. To date neurologists have dealt with dementia, cardiologists with heart disease and oncologists with tumours. At CECAD we take an interdisciplinary approach: our scientists are looking for shared causes of age-associated disorders. Their goal is to find a central mechanism involved in the aging process that would allow scientists and medical professionals to successfully intervene.



Aging research is still a very young discipline that has explored the molecular-biological causes of aging for around 25 years now. Regarding expectations, it is important to bear in mind that aging is a very complex phenomenon and basic research drives innovation by providing new impulses over a longer period of time. We must also recognise that more than just individual genes play a role in the aging process. As an object of research, the human body is a highly complex network with a multiplicity of interactions, aging-associated changes to biological molecules, and around 25,000 human genes in a considerably larger network of proteins. One of the most important goals is to understand the interplay in and among these networks and not just look at the aging of individual cells. This could define areas of intervention for realising CECAD's vision of effectively countering aging-associated diseases in future.

One of the central mechanisms often disrupted as we age is mitochondrial function. These are the powerhouses of the cells; they release the energy we need to live. All living creatures need working mitochondria to survive. As they operate though, they also release free oxygen radicals that damage the cells and set off a whole chain of failures implicated in the pathogenesis of neurodegenerative diseases.

The effect of DNA on the body is another central mechanism of aging. As we grow older, the cells in many tissues and organs lose partial or total function as DNA defects accumulate over time. This damage to the genes is extremely important because many aging-associated disorders are caused by DNA defects that cannot be repaired. These defects can accumulate in any type of cell, where they may trigger cancer growth, for example, or neurodegenerative diseases such as Alzheimer's and Parkinson's in the brain.

DNA defects are highly influential in carcinogenesis because they change how genes function. This may result in the continual activation of a gene that regulates cell growth. CECAD research findings indicate that the genetic mechanisms that regulate lifespan in model organisms such as fruit flies and threadworms react to DNA damage. A central topic of future research is whether these mechanisms can counteract the dangerous impact of DNA defects, as such preserving tissue and organ function even in advanced age.

Aging affects all the processes and functions inside the cell. In addition to DNA damage, protein aggregates also accumulate. As we age, the cell's quality control mechanisms responsible for "cellular rubbish disposal" can no longer remove the damaged proteins. They accumulate, acting as potential triggers for neurodegenerative diseases such as Alzheimer's and Parkinson's, and can lead to the degeneration of other organs. CECAD scientists are therefore focusing on the processes that lead to this loss of quality control in order to better our understanding of the genesis of these diseases.

The cell membrane also reflects the aging process. Cell membranes consist primarily of lipids (fats) whose composition changes with age. These membranes stiffen, and the cell's ability to protect itself from pathogens drops. Phagocytosis is one of the mechanisms of an intact immune response to pathogens. Here the cell membrane engulfs the invading pathogen. The body's immune cells isolate it and transport it into the cell. A complex process involving hydrolytic enzymes breaks down the pathogen, rendering it harmless to the body.

Research Area A

Mitochondrial Dysfunction in Aging and Neurodegeneration

Mitochondria are the powerhouses of the cell, keeping them supplied with energy. The activity of mitochondria decreases during aging and defects in mitochondria trigger age-associated diseases including neurodegeneration. Research Area A explores the quality control mechanisms that maintain the integrity of mitochondrial processes, and how the disruption of these mechanisms contributes to diseases.

Research Area B

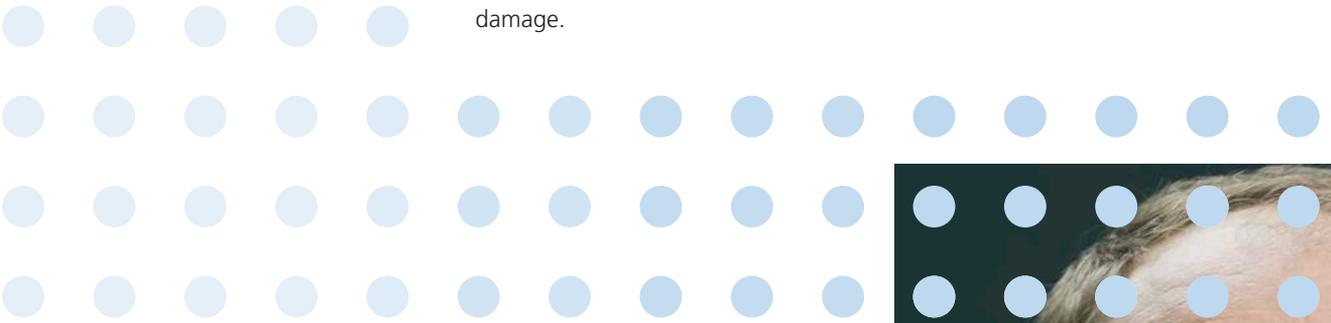
Disruptions in Protein Metabolism Cause Aging-Associated Diseases

Cellular differentiation, developmental processes, and environmental factors challenge the integrity of the proteome in every eukaryotic cell. The maintenance of protein homeostasis, or proteostasis, involves repair and degradation of damaged proteins and is essential for human health. It is commonly thought that age-related impairment of protein quality control affects general proteostasis networks and is involved in age-related pathologies.

Research Area C

DNA damage responses in Aging-associated Diseases

The genome in each cell of the human body is constantly under attack. Over a lifetime DNA damage accumulates and drives the aging process and causes age-related diseases including cancer. Investigators in Research Area C focus on understanding how DNA repair systems remove the damage and how cells and tissues counteract the detrimental consequences of genome damage.



Research Area D

The Aging of Membranes

Cell membranes are integral to our cells and contain enzymes, receptors and ion channels. The composition of their building blocks (lipids) changes over the course of a lifetime. Changes in lipid metabolism play an important role in aging-associated diseases such as hair loss, muscle weakness and obesity. Scientists in Research Area D look into why lipid composition in the cells alters over time and the mechanisms that promote aging-associated diseases.

Research Area E

Inflammation in Aging-Associated Diseases

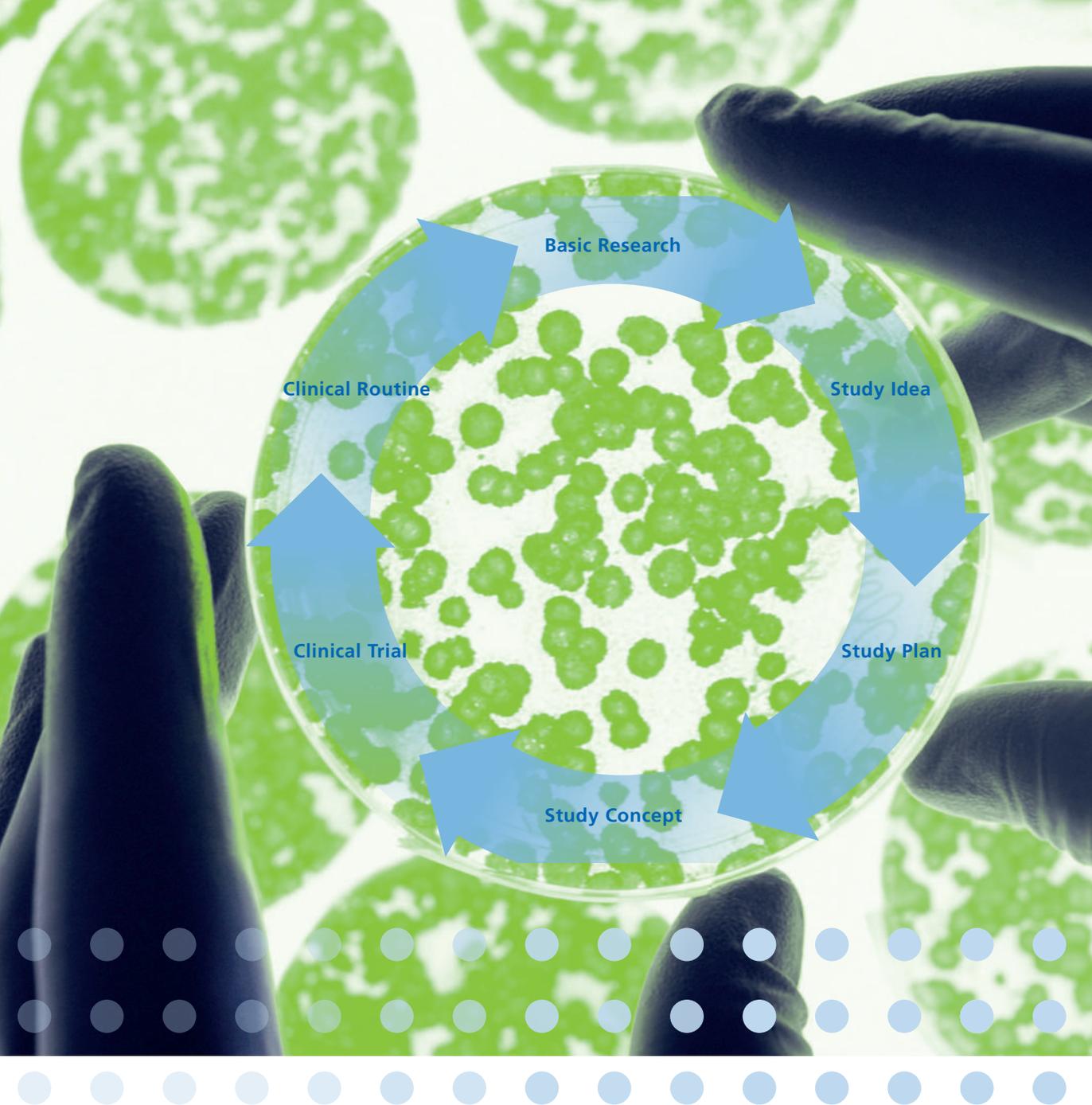
When the immune system is not properly regulated it can cause chronic inflammatory reactions. Prolonged inflammation can trigger aging-associated diseases like cancer, chronic wounds, and type 2 diabetes. Research Area E focuses on the different phenomena associated with inflammation, such as the role of chronic inflammation in tissue and aging, or the link between inflammation and carcinogenesis.

Research Area F

Metabolism in Aging Process, Diabetes and Obesity

Nutrient intake and energy expenditure are controlled by a variety of metabolic and neuronal signaling pathways. Imbalances here can result in diseases such as obesity and type 2 diabetes. The energy-regulating signaling pathways also influence development, growth and the aging process. Scientists in Research Area F work to identify the signaling cascades involved in regulating energy metabolism and explore how their findings might contribute to a longer, healthier life in old age.





From Bench to Bedside and Back: Translational Research at CECAD

Translational research is one of CECAD's key focus areas. It links scientists engaged in basic biological research with those in clinical practice. In cooperation with the Center for Clinical Studies, the translational platform provides the efficient drive and intelligent control system for the whole process. The platform is the partner for successful cooperations between biotech companies, basic sciences, and clinical practice. It includes the clinical application of new medications, substances, and procedures, as well as quality assurance of studies and medical findings. Patents that have already been granted and pending patent applications reflect both the financial and the scientific success of the translational process.



Promising New Diagnostic Method for Invasive Fungal Infections

Novel diagnostic tests to identify invasive fungal infections provide chronically ill patients, such as those with diabetes and leukemia, with new therapeutic perspectives. In patients with compromised immune systems, fungi cause infections that are very difficult to diagnose and can affect the brain or lungs. In 2014, a national team of scientists around Prof. Oliver A. Cornely from the CECAD Cluster of Excellence at the University of Cologne and the University Hospital achieved a breakthrough led by using fungus-reactive T cells as read-out for diagnosing invasive fungal infections.

FLY – Fatigue with Lymphoma

Exhaustion and cognitive limitations are two of many undesirable side effects of many cancer therapies and affect up to two-thirds of all cancer patients. Most studies in this area use data based on subjective assessments. The FLY Project aims to provide an overview of the physiological and molecular aspects of cancer treatments that lead to the symptoms mentioned above. The project combines EEG results and blood analyses with subjective methods to optimize therapeutic options.

CLUD Pilot – Technical Innovation: Measuring Bladder Pressure without a Catheter

The overactive bladder (OAB) syndrome is a urological disease affecting up to 15.6% of men and 17.4% of women in Europe with a negative impact comparable to diabetes mellitus. Unfortunately, current standard urodynamic tests have only a small time schedule with an average investigation time of 20 to 30 minutes. To improve diagnosis and thus to prescribe an accurate treatment, the Department of Urology at the University Hospital of Cologne together with the cooperation of the Faculty of Electrical Engineering and Information Technology in Chemnitz, developed a capsule for longer measurements (WiCa).

The WiCa is inserted into the bladder, where it will continuously record significant bladder pressure changes for up to 3 days. As a result, side effects of antimuscarinic drugs can be avoided and different types of treatments will be offered to OAB patients.

In summary, this project represents trend-setting innovation and advancement for accurately and minimally invasively diagnosis of urinary incontinence pathophysiology. (Wille et al. PloS One 2014)



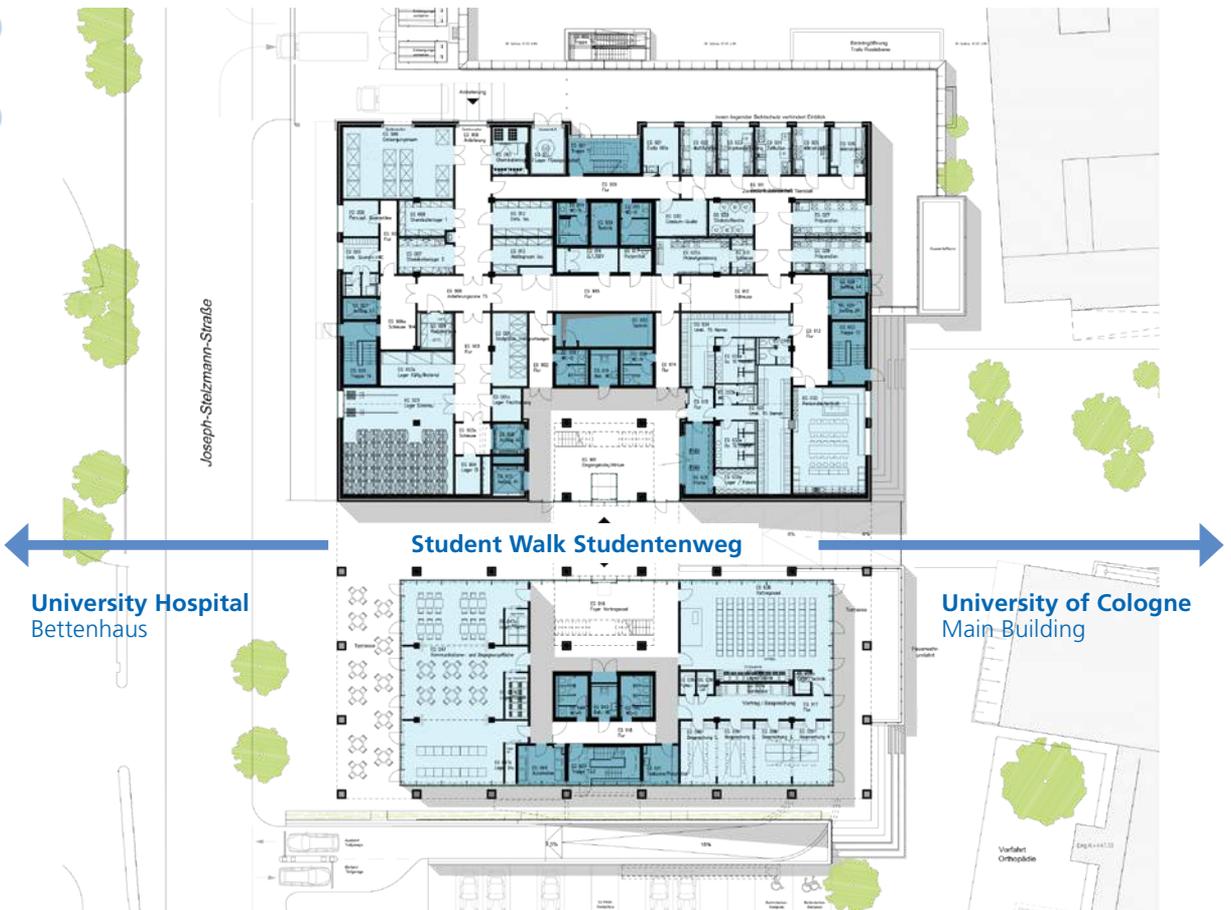
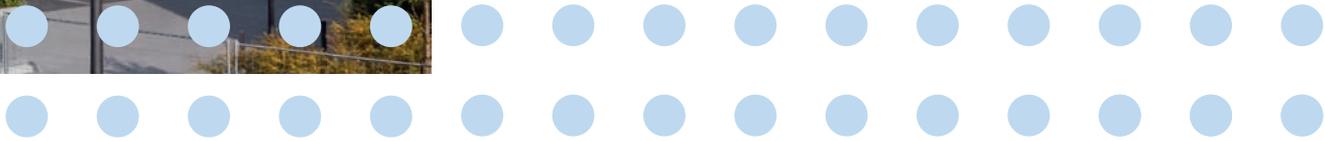
CECAD Research Center: Interdisziplinäre und cross-linked Centrally located on the Campus

Modern research is complex and based on the scientists' intensive communication. The new building, which was inaugurated May 2013, enables such close networking through a particular building and laboratory concept. With approximately 10.600 square meters and most modern technologies up to international standards it provides ideal research circumstances. A quarter of the area – the so called "White Space" – is at the disposal of varying highly qualified prospective research groups.

Due to the immediate proximity of the CECAD research groups, the clinicians and the Max Planck Institutes on campus, a world-wide unique center for aging research has been established. The University Hospital's patients profit from the systematical transfer of insights from the university's top-level research to new clinical therapies of a University Hospital with high-end medicine.



A path on campus, which connects everything from the university's main building to the University Hospital's Bettenhaus – and the CECAD research center which is located as a connection right on this student walkway. On the ground floor the path within public space leads through the building and connects to the glazed communication space on one side. Research requires communication – the latter increases in frequency and intensity congruently to the proximity. The moving-in of the research groups has boosted interdisciplinary cooperation tremendously, a big opportunity for research.





Young Scientists & Career Development: Promoting young scientists and continuing education at CECAD

The motivated and highly qualified young scientists are a key factor in CECAD's remarkable success. Therefore, at CECAD it is a high priority to offer not just optimal research conditions, but also special programs to promote professional development at any career stage.

The "Model Systems of Ageing and Ageing-Related Diseases" course teaches master's students facts about and how to apply the techniques and methods employed in aging research. Doctoral students in the natural sciences and medicine can deepen their scientific knowledge in a wide range of CECAD seminars and lectures. CECAD also offers a variety of soft skills courses for PhD students and postdocs in diverse areas. Workshops such as "scientific writing" and "scientific poster design" are opportunities to round out scientific training. Travel grants that help students and postdocs attend international conferences and a PhD/Postdoc Retreat support the development of international and regional contact to other researchers. This international networking creates opportunities for wide-ranging collaborations and interesting career opportunities.



To promote scientific independence, each year two CECAD postdocs receive a two-year 10,000 EUR/year research grant. These funds can be used for material expenses. It also covers a technical assistant. This support, together with joint laboratory management seminars and an active exchange with CECAD junior groups has already helped many postdoc grant graduates make the leap to heading up their own research groups at respected research institutes.

Another part of CECAD's mission is to encourage the professional development of junior group leaders. CECAD provides access to excellent resources, mentoring and in-house continuing education. Cologne's role as an optimal aging research network supports this objective. Three CECAD junior research groups have founded a professorship in Cologne, an impressive demonstration of how effectively CECAD promotes young talent. The numerous external research grants awarded to CECAD researchers, such as the Emmy Noether Groups, and diverse scientific prizes are additional proof of the success of CECAD's research groups.

The Cologne Graduate School of Ageing Research

Since 2009, CECAD has offered a very successful structured graduate program in the field of aging research, a highly interdisciplinary area with important implications for the future. The very popular program aims to optimally prepare young scientists for a career in academic research or in the scientific labor market.

The three-year program involves excellent research conditions with intensive mentoring and state-of-the-art technical platforms in an international working environment. This creates an ideal environment in which doctoral students can develop their full scientific potential. The English-language doctoral program is complemented by a wide range of seminars and courses on aging research and practical training. It draws students from Cologne and applicants from all over the world.

Each year doctoral candidates present their projects together with well-respected international experts from their research fields at a graduate symposium, the well-rounded end to the graduate program.

In 2013, the CECAD Graduate School fused with the IMPRS-Age doctoral program from the Max Planck Institute for Biology of Ageing, the Max Planck Institute for Metabolism Research and caesar in Bonn to form the "Cologne Graduate School of Ageing Research". The program is now even more attractive, since students profit from the synergies of all the institutes involved. This collaboration also allows potential in doctoral programs in aging research to be bundled at the Cologne and Bonn locations. The growing number of applicants is an impressive demonstration of the respected graduate school's success.



Editor

Prof. Dr. Jens C. Brüning, University of Cologne,
Scientific Coordinator of CECAD Cologne,
Cluster of Excellence, Joseph-Stelzmann-Straße 26,
50931 Cologne, Germany

Conception and project leadership

Astrid Bergmeister, CECAD Cologne, Head of PR & Marketing Department

Text, editorial office and image research

Astrid Bergmeister, Laura Knepper, Melanie Rohde

Translation

Dr. Meryl Clarke, Sarah Smithson-Compton, Jana Rogge

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