



Inserm-sponsored aging research in France

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More than 500 French academic research teams, supported by Inserm, CNRS, INRAE, CEA, INED, university hospitals (CHU), and universities, are engaged in aging research. Between 1995 and 2021, France's overall scientific output in this field was quantitatively lower than that of Germany or the United Kingdom, but comparable to Spain and higher than Japan (Web of Science). Despite producing fewer publications than Germany or the United Kingdom, the quality of French contributions appears at least equivalent, as reflected by the proportion of articles published in highly cited journals. This high level of quality can be attributed to the excellence of French teams working on specific aspects of aging, such as genome maintenance, cellular senescence, immunology, and neuroaging. Nevertheless, aging research in France has long remained too compartmentalized by discipline. In contrast, international efforts, particularly those led by researchers in the United States, were pioneering the field of geroscience, seeking to uncover early etiologies common to age-related diseases and thereby opening possibilities for their simultaneous prevention and treatment^[1]. This highlighted the urgent need to consolidate French biomedical research through interdisciplinary programs, which are essential for advancing aging research and hold the potential to transform future medicine and public health.

The first step was taken by Inserm with the launch of its first cross-cutting program dedicated to aging, from AGEd cells to MEDical applications (AGEMED). This program brought together more than twenty teams with a total budget of 3 million euros over six years (2017–2023). The initial strategy of AGEMED was to identify key cellular pathways of aging in the first phase and then, in the second phase, to translate this knowledge into innovative medical practices aimed at preventing and treating age-related diseases. To achieve these goals, AGEMED developed two main axes.

The first axis focused on cellular senescence. The general strategy was to conduct integrative analyses of large datasets in defined senescence models and to develop original mouse models that could be shared among the partners. This approach made it possible, on the one hand, to gain an in-depth understanding of the senescence program by revealing new epigenetic^[2], metabolic^[3] and immunological^[4,5] pathways. These findings paved the way for strategies to counteract pulmonary and hepatic fibrosis as well as age-related bone remodeling^[5]. On the other hand, it uncovered unexpected roles, such as the protective effect of telomerase against capillary vessel loss and pulmonary emphysema^[6], the function of p16 in reprogramming^[7] and the influence of cellular senescence on pulmonary hemodynamics, highlighting the potential of strategies targeting the control of cellular senescence^[8].

For the second axis, the general strategy was to identify the pathways underlying muscle and neuronal aging. Three notable advances were achieved. First, researchers discovered hormonal controls of neuronal pathways involved in cognition and memory^[9–12]. Second, they revealed the unexpected involvement of telomeric modifications in skeletal muscle aging, which leads to mitochondrial dysfunction^[13,14]. Third, significant progress was made in the study of Huntington's disease, opening new therapeutic avenues, including the role of huntingtin in axonal transport^[15,16] and the importance of neurodevelopmental circuits^[17,18].

Overall, AGEMED has had a strong structuring effect, fostering synergies and interdisciplinary collaborations that united a national community around the biology of aging. Collaborations within the AGEMED research community have continued through funding from the French National Research Agency, providing further evidence of AGEMED's leverage effect. This collaborative spirit has also expanded to a broader and more inclusive French community through the Thematic Network, still known as AGEMED, which was launched this year. The network now involves nearly 40 teams and focuses primarily on networking activities, while opening to disciplines beyond those of the initial cross-cutting program, including evolutionary biology, demography, nutrition, and various medical specialties.

Despite the successes of AGEMED, aging research requires international coalitions. Such collaborations are essential not only to contribute at the highest level to the remarkable efforts currently underway in many countries to combat age-related pathologies,



but also to pool resources, create new synergies, and assess the heterogeneity of aging patterns across populations. This transnational approach is critical for deciphering both the specific and universal processes and biomarkers of aging. Inserm has once again risen to this challenge by launching, in 2021, a six-year Thematic Cooperation Program on aging, InterAging (International Network to Fight Aging Diseases). The objective of InterAging is to foster collaborations between French AGEMED teams and partners in Singapore (National University of Singapore), China (Ruijin Hospital/Jiaotong University Shanghai), Germany (Cluster of Excellence for Aging Research, CECAD, Cologne), and the United Kingdom (Laboratory of Medical Sciences, LMS, London). A central component of this program is a PhD thesis scheme, in which students are co-supervised by a French AGEMED laboratory and an international partner laboratory. The program is now in full operation, featuring an annual meeting in each participating country, complemented by joint conferences involving leading researchers from France and the host nation, with high-profile publications expected to follow.

It is also worth noting that, at the interface between upstream research and medical or industrial translation, two Inserm laboratories composed of talented young researchers are partnering with University Hospital Institutes (IHU) to investigate the early stages of aging. Their aim is to identify strategies to prevent premature tissue aging and delay the onset of related diseases. These initiatives include the collaboration between the Nice Institute for Research on Cancer and Aging (<https://www.ircan.org/>) and the IHU RepirERA (<https://ihu-respirera.fr/fr/>), as well as the partnership between the RESTORE laboratory in Toulouse (<https://restore-lab.fr/>) and the IHU HealthAge (<https://ihuhealthage.fr/fr/>).

Overall, Inserm plays a pivotal role in fostering a vibrant research community focused on biomedical research on aging in France. Despite these valuable initiatives, a significant gap remains: the absence of an ambitious, inclusive, and coordinated national program specifically dedicated to the biology of aging. Such a program is essential for France to secure global leadership in this rapidly expanding field. Effectively addressing age-related diseases, which place a substantial burden on the healthcare system, cannot rely solely on Inserm's efforts. Achieving "healthy" or "sustainable" aging requires a comprehensive research program that integrates the biological processes of aging, both physiological and pathological, with their genetic determinants, lifestyle factors, socioeconomic conditions, and environmental exposures, particularly in the context of global changes. By connecting these complex factors, a national program could generate insights that not only deepen our understanding of one of the most fascinating biological processes and improve the quality of life for older adults but also help alleviate long-term pressure on healthcare resources. This underscores the urgent need for policymakers to prioritize and support comprehensive research programs on aging biology to maintain France's position at the forefront of international biomedical innovation.

Declarations

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Authors contribution

The author contributed solely to the article.

Conflicts of interest

Eric Gilson is an Editorial Board member of *Geromedicine*. No other conflicts of interest to declare.

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