

FUTURAGE

home

inclusion

partnership

healthy ageing

active ageing

ageing well

ICT well-being

community

sustainability research agenda

A Road Map for European Ageing Research

knowledge exchange

user involvement

biogerontology

October 2011

Road Map



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EXECUTIVE SUMMARY

This document contains the research agenda that will enable Europe to respond successfully to the unprecedented demographic challenges it faces. Its twin starting points are the high priority allocated to population ageing, by Member States and the European Union as a whole, and the fundamental importance of scientific research as the driver of innovations in public policy, in a wide range of clinical and other professional practices, and in the development of products and services. The combination of science and innovation will be the cornerstone of Europe's future success, both in terms of economic growth and the promotion of social quality for all citizens, and that equation lies at the heart of this Road Map.

The Road Map for ageing research is the product of the most extensive consultation ever undertaken in this field, involving all of the major stakeholder groups and end users of ageing research, and spanning a 2 year period. A specially designed iterative process ensured that the specific research priorities were not identified by scientists alone and were subjected to a high degree of reflection and cross-examination from a wide range of stakeholder perspectives, including policy makers, practitioners, business people, older people and their NGOs as well as scientists. This process led to an extraordinary broad and deep consensus on the major future priorities.

The Road Map itself consists of three main chapters. The first of these sets the scene by describing briefly the demographic context and emphasising the huge challenge facing the European Innovation Partnership pilot initiative on Active and Healthy Ageing (EIPAH) if it is to achieve its goal of increasing average healthy life expectancy across the EU by 2 years by 2020. Then the links between this document and some of the other major European policies concerning ageing are summarised.

A key role of the introductory chapter is to explain the importance of active ageing to the Road Map. Originally one of the individual priority topics generated by the iterative process it was subsequently elevated to the central theme of the Road Map. In addition the case is advanced for a new comprehensive approach to 'active ageing' which includes all activities, physical or mental, and all age groups. Then each of the major research priorities is linked to the active ageing core theme on the assumption that this should be a central aim of ageing research.

The Road Map is also based on eight basic assumptions: multi-disciplinarity, user engagement, a life course perspective, a person-environment perspective, the importance of diversities and intergenerational relationships, knowledge exchange and technological innovation – which should figure significantly in all priority topics.

The final contextual building block is a full account of how the Road Map was produced.

The second chapter forms the centrepiece of the Road Map. It is here that the following seven major priority research themes are described and explained using a common format. Within each theme the main priority topics are identified along with examples of specific research questions.

The major priority themes for future ageing research are:

- Healthy Ageing for More Life in Years
- Maintaining and Regaining Mental Capacity
- Inclusion and Participation in the Community and in the Labour Market
- Guaranteeing the Quality and Sustainability of Social Protection Systems
- Ageing Well at Home and in Community Environments
- Unequal Ageing and Age-Related Inequalities
- Biogerontology: from Mechanisms to Interventions

The third main chapter concerns the implementation of the Road Map and covers four critical issues.

First of all it is vital for Europe to invest in ageing research infrastructure. The case is made for a European Institute of Ageing, but, at the very least, there must be some coordination mechanism of the kind that the European Research Area in Ageing (ERA-AGE) has been providing since 2005, but with an enhanced capacity.

The second implementation priority is to ensure the future development of scientific expertise in this field. There is a need for additional capacity building at all levels – doctoral programmes, post-doctoral programmes and mid-career development programmes – otherwise Europe will not be able to match North America and Asia in research and innovation in ageing.

Thirdly, user engagement is a critical element of implementation as well as a fundamental assumption of future ageing research. User engagement was allocated an equal status to science in the production of the Road Map and the main challenges for both scientists and research funders in implementing the principle of user involvement are laid out in Chapter 3.

Fourthly, linked to user engagement, knowledge exchange or knowledge transfer is a neglected aspect of ageing research. The pilot EIPAHA should provide the framework to remove barriers to successful innovation in this field. What is needed is a new priority for knowledge exchange in which project funding rests not only on scientific excellence but also on the quality of the knowledge exchange plans.

Thus this Road Map sets out the major research priorities for European ageing research over the next 10 or so years. It also calls for new approaches to ageing research which are more multi-disciplinary, life course focussed, user engaged and have a big emphasis on knowledge exchange. Furthermore it calls for a new vision of ageing which promotes its positive possibilities rather than deficits, inclusion and full citizenship rather than exclusion. Therefore the Road Map challenges all stakeholders in ageing research – policy makers and research funders; NGOs, practitioners, business people; scientists; and older people – to work in unison to ensure that research maximises its impact on the well-being of all Europeans as they age.

CHAPTER 1: INTRODUCTION

Europe is the oldest region in the world. Population ageing has been a policy priority at both Member State and European Union (EU) levels for more than two decades and, in recent years has been promoted to the level of a 'grand challenge'. It is widely accepted too that scientific research is essential if Europe is to respond successfully to this challenge because it provides the evidence base for innovation in policy, practice and product and service developments. It is the key to ensuring that the positive potential of ageing is realised for both individuals and societies. In a nutshell it is the purpose of this document to facilitate that: by framing the research agenda that Europe will need to respond to the unprecedented demographic challenge in an innovative and sustainable way. The European Commission (EC) has emphasised the high importance of scientific research in addressing the challenges presented by population ageing. According to the Commissioner for Research and Innovation, Máire Geoghegan-Quinn,

Ageing research is an area of great social, political and economic importance for the European Union... I want to re-focus research and innovation policies very clearly on developing a coherent strategic research agenda which will tackle the grand societal challenges, which include both the promotion of healthy living and healthy ageing... These challenges can only be confronted if innovative and multi-disciplinary approaches are taken.¹

As the Commissioner also noted in the same speech this Road Map is the collective product of the most extensive consultation ever undertaken on this topic, which spanned two years and involved the major stakeholder groups in ageing research and policy among Member States and Associate Countries. These include scientists, policy makers, practitioners, product developers and producers, carers and older people and their organisations. Critically too, it brought together all of the relevant scientific disciplines. A high level of consensus was achieved, among the various stakeholders and between the scientific disciplines, about the research priorities contained in this document, as well as the new approaches it espouses.

Everyone involved in the production of this Road Map is agreed not only on the main research priorities and the universal organising principals and methods but, also much more fundamentally, on the necessity for a new vision of ageing and innovative ways to develop the science of ageing. A new vision of ageing is required because the present dominant paradigm is now a relic of a previous socio-demographic era in which retirement took place for a majority at state pension ages and post-retirement years were relatively short. Changes in the labour market and social behaviour coupled with a remarkable extension in longevity, associated in some countries with a pushing further up the age range (or 'compression') of morbidity, have transformed the experience of later life. Commercially too, the new old are no longer ignored, as in the previous era, but routinely regarded as targets for a diverse range of products from cosmetics to package holidays. The boundaries of frailty are being pushed back and, for a growing number of older Europeans, 70 **is** the new 50.

Unfortunately however there continues to be a 'structural lag' between this socio-demographic leap and societal institutions and attitudes, for example in the labour market and media.² Hence the need for a new vision. This has to be a positive vision in which all older people, regardless of competence and capability, are included as full citizens, expected to contribute and participate, and in which they feel empowered. The reality of the plasticity and diversity of old age must replace the outdated model of inevitable decline and disability. Later life is but one part of a life course which is characterised by lifelong development. Although there are well known problems with terminology, the concept that best captures this life course perspective is 'active ageing'. We argue later why this should be the overarching theme of future ageing research. It must be emphasised here though that this paradigm does not exclude inactive or frail older persons, it is an inclusive one.

Alongside this new vision of ageing there should also be new scientific approaches. More multi-disciplinary perspectives are required in order to reflect the fact that the ageing process and its experience are holistic. But research funding regimes have not always been open to such multi-disciplinarity, again with

important exceptions that have blazed the trail in this respect. As we argue below this new science of ageing also includes a life course perspective, pays attention to person-environment interaction and is user engaged. Moreover the changing demographic context increases the need for a greater focus on chronic conditions. The non-communicable diseases (NCDs) – strokes, cancer, heart attacks, lung disease and dementia – are increasing and, by 2020, will be the top four causes of death globally. Three in every four deaths from NCD occur in people age 60 and over and their incidence rises with age. For example dementias affect 12% of those over 65 and 30% of those over 85.

A new vision of ageing and new scientific approaches are the base lines for the FUTURAGE Road Map. In the rest of this introduction we will summarise the demographic context, show how the Road Map is linked to major EU initiatives, introduce the active ageing paradigm and explain how the Road Map was developed and designed.

Demographic context

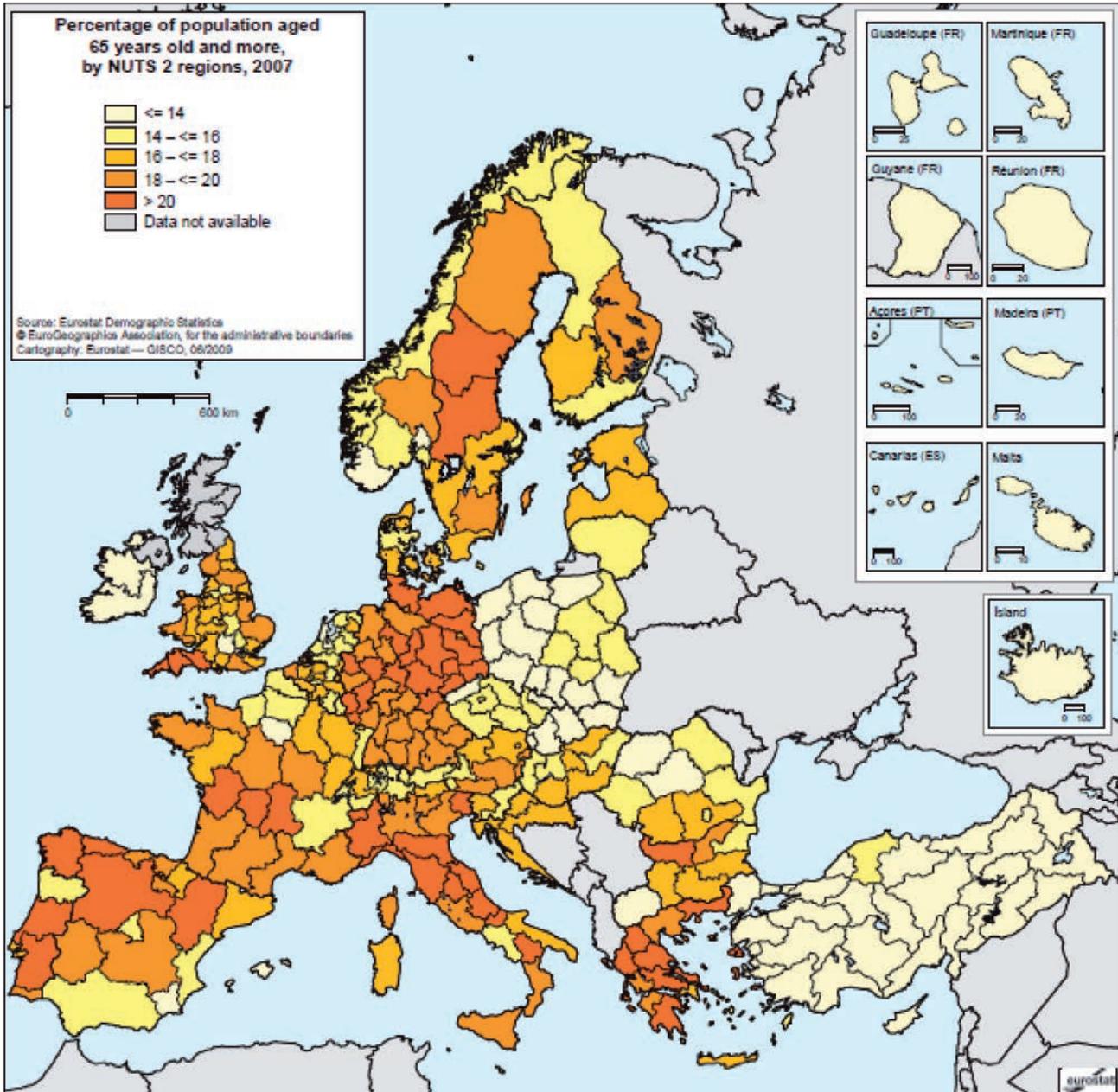
The upward trajectory of European ageing has been linear for more than 150 years. The increase in life expectancy currently averages 12 months every 5 years and shows no sign of abating.³ The number of Europeans aged 65 and over is expected to increase by 45% between 2008 and 2030, and will be over 30% of the population by 2060.

The total population of Europe is also increasing, even though some Member States are experiencing population decline. Using data from the EUROPOP2010 survey the ‘convergence scenario’ for the EU27 population is projected to increase from 501 million on 1 January 2010 to 525 million in 2035, to peak at 526 million around 2040, and thereafter gradually decline to 517 million in 2060.⁴ Accompanying this trend the share of the population aged 65 years and over rises from 17% in 2010 to 30% in 2060, with those aged 80 and over being the fastest growing age group, increasing from 5% to 12% over the same period.

A clear sign of the longevity revolution taking place currently is the growth in the number of centenarians. Although these super-survivors are still relatively rare they highlight the expansion of the much larger group of very old, aged 85 and older. Unfortunately and surprisingly we do not have reliable estimates for the total number of centenarians in all EU countries and, therefore for the Union as a whole.⁵ Analysis of this important social change has been made possible however, following the collaborative development of a Human Mortality Database (www.mortality.org). Since 2002, this has been able to progressively develop a robust range of indicators so that by 2009 datasets on 38 countries were available, including most EU countries. Robine and Saito note that in the larger Member States there has been a ‘smooth and steady’ rise in the number of centenarians, yet in the smaller states the trend is upwards but fluctuating. The most recent estimates, for 2006, are there were 57306 centenarians in total, with women outnumbering men by 6:1. By 2060, there will be between 750000 and 1.8 million centenarians in Europe.⁶

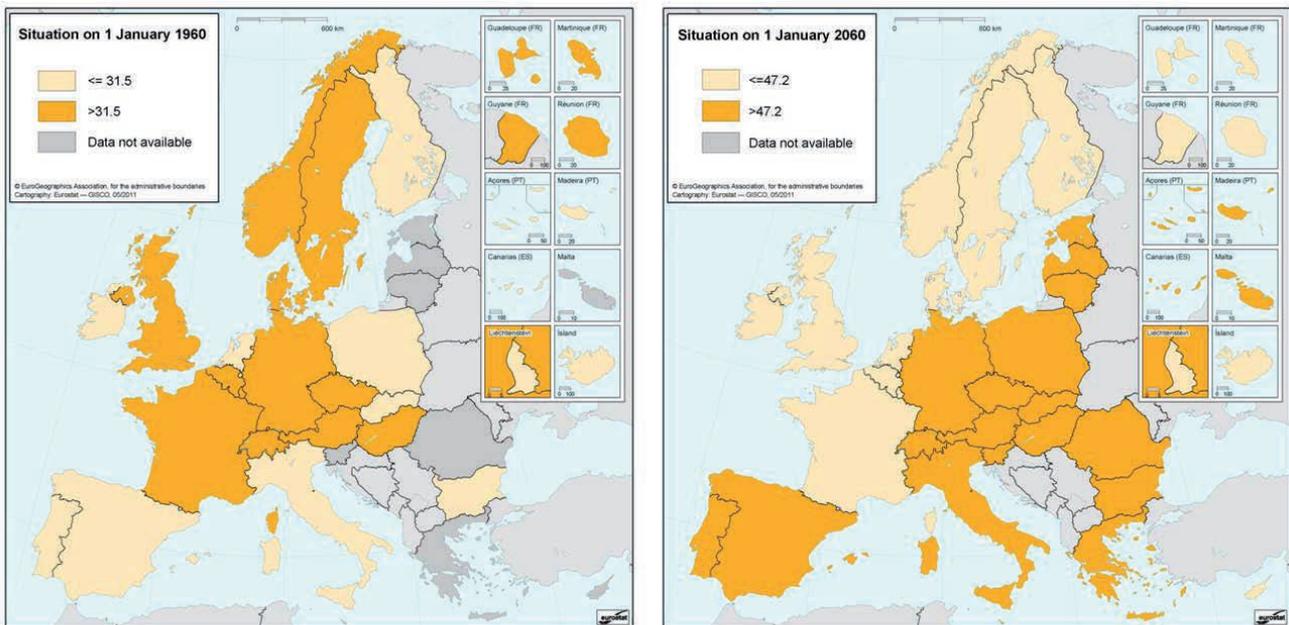
These demographic changes are not distributed uniformly across EU Member States and regions. As Figure 1 shows most people over 65 live in the Western parts of the EU, although it should be noted that data are not available for some areas of Eastern Europe. Looking to the future, not only will the average (median) European age increase but the process of population ageing will shift eastward, as shown in Figure 2. For example, it is estimated that by 2040 countries such as Latvia and Romania will have the highest median ages in Europe, while Sweden and most of the Nordic and Western European countries will share the youngest age profiles. Those countries in Southern and Central Europe, such as Hungary and Slovakia, are likely to have above average age profiles (Figure 2). These differences between Member States and regions demonstrate that a ‘one size fits all approach’ is not appropriate and therefore the future research and policy agendas have to become more nuanced. It also challenges the European scientific research community to ensure close collaboration and knowledge exchange between Member States, something that the European Research Area in Ageing (ERA-AGE) has pioneered and which we will return to later.⁷

Figure 1 Percentage of Population Aged 65 Years and Over by Region, 2007



Source: Eurostat Demographic Statistics

Figure 2 Countries Above or Below the Average of the Median Age in Selected Years



Source: Eurostat, Statistics in Focus, 23/2011 June 2011 figure 2

Healthy Life Expectancy

As the earlier extract from Commissioner Geoghegan-Quinn's landmark speech on ageing research indicates the EU places a high priority on healthy ageing. So does this Road Map. It is inevitable that, as the impact of infectious diseases recedes, the emphasis of both science and policy shifts from reduced mortality to longevity, and then to healthy life expectancy (or disability free life expectancy). This welcome policy focus has been given high visibility at the European level by the European Innovation Partnership on Active and Healthy Ageing (EIPAHA) which has set the highly ambitious target of raising healthy life expectancy across the EU by an average of 2 years by 2020.

The extent of the challenge presented by this target can be seen from Figures 3 and 4 which show the variation in healthy life years for men and women aged 65. The current average healthy life years at 65 in the EU is 8 years for both men and women, but this varies among Member States from 3 years in Estonia to 13 years for women and 14 years for men in Denmark. Healthy life years at birth average 61 for women and 60 for men across the EU, but range from 52 in Latvia to 70 in Malta for women and 49 in Estonia to 68 in Denmark for men. In fact the healthy life years gap between European countries exceeds the gap in life expectancy and both of these gaps are driven mainly by the low levels of life expectancy and healthy life expectancy in Central and Eastern European countries.⁸ Analysis of data from the EU15 prior to enlargement, by Carol Jagger and her colleagues, revealed a complex picture in which healthy life years were expanding (men in Austria, Belgium, Finland and Germany; women in Belgium, Italy and Sweden) and contracting (men in Denmark, the Netherlands, Sweden and the UK, women in Germany Greece, Ireland, the Netherlands and Portugal).⁹

This is the demographic context in which this Road Map was prepared and to which it is principally addressed. It is aimed at assisting Europe to respond to the demographic challenges and, in particular, at understanding and promoting active ageing and the growth of healthy life expectancy. We now turn to the policy context.

Figure 3 Healthy Life Years at Age 65 for Women, 2008



Source: Eurographics

Figure 4 Healthy Life Years at Age 65 for Men, 2008



Source: Eurographics

European Policy Priorities

This Road Map was not designed purely by scientists nor is it aimed at the scientific community alone. Indeed it seeks to integrate a wide range of stakeholder interests in the ageing research and general ageing fields. It was prepared with major EU policy priorities in mind. Thus the Road Map aims to contribute to the Europe 2020 strategy objective to develop a competitive and resource-efficient economy based on knowledge and innovation. The FUTURAGE partners identified research priorities that could contribute to the European smart and inclusive growth objective by investigating ways of helping people to participate longer in society and adapting good quality responsive services for people as they age. The agreed priorities could also support European sustainable growth by exploring approaches to improving older people's health and participation, thus reducing social protection costs as well as enhancing quality of life.

The priorities identified by this Road Map are also completely in line with the goals of the pilot EIPAAH recently launched by the European Commission. Extending healthy life years in Europe had already emerged as a hot topic from the FUTURAGE consultation process before this announcement was made. Therefore Chapter 2 illustrates key areas in which research could support the goal of raising the average healthy lifespan in the EU.

Moreover we hope the Road Map will contribute to the 2012 European Year for Active Ageing and Solidarity Between Generations. As we emphasise below active ageing is the centrepiece of this Road Map. FUTURAGE partners consider this European Year as an important opportunity to investigate innovative solutions to the current economic and social challenges facing our ageing population. In order to increase older people's participation in society, including the labour market, as well as to promote healthy ageing, further research is needed in the priority fields highlighted in Chapter 2. Also, being aware of the discussion on the European Institute of Innovation and Technology (EIT) FUTURAGE recommends the inclusion of 'ageing' in the Strategic Innovation agenda of the EIT. This will help to ensure that the results of the research on ageing are better translated into effective actions.

The European Pact for Mental Health and Well-being, launched in June 2008, includes, as one of its five priority areas, 'mental health and older people' and, therefore, is of direct relevance to this Road Map's priority theme on mental capacity. There is also a high level of symmetry between the approach and content of the Road Map and other prominent EU policies and initiatives. The White Paper Together for Health: A Strategic Approach for the EU 2008–2013¹⁰, overlaps in various places with this Road Map, even though our work was conducted independently of it. For example, the significance of shared health values in Europe, such as universality, access to good quality care, equity and solidarity, the importance of citizen empowerment, reducing inequalities in health and the commitment that 'health policy must be based on the best scientific evidence derived from sound data and information, and relevant research'. Similar synergies are found between this Road Map and the Demographic Report 2010¹¹. These include the promotion of active ageing, increasing healthy life years and the integration of migrants. The Road Map also speaks directly to the Digital Agenda for Europe in recognising the potential of Information and Communication Technologies (ICT) to offset some of the impact, of later life loss of function and to promote social inclusion among older people (although there is an entirely separate road map project on ageing and ICT development, see below).

Other Road Maps

FUTURAGE was not the first European road map project in the ageing field and others have been commissioned subsequently. By virtue of its disciplinary spread, however, it does claim to be the most comprehensive one. The WhyWeAge road map for biogerontological research was the first of its kind and it was amalgamated with FUTURAGE. Close links were also established with the BRAID project (Bridging Research in Ageing and ICT Development). BRAID has also adopted active ageing as a guiding concept to illuminate four different 'life settings': independent living, health and care, occupation and recreation.¹²

These aspects of life also feature in the following chapter on research priorities but in the BRAID project the emphasis is on the use of ICT to improve the quality of later life.

In the field of Ambient Assisted Living, the AALIANCE (The European Ambient Assisted Living Innovation Platform), similar to BRAID, seeks to utilise the rapid developments in ICT to enhance the lives of people as they age. Specifically the focus of the AALIANCE project is on the commercial delivery of Ambient Assisted Living (AAL) solutions based on advanced ICT technologies for the areas of ageing at work, ageing at home and ageing in society. It provides a framework for stakeholders, led by key leaders in industry (including Bosch, Phillips, Nokia and Vodafone), to define research and development (R&D) priorities through a 'road map' document, time-frames and action plans in the field. FUTURAGE kept in close touch with AALIANCE during the development of this ageing research Road Map. One of the key partners in FUTURAGE, Age Platform Europe, was also a partner in AALIANCE.¹³

The FUTURAGE Road Map development template has been replicated by the ROAMER project in a successful Framework Programme 7 application to prepare a similar one for mental health research (A Roadmap for Mental Health in European Research). The FUTURAGE project also assisted the Joint Programming Initiative (JPI) 'More Years Better Lives' by sharing early drafts of the Road Map to support its priority setting exercise.

The Priority of Active Ageing

During the Road Map development process active ageing quickly emerged as a major multi-disciplinary theme. Rather than being one among several priority themes, moreover, it is the red thread that links all of them (see Chapter 2). In scientific terms active ageing is used as a helpful umbrella term to encompass various combinations of quality of life essentials such as continuous labour market participation, active contribution to domestic labour (caring, housework), active participation in community life and active leisure. It is valuable too in being able to synthesise strands of research on ageing and developmental science which traditionally have not had much in common. For example the need to combine research able to drive social policy or cultural investments with that concerning the individual level of ageing, such as in regard to health, cognitive functioning and motivation. The concept of active ageing is also valuable in social gerontology in linking the macro, meso and micro perspectives of ageing research.

Active ageing requires a social-ecological view of ageing. Different levels such as evidence-based policy action (macro), community and neighbourhood arrangements (meso) and individual intervention (micro) must go hand in hand in order to effectively promote active ageing. In addition, the social-ecology perspective implies a contextual view to be imposed on active ageing, because active ageing outcomes are significantly driven by the interplay between persons and environmental resources and constraints. A social-ecology view also comes with a purposefully wide understanding of environmental levels including the physical, spatial, social, economic, cultural legal and value context and the 'chronosystem',¹⁴ that is, the flow of individual and historical time as a context of active ageing. This also means that the concept of active ageing must be multi-disciplinary including, for example, sociology and social policy research, psychology, biogerontology and economics in order to acknowledge its holistic nature. Because of its integrative potential, the construct of active ageing aims to nurture the bridge-building between the different thematic areas of the Road Map, for example between health, social participation and the role of place and context.

While there are compelling scientific reasons to employ the concept of active ageing as a central theme the political ones are no less so. In brief the concept already has a major European and global profile. The European Year of Older People in 1993 represented the first proclamation by Europe of a new active and participative discourse in ageing.¹⁵ This was expanded into an outline of a European approach to active ageing during 1999, the United Nations (UN) Year of Older People. The EC's policy document and the special conference it staged on the topic of active ageing set a radical vision of this concept and how it would be implemented across a broad field of national and European responsibilities.¹⁶

On the global front the World Health Organisation (WHO) has also advanced a multi-dimensional concept of active ageing:

The process of optimising opportunities for health, participation and security in order to enhance quality of life as people age. Active ageing applies to both individuals and groups. It allows people to realise their potential for physical, social and mental well-being throughout their lives and to participate in society according to their needs, desires and capacities, while providing them with adequate protection, security and care when they require assistance.¹⁷

This conceptualisation has made two important contributions to European (and global) discourses on active ageing. It added further weight to the case for a re-focusing of active ageing away from a narrow focus on employment and towards a consideration of all of the different factors that contribute to well-being. Specifically it argues for the linkage, in policy terms, between employment, health and participation. Along similar lines it emphasised the critical importance of a life course perspective. In other words, to prevent some of the negative consequences associated with later life it is essential to influence individual behaviour and its policy context at earlier stages of the life course. The WHO's approach to active ageing also contributes to the growth of the discourse on older people as active participants in society that had been signalled so strongly at European level in 1993, was reiterated in the European response to the UN Year of Older People in 1999 and will be centre-stage in 2012. The priority of active ageing was adopted by the UN's Madrid International Action Plan on Ageing (MIAPA) in 2002, along with the principle of older people's right to participate.¹⁸

The Need for a Comprehensive Vision of Active Ageing

We are convinced of the need for a new comprehensive paradigm of active ageing, one which brings together its gerontological heritage, stretching back to the 1960s 'successful ageing' concept, and the current pressing policy imperatives. This new paradigm would also reflect the need for a life course approach to ageing (in science, policy and practice) which transcends the traditional age segregation into three life stages – education, work and retirement – and adopts an age-integrated approach in which all three concurrently span much of the life course.

The foundations for a comprehensive approach to active ageing exist already in European and WHO documents.¹⁹ Their emphasis on well-being and participation is highly important as is the life course focus. Also, crucially, 'activity' must consist of all meaningful pursuits (mental and physical) that contribute to the well-being of the individual concerned. Because of the dangers of exclusion active ageing should not be focussed only on the young-old. For all age groups, it should be participative and empowering and, in public health terms, preventative.

To these essentials must be added a division of labour and responsibility to underline the fact that active ageing depends on a wide range of different actors and cannot simply be a top-down imposition by policy makers. For example age management in enterprises to improve opportunities for older workers, must be largely a matter for organisations themselves. Furthermore, we should not assume that active ageing exists as a fully developed entity but, rather, it should be seen as an aspiration. Thus it might be defined as:

A comprehensive strategy to maximise participation and well-being as people age. It should operate simultaneously at the individual (lifestyle), organisational (management) and societal (policy) levels and at all stage of the life course.²⁰

An effective strategy for active ageing would be based on a partnership between the citizen and society. As far as society is concerned the policy challenge is to recognise the thread that links together all of the relevant policy areas: not only employment, but also health, social protection, social inclusion, transport, education and so on. A comprehensive active ageing strategy demands that all of them are 'joined up' and become mutually supportive: creating a true 'Society for all Ages' as expressed by the UN. The parallel role of the citizen is to act with responsibility to take advantage of opportunities, for example in education and training, and to participate where appropriate.

It is this comprehensive vision of active ageing that is at the heart of this Road Map, including its life course emphasis and the priority accorded to reducing unhealthy life years. There is close affinity too between the Road Map and the WHO's strategy for realising active ageing. According to the WHO there are eight main determinants of active ageing: culture and gender (both of which are cross-cutting), health and social services, behavioural, the physical environment, the social environment, economic determinants and those related to the person concerned (such as biology, genetics and psychology).²¹ As will be apparent from Chapter 2 the research themes of this Road Map, although arrived at via an independent and wide ranging consultation, are very similar to these determinants of active ageing.

Designing the Road Map

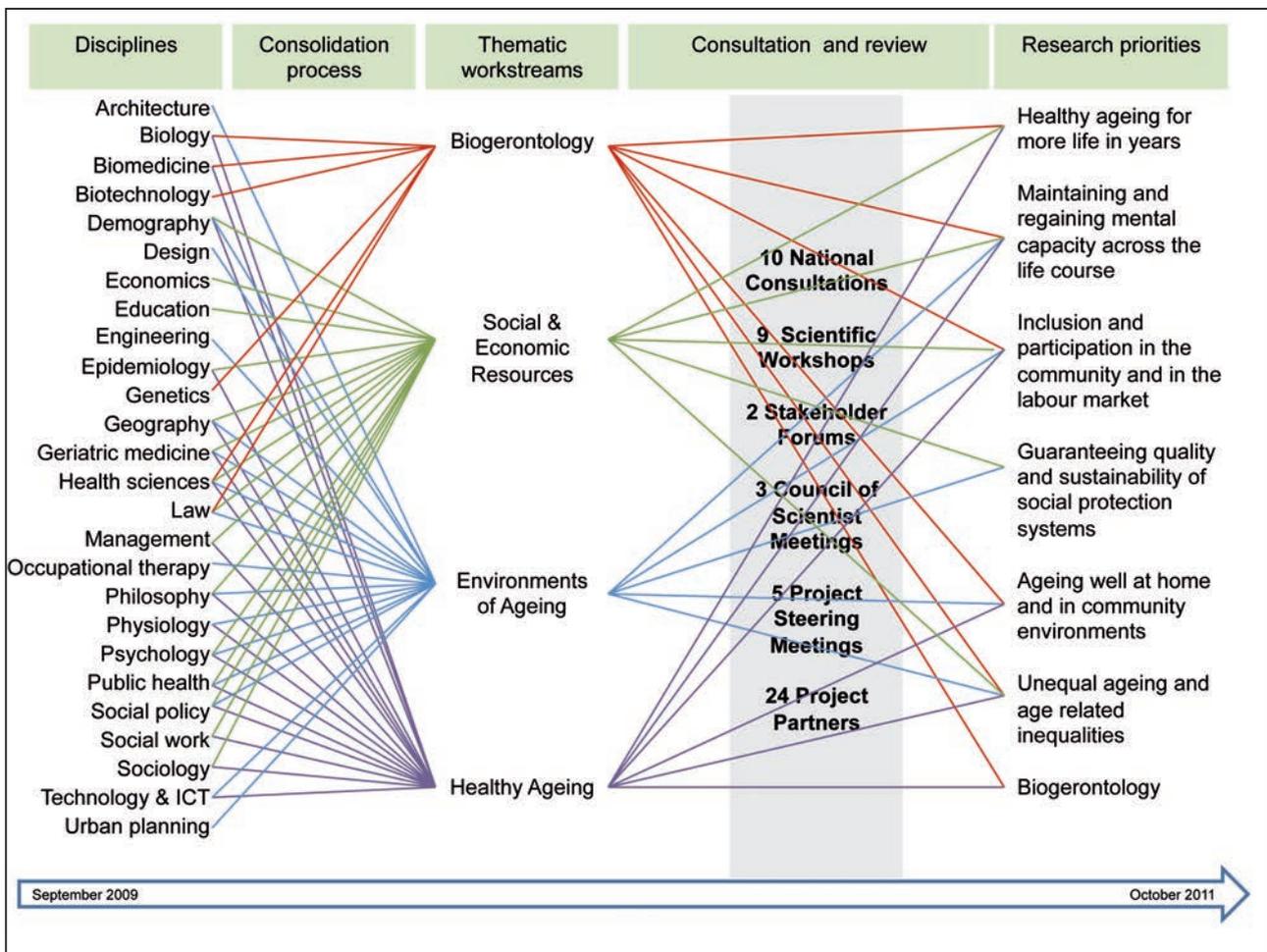
The main purpose of FUTURAGE was to produce the definitive Road Map for the future of ageing research in Europe. The project application was designed from a multi-disciplinary perspective because, as argued previously, ageing cannot be understood, or its challenges addressed, from within any single discipline or even a cognate group of them. Building on the experience of national programmes of ageing research, such as the programme of Ageing Research in Finland and the New Dynamics of Ageing in the UK²², as wide a spectrum of disciplines were assembled as could be incorporated into the 'Health' brief of the original call for proposals. These were thematically grouped as follows:

- Biogerontology
- Social and Economic Resources
- Healthy Ageing
- Environments of Ageing

Altogether some 26 major scientific disciplines were engaged in the process via these four groups (there was also a separate user engagement theme – see below). When FUTURAGE was being devised there was already a road map project on biogerontology, WhyWeAge (and, as was noted above, various others have been created since). It was decided that, rather than duplicate this work, the WhyWeAge project would be meshed into the FUTURAGE process. For the most part this operated smoothly, thanks to the project director Olivier Toussaint and his team, but it was impossible to achieve complete integration in every aspect of the FUTURAGE Road Map development process.

A key problem which confronted the core FUTURAGE team (the Coordination Team and the leaders of the thematic groups) was the apparent contradiction between the four groups and the clear commitment to multi-disciplinarity. In fact the four groups were themselves multi-disciplinary to varying degrees. Then in the work of the groups and in their interactions with other stakeholders, the essential nature of the multi-disciplinary approach was confirmed repeatedly. Finally, when the Theme Leaders and Coordination Team began to assemble the Road Map on the basis of the outcomes from the preceding iterative process, it was remarkable that the major themes identified as the leading priorities were all multi-disciplinary, with the partial exception of the biogerontological one. The connections between the four groups and their constituent disciplines, and also the major research themes of the Road Map are shown in Figure 5.

Figure 5 Scientific Foundations of the Road Map



Appendix 1 illustrates the iterative process adopted by FUTURAGE to produce the Road Map and it shows clearly that, as well as myriad scientific disciplines, research end users, including older people, were engaged throughout the process in two ways. First, there was a specific user engagement theme running concurrently with the four scientific themes and, secondly, the two stakeholder forums were composed primarily of research users. In addition users were involved in the initial round of national consultations (see next section).

Fundamental Assumptions

The FUTURAGE project was conceived with eight key assumptions in mind, several of which have been discussed already. They function as overarching, or vertical, assumptions that run through each of the priority themes in Chapter 2 (therefore they should not require constant repetition).

• Multi-disciplinarity

The first assumption is multi-disciplinarity which has been discussed previously. The assumption is not that every research topic must be tackled from a wide range of disciplinary perspectives but that the option of multi-disciplinarity should be considered in each case and that the choice should be science-led. In other words it should be used where scientifically appropriate rather than being imposed by research funders. It

goes without saying that there have to be better guidelines for scientists on multi-disciplinary research and journal outlets for this work.²³ Of course the ambitious may attempt inter-disciplinary or trans-disciplinary research but those are longer term goals for mainstream science.

Included within this priority for multi-disciplinary science is the necessity for theoretical research (and it might have been positioned as a separate basic assumption). Understanding of the meanings of ageing, its biological, social and cultural constructions, is vital to the production of effective responses as well as to the extension of human knowledge.

• User Engagement

The second assumption is user engagement. By 'user' we mean the end users of research which include practitioners, policy makers, product designers and producers, older people and their representative Non-Governmental Organisations (NGOs), research funders and scientists. It is especially essential in the ageing field for science to be informed by those who may be responsible for implementing its findings for the benefit of current or future generations of older people, in order to ensure that scientific outputs are as relevant as possible to their everyday lives. Because this assumption was so fundamental to the FUTURAGE project a distinct user engagement theme was added to the four scientific ones and this ran throughout the project in parallel to the others (see below). We also return at length to this important topic in Chapter 3 concerning the implementation of the Road Map.

• Life Course Perspective

The third basic assumption, the life course perspective, needs no further detailed comment save to emphasise the importance of research seeking to address active ageing or healthy life expectancy to focus on the whole life span and not only on older people.

• Person-environment Perspective

Fourthly, although the person-environment perspective was strongly represented in the Environments of Ageing group we are certain that it must permeate all aspects of ageing research. It is crucial for research to approach ageing individuals and groups as being embedded in and, to some extent, products of complex social and ecological exchanges and interactions.²⁴

• Diversities

Then there are two key assumptions relating to diversity. On the one hand ageing is characterised by diversities but, almost always, older people are homogeneously described. There are deep inequalities in the experience of ageing in European countries, based for example on gender, ethnicity, age, disability, sexuality, social class and location. These must be at the centre of any research or policy agenda on ageing if they are to be understood and prevented or ameliorated.²⁵ On the other hand there is diversity within the EU, North-South, East-West. In particular there is a need to study and explain differences in ageing and life expectancy between the East and West of Europe. There are also big differences in research capacity which we come back to in Chapter 3.

• Intergenerational Relationships

Sixthly, we take the view that intergenerational relationships are fundamental to ageing in this continent. While they may vary in their approaches, the economic, fiscal and social systems of all European Member States are based on solidarity between citizens of all generations. The upcoming European Year for Active Ageing and Solidarity between Generations (2012) confirms the importance that also the European policy makers give to this topic. Intergenerational solidarity is an integral part of European shared heritage and FUTURAGE partners agreed that research should routinely include it as a variable.

• Knowledge Exchange

The seventh basic assumption is knowledge exchange. It is essential for the results of scientific research to be communicated as quickly and as widely as possible, so that any translation potential may be exploited. Because this issue is so critical to the impact of ageing research we return to it in Chapter 3.

• Technological Innovation

The final vertical assumption of this Road Map is the need to maximise technological innovation. Because there is a separate road map project on ICT and ageing and the AAL programme, it was not treated as a distinct priority theme by FUTURAGE. However, it is important that ageing research includes a technological dimension wherever possible because of its potential to both assist to offset loss of function and to promote European economic growth.

In sum, these assumptions were taken for granted in the development of the seven research themes contained in Chapter 2. They emphasise the case made previously for new approaches to the science of ageing that are multi-disciplinary, holistic, life course focussed and user engaged.

Producing the Road Map

From the outset FUTURAGE was committed to achieving its ultimate objective, this Road Map, by the most inclusive process that finite resources would allow, rather than just gathering together an elite group of scientists to do the job. To achieve this aim a complex iterative process, with nine distinct stages, was created (Appendix 1). The starting point was a series of national consultations conducted by ten countries in ERA-AGE (Austria, Bulgaria, Finland, France, Italy, Latvia, Romania, Spain, Sweden, United Kingdom). They approached small representative samples of scientists, policy makers, NGO leaders and other stakeholders to ask about their priorities for ageing research. Altogether 350 people and organisations were engaged in this process, the latter representing thousands of people.

The results of this exercise became the raw material for the first round of workshops convened by the five groups (four disciplinary groups plus one on user engagement). The groups were led by leading scientists in their respective fields and, in the case of the user engagement one, a national and European NGO:

- Biogerontology – Olivier Toussaint (University of Namur)
- Social and Economic Resources – Giovanni Lamura (INRCA)
- Healthy Ageing – Carol Jagger (Newcastle University) and Stuart Parker (Sheffield University)
- Environments of Ageing – Hans-Werner Wahl (Heidelberg University) and Susanne Iwarsson (Lund University)
- User Engagement – James Goodwin (Age UK) and Anne-Sophie Parent (AGE Platform Europe)

The workshops comprised around 30 participants each, including both senior and junior scientists and very wide geographical representation including, in some cases, leading scientists from Asia, North America and Africa. To strengthen the iterative and synthesised nature of the FUTURAGE process, to the greatest extent possible, the Theme Leaders participated in each other's workshops. To avoid re-inventing the wheel the raw material for the first round of workshops included not only the results of the national consultations but also the outputs from the previous major EU coordination actions, such as FORUM, LINK-AGE and AGE-ACTION.

At the third stage the workshops reports were discussed by the first meeting of the FUTURAGE Council of Scientists. This body consisted of 23 of Europe's most senior scientists in the ageing field representing all of the main disciplines. It was chaired by Marja Jylhä (University of Tampere) and a full list of members is at

Appendix 2. Following the Council of Scientists was the first Stakeholder Forum. FUTURAGE used the existing European Forum of stakeholders in the ageing field that runs under the ERA-AGE project to conduct this stage of the iteration process. It enabled a wide range of stakeholders – policy makers, research funders, NGOs, representatives of business, practitioners – to cross-examine the outputs from the first round of workshops.

The next stage consisted of a second round of workshops (which included some new members to ensure wide disciplinary representation) based on the initial reports and the feedback from the Council of Scientists and Stakeholder Forum. These workshops were followed by further meetings of the Council and Forum. At this stage the Ministry of Science and Innovation in Spain organised a 3-day conference to discuss Spain's contribution to the Road Map. It was attended by more than 200 researchers who cross-examined the outputs from the FUTURAGE workshops. The final report from the conference was fed back into the remainder of the iterative process.²⁶ Then the thematic group leaders and the coordinator met three times to consider the results of the iterative process, distil the contents and prepare the Road Map. This was a major brainstorming effort based on the workshop reports, which produced the seven key research themes in Chapter 2 (apart from biogerontology) and the integrative theme of active ageing. During this process 'mental capacity' was identified as a key theme neglected to some extent in the workshops. Finally drafts of the major research priority themes were checked with the Council of Scientists. Interspersed between these different stages were meetings of the Project Steering Group consisting of the Coordination Team, workshop Theme Leaders and representatives from ERA-AGE.

That was the complex, inclusive process that generated the major research priorities contained in Chapter 2. The individual workshop and Forum reports and the final reports from each of the core themes have been published on the FUTURAGE website, at: www.futurage.group.shef.ac.uk/resources.html.

CHAPTER 2: MAJOR PRIORITIES FOR EUROPEAN AGEING RESEARCH

The large scale collective effort described in Chapter 1 has been distilled by the process described and illustrated in Appendix 1, into seven major priority themes:

- Healthy Ageing for More Life in Years
- Maintaining and Regaining Mental Capacity
- Inclusion and Participation in the Community and in the Labour Market
- Guaranteeing the Quality and Sustainability of Social Protection Systems
- Ageing Well at Home and in Community Environments
- Unequal Ageing and Age-Related Inequalities
- Biogerontology: from Mechanisms to Interventions

These major priorities are described in detail in this chapter following two preliminary remarks. First the health warning. While we cannot guarantee that every possible research topic of importance is included here we do have a high level of confidence that the major ones are represented. This confidence is based on the constant feedback loops built into the preparation process; the high quality of the participants involved including most of Europe's leading scientists in the ageing field; and the experience of the Theme Leaders and Coordination Team.

Second, Figure 6 provides a reminder that active ageing across the life course provides the foundation paradigm upon which the seven key priorities themes for the future of ageing research are based. While there are cross-cutting linkages between the themes all of them have the same reference point. The comprehensive conception of active ageing discussed in Chapter 1 is clearly linked closely to the healthy ageing theme. Indeed, in some formulations, the term 'healthy and active ageing' is used. Here though health is seen as a vital contributor to participation in later life. The mental capacity theme is connected to active ageing in two main ways: as a key determinant of physical engagement and as an 'activity' in its own right. As noted in Chapter 1, the full scope of day-to-day mental and physical engagement and wider participation are important for cognitive health (building up the brain reserve) and healthy life expectancy overall. The importance of inclusion and participation to the active ageing theme does not require elaboration. Social protection system sustainability similarly has been so closely identified with the active ageing policy at the European level that its role is obvious. The environmental theme is also clearly of vital importance to active ageing, chiefly in terms of accessibility and mobility. Unequal ageing connects to active ageing because it concerns diversities both in the form of different opportunities to participate actively (by gender, ethnicity, social class, income, disability, age and so on) and in the recognition of different styles and preferences for participation between different EU countries and regions. Biogerontology is the final key research connection to the active ageing goal: understanding the biology of the ageing process and what determines functional loss are essential if active ageing is to be realised for all Europeans.

Figure 6 The Key Role of Active Ageing



Each of the seven major research priority themes identified by FUTURAGE is now described and explained according to a standard format that covers the significance of the theme, the fundamental insights necessary for future research on each theme, an overview of current research knowledge and the main priority topics within the general theme with some examples of specific research questions. Citations are kept to a minimum to promote the accessibility of the text but all statements are grounded in current and recent conceptual and empirical research. Each general priority theme was drafted and led by one or more of the Theme Leaders and then subjected to at least three rounds of discussion between all of the Theme Leaders and the Coordinator (lead authorship is attributed at the back of the Road Map). Final drafts were then submitted to the Council of Scientists.

HEALTHY AGEING FOR MORE LIFE IN YEARS

Importance of Theme

The focus on extending life expectancy and reducing mortality was relevant whilst deaths from infectious diseases and maternal mortality were high. Most European countries have now substantially reduced premature mortality and mortality rates even in late old age are falling. Emphasis has therefore moved to ensuring the quality of life at older ages and many political agendas now stress the need for healthy ageing in terms of increasing healthy years of life. Nevertheless the gain in healthy years must outpace the increases in life expectancy to ensure a decrease in unhealthy years. Since health is multi-dimensional it is difficult to define but healthy ageing should encompass good physical, mental and psychological health. The benefits of this to society are immense. In early old age good health has economic benefits, improving productivity by allowing individuals to stay in the labour market or to provide informal care to grandchildren or indeed parents. Late old age is more characterised by high levels of multiple chronic diseases but maintaining good functioning and well-being in the very old could reduce pressure on health and care services. Knowledge of what older individuals have to do to 'add more years to their life' and what they might expect as they age, empowers them to make informed decisions about retirement, housing, family and leisure. In this section we use a broad definition of health, including physical, mental and psychological aspects and stress the gains that a wider European platform has to deepening our knowledge. Understanding the biology of the ageing process and what constitutes healthy ageing, identifying risk factors for unhealthy ageing and developing appropriate and timely interventions at a societal and individual level to reduce unhealthy life years is crucial to maximise the health of our older populations.

Fundamental Insights Crucial for Future Research

Healthy ageing is a well-used term that is understood on a general level to encapsulate the ability to be socially engaged, productive and to function independently both at a physical and cognitive level. Models of successful ageing, a similar and overlapping construct to healthy ageing, have been developed. As for successful ageing, there is little or no consensus on the definition of healthy ageing, despite its widespread use both in research and the wider social and political arenas. This is a major issue to be resolved if we are to appropriately and comparably monitor healthy ageing across Europe. Indeed, since environmental factors play a large role, 'biological age', ascertained through 'biomarkers of ageing', may differ from chronological age and may predict the future onset of age-related disease and/or residual life expectancy more accurately than chronological age. If healthy ageing embraces social engagement then basic cognitive-linguistic and emotional processes contribute and must be maintained. Moreover, we have little understanding of what healthy ageing means in late old age and what are the preferences of older people themselves. Does it mean ageing without chronic diseases, or without disability, or with the ability to fall ill and recover, or with a good quality of life? Similar definitional problems exist with 'frailty' which has been used to denote an older person who is vulnerable and at risk of poor outcomes, although international agreement has been reached that frailty might be considered a pre-disability state. Problems with definition and lack of comparability across European countries also extend to other measures that underpin ageing, for example socio-economic status, disability, functioning, multi-morbidity, social engagement.

It has been increasingly recognised that the ageing process is shaped throughout the entire life course, not only in old age, and that events in childhood, youth and early adulthood increase the risk of early occurrence of chronic disease, which in turn increases the risk of premature disability. A life course approach to healthy/unhealthy ageing is therefore essential but research should also be cognisant that newer cohorts may behave differently. Prospectively a life course view requires a long-term commitment

and vision but seeds must be sown soon if we are to fully understand the influence of early and midlife physical and mental health, attitudes and lifestyle. Future studies also need a more comprehensive and holistic approach to delineating the biological, social, psychological, clinical, behavioural, economic, cultural and technological factors that drive healthy/unhealthy ageing at the individual level as well as the wider societal, public health, health and social care delivery and environmental reforms which may also impact positively on reducing unhealthy life years. Europe provides a ready platform for evaluating macro level influences.

Current Research in Europe

The feasibility of implementing the collection of a comparable dataset across Europe has already been demonstrated by the adoption of the Healthy Life Years (HLY) indicator, the first EU structural indicator on health derived from the European Survey on the Statistics of Income and Living Conditions (EU-SILC). The HLY indicator has highlighted that the health gaps between European countries (a difference of 14 years of healthy life at age 50 for men and women) exceeds the gap in life expectancy (a difference of 9 years for men and 6 years for women at age 50)²⁷ and that these gaps are driven by the low life expectancy and HLY in Central and Eastern European countries. Moreover two further pan-European surveys are planned or in progress: the European Health Interview Survey (EHIS) with a modular form which provides a flexible basis on which to build, and the planned European Health Examination Survey.²⁸ The Survey of Health, Ageing and Retirement in Europe (SHARE), which now collects comparable longitudinal data from 13 European countries including two in Central and Eastern Europe, is also a contributor to insights into healthy ageing in Europe.

There are a number of leading European research centres on ageing with healthy ageing as a core aim, with some based on cross-sectional and longitudinal studies specifically targeting extreme ageing (cohort studies of octogenarians, nonagenarians and centenarians). There is no doubt that these centres are contributing substantially to understanding the drivers of healthy ageing. However three important gaps remain:

- i. Few centres encompass the whole spectrum from biology, through clinical medicine to social science and population studies to environmental science. For example, growing inter-disciplinarity in geriatrics and biogerontology, enabling interaction between basic scientists and clinicians, holds much promise and could greatly augment novel findings being transferred in an integrative clinical approach to the patient.
- ii. Few cohorts have data from birth or early life and are therefore able to address the association between development and ageing processes over the entire life course.
- iii. Centres of ageing research are located in only a few European countries; the new EU countries in Central and Eastern Europe have little experience or expertise in ageing research, and this must be built up quickly if the science is to be able to resolve the inequity in life expectancy between these countries and the rest of Europe.

Key Topics for Future European Ageing Research on Healthy Ageing for more Life in Years

As healthy ageing underpins all the other sections in this report, there are necessarily some overlaps which are highlighted below. The current section has identified seven challenges related to future European ageing research in the area of healthy ageing for more life in years as follows.

• Healthy ageing and frailty – understanding the process and defining the concepts

Currently the major models of healthy, or more predominantly successful, ageing,²⁹ originate from psychological or social disciplines, are operationalised in a variety of ways across European studies and were developed from a researcher's perspective when the numbers of individuals living to advanced ages was relatively small. There is an urgent need to explore through multi-disciplinary and multi-country studies involving both qualitative and quantitative components, how older people themselves define healthy ageing, including the oldest-old with multi-morbidity, and whether healthy ageing means the same for individuals from different socio-economic, cultural or ethnic backgrounds, and for different age cohorts and genders (see also Unequal Ageing and Age-Related Inequalities). This would not necessarily need to be pursued across all EU countries but could be constrained to a broadly representative sample of countries covering geography (north-south, east-west), and range of life expectancy and gender difference in life expectancy.

A similar challenge exists for the definition of frailty. The two most widely used frailty models were developed in North America and represent different conceptual approaches, one viewing frailty as a clinical syndrome whilst the other as an accumulation of deficits in physiological systems. If we are to fully understand how frailty manifests itself and progresses and how physically frail older individuals can maintain high levels of daily functioning and well-being, a consensus on its definition must be reached taking into account a range of possible research designs to capture this syndrome. Biogerontology in particular can contribute here through a number of avenues: by identifying biomarkers of frailty; through the use of systems biology to gain understanding of progressive, irreversible alterations in systems that are a feature of ageing; by clarifying molecular biological profiles (muscle protein breakdown, oxidative stress and accumulation of modified proteins) in sarcopenia, a universal, age-related, loss of muscle mass which is a major factor leading to frailty (see Biogerontology: from Mechanisms to Interventions for a fuller exposition on these topics).

Main research questions for the future include:

- What do older people understand by healthy ageing and does this vary between the young and old-old, between men and women and between different European cultures?
- Can we agree a definition of healthy ageing and its relevant dimensions that cross cultures and societies?
- What is frailty? How does it progress and can we identify biomarkers of frailty to intervene earlier?

• Organising and delivering interventions for health promotion

Research evidence has demonstrated that physical activity/exercise, social 'interaction' and good nutrition are strongly associated with healthy ageing whilst smoking, alcohol consumption and poor diet/obesity are related to increased mortality and poor health. All these factors have formed the basis for health promotion activities, yet even where evidence is strong, gaps remain that limit ability to design, organise and deliver effective interventions to promote healthy ageing. Exposure to these determinants is related to measures of advantage across the life course, for instance education, social class, wealth, deprivation, although the manner in which social factors hinder healthy lifestyles is not fully understood. Moreover multi-disciplinary research encompassing the underlying biology with clinical and social and behavioural science is rare. Undertaking such research within Europe has advantages since dietary patterns and social structures vary.

With regard to physical activity, future research should include: whether the timing of physical activity/exercise over the life course is important and the conditions under which the exercise is done; the relative merits of different forms of physical activity (habitual exercise, sustained aerobic exercise, strength and

balance training); and whether there are gender differences in the way physical activity influences healthy ageing. While sarcopenia is inevitable with ageing, it can be mitigated through physical, nutritional and pharmacological intervention. Strong evidence exists that regular resistive exercise slows down the ageing-associated decrease in muscle mass, and its possible role in protecting against the loss of motor units should be further explored.

As the number of obese persons in Western populations is growing, optimal nutrition is an important area for future studies on healthy ageing yet no consensus exists on the types of nutrition to be recommended in midlife and old age to maintain health. Neither is there a detailed understanding of the social factors linked to healthy eating. However, advances in biogerontology increasingly point to metabolism as a determinant of ageing and health from two approaches: (i) Studies of age-slowing interventions in animal models, including single gene mutations and dietary restriction (DR); (ii) Longitudinal studies of the biological changes accompanying the ageing process. Such studies show that factors such as diet and exercise can produce changes in metabolism that profoundly affect ageing and health, but it is difficult to determine the underlying mechanisms as most known mechanisms of ageing are affected. Studies of metabolism, how it changes with age, and how interventions can slow ageing and increase healthy lifespan could also provide a deeper understanding of the biology of ageing and improve late-life health. The role of immunity is important here also since circumstantial evidence from a very small number of longitudinal studies mostly limited to the oldest-old humans, have begun to reveal clusters of parameters increasingly recognised as an 'immune risk profile' (IRP). Establishing whether the IRP is a general characteristic of human populations and understanding the mechanisms responsible for its emergence would allow the design and validation of interventions to reverse the effects of immunosenescence. In addition understanding the interaction between IRP and nutrition could provide the evidence needed to develop personalised interventions to extend healthy lifespan.

Research on social interaction has additional problems due to the host of interrelated concepts: social interaction; social activity; social integration; social engagement; social participation, and because social interaction can be operationalised on a number of discrete levels: frequency; density; quality; type; purpose. In the field of biological ageing, social markers should not be excluded since, for example, wrinkles are among the most visible signs of ageing, with a tremendous social impact particularly for women. However wrinkles reflect deeper modifications, with important consequences for several biological functions, illustrating how organ decline and morbidity in ageing often leads to broader psychological sequelae and socio-economic burden and vice versa. Reinforcing links between psychosocial and biological sciences pertinent to old age should become an urgent priority to clearly conceptualise a highly complex area and determine the exact element or elements of social 'interaction' that determine healthy ageing.

Positive and negative lifestyles also affect healthy ageing through mutual action which requires an integrative approach to understanding drivers of healthy ageing as well as how late in life gains can be made. But as well as population based and behavioural approaches to prevention of age-related disease and ill health, there is also the possibility of pharmacological preventive interventions. In particular, a combination of recommendations in terms of lifestyle and nutrition, with appropriate drugs can be a powerful means of promoting healthy ageing, although the risks of polymedication should not be forgotten. Targets for prevention should include mental fitness, cognitive function and processes and promotional strategies for all levels of health and fitness.

A further overarching issue is to develop a comprehensive and multi-disciplinary understanding of the science of behavioural change, determining interventions (individual/social/public health) that lead to behaviour change, the maintenance of behaviour change following cessation of intervention, and how behaviour change is moderated via individual (self-images of ageing), social, cultural and environmental barriers and facilitators. Research here should be framed within a life course perspective to understand how behaviour change and change maintenance in later life relates to cognitive and behavioural

development over the life course and, how physical, social, cultural and economic environments impact upon the person and influence behavioural development. Helping people to change their behaviour is the most relevant public health and social action in which a community could invest to decrease the avoidable burden of risk, harm and disease among older people and to fully empower older people to participate to their own salutogenesis process thereby increasing the chances for active and successful ageing.

It is important that older people's views are incorporated into the design of services as many interventions and public health messages are developed by policy-makers, researchers and practitioners with little account of the cultural and social diversity of the population and are all too frequently 'top-down'. It is extremely important to tap the ideas of older people for innovative but often 'low tech' interventions in the future as well as including older people as experts during the implementation and/or evaluation of specific programmes and interventions. As yet little is known on more innovative types of intervention, e.g. individual educational programmes for older people and educational programmes via email, Facebook, cell/mobile phones. Specific population subgroups are particularly vulnerable in this respect, for instance the socially disadvantaged, ethnic minorities, new widow(er)s, newly discharged from hospitals, and it is important to ensure these are included to prevent and reduce the already existing 'digital divide' affecting most of these groups. Moreover future cohorts will have very different experience and expectation of technology-based interventions (see also Ageing Well at Home and in Community Environments).

Finally, a fundamental aspect deserving more attention concerns the need to perform a systematic assessment of the economic impact of interventions, including the preventive ones. This is particularly relevant in times of economic constraints, when limited budgets require choice between different alternatives, thus making the understanding of the effectiveness and cost-effectiveness of interventions a crucial element of decision-making processes in the field of health promotion.

Main research questions for the future include:

- Is the timing of physical activity/exercise over the life course important for healthy ageing?
- Are there gender differences in the way physical activity influences healthy ageing?
- What are the relative merits of different forms of physical activity (habitual exercise, sustained aerobic exercise, strength and balance training) on specific domains of healthy ageing such as cognitive functioning?
- Can we use the immune risk profile (IRP) to personalise nutritional interventions?
- How do lifestyle, behavioural and pharmacological interventions interact to increase healthy ageing?
- How do socio-economic factors inhibit healthy lifestyles and can this knowledge be harnessed to improve interventions?

• The ageing process and early markers of ill health

For primary prevention it is useful to be able to identify individuals at high risk for unhealthy ageing before disability or frailty has occurred by characterising early markers which are not in themselves manifested as diseases or pathological conditions. Such early markers may be biological indicators, physiological markers, physical performance, behavioural indicators, or measures of early frailty and include those termed as biomarkers of ageing and may be able to predict the future onset of age-related disease and/or residual life expectancy more accurately than chronological age. In addition, if we are to intervene in the ageing process, it is important to understand the main drivers of biological ageing to identify

possible targets for intervention, whether this be via lifestyle, pharmacological or societal change. The WhyWeAge report identified eleven topics as most urgent to research on human ageing. A number of these topics have been mentioned in earlier sections, specifically biomarkers of ageing, systems biology, immunosenescence, metabolism, sarcopenia and age-related skin modifications. A further urgent research topic is vascular ageing since ageing is the major risk factor for cardiovascular disease, which itself is the most important public health problem in the ageing European population. Vascular ageing is a phenomenon where biology, lifestyle and social factors converge to accelerate a pathophysiological process resulting in both subclinical and clinical events, ranging from cognitive decline to heart failure and stroke. Current therapeutic interventions do not tackle the manifestations of vascular disease specifically related to the underlying organismal ageing. To address this situation there is an urgent need to gain a detailed understanding of the complex interactions between the molecular, biochemical, morphological and functional aspects of vascular ageing (see also Biogerontology: from Mechanisms to Interventions). Often the main advantage of conducting this research across Europe is to achieve the necessary precision for estimating effects through the use of multiple studies.

Though there is clearly a need for single biogerontological focussed research investigations, at a population level crucial research questions remain unanswered, including: Is it possible to identify markers of ageing in midlife? Are markers of ageing in midlife different from those which become apparent in late life? Are markers of ageing as 'dangerous' in midlife as in late life? Are markers of ageing the same in men and women and do they have the same consequences? Are different markers of ageing interrelated or do they progress in parallel to each other? What effect do individual protective mechanisms for health or positive emotions have on biomarkers of ageing? These questions should not exclusively be investigated at the level of the cell and more often as an intellectual exercise, as has been the case in the past, but benefit would be gained from the integration of scientists from, for example, social science, population studies and environmental science. Moreover there is a real need for increased breadth, in terms of the number of candidate markers included, and length, in terms of longitudinal components, of such studies. The main stumbling block for this so far has been cost.

Main research questions for the future include:

- How do the molecular, biochemical, morphological and functional aspects of vascular ageing interact and how does this play out in different subclinical and clinical events?
- Are markers of ageing in midlife different from those which become apparent in late life?
- Are different markers of ageing interrelated or do they progress in parallel to each other?
- Are markers of ageing the same in men and women and do they have the same consequences?

• Modelling links between disease and functioning over the life course

Although there has been varying amounts of research in this area, gaps in knowledge remain, specifically how different social groups and genders transition through disease to mental and physical functioning and through to participation in society, the role of the environment (see Ageing Well at Home and in Community Environments), and how these relationships will play out in future healthy life expectancy. Cognitive impairment and dementia especially in advanced old age as well as transitions from normal to pathology are also addressed in the section on Maintaining and Regaining Mental Capacity. Understanding how individuals progress through disease to disability and frailty is important to inform policy makers for planning for ageing populations. Since the same level of disease may impact differentially on disability in different environments or countries and the context and indeed the transitions may differ between countries, such differences will assist in our understanding of the disablement process.

This area of research requires longitudinal studies in representative groups of countries. Long-term, large scale, strategically designed longitudinal studies are of utmost importance. This is particularly relevant to the European countries, where population heterogeneity and environmental diversity has been shown to influence the ageing process and play a critical role in disease prevention. Moreover a long-term vision is required since any longitudinal studies set up in the near future will require adaptation and improvement as knowledge advances.

Main research questions for the future include:

- What drives increasing disability?
- Can we identify different population subgroups whose progress through disease to mental and physical functioning and through to participation in society, is slower than others?
- What role does the environment play in delaying progress through the disablement process?

● **Effectiveness and efficiency of clinical care and social care**

As the European population ages, health services will need to evolve to meet the new needs of aged populations for health and well-being with multi-morbidity. However, as early as 1935, it was shown to be possible to give autonomy back to bedridden older patients. Successful implementation in general hospitals followed and this began the development of geriatric units in modern general hospitals all over the world. The effectiveness of these models of care has been confirmed by others and, in particular, that follow-up after an acute hospital intervention is essential.

A further growing area of concern is the need to address research on optimal services to maximise well-being at the end-of-life. Palliative care services have largely developed services for middle aged and younger patients with cancer, which are based on a specific type of dying trajectory and a model which prioritises awareness and acceptance, autonomy and individual choice, in the context of family engagement with the dying person. This fails to acknowledge the different experiences and preferences of older people dying in late old age, including high levels of dementia, family geographically dispersed or out-of-touch, and under-recognised pain, despite the majority of all deaths occurring in old age (see also Ageing Well at Home and in Community Environments for end-of-life research addressed through places of dying).

Presently within Europe there are a range of health care systems in operation, with significant heterogeneity in the distribution of service models and configurations. Despite integration of primary healthcare with social care and universal access being the preferred option, further clarification is needed on service configuration, delivery and organisation and relationships with social care as well as interrelationships with family and carers (see Guaranteeing the Quality and Sustainability of Social Protection Systems for discussion of sustainability of informal support networks). Given our long experience of the effectiveness of some care models, it is not necessary to revisit existing work. Rather there is a need for comparative effectiveness studies which focus on 'what works best' and 'at what cost', building on innovations identified in different countries. For instance research should progress how to implement in all European countries, the good models of inter-disciplinary care that are effective in many European countries (Sweden, Norway, Finland, Denmark, Belgium) and in Australia. Use of the same validated comprehensive geriatric assessment tools in all the settings would help to ensure continuity of care to older patients moving between health and care services and would facilitate cross-country research. Additionally research is still needed in the better management, and prevention, of the most important geriatric giants, such as dementia, incontinence and osteoporosis (Guaranteeing the Quality and Sustainability of Social Protection Systems also discusses research on long-term care needs of people with multiple chronic conditions and includes the use

of technology which is more fully covered by Ageing Well at Home and in Community Environments). Comparative and experimental studies within and between countries will require concerted, coordinated action and cooperation but could offer the opportunity for rapid improvements in the understanding of effective, and cost effective design and delivery of interventions for health and well-being with ageing and multi-morbidity.

At a time of economic downturn, it is imperative that the cost effective implementation of evidence-based medicine is prioritised. Optimal drug therapy is the key to treating acute and chronic illness, maintaining health and in some cases preventing further decline. Indeed about 85% of all people aged 75 years and older receive at least one daily prescription drug and an evidence-based regimen has a proven positive effect on biological, functional, and quality-of-care outcomes. Nevertheless such evidence is often based on trials where included participants had no co-morbidity and were unrepresentative in terms of people aged 75 years and over. Optimal drug therapy for an illness has to be developed in relation to other co-morbid conditions.

Preventive medication can provide enhanced functional ability and life expectancy with improved quality of life, examples including vaccination, Vitamin D, and drugs against hypertension, cardiovascular disease and osteoporosis. Research priorities here include: handling of polypharmacy; improving compliance; monitoring effects, side effects and adverse drug reactions; tools for deciding to begin, continue and stop medication; and alternatives to preventive medication.

Main research questions for the future include:

- What are the barriers to implementing the best models of inter-disciplinary care that are effective in many European countries in all the European countries?
- How should clinical trial design be best adapted to include all patients who may receive the therapeutic intervention?

• Education and lifelong learning

Attributes of the individual are known to have implications for healthy/unhealthy ageing. Education is not least of these, and over the last decade there has been a rise in both formal education and training (including in educational establishments and the workplace and whether carrying certification or not), and informal educational opportunities (through family, friends, communities or self-directed learning) resulting in the concept of 'lifelong learning'. Whilst we know with some certainty that early life education differences contribute to inequalities in mortality, morbidity, disability and healthy life expectancy, the mechanisms whereby education and indeed lifelong learning affect their influence requires clarification. This includes in particular to better understand how education and lifelong learning are interrelated with other socio-economic measures (such as for instance: occupation, income and material circumstances), and their multiple effects on healthy/unhealthy ageing. To what extent can lifelong learning mitigate the impact of key life events: negative health events; the successful restoration of functioning/the decline into frailty; the negotiation of the transition from autonomy to dependency; work, retirement, and withdrawal from the labour force; migration; and widowhood and bereavement. A relevant issue in this respect is the identification of the most effective and economically sustainable forms of education and lifelong learning, in order to ensure that the largest segments of population as possible can benefit from them to reduce unhealthy ageing behaviours (see also Inclusion and Participation in the Community and in the Labour Market).

Main research questions for the future include:

- How are older measures of education and more recent and wider measures of lifelong learning interrelated with other socio-economic measures (occupation, income and material circumstances) and do they have an additive or multiplicative effect on healthy ageing?
- To what extent can education and lifelong learning mitigate the impact of key life events?

- **Environmental conditions for ageing well**

Traditionally, research on ageing mainly focuses on the ageing individual and population – much less on environments and even less on the interaction between the person and the environment. Independence in daily functioning and the well-being of older European citizens in the future will be significantly enhanced through an improved understanding of the interrelations between ageing persons and their physical-social environments in areas such as home environments, out-of-home environments, and technology and products. Making the best out of environmental potentials is critical to decrease inequality amongst older citizens within and between European countries. As with other research areas, multi-disciplinary work is key, although this has not, as yet, included the breadth that it might. For example, interrelations between environment and the neurosciences of ageing, may lead to new insights on whether and how living environments of older adults may impact on brain ageing trajectories. More recognition should be made of the fact that environmental conditions act at both micro and macro level, thereby adding complexity in analysis as well as concepts. Multi-level analyses can ascertain whether and how the interrelation between the person and their environment is driven by contexts such as urban versus rural environments, community contexts such as deprived neighbourhoods, or wider country legislation and social policy values. Environmental research must also focus on the question of whether such interrelations and outcomes depend on the societal, cultural and/or political context, and may therefore be different across Europe and whether future cohorts will behave differently. These and other issues are discussed more fully in Ageing Well at Home and in Community Environments.

Main research questions for the future include:

- How does the interrelation between the person and their environment affect mental, physical and psychological health and their trajectories with ageing?
- To what extent do these relationships differ by generation, culture, society or political context?

MAINTAINING AND REGAINING MENTAL CAPACITY

Importance of Theme³⁰

By the overarching term mental capacity we mean a collection of abilities and behaviours that ageing individuals possess and apply in aligning their lives most closely to their needs.³¹ In addition, with the term mental capacity we also refer to the capability of ageing individuals to share their competence, life experiences, and world views with others, particularly the younger generations. As a consequence, mental capacity certainly encompasses the entire spectrum of cognitive functions such as memory processes, speed of information processing, or executive functions as addressed by traditional cognitive ageing research as well as geriatric medicine and gero-psychiatry. However, this topic also addresses more general competencies such as knowledge important to master daily life, skills to maintain and secure one's social integration, coping abilities that enable ageing people to deal with critical transitions and major life experiences, and the regulation of positive and negative emotional functioning and forms of psychological resilience. The latter is highly significant in advanced old age, i.e. in a period of life in which losses accumulate and the end-of-life approaches rapidly. In this wide sense, mental capacity is central to day-to-day health and functioning, independent and rational action, societal participation and personal meaning in the last stages of the human lifespan. The ability to deal with end-of-life issues also significantly depends on the availability of mental capacity. Losing mental capacity in a dramatic way can be seen in the most profound way in dementia-related disorders. Depression including sub-threshold depression and anxiety-related disorders are other major conditions, which undermine mental capacity greatly. However, in this chapter we mostly follow a normal ageing perspective addressing behavioural and social ageing processes of the majority of older adults. This is important to note because robust evidence underscores that coping abilities supporting efficient loss management in old age (e.g. in terms of multi-morbidity and social losses) largely remain intact until very old age. Similarly, effective down-regulation of negative affect and the maintenance of high well-being into very old age (e.g. the so-called well-being paradox of ageing) are resources available to the majority of older adults, even if cognitive functions such as working memory or speed of information processing are on the decline.

Against this background, this section builds on two meta-premises important for the understanding of behavioural and social ageing processes and outcomes. First, we follow a positive psychology perspective translated to the lifespan, in which we assume that the human system is equipped rather well to deal with the challenges of an increasing long life. Second, we assume at the same time that 'a long life,' particularly the period of advanced old age, brings new developmental risks, which have to be treated intensively and in detail in future ageing research and practice. For example, recent research based on the distance-to-death research paradigm (data-analysis are done with death as reference point) shows that dramatic decline in cognitive functioning, well-being and affect can happen in the time window close to death and may thus challenge meaning-making processes at the end-of-life. Research on mental capacity can only be successfully conducted by forging linkages between biogerontology, psychology, the health and exercise sciences, geriatric medicine, public health and the social and political sciences of ageing. The latter perspectives are crucial in order to translate fundamental insights on the mechanisms for maintaining and regaining mental capacity to everyday life contexts. In light of such reasoning, it is also becomes evident that this section of the Road Map must be seen in close conjunction with the Road Map's section devoted to Healthy Ageing for More Life in Years, and also with themes such as Inclusion and Participation in the Community and Labour Market and Ageing Well at Home and in Community Environments.

Due to its central role for everyday functioning as well as the multi-faceted nature of the consequences of losing mental capacity, the issue also comes with huge financial implications related to long-term care and losing social capacity for our societies at large. A particularly important area for Europe's future growth is the ageing workforce, an issue with substantial linkages to the psychology of ageing. For

example, because several cognitive processes already begin to decline rather early in the lifespan (such as speed of information processing and psycho-sensori-motor and executive control processes), efforts to counteract and counterbalance such trajectories will become a key intervention issue. Therefore, investing into research able to fully exploit the impact of lifelong prevention and training towards maintaining and regaining the highest possible mental capacity must become a key European ageing research priority in the future.

Fundamental Insights Crucial for Future Research

The principles of using a lifespan developmental perspective, treating ageing as a multi-dimensional, multi-directional process with remaining plasticity are of crucial importance with regard to mental capacity. While cognitive abilities such as information processing speed, working memory, attentive processes, and episodic memory already show reliable decline beginning already around the age of 30 years, other abilities related to 'world knowledge' such as verbal skills, the complex integration of life experiences, and wisdom oriented cognitive performances such as insights into the relativity and uncertainty of human existence remain rather stable into very old age or may even increase. In addition, older people seem better capable of dealing with negative emotions (such as feeling sad or angry) and also better equipped to maintain positive emotions (known in the current research literature as the 'positivity effect' of ageing).

Such proof of multi-dimensionality and multi-directionality of mental capacity must also be seen in the light of the plasticity of mental functioning. For example, cognitively stimulating and enriching environments contribute much to the exploitation of cognitive reserve capacities along the full ageing process until very old age, although the impact and sustainability of such engagement effects seem to diminish in very old age. Similarly, it has been found that some social contexts (e.g. focussed intergenerational interchange and social learning opportunities at large) are able to elicit personal growth even in very old age, for example in regard to personality traits such as openness to experience and creativity. It generally seems to be the case that cognitive reserve and compensation potentials in old and even very old age are significant, but frequently still under-rated in our societies and health-care systems. This also means that the course and outcome regarding mental capacity can only be understood in a lifespan developmental perspective. In particular, the role of middle adulthood as the most direct bridge to old and very old age deserves much more research attention in the European ageing research context.

Going further, mental capacity is also closely linked to another core lifespan developmental science principle, i.e. the need to consider the historical context of development and the role of cohort flow. Major areas of mental capacity such as speed of information processing or inductive reasoning have been found to be generally on the rise in different ages including old age (see in particular the findings of the Seattle Longitudinal Study of Cognitive Aging) reflecting the generally observed so-called Flynn effect, i.e. the increase of intelligence (IQ) across the recent decades in the population. This positive cohort effect in mental capacity seems to go hand in hand with a trend toward better health and functioning in the cohorts of older adults since the 1960s, although there is evidence that some plateau may have been reached. Indeed, emerging evidence suggests that these trajectories may not be the same in more recent cohorts due to new health and function risks, which forthcoming cohorts bring to their ageing process. Cohort effects play a major role when it comes to new input into mental capacity such as skills and knowledge needed to deal with ICT. Such technology increasingly emerges for the ageing end-user as a significant tool to support and optimise ageing processes in various constellations, including conditions of multi-morbidity, major care needs, and severe cognitive impairment. Therefore, great and sustainable investment is needed to bring such skills to older people in the most efficient way possible as well as to largely reduce their cohort-related disadvantages to fully use new technology.

At the same time, due to the significantly increased life expectancy, there is an increased risk in late and especially very late life for cognitive impairment and the occurrence of dementia-related disorders, although some evidence underscores that prevalence may decrease in the future, for example due to increasingly better educated cohorts. Individual as well as clinical and societal challenges also include the 'discovery' of mild cognitive impairment (MCI; with a high likelihood of converting into dementia in the longer run) as well as sub-threshold and 'mild' depression (with a high likelihood of converting into affective disorder in the longer run and possibly also into cognitive impairment trajectories). This highlights the need to widen the aims to better understand brain ageing from a fundamental biological level to social and psychological aspects. It is important to mention in this context that age changes in brain metabolism are still poorly understood. Factors influencing peripheral metabolism and longevity often have good or bad effects on brain ageing depending of degree and/or context. Different brain areas and cell types need to be studied with regard to brain metabolism and ageing, and their function understood in the context of the whole organism. Interesting topics include whether age-related neuronal and cognitive changes in humans implicate any of the master regulators of metabolism or the neuroendocrine system. Therefore, research at the behavioural and social level must be much better coordinated in the future with biogerontology research, in order to more comprehensively understand the underlying dynamics as well as identify promising intervention areas.

Current Research in Europe

Europe has major research centres targeting the development of mental capacity in a life course perspective into very old age and many are involved in fruitful cooperation with other regions of the world such as North America and Asia. It should also be mentioned here that Europe can offer a number of longitudinal studies such as the Longitudinal Aging Study Amsterdam, SHARE, the German Ageing Survey as well the OCTO-TWIN study, which all contain measurement programmes able to speak profoundly to the longitudinal development of mental capacity. It is thus fair to say that research in Europe is significantly contributing to all major areas regarded as central to the topic of mental capacity such as:

- Research on the development of memory processes
- Research on the development of other intellectual functions, such as pragmatic and mechanic intelligence, attention, expertise, sensory-motor-mental function connections, and language processes
- Neuroscience related insights on cognitive ageing
- Research on well-being and emotional regulation and coping processes

Research in these areas is conducted experimentally as well as by relying on major cross-sectional and, increasingly, longitudinal data sets as well as innovative research designs, such as measurement-burst designs and the combination of the assessment of short-term intra-individual variability with long-term stability and change. Substantial intervention research has been conducted in the area of mental capacity and ageing in Europe. There is also key inter-disciplinary research, which for example targets the transition to pathological cognitive ageing in terms of processes related to MCI that convert into dementia.

Key Topics for Future European Ageing Research on Mental Capacity

Eight challenges related to future European ageing research in the area of maintaining and regaining mental capacity across the lifespan have been identified as follows.

• Research on the outcome of cognitive training and physical exercise

Making optimal use of the existing plasticity of the human mind is critical in terms of maintaining independence, societal participation, as well as the reduction of the burden put on family caregivers. There is therefore a strong need to replicate and extend in a European context randomised control trials in cognitive training, such as the ACTIVE study in the United States (US). Going further, new intervention research targeting the full range of primary and secondary outcomes of physical exercise is needed, including multi-component designs. Such research may consider specific conditions in different countries and should allow for data integration and analysis across different training strategies and countries involved (see REACH study in the US for such an approach). Especially important is more research on the short- and long-term impact of cognitive training and physical exercise in middle adulthood, including the important target area of the ageing workforce. Indeed, work environments can in itself have an intervention-like effect and can support the long-term maintenance of cognitive functioning and mental capacity at large.

Cognitive training and physical exercise related research must, from its very beginning, better consider the issue of implementation into the 'real world' and therefore much more research with special consideration of differences in cultural and health system/behaviour differences across Europe is needed.

In addition, cognitive training and systematic instruction may significantly help to facilitate the use of technology, particularly ICT. Such efforts will significantly contribute to reducing the risk of digital divide and the ongoing underrepresentation of older adults as end users of new technology.

Main research questions for the future include:

- How far can training, particularly multi-component training including cognitive and physical exercise components, take the ageing system in different stages of the lifespan (middle adulthood, young-old age, oldest age)?
- What are the most efficient training and psycho-educative approaches and how can they become implemented most successfully in everyday life of older adults?
- How is healthy life expectancy affected by effective training models and how can better sustainability of training net effects be achieved?

• Role of context for enhancing cognitive engagement

Contextual conditions have always been argued to be of critical importance for the development of mental capacity across the life course. However, a focussed research programme targeting this issue in a broad perspective is still missing within Europe. Systematic research is needed on the role of contexts such as social relations, home environments, neighbourhoods, out-of-home environments and leisure activity settings for cognitive engagement and cognitive outcomes in the longer run. It is interesting to observe in this context that, considering the highly encouraging research on the relationship between cognitive functioning in normal ageing or Alzheimer's transgenic rodents and the role of Enriched Environments (EE), that there is little analogous research at the human ageing person-environment interaction level. For example, there is no rigorous research which brings together old and new housing solutions and their possible impact on the course and outcome of cognitive functioning or research that systematically manipulates housing and neighbourhood features in order to test for possible effects on cognitive ageing. Similarly, the role and influence of social engagement deserves much more rigorous research attention.

Related with the previous topic 'Research on the outcome of cognitive training and physical exercise', there is much more research in place when it comes to learning about the cognitively stimulating versus constraining characteristics of work environments for older employees. In addition, given the intervention

implication inherent in such findings, future research in the area must secure strong interlinkages with the health and exercise sciences as well as research related to ageing and the physical-spatial-technical environment.

Research in this area should derive a better picture on the role and dynamics of everyday contexts for the maintenance of mental capacity. While much research on the human cognitive system has been conducted under experimental and laboratory conditions, detailed knowledge on how older adults (including older and very old couples) are engaging in compensation and optimisation in their everyday world is still missing. Such research should also increasingly include research designs able to target short-term intra-individual variability, i.e. measurement burst studies with daily measurements across a limited period of time (e.g. two weeks).

Main research questions for the future include:

- How strong is the effect size of social and physical environments as compared to person factors related to mental capacity development?
- Can improvements in the work environment lead to the maintenance or enhancement of mental capacity of ageing employees?
- How are older adults dealing with cognitive decline in everyday life? What are efficient compensatory and optimising strategies and what can we learn from such real world analysis for maintaining mental capacity at large?

• **Role of the motivational-emotional, personality and self-related system for the development and maintenance of mental capacity**

Fascinating new insights on the relationship between cognitive functioning in old age and motivation and emotion have emerged during the last 10 to 15 years, particularly driven by socio-emotional selectivity theory. For example, there is evidence that older adults' cognitive processing may be influenced under certain conditions by a positivity effect; that is, older adults seem to analyse positive information more efficiently than younger adults. This may also add to the explanation of the subjective well-being paradox in old age. Personality and self-schemata have been found to play a major role in the orchestration of resources in everyday life. Research in this area has remained rare in the European context, but seems crucial, because it is able to shed new light on traditional views of cognitive development, which are to a major extent still dominated by a decline perspective.

Main research questions for the future include:

- How far does the positivity effect in terms of cognitive processing lead and what are the potentials and limitations for older people?
- What are the relations between personality and self processes and the course and outcome of mental capacity?
- Can there be new synergies between the declining cognitive apparatus and the relatively stable personality and self system that could be better used for the improvement of healthy life expectancy?

- **Better considerations of life course dynamics of mental capacity**

Although there are good reasons to study mental capacity from a life course perspective, a rigorous description of such a view is still rare. First, new investment into a theoretical account based on the existing conceptual ideas and empirical evidence on life course trajectories of mental capacity is needed. Second, existing longitudinal data as well as long-term data to be generated in the future are needed to better understand the life course dynamics of systems such as early life education, physical activity, disease over the life course, social engagement, labour force and leisure time involvements on the outcome of mental capacity later in adult life. In addition, the role of major person-environment transitions such as relocation to various forms of long-term care or 'new' housing solutions are not well researched so far (see also the Road Map's section on Ageing Well at Home and in Community Environments). Such research is highly important to exploit preventive potentials toward maintaining mental capacity into very old age to the best possible.

Main research questions for the future include:

- How strong is the effect of life-span precursors on the course and outcome of mental capacity trajectories in later life (in particular: middle adulthood, but also very early periods of life, even those before birth)?
- Is there an effect of major person-environment transitions as people age on mental functioning?
- How can the lifespan-based potential toward prevention of mental capacity decline be used to the maximum effect possible in order to extend healthy life years?

- **Better consideration of transitions from normal to pathological processes related to mental capacity**

The need to increase and improve research targeting transitions from normal cognitive ageing to various forms of pathological ageing, particularly dementia-related processes, is obvious. Research efforts must be focussed to learn more about the mechanisms, risk and protective factors involved from the biological and clinical to the social and behavioural level. It is reasonable to expect that the outcome of such research will significantly contribute to evidence-based early intervention strategies with the possible ability to counteract possible pathological trajectories in the area of mental capacity.

Main research questions for the future include:

- How far can a more fine-tuned differentiation between normal and pathological ageing go?
- What are the major markers of transitions from normal to pathological cognitive processes and how similar or dissimilar are these across countries?
- Can such new knowledge be efficiently used for prevention purposes and the extension of healthy life expectancy?

- **Research on how societies are dealing with mental capacity**

The theme of mental capacity related to ageing brings huge challenges to European ageing societies at various levels. For example, European societies must address the question, what kind of societal and political role large portions of cognitively impaired citizens are able or should play and which models (e.g. in terms of assistance) may be promising. In addition, dementia has risen nearly to the top of the most feared diseases in those 50 years and older and societies must deal with such new highly prevalent fear. Going further, there is robust evidence pointing to the fact that age stereotyping and age discrimination may undermine mental capacity to a considerable degree via self-stereotyping. Therefore, more research targeting the issues of social participation, societal assistance, dementia worries and the function-undermining role of age stereotyping and age discrimination is needed.

Main research questions for the future include:

- How strong is the effect of stereotyping and age discrimination on trajectories of mental capacity?
- Is there evidence that the reduction of negative stereotyping is serving the maintenance of mental capacity?
- How frequently are dementia fears in European societies, what differences may exist between countries and how are such fears affecting ageing people in their everyday lives?

- **Research on challenges related to mental capacity in advanced old age**

Advanced old age brings new developmental risks to older individuals. In particular, the transition from a generally healthy and functionally competent period of 'young-old' age to an extended phase of 'old-old' age is a significant psychological challenge. This task is new in historical terms, because the majority of those affected nowadays had simply died in previous generations before they were able to reach such an extreme corridor of the human lifespan. Currently research based on the distance-to-death paradigm may also greatly inform future research regarding cognitive, but also emotional ageing. Therefore, more research targeting the issues of dealing with the manifold tasks and experiences of advanced old age, such as decline in cognitive, body and mental functioning and loss of social resources, is needed. Such research also needs to take new methodological avenues such as that echoed in the distance-to-death research paradigm.

Main research questions for the future include:

- How great is the potential to maintain mental capacity to the largest degree possible for very old individuals?
- How can very old individuals be psychosocially supported when their meaning-making processes are under threat and when coping with multi-morbidity and the accumulation of loss experiences become a life priority?
- How can society and social institutions support the required educational processes (in a wide understanding) that can help cope with the challenges of a very long life?

- **Better consideration of multi- and inter-disciplinary synergies**

Although much of the research described above has to strongly follow multi-disciplinary and inter-disciplinary pathways, such multi-disciplinary synergies should also be spelled and tested out more comprehensively and systematically in the future. This includes for instance the strengthening of research collaborations between psychology and biogerontology, neurosciences of ageing, health and physical exercise sciences, sociology, occupational therapy, architecture and urban planning. In particular, spelling out and conducting more research on the linkages between cognitive and emotional development at the behavioural level, differential environmental influences, and cortical processes seems a highly promising area in terms of pure research as well as practical outcomes. Such multi-disciplinary research must also include intervention research. Indeed, the better understanding of the malleability of the human ageing process may be a core bridge between key disciplinary areas such as health sciences, social sciences, psychology and biogerontology. For example, the interactions between health and cognitive functioning during ageing has recently been the subject of much promising research in the US and should also extend to European research.³² Another prime example would be the important area of physical exercise related research (see also Biogerontology: from Mechanisms to Interventions).

Main research questions for the future are as follows:

- What are the most synergy-rich combinations of disciplines in order to better understand the malleability and plasticity of human ageing?
- How can core issues of ageing and healthy life expectancy be furthered by focusing innovative health and cognition, physical exercise and biogerontology, or affect / personality and neuro-imaging linkages?
- How can early-stage researchers be brought together as efficiently as possible to explore and establish such synergies?

INCLUSION AND PARTICIPATION IN THE COMMUNITY AND IN THE LABOUR MARKET

Importance of Theme

Increasing the level of people's participation in society and ensuring that this contribution can continue along the whole life course represents today a widely shared policy target. The extent to which societies facilitate participation and promote inclusion at all ages is a key component of people's access to their inalienable rights as citizens, and has implications for society as a whole from an economic and social point of view.

At a micro level, participation represents a crucial element for active ageing, since being involved in social and professional activities is positively associated with several indicators of socio-economic status and well-being, including better health as well as mental and physical functioning. At a macro level, the positive impact observed on socio-economic institutions and public resources when participation is facilitated shows that stronger efforts will be needed in the coming years, in order to implement welfare policies able to reach and maintain both financial sustainability and quality of the social protection system (see also the section on Guaranteeing the Quality and Sustainability of Social Protection Systems). At an intermediate, meso level, the facilitating or inhibiting role played by social institutions such as families, companies or other social networks is also relevant in affecting people's inclusion and participation along the life course, and will therefore need to be closely monitored by future research efforts.

Demographic and socio-economic changes have produced major changes to European societies in recent decades. This calls for a new consideration of participation patterns and possible future scenarios in terms of evolving family and societal structures due to demographic (e.g. low birth rate), normative (e.g. introduction of divorce) as well as economic and cultural changes (e.g. increasing participation of women to the labour force). These are reinforced by recent phenomena such as the global economic crisis and the growing use of ICT.

Future ageing research has therefore a number of distinct roles to play in facilitating inclusion and participation over the life course, both as a support to policy makers and practitioners in their efforts and as a major social institution in its own right.

Fundamental Insights Crucial for Future Research³³

Participation in the community and in the labour market is a broad concept that embraces different dimensions of human life. It can be described as the sharing of individual resources in socially-oriented as well as economic activities, i.e. the complex set of behaviours and relationships that people activate with other individuals, groups or organisations. In this sense, it refers to different social networks in which people are embedded and interact during their life: families and kinship, friendships, peer groups, companies, non-profit organisations, political parties, and so on. Clearly, participation cannot be merely defined by the number of contacts between people and these social networks, but it should necessarily include also the quality and scope of such interactions.

Inclusion (and its counterpart exclusion) can be understood as the extent to which existing social, economic, political and cultural norms, institutions and environments facilitate or inhibit participation. Uncovering the mechanisms and processes of inclusion/exclusion in our societies is crucial to better define the prerequisites and enablers for participation, taking into account also the psychological structure of ageing individuals and their behaviours and attitudes toward different forms of social interaction.

Research in this area requires therefore not only a multi-disciplinary but also a multi-layered approach, able to capture for instance existing gender and cultural differences, both within countries and across Europe, at a micro, meso, and macro level. Research on participation related to ageing and older people will certainly benefit from a stronger and more systematic life course perspective, since social interactions necessarily modify as individuals age and face changes, such as those related to family structure (e.g. birth of a child, death of a relative), working conditions (e.g. relocation), urban dynamics (e.g. the ethnic composition of neighbourhood) as well as social and cultural transformations (e.g. concerning the path to retirement or the gender division of care tasks).

Current Research in Europe

In the last decades, European research on inclusion and participation has made remarkable steps forward. A crucial role in this respect has been played by an increasing number of national as well as international studies aimed at understanding how social interactions change over the life course, in some cases also including a cohort and/or longitudinal perspective (e.g. SHARE).

Despite these developments, a series of gaps in ageing research have been identified by scientists and users with regard to topics deserving more attention to improve our knowledge on barriers and enablers to participation and inclusion. These refer, in the first place, to the understanding of the basic physical, psycho-social and economic prerequisites of social participation, whose more comprehensive analysis would help identify, among other things, which policy instruments could be more effectively used to facilitate people's engagement across all age groups.

These would have to take into account individuals' freedom of choice (e.g. in relation to normative expectations), as well as cross-national and intra-national differences between different population groups in terms of e.g. income, social class and living arrangements. The debate concerning individual freedom of choice, however, is partly overlapped with that on intergenerational solidarity, as changing economic scenarios in Europe call for a major engagement of all generations in order to achieve adequate standards of living and population well-being. The implementation of such a goal could be facilitated and supported through more systematic intervention studies, aiming at developing innovative measures to stimulate ageing individuals' participation. This approach would benefit policy by facilitating both the transferability into practice of existing research findings and a more systematic adoption of an experimental design to assess the effectiveness (also in economic terms) of the new applied solutions. Within this challenging area of research, more investigation is also required on assessing the impact of interventions in rural areas, where previous studies have shown that older people are at higher risk of social isolation and exclusion.

On the other hand, research should gain a more systematic comprehension of the effects of participation in the community and in the labour market. This would include an in-depth investigation of the micro level impact of activation measures for individuals, in terms of identity, perception of ageing, family and social relationships, attitudes and expectations among different generations. For the development of future social and economic policies, this would imply a macro level analysis of the consequences of activation for the economic and social protection systems (see also *Guaranteeing the Quality and Sustainability of Social Protection Systems*).

Key Topics for Future European Ageing Research on Social Participation

A series of research areas key to the development and success of people's participation and inclusion along the life course are outlined below. The first six consist of over-arching challenges for promoting participation and inclusion in its widest sense, cutting across all social relationships and socio-economic activities. A further set of more specific key priorities can furthermore be distinguished between barriers or enablers experienced in the community and those in the labour market. Future research in all these areas will need to encompass an in-depth understanding of the identified challenges and opportunities, and apply that understanding to formulate recommendations on how to best tackle them within the contexts of existing structures and institutions.

- **Ageism**

One of the most entrenched barriers posed to appropriate participation and inclusion of people during their life course concerns the phenomenon of ageism. This term encompasses the attitudes, prejudices, behaviours and social structures that result in discrimination against individuals or groups on the basis of their age. Ageism is manifest as exclusionary practices throughout all areas of the community and labour market, creating barriers to participation. This can take place at a micro level (e.g. during interactions between individuals), meso level (e.g. in form of discriminatory practices in businesses and other organisations) and macro level (e.g. in policy planning and delivery).

Perceptions of ageing and of older people, and the stereotypes that arise from them, are the root of the problem of ageism. Research has established that older people are perceived positively as more friendly, moral or admirable than younger people, but at the same time also as less competent or capable.³⁴ Although less overtly hostile than many other stereotypes, this form of prejudice nevertheless leads to discriminatory behaviour. In order to tackle ageism at its roots, we must therefore do more to understand and change perceptions of ageing. For example, stereotypes are often formed early in life and are resistant to direct change. However, evidence suggests that positive contact in the form of close friendships between people from different age groups can be a very powerful tool to overcome age stereotypes. This evidence supports the forthcoming 2012 European Year for Active Ageing and Solidarity Between Generations, aiming to promote positive images of older people that show the importance of their active role in a society for all ages. This is an excellent example of how research into the micro mechanisms required to change perceptions and behaviour can feed in to policy and practice. However, given the current high levels of ageism and the diversity of circumstances and contexts in which this phenomenon is taking place across Europe, it must be considered a priority to expand this evidence base and build up a wide range of potential interventions (appropriate to the context in which discrimination is taking place).

A particularly significant priority for future research in this area is to help tackle the development and perpetuation of ageist attitudes and prejudices through the media. The latter plays a central role in our society, both informing and reflecting public attitudes. Emerging evidence suggests that older people are under-represented in the media and, where represented, they are often portrayed negatively. Research targeted at interventions to change perceptions and portrayals of age and ageing within the media industry are therefore key to breaking the cycle which perpetuates ageist stereotypes and attitudes.

Finally, research designed to fight ageism must not only focus on perceptions and individual behaviour, but also seek to develop interventions to change discriminatory practices and processes at an institutional level. This is a key area for meso and macro level research, in order to tackle entrenched and often subtle ageist structures (such as organisational policies and procedures), that lead to discriminatory and exclusionary outcomes for older people in the community and in the labour market (this last issue is discussed in more detail in a subsequent section on 'Discrimination in the labour market').

Main research questions for the future include:

- What are the attitudes to ageing as a process? How are they formed and evolved? How can they be altered?
- What are the gaps between perceptions and realities of older people's skills, abilities and contributions to society?
- How can the current social perceptions of age and ageing be effectively influenced in order to eliminate prejudicial attitudes? Which role can the media play in this respect?
- What interventions at the micro, meso and macro level can be successful in changing perceptions towards older people?
- To what extent is discrimination 'institutionalised' through legislation and regulations (e.g. in limiting access to health and social care services) across European countries?

- **Lifelong learning**

Lifelong learning is fundamental not only for the competitiveness and economic prosperity at a country or EU level, but also for the social inclusion, active participation and personal fulfilment of its citizens. In particular, in the context of demographic change, employing the full potential of adult learning has a key role in extending the participation of older workers in the labour market and allowing their better integration into all spheres of life in society. However, the age of individuals has a clear impact on their propensity to take up or have access to opportunities for training and lifelong learning.

Research is therefore needed to identify the types and number of non-formal and informal learning opportunities in which older people participate as well as the specific issues they face in accessing formal training and educational programmes. Particular attention should be paid in this respect to the gender, ethnic and disability dimensions as well as to the needs of older people living in rural or remote areas, in order to facilitate a widespread implementation of lifelong learning strategies and the modernisation of existing training systems.

Further studies are also required to assess how to transfer know-how and experiences among generations, within and outside the labour market. On the one hand, knowledge transfer from the younger to the older generations plays a key role in fostering intergenerational understanding and re-skilling older workers. On the other hand, the transfer from the older to the younger generations can preserve older workers' skills and help older workers and retired people maintain a sense of meaning and purpose, preventing their social exclusion. Therefore, research in this field is crucial to better understand how mentoring schemes and other intergenerational exchanges can promote solidarity between generations and competitiveness.³⁵

Main research questions for the future include:

- What are the most appropriate non-formal and informal learning forms for older people?
- What are the barriers faced by older people in accessing formal training and educational opportunities? How can they be best overcome? And what is the role of educational institutions (e.g. the university sector or technical colleges) in supporting older learners?
- What are the specific needs of older women, migrants and disabled older people in this field, as well as of people living in rural or remote areas?
- How can knowledge transfer among generations be promoted to ensure the most benefits to all involved parties?

• Migration

A further challenge to European societies derives from the strong migration phenomena currently taking place in our continent, both within and from outside the EU. In this regard, more attention should be paid to the mechanisms facilitating the integration of ageing migrants in destination countries, by analysing the impact of migration trajectories over the individual life course and on society itself, on the background of local cultural and societal mediators.

In this field, crucial research issues to support the development of policy and practice are the integration of migrants into their host countries' communities and labour markets, and a better understanding of how migration can contribute to tackling the challenges associated with the ageing of our society. There is also a key need to understand the experiences of ethnic and racial discrimination faced during the life course by many migrants in their destination communities, in order to identify which measures can best contribute to prevent this occurring. A further area of interest is that of transnational families, with a more specific focus on the relationships between the ageing migrants and their left-behind kin in the countries of origin.

Research projects in this field can deal, furthermore, with the analysis of how the ageing process might impact on the inclusion of migrant groups in their destination societies, as well as with the understanding of 'care drain' effects on source countries. More focussed research is also needed to enlighten the contribution of migration to ageing societies, also with regard to the increasing number of employed migrant care workers (see also *Guaranteeing the Quality and Sustainability of Social Protection Systems*).

Main research questions for the future include:

- Which policies and practical strategies can most appropriately tackle the challenges raised by migration for integration and social cohesion?
- How migration can contribute to the challenges associated with the ageing of our society?
- What role can the ageing process play, on the other hand, for migration-related phenomena?

• Overcoming the digital divide

Existing evidence indicates a growing use of ICT within Member States across all age groups including older adults. The uptake and use of ICT is still much lower among older age groups, and increasingly a 'digital divide' is observed and opening up as the gap between different generations grows.³⁶ As European societies become increasingly reliant on ICT and the internet in particular, as a medium for retail, media, public service delivery and social interaction, this digital divide represents a growing risk for the exclusion of older people from the community and the labour market. Therefore eliminating the digital divide represents a major priority for public policy, and future ageing research will have a crucial role in identifying how this can best be achieved.

To support this goal, more research is needed to reveal new ICT utilisation patterns and discover differences between current and new generations of older users. This field includes the analysis of changing social interactions with regard to virtual networks and their impact on traditional (also intergenerational) relationships, as well as of new services and social/health care available through more user-friendly ICT solutions.

Innovative research projects in this area could be evaluating the effects of new virtual networks on users' well-being in terms of loneliness, depression and other mental health related areas. Another possible role of virtual networks could relate, for instance, to the implementation of innovative on-line health education programmes, or to the possibility of linking persons sharing same health conditions via the web in order to foster the creation of self-help groups. A particular role could be potentially played in this respect by more systematic research in the use and preventive role of new technologies, such as web tools or telecare instruments (see also *Guaranteeing the Quality and Sustainability of Social Protection Systems*).

Main research questions for the future include:

- What role can ICT and virtual networks play in facilitating social inclusion?
- What are the effects of ICT-tools in terms of intra- and intergenerational relationships?
- Which measures are most effective in reducing or preventing the digital divide in using new technologies? And this especially in fields like long-term care, where they represent a crucial support tool for both formal and informal care providers?

- **Mobility and accessibility**

Physical accessibility is a key component of inclusion and participation, as a pre-requisite to many daily activities, such as maintaining relationships with family and friends, leisure activities, work, access to public services and health care or carrying out everyday tasks such as shopping for food.

Promoting inclusion and enabling participation through accessibility can be tackled in two ways: by maintaining and promoting physical mobility as people age (see *Healthy Ageing for More Life in Years* for a more in-depth discussion of research on how to best delay and prevent frailty), and by developing accessible environments in the community to become inclusive of the widest possible range of physical accessibility needs (see *Ageing Well at Home and in Community Environments* for a more extensive illustration of the role of supportive environments). Both these approaches have limitations, since not all existing infrastructure can be adapted to the highest standards of accessibility. Many people, especially among the very old, experience significant frailty and disability resulting in limited mobility despite advances in health care. In spite of these limitations, it is still possible to push the boundaries in both domains and, moreover, collaborative multi-disciplinary research offers a powerful opportunity to combine the focus on the person and on the environment to achieve optimal gains for participation and inclusion through accessibility and mobility. For example the recently instigated international Age Friendly Cities Programme promoted by the WHO.³⁷

Future research projects in this area can be identified in experimental trials involving the re-design of city transport systems in order to meet the changing needs of the ageing population and to increase their accessibility to people with reduced mobility (e.g. by starting new lines to ease transportation to community health or recreational centres, or by granting special discount schemes and other incentives based on universal-design principles). Appropriate follow-up assessments would ensure a scientific evaluation of the intervention, in terms of health and economic outcomes. In this respect, the role of assistive technologies will be crucial in contributing to delay dependency as people age. A more coordinated contribution from ergonomics and engineering can improve the performance of everyday life activities and facilitate mobility. Housing adaptation and domotics should also be considered.

Main research questions for the future include:

- How can we achieve an optimal balance between physical mobility and accessible environments to enable maximum participation and inclusion among all age groups?
- What are the health and economic outcomes of interventions designed to facilitate accessibility?
- What role can assistive technologies play in facilitating accessibility for those with limited physical mobility?
- How do mobility limitations impact on social relations in different, very old age groups (e.g. very old couples or singles)? And what kind of differentiated solutions are needed to overcome them?

• Ageing and spirituality

Activity and disengagement do not represent the only two fundamental elements to be considered in trying to understand the ageing process. The decision about engaging or not in social activities or other fields can be seen as the final expression of an internal process in which also spiritual components, both in their religious and non-religious facets, play a fundamental role. Whereas most European societies are characterised by an increasing tendency to neglect spirituality issues (as reflected by the low acceptance and awareness towards the role played by pain and death in our everyday life), empirical evidence shows that spirituality might represent a relevant support to inclusion and participation along the life course. Spiritual transformations seem to play a relevant role especially in later life, when a redefinition of the self and of other social and environmental relationships takes place. Some individuals tend to become less involved and more selective in the choice of social and other activities, thus possibly experiencing a decreased interest in material things and a greater need for 'meditation'. In some cases, a feeling of 'cosmic communion', implying a redefinition of time, space, life and death can also be developed, in what some scientists have tried to define as the 'gerotranscendental process'.³⁸ While the latter should not be understood as a normative judgment on how older adults should age, it should be acknowledged that different factors at a cultural, societal and individual level might facilitate or inhibit such a process. A wide heterogeneity is observed at both European and local level. This concept, and the theory behind it, adds an important dimension to develop a deeper understanding of the ageing process and of the related outcome.

In the light of the above considerations, it is increasingly important to uncover the role of spiritual needs and resources along the life course, including values, attitudes and behaviours influenced by society and cultural background. Examples of policy issues relevant in this field are the need to understand how changes in the spiritual dimension affect social cohesion and intergenerational relationships, as well as its role in promoting or hindering an active contribution of the ageing individual to different societal sectors (labour market, civic participation, informal care and so on). The integration of spirituality into the more general active ageing framework, i.e. through the conciliation of gerotranscendence and of the activity/disengagement theories, could facilitate a more comprehensive understanding of the ageing process. It could help to clarify to which extent and through which means policy-driven changes are feasible in our society. At the same time, there is evidence showing that, at an individual level, persons do tend to focus on 'the last things' they experience, an attitude which often leads to changes in attitudes, values and behaviour, independently of one's age. In this regard, it is therefore necessary to be aware of the fact that, by discussing the effects of spirituality at a societal level, we might run the risk of aiming at distinguishing between 'good' and 'bad' ageing, rather than understanding and valuing different ways of going through this process.

Assessment, measurement and comprehension of spiritual needs is also important for professionals in many areas, such as for instance that of end-of-life care and, in general, for those involved in caring for dependent people, as 'the search-for-meaning approach' can provide useful information to more effectively address the whole process of care and support provision to persons in need.

Main research questions for the future include:

- What is the role of spirituality in facilitating social participation at an individual level?
- Which role does spirituality play in promoting or hindering social inclusion and an active contribution of ageing individuals in different societal sectors?
- How does spirituality affect intergenerational relations?
- How can research on spirituality contribute to the ethical debate on 'conditions of living and dying', also in the light of current and future technological developments?

• Volunteering

Volunteering is one of the possible ways for people to remain active as they age and, at the same time, to contribute to society as well as to profit from the opportunities offered by it. Although awareness about this phenomenon is widespread across Europe, in some countries, especially in Southern and Eastern Europe, only a minority of the population is involved in this form of activity. This reflects, on the one hand, a different role of volunteering within each society and national welfare system; on the other hand, it also derives from the fact that, since there is no common definition of volunteering across countries, what is considered volunteering in one country is not necessarily considered as such in another. What is clear, however, is that the involvement of older people is becoming increasingly crucial for the vitality of the whole voluntary sector. It is therefore important to identify appropriate strategies to promote voluntary work at all ages, since especially senior citizens represent to a large extent a still untapped human resource, whose involvement in voluntary organisations should receive more attention if we really want to properly tackle the challenges of our ageing societies.

Recent studies show that, while gender distribution among ageing volunteers is not homogenous across countries, almost everywhere in Europe the time people dedicate to voluntary work is likely to increase over the life course, especially in fields such as social care, recreational and local community work. At an individual level, the probability to work as volunteer in older age is positively associated with both educational and income level, good health and 'civic' motivations and values, while being employed and/or providing informal care to a dependent relative often represent a crucial barrier to voluntary engagement. At an organisational level, the recruitment and retainment of ageing volunteers depends upon the ability to meet their individual needs and aspirations, by leveraging on organisation's characteristics such as structure, membership composition and atmosphere. Other relevant factors are represented by the awareness and appraisal of older volunteers' experience, social skills and reliability, and by the ability to capitalise these capacities through appropriate training and by fostering intergenerational relationships between volunteers of different age groups. At the institutional level, evidence shows that appropriate campaigns to promote volunteering in younger age are often able to ensure positive results in older age groups, since young volunteers are likely to play this role also later in their life course. A major role in encouraging older people to become volunteers and to look at it as a vital component to promote their active ageing might also be played by general practitioners and other health and social care professionals, who are relevant reference persons for the older population.

With regard to the relationship between volunteering and informal caregiving, it should be acknowledged that to many informal carers the involvement in voluntary organisations can provide a remarkable form of support, thanks to the possibility of establishing a sort of 'social support chain' able to overcome the isolation deriving from counting on the family network only. Furthermore, informal carers who receive support from volunteer organisations are more prone to volunteer once the caring period ended, as a way to give something back.

Last but not least, we urgently need more comparable information in form of common definitions and reliable statistical data in this area, which in many countries is still very poorly covered. Only this will allow us to really know how useful volunteering can be both to promote individuals' active ageing and to contribute to our societies' welfare.

Main research questions for the future include:

- Which measures and initiatives can improve the match between demand and supply of ageing volunteers, especially in sectors which are traditionally 'off-limits' for them? How can a better image of volunteering in older age be promoted to this purpose?
- Under which circumstances can volunteering represent a source of fulfilment and social inclusion for ageing individuals with poor health and socio-economic status?
- How are informal caregiving and volunteering reciprocally related? Is there a trade-off between the two activities?
- How can investments in volunteers' human capital be ensured along the whole life course through appropriate programmes?

- **Participation as consumer or user**

In a consumer society, the availability and accessibility of appropriate products, goods and services is a key element of participation and inclusion. The extent to which all members of society are able to participate in the consumer market is also a key indicator of market efficiency. Traditionally, the consumer market has been less effective at catering for the needs of older consumers, placing greater emphasis on targeting children and younger adults. As the share of older consumers of products and services is growing, it is becoming increasingly important to develop markets that serve the needs of older people both to promote older people's participation and inclusion and to combat market failure.

Evidence suggests there is also limited availability of goods, products and services appropriate for people in older age groups. In some cases this is direct exclusion of older people, for example insurance companies refusing to insure people over a certain age. In other cases, older people can be excluded by poor product or service design that does not account for the needs and preferences of their age group, for example food packaging that people with lower grip strength will find difficult to open. Although the principles and economic benefits of 'Design for All' are well established, it is yet to take root in many areas of the consumer market. Research has a key role to play in identifying the most effective interventions and incentives to help businesses alter their models and processes in order to incorporate a better understanding of the needs and preferences of all age groups, including older consumers.

Ageism provides a useful framework for helping to identify causes, processes and instances of exclusion of older people from service use and consumer markets. Failure to make certain goods or services accessible or available to older people can be understood as a form of discrimination based on age (whether direct or indirect), and focussed research in to the necessary interventions to tackle this phenomenon can help develop appropriate interventions and solutions within this context.

Future research should focus furthermore on how consumption and expenditure patterns vary between age groups and across the life course, identifying the mechanisms that rule supply and demand and distinguishing time, period and cohort effects. This research can help to identify both the impact of the exclusion of older people as consumers and service users as well as the economic and social benefits that result as advances are made in developing accessibility and availability of appropriate goods, services and products for people of all ages. Both the perspective of the companies and that of consumers should be considered, in order to better highlight possible risks of asymmetrical power-balance between the two actors in this market and to identify areas of market failure.

Main research questions for the future include:

- How can businesses and service providers be effectively incentivised to mainstream the principles of 'Design for All' in the development of products, goods and services?
- What role does age based discrimination play in exclusion of older people from service use and consumer markets?
- How do consumption and expenditure patterns vary between age groups and across the life course?
- To what extent are variations in consumption and expenditure patterns between age groups a function of demand (different needs and preferences based on age) or supply (markets failing to supply goods and services equally effectively for all age groups)?

- **Discrimination in the labour market**

The existing evidence base confirms that the current under-representation and exclusion of older people in paid employment is partly associated with age discrimination. Research is needed to identify and quantify the different types of direct and indirect age discrimination at play in the labour market. European level research offers the scale and the resources necessary to compare differences across countries, across employment sectors, job types and age groups. It should also investigate the interactions between age discrimination and other known grounds for discrimination such as ethnicity, gender or disability. Furthermore we need a greater understanding of which areas within the labour market people are most likely to experience age discrimination: whether in recruitment, remuneration or access to training for example. This mapping exercise is necessary to support the development of successful interventions to alter ageist perceptions, attitudes and practices within the context of paid employment and the labour market.

In addition, it is also crucial to develop research in to the impact of older people's participation in the labour market in order to understand the potential benefits of increased participation. This research will serve to build a deeper understanding of discrimination and exclusion in the labour market and labour market dynamics, but must also go beyond the individual micro level, and seek to understand the wider social and economic impact at a macro level. For example, such research might seek to investigate any relationships between reduced/increased employment among older people, older people's health and well-being and consequent demands on national healthcare systems.

Main research questions for the future include:

- What are the different types of direct and indirect age discrimination at play in the labour market?
- What is the economic and social impact of age discrimination in the labour market?
- Which measures are most effective in preventing work-related age discrimination?

- **Enabling a longer working life**

From 2012 onwards, the over 60 age group will increase by about two million people a year and many of these will want or need to continue working past the statutory retirement age. New and innovative structures and approaches in the labour market will be needed to enable older people to continue working as long as they choose. Since the working age population is shrinking, it will be also important to study solutions that motivate people to work longer. For example, preserving older people's skills through mentoring schemes could encourage older workers to keep on participating in the labour market as workers or volunteers. It will also be a way to promote age-friendly workplaces and fight ageism.

Research is needed to ensure that policy making is informed by a proper understanding of the advantages and disadvantages of the different regulations on pensions and labour laws that can support those who wish to work longer. This will be a practical resource to support new thinking and the design of better policymaking processes. Moreover, research should provide guidance to policymakers and employers in the use of incentives to retain and hire older workers, by paying special attention to women, migrants, ethnic minorities and people with disabilities.

Research should also help employers adjust to the ageing workforce, by promoting age diversity in employment. In order to maintain older people's employability, further measures should also be studied to prevent illness and disability, as well as compensate physical decline, in particular for those with physically arduous jobs involving manual labour and night shift workers.

Main research questions for the future include:

- What regulations on pensions and labour laws are most effective in supporting those who wish to work longer?
- What incentives for employers are most effective in retaining and hiring older workers?
- What is the optimal balance between social protection and labour market policies in the promotion of older worker employment?
- How can employers effectively adjust to the ageing workforce?
- What is the role of volunteering in helping older workers remain or re-enter in the labour market?
- What further healthcare and employment measures should be introduced to better preserve the employability of the workforce?
- What lessons can be learnt from the application of the 'workability' approach in various settings?

• Reconciliation of paid work and informal care

In the context of an ageing population, the oldest-old face increasing care needs and dependency not only in the institutional, but also in home-based care. This phenomenon represents a big challenge for informal carers of working age, who need to reconcile work with their family duties. In particular, there is a clear and direct link between difficulties in combining family life, private life and professional life, on the one hand, and poverty and social exclusion, on the other hand. Where the need to care for a dependant family member cannot be reconciled with the demands of work through care leaves or part-time, many people, mostly women, are forced to stop work temporarily or altogether. Having no adequate monthly income and no adequate social security coverage in case of divorce, separation or death of the partner, such people are left vulnerable to poverty and social exclusion.

Therefore, ensuring the reconciliation is a key factor to fight poverty and social exclusion. Beyond family responsibilities, the possibility of combining private life and professional life is an important component of well-being as well as of inclusion and participation in society, including through volunteering activities during free time. More focussed research is therefore needed to identify the measures in terms of policies and services that are relevant to combining work and care duties, allowing informal carers to remain in the labour market, and preventing the risk of poverty and social exclusion, with proper regard to gender equality. These measures should also promote equal opportunities and men's role in caring.

Research should furthermore provide rigorous empirical evidence, which can be helpful to companies and policy-makers to find the most effective working time arrangements and leave schemes to support employees with caring responsibilities, and ensure an adequate income for them. Appropriate measures should also be studied to support persons who wish to return to the labour market after a long break spent caring. Raising awareness on these issues among the general public at both a national and European level is an important task, in which EU research can and should play a relevant role.

Main research questions for the future include:

- What are the barriers that informal carers face to remain in employment? What are the specific barriers faced by caregiving women and migrants?
- What employment, tax and social protection policies and measures are more effective in ensuring various adequate working arrangements for reconciliation and adequate minimum income for both men and women?
- What services are more effective and should be developed to support informal carers? What is the role of the information and communication technologies in this field?
- How can we ensure a better sharing of caring and work responsibilities at a micro (individual) and macro (societal) level between women and men?
- How can informal carers be empowered in decision-making that affects their lives, in order to ensure their participation?

GUARANTEEING THE QUALITY AND SUSTAINABILITY OF SOCIAL PROTECTION SYSTEMS

Importance of theme

The concept of 'social protection' refers to the set of welfare policies and interventions aimed at preventing and managing social and economic risks (e.g. unemployment, poverty, disability or dependency), in order to ensure an adequate level of well-being to the population. Such interventions consist of providing benefits to potentially vulnerable social groups in terms of both material (e.g. cash transfers and in-kind services) and non-material resources (e.g. training and education). The final goal of social protection systems is mainly reached by means of both social insurance programmes, i.e. through measures anchored on direct contributory schemes, and social assistance, i.e. support mechanisms that, usually not based on contributions, grant monetary help and/or in-kind services to vulnerable population groups. Within the concept of social protection, the role of both governmental and non-governmental stakeholders has to be considered. This is increasingly important at a time in which public institutions are no longer the only providers of welfare services, due to the presence of multiple social actors such as non-profit organisations and market institutions, as well as stakeholders like communities, families, and other social networks.

Social protection systems represent at the same time both a traditional and an innovative research field, since recent demographic, socio-economic and cultural changes have fostered renewed interest in this area. Two major factors have exerted their influence: the in-depth impact of ageing on the demographic composition of European populations (e.g. in terms of balance between the working/non-working population, younger/older cohorts, the two genders and so on), and; the economic downturn affecting Europe and the world since 2007-08. The economic downturn has put new and increasing constraints on public welfare budgets, calling for a possible retrenchment of state interventions and a stronger role for privately funded services. Both trends pose dramatic challenges in terms of sustainability to the current welfare states, and require innovative approaches to identify solutions able to ensure that quality will remain a core feature of social protection systems across Europe in the future. Sustainability of social protection systems is a key challenge for the older but also for the younger generations, who are now experiencing new forms of social risks such as a late and difficult (re-)entry into the labour market and precarious employment. In this respect, and beyond the sustainability issue, strong inequalities can be recognised in European ageing societies between 'protected' groups of population, who in the past could benefit from relatively 'generous' early retirement schemes, and other categories, such as precarious workers and immigrants, who are more often left out of such measures.

Fundamental Insights Crucial for Future Research

Current European welfare systems were mainly built and/or restructured after the Second World War, in times of economic growth, targeting traditional forms of vulnerability such as illness and unemployment. According to this approach, pension schemes were for instance designed according to estimates based on life expectancy projections referring to a situation in which life after retirement was commonly short. Today's scenarios – and the impact exerted on them by current population ageing trends – therefore require intense scientific and political efforts, in order to update and remodel the role played by different actors and institutions. This is needed also in the light of long-term unemployment in late adulthood, a phenomenon now common in many European countries that is likely to increase the risk of poverty in older age in the future, especially now that the pension retirement age is being increased, thus exposing to unemployment many older workers who earlier benefited from pre-retirement schemes.

While it is not yet completely clear how future social protection systems will impact on the above phenomena – and, vice versa – age-related changes in the prevalence of chronic conditions call for a reshaping of the current patterns of service delivery, still mainly focussed on acute care provision. In this respect, research should pay more attention to understanding how to best meet the long-term care needs of the population using most care resources, i.e. of people suffering from multiple chronic diseases, often implying a combination of both behavioural and physical disability. For instance, the rise in the number of people suffering from Alzheimer's disease and other forms of dementia brings with it the need to develop appropriate and targeted formal services, as informal caregivers of these patients are very likely to suffer from the negative social, economic and health consequences related to a long-term, time-consuming and stressful care experience. Moreover, the increase of cancer-related morbidity and mortality is challenging the capacity of European public welfare systems to provide appropriate palliative and end-of-life care, both in home and institutional settings. The broad issue of quality of care services is furthermore related to another type of social risk, that of elder abuse and neglect, mainly perpetrated by close relatives in domestic settings but often taking place also in institutional and home care settings, when monitoring and control mechanisms are inadequate or only partly implemented.

In this respect, it is crucial to investigate more in-depth the cost-saving potential of prevention, in order to more clearly distinguish those cases in which preventing illnesses and abuses can have a saving effect on public health care costs from those which end up increasing the overall health care expenditure (such as for instance the screening costs sustained for detecting diseases with a very low prevalence). Similarly, technological development represents a further challenge for current social protection systems. On the one hand, the inappropriate use of new technology in health and social care, as well as in public (e.g. e-governance) and private organisations, can lead to an unfruitful increase of costs and poor quality care. On the other hand, evidence suggests that new technology, when carefully implemented, can contribute to either contain costs (e.g. through a cut in transaction costs) or improve the quality of services and of users' outcomes. Assuming a global and future-oriented perspective and a multi-disciplinary approach, technology assessment methodologies gain therefore a crucial relevance in the field of European social protection, in order to tackle existing risks and prevent potential damages caused by the uncritical and unguided application of new technologies.

The heterogeneity of European countries plays, however, a major role in the identification of the most crucial research gaps, since traditional types of social risk, such as poverty, may still represent a main challenge for New Member States, especially those including large rural areas in Central and Eastern Europe. Future ageing research will therefore have to consider very carefully the heterogeneity currently characterising European Member States in different social protection areas.

Current Research in Europe

European research cooperation in the field of social protection has a long-standing tradition. Recent research efforts have indeed been taking advantage of both an increasingly comparative approach and a growing awareness of the heterogeneity of existing national solutions, which have facilitated the scientific analysis of how similar/different policies might have convergent/divergent outcomes across European countries. Although research efforts in the area of social protection are still rather un-systematic and fragmented, a number of high-quality research networks have been established within the EU, fostering the coordinated exchange of knowledge and competences as well as the establishment of most advanced research groups in this area. As a result, comparable data collections have been implemented, giving rise to harmonised datasets openly available to academics and policy-makers - such as for instance EU-SILC and SHARE - as well as to broad European research projects aimed at developing comprehensive, evidence-based conceptual frameworks for a better long-term care (e.g. INTERLINKS). An extensive account of some of these initiatives has been recently provided by the European Science Foundation's

report on 'Ageing, Health and Pensions in Europe' which, using a predominantly economic perspective, identifies a wide range of key research priorities in the field of employability of older workers, retirement saving, determinants of health, health care use and well-being in later life.

The analysis on the quality and sustainability of social protection represents, indeed, a strategic field where multi-disciplinary efforts can and should be gathered, as specific topics falling into this area are already studied individually by single disciplines (such as epidemiology, health services research, social and health policy, geriatric medicine as well as biology), but where the integration of findings is not yet carried out on a systematic basis. To this purpose, an increasing need to assemble findings into a broader and coherent framework can be observed, in order to improve the implementation of research into practice. Numerous participants of the FUTURAGE consultation, as well as external expert reviews, deemed as particularly critical the 'transferability' issue, since results of scientific research are too often seen as irrelevant or too academic by decision makers. If carried out in a more coordinated and systematic way, comparative research on social protection systems could instead gain useful insights, also from the diversity of existing care and welfare arrangements in Europe, a peculiar situation which, as already mentioned, makes it a stimulating 'permanent social laboratory', allowing mutual learning across the continent in this field (see Chapter 3).

Key Topics for Future European Ageing Research on Guaranteeing the Quality and Sustainability of Social Protection Systems

In the light of the above insights, a number of potentially relevant and strategic challenges can be identified in this field, as summarised below.

- **Sustainability of social security and social care systems**

One of the most urgent challenges for ageing research in this area is represented by the analysis of the sustainability of existing informal support networks (i.e. related to family, friends or voluntary organisations) and of formal protection systems (i.e. those providing health, social and long-term care services or financial transfers in form of pensions or benefits). To this purpose, more detailed information is needed on the use and take up patterns of support measures and care services (including the consumption of drugs and medication) over the life course. Such knowledge, also in terms of financial costs, is urgently required to develop more efficient and sustainable pension, unemployment and healthcare schemes, as well as to prevent and tackle frailty in older age more appropriately.

However, since ageing *per se* does not represent the only factor putting European social security systems under pressure, research has also to comprehend and analyse more in-depth the impact of changes in technology, economic growth and productivity in the labour market. All these interrelated factors represent fundamental variables to be considered in the attempt to ensure the sustainability of European social security systems over time. The sustainability of existing systems is likely to require a new definition of individual and collective responsibilities, and a new balance between private and public interventions.

In the field of pension schemes, the issue of mandatory retirement has to be considered for further analysis. While younger Europeans today experience difficulties in entering the labour market (especially in white-collar jobs), mandatory retirement ages in most European countries has remain unchanged for a long time, often at the same levels as half a century ago despite rising life expectancy. Recently, as a measure to counteract public budget constraints, pension ages have started to rise. However today most Europeans are living longer, but experience shorter working lives, with a clear impact at both micro level (in terms of individual's ability to save for retirement) and macro level (by reducing the ratio of social security contributions to expenditure on social protection). In order to overcome such a paradox, an active ageing approach would strongly recommend that mandatory retirement should be abolished. Permitting those

older people who need or wish to continue to work beyond the official retirement age should be facilitated by a system that allows prolonged employment while providing sufficient and reliable safety nets for those workers who, for whatever reason, are excluded from the labour market or can no longer participate in paid employment. By investigating these issues, future ageing research will have to consider, among other things, which measures can enable older workers to stay longer at work, e.g. through more flexible working times, an improved reconciliation of work and private/family life, including opportunities to look after grandchildren and dependent relatives as well as initiatives to improve knowledge transfer between younger and older generations of workers (see the section on Inclusion and Participation in the Community and in the Labour Market).

Another possible example of a research project under this sub-theme could be the comparative analysis of recent reforms in the long-term care sector in European and other major industrialised countries. This study might entail both an accurate evaluation of the economic and financial aspects of these reforms, and an analysis of their impact in terms of equity and recipients' well-being. Such a cross-national analysis would particularly benefit those countries still lagging behind in the process of innovating their long-term care system, since it might help them in identifying which policies and interventions could be more effective in promoting such reforms.

Finally, in order to improve transferability, the analysis of the sustainability of social security and care systems should include the identification of existing good practices, as well as the assessment of the impact of recent and forthcoming welfare reforms on individuals, families and society, also in the light of the increasing economic globalisation that is currently taking place.

Main research questions for the future include:

- Which measures can make current pension, health, social and long-term care systems more sustainable over time? What are the most effective social and economic policy models in this respect, and how are they interrelated?
- Which role do education and training play, as 'non-material resources of social protection', in improving the sustainability of social security systems?
- Which impacts would banning the mandatory retirement age have at micro, meso and macro level?
- How can an adequate level of service quality be achieved, in times of budget constraints with an ever-growing population in need of long-term care?
- Which trade-offs and alternatives pathways exist between the urgent need to reform and modernise current social protection systems and their long-term sustainability, especially in countries with most traditional welfare traditions?
- Which role are the current trends of economic globalisation playing with regard to the sustainability of existing social security systems?

• Supporting informal carers

The integration and coordination of informal carers and home care workers employed by private households within the formal support system represents a related and increasingly relevant topic, as the role of these providers is also becoming more evident and widespread in countries where the care for dependent individuals has traditionally and essentially been a state-based responsibility.³⁹ Despite the wealth of empirical evidence accumulated in this field in the last decades, still today many informal carers face a high risk of burn-out, social exclusion and negative economic consequences due to the

physical and psychological demands of caring. Even biogerontological studies have provided clear evidence that (both perceived and chronic) stress linked to caregiving is significantly associated with different determinants and biomarkers of longevity and health (e.g. oxidative stress, lower telomerase activity, telomere length and cell senescence).

Therefore, the strengthening of ad hoc services to support informal caregivers represents a fundamental strategy to reduce the burden of carers who carry out such a socially relevant activity, with positive effects on carers' health and socio-economic conditions. Furthermore, supporting informal carers by developing respite care solutions, organising training and enabling a better cooperation between professional carers and informal carers is also key to reduce risk factors of elder abuse.

A further issue concerns the need to develop more systematic knowledge on the increasing number of migrant workers employed by private households to provide elder care. This phenomenon has become in some European countries very widespread, thanks to the growing role played by cash-for-care schemes used to pay undeclared care work. These circumstances make it a very invisible, difficult to detect object of study, thus urging future ageing research to dedicate more resources and attention to identify which challenges and opportunities are associated with it in our European ageing societies.

Main research questions for the future include:

- How can family carers and private care workers become better integrated within the formal support system?
- How can formal services support informal carers in their tasks and prevent them from stressful situations and burn-out?
- To what extent can the support from formal services allow carers to remain in paid employment which has beneficial effects both from a social inclusion perspective as well as for the public purse?
- How is migrant work in the elder care sector changing traditional formal and informal care patterns? And which measures can contribute to solve the problem of widespread undeclared work in this area?

• Improving access to services

Easing service accessibility will be an increasingly challenging issue for European welfare states. The shift of the care paradigm from a mainly hospital-based (curative) to a community-based (preventive) organisation increases the importance of reaching the widest share of users. This particularly concerns frail members of the population, who are at risk of under-utilising care services because of their lack of economic, social and family resources. Evidence suggests for instance that service access may especially be more difficult for older people living in rural areas and easier for those relying on a greater social capital.

In this regard, innovative solutions could be fostered through the identification and transfer of relevant initiatives between different welfare systems. A strategic role could be played however by ICT, too, not only by strengthening the possibility to grant tele-monitoring devices and tele-care solutions, but also by overcoming constraints due to large distances and lack of transportation affecting both service delivery and informal support networks (see the section on Inclusion and Participation in the Community and in the Labour Market).

To this purpose, a deeper knowledge of emerging vulnerability issues and their determinants is also required in order to develop more effective interventions, for example, to prevent and tackle situations of elder abuse and neglect and to deal with the effects of cumulative disadvantages over the life course – such as for instance poverty or social exclusion – in specific population groups at risk, e.g. those with an ethnic or migrant minority background or characterised by a lower educational level.

Main research questions for the future include:

- How can access to health and social care services be improved and better integrated, especially in deprived and sparsely populated areas?
- How can formal public services support hard-to-reach segments of the older population?
- Can ICT improve knowledge about the services available, and to some degree can it release some of the burden on social and health services?

• **Efficiency, cost-effectiveness and quality of interventions**

In times of economic downturn and cuts in public budgets, but equally of increasing awareness by users regarding their rights, the call for maximising the ‘value for money’ in the area of social protection is becoming stronger. This means that, at the micro level (e.g. reflecting the user perspective), rigorous research is needed to promote changes in service delivery aimed at increasing (or maintaining high) quality standards. At the same time, evidence-based analysis at the macro level has to be carried out more systematically, in order to assess the most cost-effective interventions to satisfy users’ needs. Recent estimates show that only 20% of health treatments have been objectively assessed in terms of impact and cost-effectiveness, a ratio which is likely to be even lower in the case of social care and policy interventions.

This illustrates how urgent the need is to carry out more systematic and in-depth research aimed at assessing the quality (especially from a users’ perspective) as well as the cost-effectiveness of social protection interventions (the latter also from a provider’s perspective). Innovative therapeutic approaches and care interventions, as well as translational research and optimisation of care delivery, are required especially with regard to specific subgroups of population, e.g. those people suffering from dementia, cancer, diabetes, cardiovascular diseases and other chronic diseases. Preventive care and health promotion initiatives (including those in which users, social and health care professionals are integrated in the design and implementation phase) have to be further investigated in order to unveil their cost-saving potential. The potential of the ‘-omics’ technologies (i.e. genomics, proteomics, structural biology, epigenomics, interactomics, metabolomics, pharmacogenomics, and so on) in enabling new innovative approaches in diagnosis, drug development and individualised therapy has to be further explored, in order to develop new approaches for diagnosis and treatment of diseases, including rare diseases. Integrated care also has to be investigated more in-depth, as it can contribute to quality care by delivering health and social care provision that is flexible, personalised, and seamless.

Rigorous findings in this field would indeed represent a valuable support for decision-making in policy and practice, thus allowing a more evidence-base identification of inefficiency areas in service provision, and a better allocation of resources in times of economic constraints, thus overcoming current limitations in terms of impact on the overall quality of delivered interventions. These issues link also to the need for improved transparency, and to the importance for citizens of knowing what use is made of public resources.

Main research questions for the future include:

- How can improved transparency be achieved regarding the use of resources made within the public welfare systems? How can the value-for-money in this sector be maximised?
- Which strategies can increase the quality (from a user's perspective) and cost-effectiveness (from a provider's perspective) of interventions?
- What are the most promising intervention in the field of preventive care and integrated care?
- Which are the innovative interventions to support people coping with chronic diseases?
- What is the potential of the '-omics' technologies in developing new approaches for diagnosis and treatment of diseases?

- **ICT-supported informal caregiving**

While a considerable amount of research has already been conducted on the predictors of caregivers' stress and burden, including the use of new technologies in the field of 'ambient assisted living' and 'smart homes', much less attention has been paid so far to the role of new technologies and ICT in improving the quality of informal caregivers' everyday life. Indeed, most carers across the EU remain neglected or not properly addressed in their support needs by web-based and other ICT-based services, also because they are mainly women in mature age with little digital competence. Therefore, research on the new opportunities made available to informal caregivers through the use of ICT-based solutions represents a strategic area, potentially able to shed light on how to improve the integration (and balance) between formal and informal care through technologically facilitated exchanges between the two sectors.

ICT-stimulated improvements could also be expected in terms of a better reconciliation between unpaid care and paid work, improved training opportunities and decreased isolation by carers, as well as to overcome existing language barriers in the increasingly frequent case of migrant care workers being directly employed by households. This field overlaps with other research areas, since the education of users through ICT-based solutions represents a key challenge to take advantage of technological progress on a large scale.

Main research questions for the future include:

- How can ICT-based tools support informal caregiving?
- What is the role of ICT-based solutions in improving the quality of long-term care provided by informal carers, as well as their quality of life?
- Which impact can ICT have in reducing the direct and indirect costs attached to informal caregiving?
- Which ICT-solutions are most easily transferrable and implementable on a large scale, also in contexts in which no strong tradition nor digital competences exist in using ICT?

- **Reviewing and strengthening intergenerational solidarity and cooperation**

Cohorts, following the societal developments in which they are embedded, present changing social, economic and cultural needs, and experience dissimilar intergenerational relationships, thus urging a differentiated analysis of the social roles and expected behaviours attached to diverse age groups.⁴⁰ Maintaining productive and mutually beneficial relations between generations is critical, especially during

times in which traditional intergenerational relationships have been redefined. This is due to phenomena such as for instance increasing divorce rates, stronger age segmentation of society and the reduction in the number of multi-generational households, although high youth unemployment rates in several countries push many young adults to remain living with their parents until their late 30s. Accordingly, policy adjustments are needed in order to renegotiate the 'intergenerational contract' into new sustainable ways of family and social relationships, aiming at improving integration and collaboration between different generations. Future ageing research should therefore aspire to discover, both at a micro and macro level, how policies can support multi-generational contributions to society and to strengthen solidarity between citizens of all generations.

Besides the already analysed issue of sustainability, the equity of current pension systems represents another strategic call for research in this area, two crucial sub-themes of it being the ability of pension policies to prevent people from falling into poverty in older age, and the capacity of pension schemes to maintain the living standards achieved during working life. Another area of possible investigation refers to the housing issue. This is gaining increasing relevance in EU countries, as due to financial and employment constraints younger cohorts have more and more limited access to independent housing, thus often leading to multi-generational households, a pattern of living arrangements requiring a renegotiation of intergenerational relationships and transfers on which more light has yet to be shed.

Furthermore, few studies seem so far to have focussed on the productivity of people after retirement. Despite being inactive in the labour market, retired individuals keep on making important contributions to society (through their so-called 'unwaged productivity'), both within (e.g. grand-parenting) and outside the family (e.g. volunteering). A more systematic, in-depth assessment of the value and role played by such social and economic contribution would be important also to contrast ageist stereotypes which are still deeply rooted in our society, and to formulate a more accurate judgement over the intergenerational flows of resources within society (see the section on Inclusion and Participation in the Community and in the Labour Market).

Main research questions for the future include:

- Which changes are needed to ensure that today's social and demographic context will not weaken solidarity between generations in the long-term?
- How can the contribution given by retired people to society be measured through their unwaged activities like grand-parenting and volunteering?
- What are the good practices aimed at increasing older people participation to such activities after their retirement?

AGEING WELL AT HOME AND IN COMMUNITY ENVIRONMENTS

Importance of Theme

With increasing age, and particularly in very old age, people spend most of their time in the home. That is, all over Europe the home is the major place for ageing. The meaning of being at home and the sense of belonging and attachment to a circumscribed spatial terrain are crucial for identity and feelings of security among older adults. Increasingly with coming cohorts, not only the home but also community environments at large play an important role. However, the role of home and community environments for ageing well has not been sufficiently studied. Therefore, future ageing research must put a strong emphasis on the everyday environments of ageing, including not only the dwelling as such but also out-of-home environments as important arenas for activity and participation. Home and out-of-home environments have physical and spatial components, but also social components (treated in other chapters of the Road Map). Considering perspectives for the future, we see new cohorts of ageing adults across Europe being mobile as never in history as well as increasingly using technical environments such as ICT for serving their quality of life. Accordingly, in this chapter physical-spatial-technical (PST) environments are focussed on as a research and practice area. PST environments thus include the full range of private living units, neighbourhoods, retirement communities, workplaces, shops and other service facilities, public transport facilities as well as long-term care institutions, hospitals, other health care facilities and products. It is clear that the human interchange with PST environments also deserves the consideration of legislation and policies (e.g. in terms of barrier-free environments), pension schemes, health and social care provision, transport solutions, age and cohort distribution, urban versus rural contexts, culture and ethnicity, segregation versus integration of older adults, and economical and environmental standard of a region or country. The development of PST environments supporting active ageing must also consider important subgroups of the ageing population such as e.g. older adults with dementia-related disorders or other severe care needs and those with a migration background. Particularly for such vulnerable subgroups, where the resources of the ageing individual may be very limited, the potential of PST environments to compensate and enhance the remaining potential for positive emotions, autonomous action, and leisure and social life deserves more research investments in Europe in the future.

Traditionally, research on ageing has focussed primarily on the ageing individual and population – much less on PST environments and even less on the nature and potential of person-PST environment interactions. Moreover, while inter-disciplinary work is an asset and prerequisite for many research strands, research on ageing as related to PST environments is an area requiring inter-disciplinary research. Research on ageing as related to PST environments is also a domain par excellence to consider the interrelations between micro, meso and macro levels of analysis of ageing processes and outcomes. One example is the question, whether and how the course and outcome of ageing is also driven by contexts such as urban versus rural environments, various community contexts including deprived neighbourhoods, or national legislation and social policy. Another issue is gender, as more knowledge is needed on the differences between women and men regarding person-PST environment interactions, e.g. the perception of home, the function of home and the possibility of influencing the home environment and the neighbourhood, including the question of involvement in neighbourhood and city planning. It is of utmost importance to understand how ageing persons and user organisations representing senior citizens can be empowered to play an active role in shaping and designing housing, neighbourhoods, public transport, and health care and social services in urban and rural contexts, so that they better serve healthy ageing. This is indeed an issue of participation and democracy and the citizen's right to influence her / his immediate living conditions.

Research on ageing as related to PST environments also has critical implications for the consideration and practical treatment of end-of-life issues, because places of dying will remain among the crucial ethical challenges of our ageing societies. This is just one example to showcase that this area of research may evolve strong synergies with important ethical discourses within Europe. Multi- and inter-disciplinary research on ageing as related to PST environments has the potential to contribute with new conceptual, theoretical and empirical insights on processes of ageing, help to identify critical and frequently underrated antecedents of desirable outcomes of ageing, and through the findings, add to the identification of critical challenges related to improving quality of life of older adults all over Europe. For instance, an evidence-based and engaged consideration of the potential of environments supporting healthy and active ageing will help to decrease inequality among senior citizens (e.g. in terms of housing and transportation standards) within and between European countries. In this respect, the understanding of cultural differences regarding PST environments between countries, regions but also of ethnic groups regarding the design and use of space is important. This type of knowledge will show, for example, how different groups and individuals, as they age, perceive home and the sense of belonging. Such evidence might also serve as a basis for understanding their willingness to engage in the local society including voluntary engagement. The quality and meaning of home and community environments are also crucial for supporting the possibility to lead a healthy, active and meaningful life also in advanced age, and - while still not sufficiently targeted in research - will ultimately have an impact on the possibility to expand the number of healthy life years as we age.

Fundamental Insights Crucial for Future Research

A plethora of empirical work supports the notion that physical, spatial and technical aspects of home and community environments are able to significantly support healthy and active ageing. For example, the home environment has been found to support autonomous functioning, even after controlling for confounders such as age, co-morbidity, and education.⁴¹ Similarly, technology has become a new resource for ageing persons. Currently and increasingly, the internet is being used as a tool for intergenerational exchange or a means to search for information on societal services, technologies such as sensor mats or GPS-based orientation systems are used to support frail older people, robot animals and ICT-based entertainment are being introduced to stimulate emotional life or cognitive capacity, and so on. Still, the scientific knowledge on relationships and interaction between the ageing individual and such environmental features is weak.

Aspects of innovative power of research on ageing as related to PST environments lay in its strong potential to stimulate and drive new inter-disciplinary synergies (without neglecting the value of disciplinary approaches), its contextualised image of older adults as being proactive as regards their environments, and its emphasis on end-user orientation and participatory research (without neglecting scientific rigour and the value of basic and applied research approaches). With such perspectives serving as a platform for research on ageing as related to PST environments, there is a set of cross-cutting, fundamental insights crucial for future European research in the area as follows.

Emphasis on the diversity of ageing persons and PST environments: research on ageing as related to PST environments can serve a better understanding of ageing and diversity. This applies, for example, to studies on housing conditions, quality of urban environments, deprived neighbourhoods, and the provision of assistive devices. Additionally, diversity appears in environments such as retirement communities, long-term care institutions, and prisons (in which a rapidly growing proportion of prisoners now belong to the older age segment), workplaces or leisure activity areas. Such environmental diversity interacts with the diversity at the person level, reflected for instance in gender, the distinction between the third and fourth age, ethnicity, and social class. Diversity also increasingly appears in technological and virtual places and contexts, where there are still marked differences in to what extent different subgroups of the ageing population use such resources. Important in terms of diversity are also differences within and between

European countries in 'green issues' such as air pollution or climate change. In sum, research on ageing as related to PST environments can significantly enhance the understanding of diversity and ageing issues in Europe.

Emphasis on the life course dynamics of person – PST environment relations: it is crucial to understand the interaction with PST environments from a life course perspective. For example, many decisions taken earlier in life (e.g. residential decisions in middle adulthood) may have a strong influence on adaptation late in life. The concept of transitions in adult human development is also important and helpful for future research on PST environments. Turning points such as transitions from middle adulthood into late adulthood (such as retirement), and from early old age to advanced old age (such as relocation to a sheltered housing facility), imply major alterations in terms of potentials but also risks. A prime area targeting such transitions with high importance for our societies is the role of environmental design and optimisation for the ageing workforce. That is, to minimise the risks in terms of both health and economy a profound consideration of the role of PST environments in workplaces is needed in order to support the potential of the ageing workforce. At another level, transitions from normal cognitive ageing to mild cognitive impairment or dementia create significant changes, not the least from a person- PST environment interaction perspective. Moreover, thanks to the advancement of medical research many chronic and progressive diseases can now be treated, with positive effects on survival. Such developments result in more people living longer parts of their life with a disability – that is, ageing with a disability is an experience shared by an increasing proportion of the population, increasing the need for research on person-PST environment interactions in such subgroups of the population.

Emphasis on future cohorts' relations with PST environments: research on ageing as related to PST environments can also contribute to increase the understanding of forthcoming cohorts of older adults. In particular, new cohorts of older people appear with new environmental habits and lifestyles, which will shape the life course at large as people age in the future. A prime example is the expected use of new technology such as ICT but also robotics or GPS tracking technology.

Current Research in Europe

During the last two decades, European research on ageing has gained in impact and importance in the research area of home and community environments. There is a growing body of knowledge aimed at understanding person-environment dynamics and the importance of PST environments along the process of ageing.⁴² As to the overriding importance and inter-disciplinarity in this area of research, currently this field tends to be somewhat scattered, while there are many studies that could be framed under the theme home and community environments. For example, there is a considerable body of research on health care and social services contexts, public transport, the effects of outdoor activity, fall prevention, and so on, while not so often synthesised to form a knowledge base driven by the ambition to understand healthy ageing from PST environment perspective. To date, European research with an explicit emphasis on home and community environments as related to ageing has to a large extent been driven by geropsychology, occupational therapy and public transport planning. For example, there are longitudinal studies focusing on home and health in the fourth age, including Northern, Central and Eastern European countries. There is also a growing body of knowledge on out-of-home mobility, including physical planning as well as the use and need of mobility devices. Yet another research strand concerns use of everyday technology for people with neurodegenerative disorders. In order to nurture the knowledge development in such fields, disciplines such as architecture, sociology, geography, neuroscience, besides many others, should be encouraged to engage in inter-disciplinary research endeavours on ageing as related to PST aspects of home and community environments.

Key Topics for Future European Ageing Research on Physical-Spatial-Technical Environments

To exemplify future research needs within this field of research on ageing, seven challenges related to future European ageing research in the area of PST aspects of home and community environments have been identified.

- **Generation of differentiated knowledge on the enabling and constraining characteristics of PST environments at the home and community level**

Future research in the area needs to generate more differentiated knowledge regarding the enabling and constraining characteristics of PST environments for the full diversity of the European ageing population. For example, the full scope of housing solutions across Europe must be empirically targeted and studied from individual as well as subgroup and population perspectives. That is, there is a need to study e.g. highly competent older adults, adults of various levels of education and income, various constellations of multi-morbidity, physical and cognitive functional loss, frailty and various degrees of disability. It is also important to stress the general lack of knowledge as to gender differences regarding PST environments, as are issues regarding the role of various family constellations, ethnicity and migration.

Main research questions for the future include:

- What are the key enabling and constraining characteristics of PST environments for older adults, for example in terms of maintaining autonomy, well-being and identity?
- How important is the role of home characteristics including home adaptation as compared to person factors such as multi-morbidity and functional limitations?
- What role do major differentiating variables such as age, gender, ethnicity, mental status, functional impairment, region and culture play when it comes to the impact of PST environments on healthy ageing?
- What are the effects of implementing an as focussed as possible policy 'to stay in your own home as long as possible' to the ageing individual, to the care services, and to society at large?

- **Better understanding of the meanings of PST environments of older adults' lives**

Connected to the former issue is the need for up-to-date evidence concerning the plethora of roles and meanings of PST environments for current and future cohorts of older adults. It could well be, for example, that a technologically equipped home environment may serve the needs of future older persons better than traditional environments. Therefore, research connecting housing studies with issues of technology and cohort dynamics is highly important. There is also a strong need to become more concrete and specific in research on ageing as related to PST environments. For example, research on the role of specific parts or functions of the home as related to daily activity, e.g. the kitchen, may prove to be very important. At a more general level, the overarching question may be framed like this: Do we know enough about the meaning of specific places as people age and about cohort-related change of the role and function of such specific places? The role of specific parts of home will also vary with gender and culture, warranting further study. The influence of social ties with family, friends and neighbours are also important to consider when studying ageing individuals and their interaction with PST environments.

Main research questions for the future include:

- What do home environments and neighbourhoods mean for current cohorts of older adults, for example in terms of cognitive and affective ties to the home, place attachment and their possible role of maintaining the ageing self and identity?
- How does meaning of home and neighbourhood vary when it comes to the diversity of older adults, including mental status and ethnicity? Can such evidence be efficiently used for intervention purposes?
- Is there evidence for cohort-related changes in what home environments and neighbourhoods mean to older adults?
- Will technology, for example home-based robotic systems, be accepted better by future older adults as a means to support and enrich quality of life?
- What meaning do specific places (e.g. kitchen, garden) hold as people age, and is there a change of the role and function of such places over time?

- **More research on the relationship between transport and ageing well**

Transport issues are an ever-increasing theme of ageing all over Europe, while there is a need for more explicit research attention of this key component of PST environments. Optimal transport plays a critical role for quality of life in old age. At the same time, risks related to the increasing share of older drivers have to be kept in mind. The research area of transport also involves a full scope of issues related to technology, for example use of mobility devices for supporting older adults with dementia.

Main research questions for the future include:

- What are the transportation needs of the future ageing population of Europe, and how are these needs related to health and quality of life?
- How can the needs in terms of out-of-home mobility of older adults with cognitive impairments be supported in optimal ways?
- What kind of technology is needed to serve the transportation needs of older adults in optimal ways, and how can such technology be implemented most efficiently?

- **Work environments as key PST environments for ageing societies**

A critical area for European societies is the role and potential of work environments of older persons (see the section on Inclusion and Participation in the Community and in the Labour Market). The key question is how optimisation of workplace environments contributes to the possibilities to be part of the workforce also in advanced age, but also to health-related outcomes and innovation capacity.

Main research questions for the future include:

- What are the key elements of designing work environments in order to release older employees' potential in the best way possible (e.g. in terms of health, cognitive functioning)?
- What kind of role can technology play in order to optimally serve the needs and capabilities of older employees?
- Is there a relation between the characteristics of the work environment and older adults' innovativeness? How can such a linkage be optimised in the future?

- **Long-term care environments for vulnerable and frail older adults**

Research on PST environments in the long-term care context must remain a significant area of research on ageing as related to PST environments. This research stream must also have a strong connection to health issues and provision of health care and social services, because institutions are increasingly used by older adults with multi-morbidity and frailty. Currently, research on individual needs of nursing and care dominate this research domain, while more research is needed on how the provision of housing options for senior citizens is changing, including studies on the diversity across Europe. Since access to preventive measures and health care is important for battling inequality in the prerequisites for active and healthy ageing, diversity should also be regarded in relation to socio-economic status and minority issues.

Main research questions for the future include:

- How can long-term care environments be designed in the future to support optimal ageing in old and very old age even in the situation of much reduced resources (such as dementia)?
- What synergies and possible risks are coming with future alliances between long-term care institutions and technology?
- What are the most convincing alternatives to traditional long-term care solutions for older adults with different degrees of frailty? What potential and limits do they have?

- **PST environments as supporting healthy ageing and increased life expectancy**

We need more research which adds to the important connection between environments and public health issues and outcomes. User involvement is crucial in this type of research, and also research on how to engage and empower ageing persons and groups in shaping age-friendly (rather cohort friendly) and health-supporting environments is called for.

Main research questions for the future include:

- How can we create environments that optimise the exertion of physical activity in later life?
- How do we create mobilising environments that support health promotion and serve the empowerment of older adults?
- What are the implications of and what elements and resources are needed to create age-friendly communities within urban and rural areas?
- What kind of PST environments do best serve the maintenance and possibly the enhancement of cognitive functioning in old age?
- Can virtual environments be used to stimulate healthy ageing, and in which ways?

- **Healthy home and community environments for very old age**

We need more evidence on how we may define vulnerable constellations of persons ageing in over- or under-demanding PST environments and how such constellations shape ageing outcomes, particularly in very old age. This issue is closely related to physical and cognitive functioning along the process of ageing and how such aspects operate as facilitators or barriers in designing environments supporting healthy and active ageing. Important issues include older adults with dementia, multi-morbidity, as well as places for dying and death.

Main research questions for the future include:

- What are key synergies between the characteristics of PST environments and older adults with dementia? Can such synergies be used better in the future and what is the potential?
- How can places counteract the pronounced vulnerabilities of extreme old age? What can different European countries learn from each other in terms of the creation and design of such places?
- How can optimal places for death and dying be created for old and very old adults and how can such environments support a possible new culture of death and dying in Europe at large?

UNEQUAL AGEING AND AGE-RELATED INEQUALITIES

Importance of the theme

While the life expectancy of EU citizens has risen steadily over recent decades, the gradient in life expectancy between more or less deprived populations and those with greater access to social and environmental resources continues to persist. Inequalities in life expectancy are systematically generated and grounded in social and economic factors. Within the EU, there is uneven distribution of life expectancy and healthy life expectancy between Member States and between population groups within Member States health follows socio-economic gradients so that, put simply, the worst off experience the shortest lives and also live a greater proportion of those lives in worst health.

Life course trajectories are socially embedded and strongly influenced by the accumulation of opportunities and risks. Some of these risks are 'structural' and relate to the 'social environment' and the way society is organised. Individuals exert little if any control over these factors, which *de facto* restrict the potentiality of individual human agency. Family lineages, in the first instance, set the background conditions of individuals' early life and through them inequalities are transmitted between the generations. Along the life course, the ageing of individuals differs as a consequence of the unequal impact of life events: childhood, puberty, reproduction, and senescence. Inequalities are influenced by biological, social, psychological, economic and ecological processes.

Inequalities are par excellence a multi-dimensional concept which may refer to the financial, social, functional, spiritual, and cognitive sphere. Much attention has been paid so far to the social inequalities (and inequities, the normative concept applied to inequalities which are judged to be unfair and unjust) in health: social differences are well reflected in the health domain, with many of the common age-related health conditions being distributed unequally across socio-economic gradients so those with limited access to socio-economic resources also tend to experience the worst health.

Fundamental Insights Crucial for Future Research

Inequalities result from the interplay between genetic and key environmental determinants. Ageing contributes as a risk factor for inequality, along with other factors such as access to social, environmental and economic resources, class, gender, ethnicity, health risk-related behaviour (such as smoking, exercise and diet) and access to services. Many of these factors are open to intervention. The rate at which individuals and populations age is also dependent on interaction between these factors.

There are large variations in income and other dimensions of socio-economic status (including social class) across the EU. For the population over 50 years of age, income difference analysis of SHARE showed that, for older people, average income exceeded €45000 in three countries (Denmark, the Netherlands, Switzerland), was between €30000 and €45000 in Austria, France, Germany and Sweden, and was below €30000 in Italy, Greece and Spain. The relationships between national average levels of income and poverty are revealed in the SHARE database for the distribution of poverty (defined as <60% median income) between EU countries among the over 50s shows that overall about a quarter of EU citizens over the age of 50 live in poverty with significant variation between Member States. For example at the extremes of the distribution the figure for Sweden is 17.2% and that for Italy is 27.7%. Similar statements can be made about the distribution of socio-economic resources *within* Member States.

Such examples serve to illustrate the complexity of interactions between socio-economic and demographic factors and inequality across Europe. Health follows these socio-economic gradients so that, put simply, the worst off experience the worst health.

In addition to age and socio-economic deprivation, there are other important contributory factors to inequality such as the complex and contested dimensions of race and ethnicity. This is a challenging area to investigate for a number of reasons. It is undeniable that ethnic identities have important implications for people's lives, with some ethnic groups apparently experiencing particular disadvantage in relation to both health and socio-economic status, reflecting distinct life course experiences and inequalities in health and longevity. In this regard across the EU, special mention must be made of migration, particularly with respect to the employment of migrant care workers and the integration of migrants into destination countries. A key issue here concerns ensuring the effective utilisation of health and social services, a particular priority for first generation migrants who may face significant language difficulties as well as discrimination in gaining full access to services.

People with a disability are at increased risk of many other health problems, and have shorter life expectancy than those without disability. These risks are elevated for both physical disability and learning disability.

Sex and gender, are significant contributory factors to the mix of determinants of inequality. For example the health and longevity of men and women varies because of genetic and physiological differences. These differences are amenable to research not only at the level of international or intra-societal comparison in humans, but also at the biological level. It is increasingly recognised that sex and gender influences on health are complex, and that the health and longevity profiles of men and women deserve further research and analysis. Correlations between reproductive activity and lifespan have been seen in many organisms, particularly with regard to the actions of hormones as determinants of metabolism with ageing at the cellular and molecular level. This illustrates the importance of understanding the interactions between reproduction on the one hand and nutrition and metabolism on the other. Both are key determinants of ageing, and both are dependent on factors such as income, poverty and other dimensions of socio-economic status.

Among other things, research in this area promises to provide insights into the distribution of gender differences in ageing and reveal mechanisms (and therefore potentially targets for therapies) underlying the variation in the prevalence and treatment of specific diseases, and the response to drug (and other) treatments between men and women.

The very old are the fastest growing section of the population in many countries and is also the group a high prevalence of functional limitation, which, even in advanced old age, is distributed along socio-economic gradients. This population group also faces increasing care needs including dependency on informal and institutional care which puts them at high risk of their rights being abused. There is a current lack of knowledge on the distribution and patterns of complex health problems and frailty in old age, including the biological factors (or biomarkers), which could predict the future onset of age-related disease and/or residual life expectancy, and what the very old consider is important in terms of quality of life and well-being. The very old are a group at relatively high risk of abuse and neglect, which varies in prevalence across the EU27.

Current Research in Europe

There is a body of knowledge aimed at understanding the drivers of inequalities in health across Europe although using existing European data collections to develop this knowledge requires comparisons between existing datasets, which are not all harmonised for measures of health. Crude proxies for health (such as mortality and survival) have been used, rather than measures of health status. Research on inequalities in health status has relied either on post-harmonisation of studies, for example the Cross-national determinants of Quality of Life and Health Services for the Elderly (CLESA) project, or, more recently, the development of cross-national studies such as SHARE. Though SHARE does not cover all EU countries, a small

number of Central and Eastern European countries are now included as well as a longitudinal component. EU-SILC and the more recent EHIS, are also key datasets for exploring determinants of inequalities in ageing across Europe. It should be noted however that the multiplicity of studies does not infer any redundancy since maximum breadth (coverage of countries and topic areas) and depth are impossible given funding constraints.

Key Topics for Future European Research on Inequalities and Ageing

There is considerable overlap between disciplines and research themes on the priorities for inequalities research. This is illustrated below with reference to six broad research areas.

• Monitoring inequalities

Monitoring and resolving inequalities in healthy ageing across Europe demands not only that there is concerted collection of measures that are truly harmonised but also that they are appropriate at a country or regional level. Not only does this include the key concepts of healthy ageing and frailty, addressed in the section on Healthy Ageing for More Life in Years, but also the major drivers of health inequalities: for example socio-economic status, multi-morbidity, social engagement. Newly harmonised measures must also reflect current social priorities and concerns. Data collection methods including survey design and sampling must also be harmonised. Consideration should be given to the collection and banking of biological data (BioBanking), which could provide unprecedented opportunities to expose biological mechanisms by which inequalities in healthy ageing might be addressed (for example by the development of new clinical or pharmacological targets for intervention). Monitoring any indicator across all European countries immediately poses tensions between maintaining individual countries' needs with those of the collective whole, but the gains are great in terms of potentially quantifying the impact of health systems, social and health reforms and wider social policies.

Main research questions for the future include:

- How cumulative advantages and disadvantages shape opportunities and risks, which ultimately influence health and other outcomes in older age?
- Do adverse circumstances in younger age have irreversible effects, or can early drawbacks be overcome at a later stage during the ageing process?
- What are the compensatory mechanisms along the life course that reduce the adverse impact of risks and disadvantages?
- What is the role of human agency and the impact of structural factors on inequalities in older age?
- What factors can strengthen resilience to potential stressors and disadvantages?

• Health in work and retirement

Many countries are considering extending working life and delaying the age at which state pensions are provided. We have little understanding of how health in later life and healthy ageing are affected by changes in the pension system or the current economic crisis and unemployment, how these changes are affecting social gradients in health and whether we can increase (healthy) working life. This area requires explanation of the trends in the health (physical and mental) of the young-old and understanding of the relationship with the different exits from the labour market, pensions, socio-economic status, social engagement, family structures, informal caregiving and cultural expectations surrounding work and caring. With the growth in the numbers of the very old, decisions to retire or not may be influenced not only by the individual's family circumstances and whether they are required to provide care to an aged parent but

also the cultural expectations of elder care and the health and social support systems within the society. Enhanced support within the workplace will also be vital to ensure longer working lives, hence the need for research involving public and private sector organisations assessing the scope for work-based health promotion to older employees (see the section on Inclusion and Participation in the Community and in the Labour Market).

This topic area requires harmonisation of measures and is therefore potentially risky and long-term. Longitudinal studies will be required but these should be conducted in comparative countries to cover the variation in pensions and social policy. We should also utilise existing datasets such as those established by the Finnish Institute of Occupational Health⁴³ across a 30-year long period together with those established by surveys such as The Irish Longitudinal Study on Ageing (TILDA),⁴⁴ and the English Longitudinal Study on Ageing (ELSA).⁴⁵

Main research questions for the future include:

- Can the workplace be considered as a suitable setting to develop effective healthy ageing interventions?
- How can work-related health inequalities be prevented? And those accumulated during the working life be reversed or compensated after retirement?
- Is there a link between inequalities in pension schemes and health status after retirement?
- How does retirement affect health? Are there commonalities/differences between social groups and occupations?

• Inequalities and discrimination in the labour market

As life expectancies continue to rise, achieving longer working lives is becoming a common goal across Europe and features as an integral part of the Europe 2020 strategy for growth. The current low levels of labour market participation across Europe for older workers (46% of those aged 55-64) suggest there is a significant challenge here to be met. There are many factors that impact on an older person's capacity to engage in the labour market which include age discrimination in the work context and the challenges of combining work with family responsibilities. The research priorities in this field are covered in the section on Inclusion and Participation in the Community and in the Labour Market.

• Inequalities and discrimination on health

Discrimination within the health field can happen in a variety of ways and levels. It can manifest itself as sub-standard or inappropriate treatment of older people by individual healthcare practitioners or it can take a more structural form, limiting older patients' access to healthcare or appropriate medication.

There is a need for multi-disciplinary research including health professionals, carers, gerontologists, geriatricians, demographers and involving older patients to map different areas where discrimination on the grounds of age (but also combined with other grounds like ethnic origin, gender or disability) have an impact on the health treatment or health condition of an older person. This comparative work would pinpoint problematic areas in the European countries involved and provide policy recommendations. This research should come to support the PREDICT Charter, a European Charter for the rights of older people in clinical trials,⁴⁶ and the work of the European Medicines Agency on geriatric medicines.⁴⁷

Research is required to understand the prevailing norms within the health and care sectors that potentially contribute to negative attitudes such as 'why bother creating a drug which is efficient for the over 85 years-old?' or 'prevention of a disease after the age of 50 is not possible as people have already acquired habits that they cannot change in order to get results'. This is knowledge that is required in order to contribute to the development of effective interventions against common failings of healthcare systems, such as a failure to treat co-morbidities. It is anticipated that 'changing perceptions', and ultimately behaviours, within the health field will require specific knowledge and skills and therefore will require a specific focus in addition to a general focus on 'changing perceptions' throughout society.

At a macro level, more research is needed on age discrimination in access to health care, including the financing of treatment and hospitalisation. As the burden of paying for health care increasingly shifts to the private sphere and because of the increasing uncertainty on the future of pension rights for older people, insurance companies need to provide affordable solutions to older patients. A future project could focus on gathering examples of current practices, analysing them and providing recommendations for sustaining health care systems taking into account financial capacity and risk factors for older people. An understanding of ageism, equality and rights provides a useful framework for this research to help identify why and how access to healthcare needs to be and can be improved for older people.

Main research questions for the future include:

- In what ways does discrimination on the grounds of age have an impact on inequalities in health?
- What are the prevailing norms within the health and care sectors that potentially contribute to negative attitudes towards older people and inequalities? How do these attitudes deter effective health care interventions?
- How does the financial capacity of older people impact on their access to health care? Is there age discrimination within the financing of health care provision?
- Which are the prevailing risk factors for the exclusion of older people from health care provision? Are there any good practices addressing these risks?
- Are there age limits in clinical trials and pharmaceutical trials? Do such practices respond to the needs of the ageing population? Are there risks for older people's health care provision?

• **Ageing and migration**

Another relevant and complex phenomenon which contributes to increase the range of inequalities observed in European ageing societies, both in positive and negative terms, is that of migration. Migrants' different background and life course experiences are often reflected in remarkable differences, within the general population, in crucial dimensions such as health and socio-economic status. Inequalities and discrimination based on ethnic and/or racial diversity represent indeed a relevant issue for many – migrants and non-migrants – but are particularly salient among the subsets of migrants featuring physical, linguistic, religious or cultural differences compared to the majority population of their destination country.

Especially – but not only – with regard to these groups of migrants it is therefore important that future ageing research in Europe focuses on existing and perceived migration-related socio-economic inequalities, conflicts and integration difficulties, in order to identify the most appropriate interventions and policy strategies to tackle and prevent them. More research is for instance needed to explore how to improve the access of ethnic minority elders to health and care services, through a better understanding of the intersection between age, ethnicity, gender and disability. Future investigations should try to capture both

migration-related multiple and intersectional discrimination as well as forms of direct (e.g. refusal to treat a patient and so on) and indirect discrimination (e.g. absence of linguistic support which hinders chances of access to care). Comparative policy analyses of provisions relating to inequalities and discrimination experienced by minority ethnic elders will also be crucial in this regard, as will comparative studies addressing research questions concerning needs, expectations and perceptions of minority ethnic elders and health professionals on how to improve and manage culturally sensitive services.

Main research questions for the future include:

- What is the impact of migration trajectories in determining inequalities over the individual life course and within society?
- Which initiatives are most successful at national and regional level to address in a culturally sensible way the needs of migrants and minority ethnic elders?
- How can barriers of access to quality care services care for migrants and minority ethnic elders be prevented? And what are the roles played by professionals in this area?
- How can the collaboration between researchers, policy makers, practitioners and older migrants (organisations) be improved to inform ageing research, policies and practice, thus reducing migration-related disadvantages and increasing migrants' contribution to society?

• **Focus on the very old**

In the context of an ageing population, the very old face increasing care needs and the dependency on institutional and informal care creates a higher risk of inequalities as well as elder abuse.

There are already a number of epidemiological studies which have been or are being conducted in this age group (for example the Leiden and Newcastle 85+ studies). Ideally these studies should be extended to include a wider geographical representation and areas which include a range of life expectancy trends. These studies allow the validation of existing and emerging biomarkers relevant to treatment of this population, so that evidence-based interventions for health and longevity in advanced old age can be developed for the benefit of the very old. For example, it is currently unclear how risk factors contribute to cardiovascular disease in the older patient. The widely used cardiovascular risk equations derived from the Framingham studies only apply up to 75 years of age and many European studies have excluded people older than 60-65 years. Where the relevance of conventional risk factors has been studied in advanced old age they are shown to carry different implications than in the young.

Longitudinal and sequential cohort studies in this age group require smaller intervals between follow-up in order that transitions are not missed through death. Studies of the ways in which older people utilise their time (time use studies) could be important here also to assess how this age group adapt and cope with increasing frailty.

One of the main challenges in conducting studies in this age group is ensuring the participation of people who are cognitively impaired or frail. This issue is also highlighted in respect of clinical research. While older people suffer the greatest burden of ill health and associated disability, they are consistently under-represented in clinical research.⁴⁸ In the UK, a recent Department of Health 'Technology Assessment' concluded that a continuing lack of fit between participants in clinical trials and users of healthcare in the real world raised serious concerns regarding equity of care.⁴⁹ Older people may not receive potentially useful therapies because of lack of evidence, and may also be exposed to unnecessary hazard because of a lack of accurate information on adverse events rates. This can be seen as morally, ethically and possibly also legally indefensible⁵⁰ and signals an urgent need for further research on the use of pharmaceutical

treatments in older age using new targets derived from biogerontological investigation and more selective drugs, potentially better adapted to the ageing organism, and particularly to age-related diseases. These efforts should be supplemented with research to optimise the use of existing therapies, and in particular the problems of polypharmacy, drug induced ill health and vaccination.

Patient data recording and the use of record linkage have enormous potential for both epidemiological and clinical research. Ethical and legal issues surrounding the protection of confidential personal information and its use for research could be solved at a European level for a pan-European database. This would require considerable effort concerning harmonisation of standards and regulations across Europe.

It is recognised that many older people want to participate in clinical research and may be more likely to consider participating in research than younger people.⁵¹ This is potentially a key dimension of inequality of direct relevance to the FUTURAGE project, namely inequality of access to participation in research, and by implication inequality in the potential to benefit from research findings.

Further research involving older people specifically, must be conducted in regards to the impact discrimination has on health. Research including health professionals, carers, gerontologists, geriatricians, demographers and older patients is necessary to understand the impact discrimination based on the grounds of age have on health treatment or condition of an older person. All too often health research fails to consider the specificities of older people and statistics often fail to represent meaningful age and gender groups.

Additional research, featuring older people more prominently, is necessary in the area of elder abuse. In order to better understand, recognise and prevent elder abuse we must understand as much as we can about it from both the victim and the perpetrators perspectives.

We must also come to better understand the complexity of the relationships between the carers and the cared for and how they differ from state to state, societal status, economic status and so on.

In order to tackle inequalities and abuse, research is first needed to better measure the prevalence of abuse and neglect across the EU27. One of the greatest challenges of this research will be to overcome the methodological problems associated with detecting abuse. These include reluctance of victims to admit to abuse, lack of recognition of certain behaviours as abusive (this is particularly key to financial and emotional abuse) and concealment of abuse by the abuser. Meeting this challenge must become a priority for research in this area. In order to develop a sophisticated understanding of the prevalence of abuse, research in this area must measure the experience of different types of abuse (including physical, emotional and financial) and identify how experience of multiple types of abuse is correlated.

Furthermore, research in this area needs to be designed to highlight ways in which abuse may be experienced differently among older people according to other characteristics such as gender, sexuality, nationality, migration status, disability and within specific types of relationships, such as informal care and end-of-life care. Future research has to be informed by those existing studies at EU level.⁵²

Abuse must be tackled as a participatory process involving older people themselves. This can be supported by the European Charter of the rights and responsibilities of older people in need of long-term care and assistance.⁵³ In terms of knowledge transfer, research should be used to provide concrete policy developments and recommendations. There is a need to develop strategies at all levels, as abuse and neglect are linked to social exclusion (intergenerational solidarity, access to close services), health (quality services but also working conditions of health workforce, mental health, depression and anxiety), anti-discrimination (gender, ageism, racism, homophobia, and so on), access to justice and to civic rights, to adequate financial services and quality of housing.

Main research questions for the future include:

- What methodological approaches allow achievement of a better inclusion of frail and dependent older people into clinical and socio-economic investigations?
- To what extent does the lack of representativeness of research samples in terms of older population limit the generalisability of results?
- To what extent do the very old population in Eastern Europe resemble or differ from its Western European counterparts? What are the similarities and specificities which can be found across countries?
- How prevalent is elder abuse and neglect across the EU27? What are the different kinds of abuse and neglect? How are they related?
- How is neglect and abuse experienced at the micro level? Do individual characteristics of the victim play a role in the detection, acknowledgement, prevention and tackling of elder abuse?
- What evidence is there for abuse and neglect within hospitals and long-term care settings?
- What are the features of the long-term care systems that have an impact on the prevalence of elder abuse and neglect?
- What is the link between the quality of care and the quality of the work of the healthcare workforce and elder abuse? Is the lack of support to caregivers (informal and professional) a contributory factor to elder abuse?

BIOGERONTOLOGY: FROM MECHANISMS TO INTERVENTIONS

Importance of Theme

The increase in life expectancy across Europe and the challenges that arise from population ageing need, at the most fundamental level, to be understood in terms of the biological mechanisms that sustain life and of the gradual compromise of these mechanisms which results in age-related morbidity, disability and death. Individual persons have many dimensions of being – social, cultural, economic, medical, and others – each of which is important for well-being. Underpinning each of these dimensions is the current state of the individual body as a biological organism. In parallel with the change in demography, there has occurred significant progress in one of the newest areas of biomedical research – the biological study of ageing, or biogerontology.

From a biological perspective, ageing is one of the most demanding objects of study. The ageing process affects the functions of the body at all levels, from the smallest changes affecting individual molecules, through impacts on cellular integrity and function, to changes that influence the operation of whole organs and organ-systems. The ageing process is influenced by genes, with some tendency for longevity to run in families, but overall the genetic contribution is modest (around 25% of the whole complex of factors influencing longevity) and there is an overwhelming consensus among biogerontologists that ageing is not itself programmed by direct gene actions. Instead, ageing is caused by the accumulation through life of a wide variety of faults in molecules and cells. Indeed, gene actions are for the most part concerned with survival, regulating the numerous maintenance and repair systems that allow humans to survive as long as they do.

Key questions in biogerontology concern:

- i. The nature of the mechanisms that cause the age-associated accumulation of damage
- ii. How genetic and non-genetic factors, including lifestyle factors such as exercise and nutrition, influence the trajectory of health across the life course
- iii. The deep connections between intrinsic biological ageing and the many diseases for which age is the dominant risk factor
- iv. How medicine can develop new, biologically-informed ways to target age-related frailty
- v. How interventions might be developed to improve health span faster than the growth in average longevity, and
- vi. How the biological age of individuals can be monitored to provide a rapid feedback of data that can inform about the success of intervention strategies.

The FUTURAGE biogerontology theme is informed by previous EU actions in the field of biological ageing research, including among others AGEACTION, LINK-AGE and WhyWeAge.

The importance for Europe of developing strength in biogerontology is that this field will be essential to provide the knowledge base for future improvements in age-related health, including initiatives that recognise the life course nature of ageing. While some goals concern improving the health and vitality of those who are old already, in order both to minimise the risk of high-cost dependency and to enhance the social and economic contributions of growing numbers of older citizens, others must address factors that apply from the earliest stages of life, even antenatally, to boost the lifelong trajectory of health and well-being. Europe has established significant strength in this rapidly expanding scientific field, which is of global significance. Nevertheless, the current effort is extremely modest with respect to the size of the challenge.

Europe therefore faces three key challenges in biogerontology: 1) To integrate ongoing research most effectively; 2) To increase by a large factor the research capacity by training new researchers at all career stages; 3) To deliver international impact by securing adequate competitiveness with other regions and through strategic global collaborations.

Fundamental Insights Crucial for Future Research

Biological ageing is a complex process but one that has become scientifically tractable with the advent of new theoretical concepts and major technological advances in the biosciences. As recently as twenty years ago, leading biomedical scientists would sometimes dismiss ageing as just too complex for realistic analysis. This tendency has disappeared and been replaced by growing recognition that biogerontology is one of the most important emerging fields of research. The complexity has not gone away, however, and there will need to be a very substantial expansion of biogerontology research if insights are to progress to mature techniques to intervene successfully to enhance health in old age. Perhaps the most significant insight has been the recognition that the ageing process is much more malleable than used to be thought. The body is programmed for survival, not death; it was just never a high enough evolutionary priority to evolve the capacity for indefinite survival, given the hazardous conditions in which most organisms (including our human ancestors) lived their lives. Ageing thus results from the gradual accumulation of cellular and molecular faults. Genes influence longevity by conferring robustness on the body, and there is a general tendency for increased genetic robustness/longevity to be associated with some biological cost, such as somewhat reduced fertility. However, the length of life (and reproductive success) of an individual is strongly influenced by many factors, including lifestyle and chance. There is growing epidemiological evidence that factors such as nutrition can have important effects on ageing and health, and the mechanisms underlying such effects are beginning to be investigated. There is also evidence that exercise has generalised benefits for ageing and health, in addition to immediate effects on cardiovascular and muscle function and on reducing the risk of obesity and diabetes. It is through the application of these non-genetic factors that the most immediate further improvements in ageing and health are likely to be generated, and there is particular reason to wish to focus such application on the most disadvantaged sectors of the population, in whom the adverse effects of unhealthy nutrition and lifestyle are most evident.

Beyond the already known potential to improve ageing and health by modifying nutrition and lifestyle, it seems entirely reasonable to expect that advances will be made in biological measurement of age changes and eventually by direct intervention in mechanisms causing intrinsic ageing and age-related diseases. If the malleability in ageing mechanisms can be exploited, for example, to postpone neurodegeneration, osteoporosis, muscle waste and immune system decline, it should prove possible significantly to reduce the prevalence of these conditions across Europe. As will be described below, research is advancing in many of these areas although there are many scientific questions still requiring further research.

In terms of how age affects the health of older people, there is still a significant lack of information of sufficient detail to inform biogerontological insights. Some national and European projects are beginning to address this shortfall but there is still great need for detailed, longitudinal studies that can capture data on biological measures related to underlying biology of ageing. Such studies need also to capture detailed health information that will enable connections to be made between biological mechanisms and age-related frailty and disease. The fact that biological mechanisms of ageing are influenced by social and environmental factors means that it is no longer acceptable for biogerontology and social gerontology to be conducted in isolation from each other.

Current Research in Europe

The recently concluded EU projects LINK-AGE and WhyWeAge sought to include inputs from the growing number of biogerontology research groups across Europe. Their reports provide a useful indication of the scope and extent of this activity. Additionally, there have been numerous specific projects and programmes focusing on particular aspects of the field. Most European countries now have several institutes, centres or research groups beginning to develop programmes in biogerontology, some of which such as the Institute for Ageing and Health in Newcastle upon Tyne (UK) are now well-established multi-disciplinary centres with more than 15 years experience. Overall, however, the majority of such groupings are relatively new, having been established for 5 years or less. There is a major limitation in research capacity, since the number of early career researchers completing training in biogerontology in each year is still very much smaller than in other fields of biomedical research. The shortfall in research capacity is likely to be the most serious obstacle to expanding European research effort in this area, unless steps are taken urgently to resolve this situation (see also WhyWeAge report). The ERA-AGE Future Leaders of Ageing Research in Europe (FLARE) programme of post-doctoral fellowships is a model in this respect.

Key Topics for Future European Ageing Research on Biogerontology

The recently completed EU Framework Programme 7 project WhyWeAge aimed to identify key elements of a European road map for research in biogerontology. Eleven scientific topics for future European research in the area of biogerontology were identified. These form the biogerontological theme in FUTURAGE and are summarised as follows (greater detail can be found in the WhyWeAge final report on the FUTURAGE website).

- **Biomarkers of ageing**

Ageing affects all tissues and organs of the body but there is great variability in the way individuals exhibit these effects. Thus some individuals appear to age biologically faster than others. There is urgent need therefore to identify age-related changes in body function or composition that could serve as measures of 'biological' age and predict the future onset of age-related diseases and/or residual lifetime more accurately than does chronological age. Such measures are termed biomarkers of ageing. A biomarker can be predictive for the years of healthy survival but also can be indicative for an already initiated but not yet clinically manifest disease. Therefore, the quest for biomarkers is always dependent on the question asked. The EU Framework Programme 7 Large-Scale Integrating Project MARK-AGE, for example, represents an important and encouraging step in this direction. It was launched in 2008 and it aims at establishing a set of robust biomarkers of ageing in a European cohort of 3700 men and women aged 35-74 years. Such an ensemble of several biomarkers with appropriate weighting should enable a better description of biological age than any single biomarker in isolation. This project in part draws on the existing cohort already recruited within the EU Framework Programme 6 Integrated Project Genetics of Healthy Ageing (GeHA). The major limitation of the ongoing MARK-AGE project is the lack of a significant longitudinal component due to restriction of project lifetime and finances. Further studies incorporating scope for longitudinal follow-up of the study subject will, therefore, be important for validation of the predictive power of the candidate biomarkers.

Biomarkers can be categorised at several levels (whole organism, cellular, molecular, and so on) and research is necessary both for humans and also for non-human model systems in which much current biogerontological research is conducted. In humans such studies should aim also at the identification of organ and tissue specific biomarkers. In view of the considerable diversity that exists within human populations, there may also be need for studies to incorporate stratification of the examined population according to age, gender, health or frailty status of the subjects as well as genetic profiles (e.g. APOE alleles). Regarding biomarkers of specific age-related diseases, a clear distinction between healthy people being at risk of developing a certain condition and patients should be made. Therefore, studies should focus on

revealing markers that indicate the risk of developing an age-related disease and markers that will indicate the treatment outcome of patients that are already diagnosed. Furthermore, not only the identification of biomarkers for individuals (e.g. in order to decide the treatment regime of a certain geriatric patient) but also for subgroups is desirable, as the latter will narrow down multiple treatment choices.

In order to deliver effective implementation of outcomes from biomarker research, consideration needs also to be given to enabling European infrastructure. This will include integration of existing and new databases and creation of one or more integrated BioBanks providing access to blood products and tissues from relevant donors (see Chapter 3).

Main research questions for the future include:

- Can we identify a practically useful set of biomarkers of ageing capable of predicting future health and longevity in individual humans?
- Can we identify similar markers for non-human models that will facilitate translation of research on interventions from models to humans?
- How can we deliver the most effective infrastructure to underpin ageing biomarker research and development within Europe?

• **Telomere erosion, DNA damage and mitochondrial dysfunction**

Ageing at the cellular level appears to be driven significantly by erosion of telomeres (protective tips of chromosomes), by DNA damage and by mitochondrial dysfunction. These contribute in the case of dividing cells to the loss of division capacity (i.e. replicative senescence) and may also contribute to dysfunction in cells such as neurones (which are post-mitotic, i.e. non-dividing). Telomeres shorten with cell division. If not fully counteracted by telomerase (which is switched off in the majority of human cells), this eventually leads to chromosome 'uncapping', which triggers cell senescence. Even though telomere maintenance ensures cell immortality, intervention on telomeres can be associated with potential cancer risk, and therefore they might not be ideal targets for treatments. Their potential as biomarkers for ageing is under examination. DNA damage occurs constantly as a consequence of normal cell metabolism ($>10^4$ events per cell per day). Elaborate repair systems have evolved for various types of damage. Persistent DNA damage can induce disturbances of gene expression, blockage of DNA replication, cell death, cellular senescence and loss of insulin/IGF-1 signalling. DNA repair pathways are of crucial importance for keeping levels of persistent DNA damage low, thus controlling the rate of ageing. Mitochondria are the centre of major metabolic pathways and thus tightly interconnected with systemic regulation of nutrient utilisation and cell growth, processes that determine the rate of ageing and are so far the best known targets for life-extending interventions. Mitochondrial DNA accumulates lesions with ageing in many organs. When the proportion of dysfunctional mitochondria becomes too high, this results in overt pathology, but the importance of low levels of mtDNA lesions may also have relevance for ageing. Dysfunctional mitochondria are a main source of reactive oxygen species (ROS) which cause generalised molecular damage within cells and thus provide scope for a range of detrimental effects. They are also less able to produce the energy on which all cells depend for their functions.

Main research questions for the future include:

- What are the exact mechanisms by which telomere erosion, DNA damage and mitochondrial dysfunction contribute to cellular ageing?
- How do these mechanisms interact?
- How do the effects of these mechanisms at the cellular level give rise to age-related dysfunction and disease of tissues and organs?
- How can this knowledge be harnessed towards safe and effective intervention at the molecular and cellular level?

- **Oxidative stress, protein damage and protein maintenance**

A key mechanism contributing to the molecular damage responsible for ageing has long been thought to be oxidative damage caused by reactive oxygen species (ROS; commonly known as 'free radicals') that arise within cells as by-products of essential metabolism. Since this idea was first proposed 50 years ago, the concept has undergone considerable testing and refinement and it has been found that ROS are also utilised by cells for important signalling functions, as well as to kill pathogenic micro-organisms. Thus, the exact role of oxidative stress in ageing is currently the focus of renewed intensity of research. Among the important targets for damage by ROS are the many proteins the cell requires for its normal functions. Proteins are constantly attacked and damaged by exogenous (e.g. UV, chemicals) and endogenous agents (e.g. ROS and other damaging by-products of cellular metabolism). Protein damage combined with an age-dependent decline in anti-oxidant capacity and protein quality control result in an imbalance of protein homeostasis, which has been clearly linked to ageing and age-related diseases. Maintaining protein homeostasis is essential for health, while failure of protein maintenance has been implicated in the age-related accumulation of intracellular aggregates of altered proteins such as the amyloid plaques and neurofibrillary tangles associated with Alzheimer's disease. Protein maintenance requires sensing and elimination of damaged proteins through repair or degradation combined with ongoing protein synthesis to replace damaged and degraded molecules. All interventions known to delay ageing (e.g. dietary restriction, insulin-insulin growth factor 1 signalling pathway) reduce protein aggregation, suggesting an intrinsic link between protein aggregation and ageing.

Main research questions for the future include:

- Which proteins are most susceptible to damage and why, and how do protein modifications contribute to breakdown in protein homeostasis?
- How extensive are protein modifications in cells during ageing, and can we enhance techniques to detect random modification of proteins as powerful as those which now exist for DNA?
- What factors are responsible for protein aggregation and how exactly do protein aggregates contribute to age-related cellular pathology?
- What factors underlie age-related changes in protein synthesis and degradation and how might these most effectively be targeted?

- **Systems biology of ageing**

The ageing process is highly complex and a fuller understanding will only be gained by applying an approach that takes into account multiple interactions at multiple biological levels operating over a wide range of time scales, ranging from molecular interactions taking less than a second up to life course

processes that develop over decades in humans. The task is daunting but new effort is being dedicated to developing such an approach within the emerging field of systems biology. It is essential that full use is made of developments as they arise but it is also essential that researchers in ageing are fully engaged in steering the specific developments that are necessary for ageing.

A central problem is to understand the role of single genes and gene products, molecular functions and cellular processes that contribute to ageing. It appears that specific genes or molecular functions are not well conserved during evolution to form different animal species, but that cellular processes are, raising important questions about the organisation, function and robustness of gene networks. Another important area of development in systems biology is the iterative cycle of focussed experimentation and mathematical modelling that is used for detailed investigation of hypotheses about the underlying dynamics of cellular and molecular processes. Systems biology approaches are particularly well suited for study of the underlying mechanisms of system robustness, the inherent trade-offs and particular points of vulnerability. Systems biology is also essential for understanding the biological underpinning of the major differences in ageing rate between individuals for which a complex combination of genetics, environment and intrinsic chance is thought to be responsible.

It is an unavoidable but challenging truth that the complexity of ageing will require the use of systems biology approaches if the process as a whole is to be understood at the level of detailed integration that will enable effective interventions to be examined first *in silico* and then tested and interpreted experimentally. Infrastructure for systems biology approaches to ageing will also be necessary to bring research on different aspects of the biology of ageing into maximally synergistic interaction. However, systems biology depends on technology and on the development of suitable transnational infrastructure. Up-to-date and reliable computing facilities are essential. Computing hardware must be maintained and software must be constantly updated. Applications that are web-service enabled are proving to offer major advantages as they enable researchers to design their own pipelines relatively simply. Much analysis and modelling require substantial computing power and the Cloud is fast becoming an attractive alternative to running in-house computer clusters.

Main research questions for the future include:

- How do the multiple mechanisms of cellular and molecular interact to drive age-related pathobiology?
- How do the multiple maintenance and repair pathways interact to sense and respond to damage of the various kinds?
- How do the above two networks interact and where might be nodes that offer opportunities to target interventions that can improve health in old age?
- How best to configure and implement European infrastructure to support systems biology of ageing?
- How to generate the added value from currently disintegrated research activity by delivering the necessary integration for effective progress in systems biology of ageing?

• Inflammation and impaired immune functions

A shared feature of many diseases associated with ageing is an increase in inflammatory processes including those mediated by the body's innate immune system. It is also widely believed that dysregulated or compromised immunity ('immunosenescence') is causally related to the decreased control of infectious disease by older people, to their poorer response to vaccination, and to the increased signs of systemic inflammation often seen in older adults. The latter is implicated in a plethora of age-associated diseases

including cardiovascular disease, Alzheimer's Disease, and type II diabetes. Immunosenescence may become clinically important in different people at different ages, according to genetics and many other factors, including lifestyle, socio-economic status and the pathogen load to which individuals are exposed throughout life. Immune parameters predicting mortality have been sought for many decades, and establishing a robust set of biomarkers of immune ageing applicable to diverse human populations would pave the way for monitoring interventions aimed at restoring appropriate immunity in older people, as well as proving causation. Although many studies report associations between certain age-influenced immune parameters and mortality, most have been based only on cross-sectional measurements on different young and old populations. These cannot establish causality. However, circumstantial evidence from a very small number of longitudinal studies have begun to reveal 'immune signatures' of ageing consisting of clusters of parameters increasingly recognised as an IRP. Establishing whether the IRP is a general characteristic of human populations and understanding the mechanisms responsible for its emergence is likely to allow design and validation of interventions to reverse the effects of immunosenescence.

Main research questions for the future include:

- How does inflammation contribute to age-related pathology and how can these processes be targeted to reduce adverse effects of 'inflammaging'?
- What mechanisms underlie age-related deterioration of immune functions and how can effective function be maintained for as long as possible?
- What is the role of chronic infections such as with cytomegalovirus (CMV) in contributing to immune dysfunction?
- How can immune risk be defined using suitable biomarkers and can the immune risk profile be modified?

• **Metabolic factors**

Growing evidence points to important roles for metabolic factors in modulating the ageing process. This evidence derives from: (1) studies of interventions that slow the ageing processes in animal models; and (2) longitudinal studies of the diverse biological changes that accompany the ageing process. What these show in particular is that factors such as diet and exercise can produce changes in metabolism that profoundly affect ageing and health. They provide proof-of-principle that appropriate interventions in metabolic processes can promote healthy ageing and reduce late-life pathology, in the relevant animal models. Moreover, analysis of the pathways by which metabolic processes impact ageing may lead to increased understanding of the biology of ageing itself. Interventions that slow ageing in animal model systems include dietary restriction (DR), mutations of genes involved in metabolic regulation and treatment with drugs. Such interventions tell us that ageing is not a fixed and immutable process; in fact, it is relatively easy to manipulate in the laboratory. Interventions of this sort usually lead to decelerated ageing, which produces a reduction of incidence of the full spectrum of ageing related pathologies, and an increase in healthy lifespan. The effects seen in short-lived animal models may however reflect distinctive plasticity in metabolic regulation which has evolved to provide small animals, exposed to highly varying environments, with strategies to survive adverse circumstances. It remains an important open question whether similar plasticity exists in human biology.

Studies of metabolism, how it changes with age, and how interventions can slow ageing and increase healthy lifespan have the potential both to provide a deeper understanding of the biology of ageing, and to greatly improve late-life health in the future. In particular, we foresee a combination of recommendations in terms of lifestyle and nutrition, and drugs with a powerful capacity to promote healthy ageing as a long-term output of this research. If proven effective in humans, this would allow people to live longer, healthier lives.

Metabolic and associated endocrine factors are likely also be relevant for studying sex/gender differences in ageing and longevity. In many species, including humans, there are significant differences in longevity between males and females. Women live on average around 6 years longer than men but experience more years of compromised health at the end-of-life. Biological differences between males and females derive principally from endocrine factors which need to be investigated both for their intrinsic effects and also for interaction with environmental and behavioural factors.

Main research questions for the future include:

- How is metabolic homeostasis affected by diet, age and other factors?
- What metabolic sensing and signaling pathways have beneficial effects in animal models and might these exert similar effects in humans?
- How are metabolic gene regulatory networks configured and can systems biology reveal specific targets for effective interventions?
- How and in which organs do effects of metabolism exert their effects on ageing?
- How do neuro-endocrine signals influence and interact with metabolic factors affecting ageing?
- How do fat tissue and associated signals influence and interact with metabolic factors affecting ageing?
- What biological mechanisms contribute to the sex/gender differences in ageing and longevity?

• **Nuclear receptors**

Nuclear receptors serve as molecular organisers and activators of physiological responses. In mammals the nuclear receptor family has 48 members. In the last 10 years, thanks to the development of a vast array of transgenic animal models, progress has been made in understanding the roles played by these receptors and their involvement in the regulation of physiological functions relevant to ageing and age-related disorders. For instance, the estrogen receptors, which function was originally believed to be limited to the regulation of reproductive functions were shown to have a significant metabolic role modulating liver functions (eg IGF-1 production) and fat (eg adipokine production) functions, in the control of immune functions and CNS development and plasticity. Of great interest are the recently identified nutrient sensor receptors, LXR and PPARs which are implicated in regulating immune function. Preliminary studies have shown their ability to affect positively the progression of pathologies with a strong inflammatory component (such as atherosclerosis, neurodegenerative diseases). Cross-talk between these and other nuclear receptors such as the thyroid hormone receptor (TR) are an area of active research, pertinent to many aspects of ageing, including neurodegenerative and metabolic disease.

Main research questions for the future include:

- What is the nature of the cross-talk between nuclear receptor signals and metabolic signalling pathways?
- To what extent do epigenetic modifications affect nuclear receptors and their impacts on ageing and health?
- What are the roles of nuclear receptors in the control of biological rhythms and their dysregulation during ageing?
- What links exist between metabolic signalling through nuclear receptors and homeostatic control of somatic stem cell functions?

• Age-related disorders of blood circulatory (vascular) system

Vascular ageing is characterised by endothelial dysfunction (resulting primarily from a reduction in nitric oxide bioavailability), diffuse intimal thickening, arterial wall stiffening, vascular calcification and defective vascular repair. These age-associated changes in vascular structure and function may lead to a number of pathologies including the development of hypertension, atherosclerosis, coronary syndromes, vascular dementia, as well as heart and kidney failure.

The structural and functional manifestations of vascular ageing can be investigated using various non-invasive techniques. In addition, these techniques are currently being investigated for their predictive value, i.e. to detect vascular changes in young and middle age individuals, in the absence of overt cardiovascular disease.

Currently our understanding of the molecular and cellular events taking place with ageing in the vessel wall stems primarily from evaluation of surrogate systemic markers in specific human cohorts (e.g. white blood cell telomere length or urinary isoprostanes), from post mortem studies and from investigations in animal and cell culture models. Even though most studies suggest that oxidative stress is the main process driving vascular ageing, the mechanistic picture is far from complete. Moreover, an emerging theme in this area is the role of attenuating mechanisms, such as those invoked by physical exercise and dietary interventions.

Main research questions for the future include:

- What is the role of known molecular/cellular mechanisms of ageing (e.g. oxidative damage, cell senescence) in the aetiology of vascular stiffness and vascular calcification?
- How to identify protective genetic traits and their relationships to mechanisms of vascular cytoprotection?

• Muscle weakness, sarcopenia and physical exercise

Preservation of muscle mass and strength is a key component of healthy ageing. Sarcopenia is the age-related, loss of muscle mass which can start as early as 30 years of age and can result in a loss of about 30-50% of the muscle mass by the age of 80. Sarcopenia currently affects 42% of European men and 57% of women aged 70-79. Diagnosing sarcopenia is difficult as there are as yet no standards to define healthy muscle ageing as opposed to debilitating muscle weakness. The current understanding, based on the knowledge generated by previous EU-funded research programmes, recognises 6 major causes and exacerbating factors of sarcopenia: 1) loss of neuromuscular integrity, 2) lifestyle changes such as physical inactivity and poor nutritional status, 3) anabolic resistance to feeding and exercise, 4) hormonal changes, 5) chronic inflammation, 6) reduced muscle regenerative capacity. The increased prevalence of sarcopenia is occurring together with a pandemic of obesity in the population.

While sarcopenia is inevitable with ageing, it can be effectively mitigated through physical, nutritional and pharmacological intervention. In contrast, acute trauma or illness often leads to a rapid and potentially devastating additional loss of muscle mass and, as a consequence, loss of independent living. Preventing this transition is a major challenge. In this regard, the impact of communication between muscle tissue and other organs for maintaining health is an emerging field of research.

The regenerative capacity of skeletal muscle is intimately linked to the function of muscle stem cells (satellite cells). These cells can proliferate during periods of muscle growth and repair in response to increased functional demands or injury. The number of satellite cells and their function decreases throughout life. However, the consequences of these changes are insufficiently explored. Old muscle can increase in size with strength training, and it can repair injury, albeit to a lesser extent and at a slower rate. There is some evidence to suggest that systemic and local environmental factors directly influence satellite cell activity; thus, constant exposure to e.g. low-grade inflammation, also related to intramuscular fat accumulation, has negative effects on muscle regenerative capacity.

Main research questions for the future include:

- What are the prevalence, causes and functional consequences of sarcopenia?
- What are the roles of muscle protein breakdown, oxidative stress and accumulation of modified proteins in muscle ageing?
- What are the most effective physical, nutritional and pharmacological strategies to combat sarcopenia and sarcopenic obesity?
- What are the effects of exercise, inactivity and inflammation on age-related regulation of skeletal muscle mass and function?

• **Age-related modifications of skin and elastic tissues**

Skin ages in response to extrinsic factors, such as UV, and intrinsic factors such as poor nutrition and chronic stress. Wrinkles are among the most visible signs of skin ageing, which although not significantly deleterious to physical health may profoundly affect psychological well-being and self-image. Skin ageing also adversely affects wound repair and risk of skin ulceration. Skin damage, associated with ageing, is implicated in skin cancers so the ageing of the European population is likely to be associated with a notable increase in the number of skin cancers to be diagnosed and treated. Factors affecting skin ageing that are associated with intrinsic ageing are likely to be similar to the factors responsible for the more general loss of tissue elasticity with increasing biological age.

Main research questions for the future include:

- What causes the changes in extracellular matrix during ageing?
- How does intrinsic ageing affect stem cell functions within skin?
- What are the most effective nutritional and pharmaceutical strategies to combat skin ageing?
- What are the effects of exercise, inactivity and inflammation on age-related regulation of skeletal muscle mass and function?

- **Connecting biogerontology with clinical ageing research**

Several of the specific areas described above have touched already on the need for inter-connection between research on basic biological mechanisms of ageing and those contributing to age-related diseases. There has been longstanding debate about the nature of the interface between ageing and disease but it is an established fact that age is the greatest single risk factor for many of the diseases of current medical interest. These are becoming increasingly prevalent as the European population ages. Therefore there is urgent need to expand research on the mechanistic connections between ageing and disease. Older people also tend to exhibit multiple diseases at the same time, raising important questions about common underlying causes. Intriguingly there are sometimes also inverse relationships, such as the inverse epidemiological association between Alzheimer's disease and cancer, which suggests that there may be mechanistic trade-offs such that vulnerability to one disease is associated with resistance to another. An inherent difficulty in many ongoing clinical studies is not just exclusion of the very old, but especially of those in frail and/or with complex co-morbid conditions. This should be corrected, since it might be a limiting factor towards generalising findings and fail to reveal those mostly at need for evaluation and intervention.

All of these questions require the development of much closer links between biogerontology and clinical ageing research, a recommendation previously made strongly by AGEACTION.

Main research questions for the future include:

- Do common ageing mechanisms contribute to multiple age-related diseases?
- How can we explain mechanistically the differential vulnerability to different age-related diseases, including inverse epidemiological associations?
- What mechanisms underlie age-related frailty, and how can this syndrome best be prevented or delayed?

CHAPTER 3: IMPLEMENTING THE ROAD MAP

This document cannot be concerned purely with scientific research priorities and must give some attention to the implementation process. Of course we hope that the thematic priorities in Chapter 2 will be taken up quickly by research funders and policy makers at all levels. In particular this Road Map should be followed to prioritise ageing in Framework Programme 8, which was the consistent call from all stakeholders throughout the FUTURAGE process. But, even if this happened, it would not be enough to secure the future of ageing research in Europe and ensure that its full potential, in scientific, economic and societal terms, is realised. In particular there are four important aspects, or pillars, of implementation which demand attention. They are: infrastructure, capacity building, user involvement and knowledge exchange.

Ageing Research Infrastructure

The priority given to ageing research between Europe and North America is often contrasted. The higher levels of funding per capita in the latter, compared to the former, as well as more successful exploitation, are attributed to the existence of national research institutes. In the case of the US the National Institute of Aging has coordinated, prioritised and encouraged research in this field for 35 years. It even funds longitudinal research in other countries, including European ones. By comparison, with the notable exception of SHARE, what Europe has managed to achieve with respect to coordinated effort is very limited indeed and always project based and, therefore, short life. (This is in direct contrast to the world leading quality of a great deal of Europe's ageing research, in areas such as social gerontology, biogerontology, epidemiology and cognition.) The European Forum on Population Ageing Research (FORUM) 2002-2005 was the first initiative to seek to coordinate ageing research across the Member States.⁵⁴ This was followed by two stages of the European Research Area in Ageing (ERA-AGE), 2005-2008 and 2009-2012.⁵⁵ Both have made important contributions, especially ERA-AGE which has developed and funded Europe's first post-doctoral programme in the ageing field, FLARE, and mounted Europe's first joint programme of ageing research, based on the EIPHA priority and supported by nine countries. Despite this notable record ERA-AGE lacks the resources to properly coordinate ageing research and ensure its maximum exploitation. It may be that the JPI 'More Years, Better Lives' can fulfil this role but that remains an open question and the need for action is urgent.

What scientists have been calling for since the first European Forum, organised by the FORUM project, is a European Institute of Ageing. In practice this could take the form of a virtual institute with appropriate infrastructure, along the lines of the successful Canadian Institute of Aging. It is needed urgently to accomplish three tasks.

First it is essential to coordinate existing and future research initiatives on ageing, as ERA-AGE has sought to do.⁵⁶ This discourages duplication between countries and regions, builds cumulatively on previous experience and encourages joint projects. It tries to realise the potential of Europe as a geographic research laboratory. An important and so far neglected aspect of this coordination concerns the harmonisation of definitions, protocols and ethical guidelines. To facilitate pan-EU ageing research harmonisation of legislation pertinent to clinical trials and clinical research is a necessity since the current lack of uniform trial guidelines and ethics protocols, mainly attributed to the great differences in legislation between countries, pose a serious obstacle when dealing with study design, patient recruitment, handling of samples and data acquisition.⁵⁷ The use of validated classification schemes, such as the International Classification of Functioning Disability and Health (ICF) and/or assessment tools, for instance GerontoNet or the Resident Assessment Interview Minimum Data set (RAI-MDS) might resolve some of this and should be encouraged. Special efforts have to be made to promote networking opportunities and enhance exchange capabilities within and between European countries. Much greater benefit needs to be derived from sharing data from BioBanks and registries, easier access to hard-to-find patient samples including ones from frail older adults, and systematic analysis of larger amounts of data.

Second, the absence of a comprehensive European database of ageing research is holding back the exploitation of much of the excellent, high quality research that European scientists produce. An infrastructure to maintain such a database and to enable the more rapid than at present translation of research into tangible impact is a serious vacuum (see below). Third it is essential to build the European capacity in ageing research (see below). Funding for a European virtual institute of ageing need not rely only on EU sources and should welcome national and regional contributions and affiliations. Business sponsorship could also play an important role in securing the economic sustainability of this vital European resource.

Capacity Building

Capacity building is a fundamental requirement for the successful implementation of this Road Map. Again this has been flagged as an urgent need by European scientists since the FORUM project. (Ageing is evident among the senior cohort of researchers and it is they that have led the calls for support for doctoral, post-doctoral and mid-career programmes.) In some countries it is clear that there is a dire lack of ageing research capacity and career structure for scientists in the field. The FLARE programme is a model post-doctoral programme: 3 year fellowships entailing mandatory geographical and disciplinary mobility funded by nine countries.⁵⁸ It should be expanded to include more countries and a larger number of fellowships than the current 15 to form the basis of a systematic investment in early career researchers in this field, especially in Central and Eastern Europe. An institute of ageing could also provide encouragement to Member States to develop joint career paths for researchers and notice boards for scientists looking for job or training opportunities.

A second critical aspect of capacity building is the gap between Member States in their research infrastructures. The variable capacity in clinical science, especially geriatrics, is a clear example. The differences in research capacity between the East and West were referred to in Chapter 1, as was the gap in life expectancy. If the EIPHA target of increasing healthy life expectancy by an average of 2 years by 2020 is to be achieved it is crucial to focus special efforts on the New Member States (NMS). This includes research effort. An institute of ageing research could be the pivot for building capacity in the NMS based on sharing expertise and infrastructure and promoting good practice, as ERA-AGE has begun to do. Providing infrastructure, support and training to those countries with relatively low ageing research capacity would serve very well future European initiatives in this field. There is a third aspect of capacity building, among users, which is dealt with in the next section.

User Involvement

Another important pillar of this Road Map's implementation is the engagement of end users. For this reason the FUTURAGE project allotted significant space for discussion and interaction with users: on the one hand, two workshops dedicated to user involvement gathered 79 delegates (older and disabled people, carers, NGOs, academics and researchers, policy makers and business persons) from over 20 countries to debate the priorities and the concerns around user engagement; on the other hand, this topic has been considered as a cross-cutting issue throughout the whole project, thus ensuring that users were engaged also in the various scientific workshops and at all stages of discussion, guaranteeing that they could contribute to development of the research priorities across the different thematic groups.

User involvement means to concretely engage users at all stages, to design with them their role throughout the process, to take into account their needs and concerns throughout the whole process, to carefully encourage, recruit, support and train them. This implies the need for sufficient resources, which are not only related to research funding, but also to human support.⁵⁹ User involvement implies the sharing of research outcomes with the users who take part in the activities, as well as involving them in the evaluation

and eventual follow-up. User involvement means compliance with ethical requirements and contributing to users' quality of life, mostly following a multi-disciplinary and inter-disciplinary approach. Users are not a homogeneous category (various aspects must be taken into account, such as age, gender, cognitive and physical abilities, social and cultural background, income, level of education and literacy, ethnic and geographic origin). The involvement of multiple actors (including caregivers, professionals, insurers, decision makers, political leaders) is equally important.

Implementing the principle of user involvement

Given that there cannot be one single model of user involvement which applies everywhere in Europe, and that the academic disciplines, the study design, the objective of the research and other factors, such as the available resources, also impact on the methodology of user involvement, implementation would be most effective if it could be based on a policy to support and strengthen user involvement in ageing research across Europe and which would carefully take into account these aspects of diversity.

Such a policy, to apply to the whole EU, encompassing principles and guidelines for user involvement, could ensure the delivery of more appropriate and effective responses to the challenges of an ageing Europe, with a direct and positive impact on the quality of research, along with greater potential for knowledge transfer and with a beneficial effect on the economic competitiveness of Europe, where solutions designed for all are the result of a conscious and more informed market pull and a coherent business push.

Involving users also means including them in research projects at all stages: and this should be a requirement in the various funding schemes. Ensuring that resources can be used only if users are effectively engaged in the research is an important step for the concrete implementation of user involvement throughout Europe.

Another important element leading to the improvement of user involvement in European ageing research is to support the growth and development of NGOs and user organisations, particularly in new and candidate countries where these developments are often fragile. This step will ensure more awareness about user engagement and more representativeness and engagement of users in very different disciplines and domains.

It was clear from the Road Map process that user involvement is key for the achievement of the other three implementation pillars: it not only has the potential to improve (multi-disciplinary and inter-disciplinary) research quality in this field, ensuring that more of European ageing research is world-class, but it also has the potential to increase research productivity, delivering data and providing evidence in which there is a wide sense of ownership. It underpins the improvement of knowledge transfer, including dissemination, implementation, and the development of better products and services; market deployment of the developed products and services, as well as user acceptance, are facilitated because real world needs and problems are addressed. Furthermore research which engages with its user community subsumes a life course approach, as ageing occurs across the life span and is not an isolated end-of-life phenomenon.

Knowledge Exchange

Going hand in hand with user engagement, knowledge exchange or knowledge transfer is a vital element of ageing research but one which has been neglected. Too often the results of research take years to come to the attention of those who can employ them to improve the experience of later life. Various factors contribute to this unfortunate situation, including the lack of expertise among and disinterest of some scientists in the impact of their work beyond academia and the absence of dedicated funding

to support such work. Experiences differ widely across the EU Member States with some research funders focussing exclusively on science and others developing a range of initiatives to support knowledge exchange. Europe urgently needs to become much smarter at exploiting the results of the research it produces, starting with the outputs from its Framework Programmes. The innovation potential of much of the high quality ageing research in Europe is being blocked by this lack of attention to knowledge exchange and impact. A specific problem in the ageing field is the over-emphasis on technology push and neglect of market and societal pull. The result is a stockpile of highly innovative gadgets that are not used by the target population, while critical needs go unmet because of lack of awareness or lack of effective demand. The US has taken strong action to encourage rapid knowledge translation and the Roybal centres provide a potential model.⁶⁰

The pilot EIPAHA should provide the framework to remove barriers to successful innovation in this field. What is required is a new priority for knowledge exchange coupled with user engagement. Project funding should rest not only on scientific excellence but also on the quality of the knowledge exchange and user engagement plans. Dedicated funding should be reserved for these vital activities. To progress the growth of expertise in this neglected element of ageing research and ensure that it is spread evenly across EU countries there is a need for a specific resource that provides support and examples of good practice in knowledge exchange/user engagement. As argued earlier this is one of the main reasons why Europe urgently needs an institute on ageing, dedicated to high quality science, capacity building, user involvement and knowledge exchange.

CHAPTER 4: CONCLUSION

This document is the culmination of two years' effort that entailed the most extensive consultation ever undertaken in the European ageing research field and probably any other field of science. The carefully designed iterative process that produced this Road Map engaged the enthusiastic participation of all the key stakeholders – scientists from every relevant discipline, policy makers, research funders, NGOs, a wide range of practitioner groups, business and older people and their representatives – and, therefore, commands a uniquely high level of legitimacy in the recommendations it makes. This is reinforced by the very high level of consensus among those stakeholders about what the future of ageing research in Europe should look like: more multi-disciplinary, more life course orientated, more user engaged, more dedicated to knowledge exchange and overall, more mindful of the active ageing paradigm.

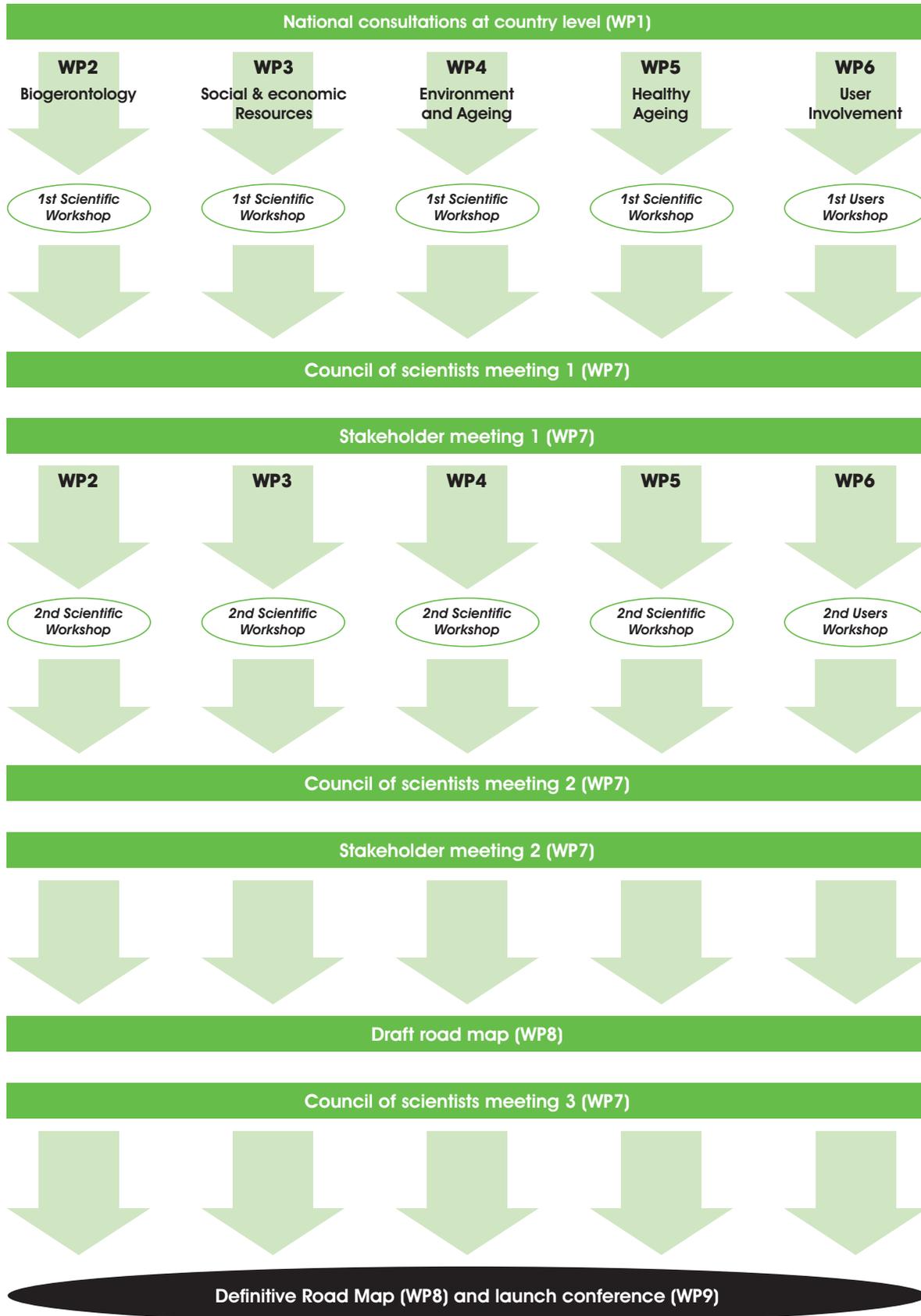
Thus this Road Map presents challenges to all of those stakeholder groups to start the journey in earnest:

- *Policy makers and research funders* should implement this Road Map quickly at European, national and regional levels.
- *NGOs, practitioners and business* should engage actively with ageing research to raise the profile and impact of user engagement and knowledge exchange.
- *Scientists* should prioritise multi-disciplinarity, user engagement and knowledge exchange and develop project proposals reflecting these priorities.
- *Older people* should take part more proactively in ageing research, as one of the main intended beneficiaries, and offer guidance to scientists from their experiential perspective.

Although each of these constituent groups can make progress independently it is only when they operate in unison that this Road Map will achieve its main aims which are to ensure that European ageing research reaches its full potential, and, thereby, creates the knowledge foundation for the best possible later life for all Europeans.

APPENDIX 1: THE ROAD MAP CREATION PROCESS

The project contains 11 work packages (WP) which create an iterative process of consultation to develop the Road Map for ageing research in Europe.



Dissemination (WP10), Project management and Network Steering Committee (WP11)

Adapted from the original design by Dr Carlos Chiatti at INRCA

APPENDIX 2: COUNCIL OF SCIENTISTS

Marja Jylhä, University of Tampere, Finland (Chair)

Vladimir Anisimov, N.N.Petrov Research Institute of Oncology, Russia

Jean-Pierre Baeyens, University of Luxembourg, Luxembourg

Brian Clark, University of Aarhus, Denmark

Dorly Deeg, VU University Amsterdam and VU University Medical Center Amsterdam, Netherlands

Pearl Dykstra, Erasmus University Rotterdam, Netherlands

Rocío Fernández-Ballesteros, Universidad Autónoma de Madrid, Spain

Dieter Ferring, University of Luxembourg

Claudio Franceschi, University of Bologna, Italy

Stathis Gonos, National Hellenic Research Foundation, Greece

Beatrix Grubeck-Loebenstein, Austrian Academy of Sciences

Tom Kirkwood, Newcastle University, United Kingdom

Jane Lord, University of Birmingham, United Kingdom

Ariela Lowenstein, University of Haifa, Israel

Fiorella Marcellini, Italian National Institute on Ageing

Jean-Pierre Michel, University Hospital of Geneva/President Elect of the European Union Geriatric Medicine Society (EUGMS), Switzerland

Heinz Osiewacz, Goethe-Universität Frankfurt, Germany

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Dietmar Wuppermann, Federal Ministry of Research and Education, Germany

Leon Zagrean, 'Carol Davila' University of Medicine and Pharmacy, Romania.

APPENDIX 3: SUMMARY OF RESEARCH PRIORITIES AND MAIN RESEARCH QUESTIONS

HEALTHY AGEING FOR MORE LIFE IN YEARS

Seven challenges and the main research questions relating to future European ageing research in the area of healthy ageing for more life in years are listed below:

Healthy ageing and frailty – understanding the process and defining the concepts

- What do older people understand by healthy ageing and does this vary between the young and old-old, between men and women and between different European cultures?
- Can we agree a definition of healthy ageing and its relevant dimensions that cross cultures and societies?
- What is frailty? How does it progress and can we identify biomarkers of frailty to intervene earlier?

See also: Unequal Ageing and Age-Related Inequalities, and; Biogerontology: from Mechanisms to Interventions

Organising and delivering interventions for health promotion

- Is the timing of physical activity/exercise over the life course important for healthy ageing?
- Are there gender differences in the way physical activity influences healthy ageing?
- What are the relative merits of different forms of physical activity (habitual exercise, sustained aerobic exercise, strength and balance training) on specific domains of healthy ageing such as cognitive functioning?
- Can we use the immune risk profile (IRP) to personalise nutritional interventions?
- How do lifestyle, behavioural and pharmacological interventions interact to increase healthy ageing?
- How do socio-economic factors inhibit healthy lifestyles and can this knowledge be harnessed to improve interventions?

See also: Ageing Well at Home and in Community Environments.

The ageing process and early markers of ill health

- How do the molecular, biochemical, morphological and functional aspects of vascular ageing interact and how does this play out in different subclinical and clinical events?
- Are markers of ageing in midlife different from those which become apparent in late life?
- Are different markers of ageing interrelated or do they progress in parallel to each other?
- Are markers of ageing the same in men and women and do they have the same consequences?

See also: Biogerontology: from Mechanisms to Interventions.

Modelling links between disease and functioning over the life course

- What drives increasing disability?
- Can we identify different population subgroups whose progress through disease to mental and physical functioning and through to participation in society, is slower than others?
- What role does the environment play in delaying progress through the disablement process?

See also: Ageing Well at Home and in Community Environments and Maintaining and Regaining Mental Capacity across the Life Course.

Effectiveness and efficiency of clinical care and social care

- What are the barriers to implementing the best models of inter-disciplinary care that are effective in many European countries in all the European countries?
- How should clinical trial design be best adapted to include all patients who may receive the therapeutic intervention?

See also: Ageing Well at Home and in Community Environments (end-of-life and places of dying); Guaranteeing the Quality and Sustainability of Social Protection Systems (sustainability of informal support networks and long-term care needs of people with multiple chronic conditions), and; Ageing Well at Home and in Community Environments (use of technology).

Education and lifelong learning

Main research questions for the future include:

- How are older measures of education and more recent and wider measures of lifelong learning interrelated with other socio-economic measures (occupation, income and material circumstances) and do they have an additive or multiplicative effect on healthy ageing?
- To what extent can education and lifelong learning mitigate the impact of key life events?

See also: Inclusion and Participation in the Community and in the Labour Market.

Environmental conditions for ageing well

- How does the interrelation between the person and their environment affect mental, physical and psychological health and their trajectories with ageing?
- To what extent do these relationships differ by generation, culture, society or political context?

See also: Ageing Well at Home and in Community Environments.

MAINTAINING AND REGAINING MENTAL CAPACITY

Eight challenges and the main research questions related to future European ageing research in the area of maintaining and regaining mental capacity across the lifespan are listed below.

Research on the outcome of cognitive training and physical exercise

- How far can training, particularly multi-component training including cognitive and physical exercise components, take the ageing system in different stages of the lifespan (middle adulthood, young-old age, oldest age)?
- What are the most efficient training and psycho-educative approaches and how can they become implemented most successfully in everyday life of older adults?
- How is healthy life expectancy affected by effective training models and how can better sustainability of training net effects be achieved?

Role of context for enhancing cognitive engagement

- How strong is the effect size of social and physical environments as compared to person factors related to mental capacity development?
- Can improvements in the work environment lead to the maintenance or enhancement of mental capacity of ageing employees?
- How are older adults dealing with cognitive decline in everyday life? What are efficient compensatory and optimising strategies and what can we learn from such real world analysis for maintaining mental capacity at large?

Role of the motivational-emotional, personality and self-related system for the development and maintenance of mental capacity

- How far does the positivity effect in terms of cognitive processing lead and what are the potentials and limitations for older people?
- What are the relations between personality and self processes and the course and outcome of mental capacity?
- Can there be new synergies between the declining cognitive apparatus and the relatively stable personality and self system that could be better used for the improvement of healthy life expectancy?

Better considerations of life course dynamics of mental capacity

- How strong is the effect of life-span precursors on the course and outcome of mental capacity trajectories in later life (in particular: middle adulthood, but also very early periods of life, even those before birth)?
- Is there an effect of major person-environment transitions as people age on mental functioning?
- How can the lifespan-based potential toward prevention of mental capacity decline be used to the maximum effect possible in order to extend healthy life years?

See also: Ageing Well at Home and in Community Environments.

Better consideration of transitions from normal to pathological processes related to mental capacity

- How far can a more fine-tuned differentiation between normal and pathological ageing go?
- What are the major markers of transitions from normal to pathological cognitive processes and how similar or dissimilar are these across countries?
- Can such new knowledge be efficiently used for prevention purposes and the extension of healthy life expectancy?

Research on how societies are dealing with mental capacity

- How strong is the effect of stereotyping and age discrimination on trajectories of mental capacity?
- Is there evidence that the reduction of negative stereotyping is serving the maintenance of mental capacity?
- How frequently are dementia fears in European societies, what differences may exist between countries and how are such fears affecting ageing people in their everyday lives?

Research on challenges related to mental capacity in advanced old age

- How great is the potential to maintain mental capacity to the largest degree possible for very old individuals?
- How can very old individuals be psychosocially supported when their meaning-making processes are under threat and when coping with multi-morbidity and the accumulation of loss experiences become a life priority?
- How can society and social institutions support the required educational processes (in a wide understanding) that can help cope with the challenges of a very long life?

Better consideration of multi- and inter-disciplinary synergies

- What are the most synergy-rich combinations of disciplines in order to better understand the malleability and plasticity of human ageing?
- How can core issues of ageing and healthy life expectancy be furthered by focusing innovative health and cognition, physical exercise and biogerontology, or affect / personality and neuro-imaging linkages?
- How can early-stage researchers be brought together as efficiently as possible to explore and establish such synergies?

See also: Biogerontology: from Mechanisms to Interventions.

INCLUSION AND PARTICIPATION IN THE COMMUNITY AND IN THE LABOUR MARKET

The first challenges are over-arching issues for promoting participation and inclusion in its widest sense, cutting across all social relationships and socio-economic activities. A further set of more specific key priorities can furthermore be distinguished between barriers or enablers experienced in the community and those in the labour market. The challenges and main research questions are listed below:

Ageism

- What are the attitudes to ageing as a process? How are they formed and evolved? How can they be altered?
- What are the gaps between perceptions and realities of older people's skills, abilities and contributions to society?
- How can the current social perceptions of age and ageing be effectively influenced in order to eliminate prejudicial attitudes? Which role can the media play in this respect?
- What interventions at the micro, meso and macro level can be successful in changing perceptions towards older people?
- To what extent is discrimination 'institutionalised' through legislation and regulations (e.g. in limiting access to health and social care services) across European countries?

Lifelong Learning

- What are the most appropriate non-formal and informal learning forms for older people?
- What are the barriers faced by older people in accessing formal training and educational opportunities? How can they be best overcome? And what is the role of educational institutions (e.g. the University sector or technical colleges) in supporting older learners?
- What are the specific needs of older women, migrants and disabled older people in this field, as well as of people living in rural or remote areas?
- How can knowledge transfer among generations be promoted to ensure the most benefits to all involved parties?

Migration

- Which policies and practical strategies can most appropriately tackle the challenges raised by migration for integration and social cohesion?
- How migration can contribute to the challenges associated with the ageing of our society?
- What role can the ageing process play, on the other hand, for migration-related phenomena?

See also: *Guaranteeing the Quality and Sustainability of Social Protection Systems.*

Overcoming the digital divide

- What role can ICT and virtual networks play in facilitating social inclusion?
- What are the effects of ICT-tools in terms of intra- and intergenerational relationships?
- Which measures are most effective in reducing or preventing the digital divide in using new technologies? And this especially in fields like long-term care, where they represent a crucial support tool for both formal and informal care providers?

See also: *Guaranteeing the Quality and Sustainability of Social Protection Systems.*

Mobility and accessibility

- How can we achieve an optimal balance between physical mobility and accessible environments to enable maximum participation and inclusion among all age groups?
- What are the health and economic outcomes of interventions designed to facilitate accessibility?
- What role can assistive technologies play in facilitating accessibility for those with limited physical mobility?
- How do mobility limitations impact on social relations in different, very old age groups (e.g. very old couples or singles)? And what kind of differentiated solutions are needed to overcome them?

See also: Healthy Ageing for More Life in Years (on delaying and preventing frailty), and; Ageing Well at Home and in Community Environments (on the role of supportive environments).

Ageing and spirituality

- What is the role of spirituality in facilitating social participation at an individual level?
- Which role does spirituality play in promoting or hindering social inclusion and an active contribution of ageing individuals in different societal sectors?
- How does spirituality affect intergenerational relations?
- How can research on spirituality contribute to the ethical debate on 'conditions of living and dying', also in the light of current and future technological developments?

Volunteering

- Which measures and initiatives can improve the match between demand and supply of ageing volunteers, especially in sectors which are traditionally 'off-limits' for them? How can a better image of volunteering in older age be promoted to this purpose?
- Under which circumstances can volunteering represent a source of fulfilment and social inclusion for ageing individuals with poor health and socio-economic status?
- How are informal caregiving and volunteering reciprocally related? Is there a trade-off between the two activities?
- How can investments in volunteers' human capital be ensured along the whole life course through appropriate programmes?

Participation as consumer or user

- How can businesses and service providers be effectively incentivised to mainstream the principles of 'Design for All' in the development of products, goods and services?
- What role does age based discrimination play in exclusion of older people from service use and consumer markets?
- How do consumption and expenditure patterns vary between age groups and across the life course?
- To what extent are variations in consumption and expenditure patterns between age groups a function of demand (different needs and preferences based on age) or supply (markets failing to supply goods and services equally effectively for all age groups)?

Discrimination in the labour market

- What are the different types of direct and indirect age discrimination at play in the labour market?
- What is the economic and social impact of age discrimination in the labour market?
- Which measures are most effective in preventing work-related age discrimination?

Enabling a longer working life

- What regulations on pensions and labour laws are most effective in supporting those who wish to work longer?
- What incentives for employers are most effective in retaining and hiring older workers?
- What is the optimal balance between social protection and labour market policies in the promotion of older worker employment?
- How can employers effectively adjust to the ageing workforce?
- What is the role of volunteering in helping older workers remain or re-enter in the labour market?
- What further healthcare and employment measures should be introduced to better preserve the employability of the workforce?
- What lessons can be learnt from the application of the 'workability' approach in various settings?

Reconciliation of paid work and informal care

- What are the barriers that informal carers face to remain in employment? What are the specific barriers faced by caregiving women and migrants?
- What employment, tax and social protection policies and measures are more effective in ensuring various adequate working arrangements for reconciliation and adequate minimum income for both men and women?
- What services are more effective and should be developed to support informal carers? What is the role of the information and communication technologies in this field?
- How can we ensure a better sharing of caring and work responsibilities at a micro (individual) and macro (societal) level between women and men?
- How can informal carers be empowered in decision-making that affects their lives, in order to ensure their participation?

GUARANTEEING THE QUALITY AND SUSTAINABILITY OF SOCIAL PROTECTION SYSTEMS

Six challenges and the main research questions related to future European ageing research in the area of the quality and sustainability of social protection systems are listed below:

Sustainability of social security systems

- Which measures can make current pension, health, social and long-term care systems more sustainable over time? What are the most effective social and economic policy models in this respect, and how are they interrelated?
- Which role do education and training play, as 'non-material resources of social protection', in improving the sustainability of social security systems?
- Which impacts would banning the mandatory retirement age have at micro, meso and macro level?
- How can an adequate level of service quality be achieved, in times of budget constraints with an ever-growing population in need of long-term care?
- Which trade-offs and alternatives pathways exist between the urgent need to reform and modernise current social protection systems and their long-term sustainability, especially in countries with most traditional welfare traditions?
- Which role are the current trends of economic globalisation playing with regard to the sustainability of existing social security systems?

Supporting informal carers

- How can family carers and private care workers become better integrated within the formal support system?
- How can formal services support informal carers in their tasks and prevent them from stressful situations and burn-out?
- To what extent can the support from formal services allow carers to remain in paid employment which has beneficial effects both from a social inclusion perspective as well as for the public purse?
- How is migrant work in the elder care sector changing traditional formal and informal care patterns? And which measures can contribute to solve the problem of widespread undeclared work in this area?

Improving access to services

- How can access to health and social care services be improved and better integrated, especially in deprived and sparsely populated areas?
- How can formal public services support hard-to-reach segments of the older population?
- Can ICT improve knowledge about the services available, and to some degree can it release some of the burden on social and health services?

See also: Inclusion and Participation in the Community and in the Labour Market.

Efficiency, cost-effectiveness and quality of interventions

- How can improved transparency be achieved regarding the use of resources made within the public welfare systems? How can the value-for-money in this sector be maximised?
- Which strategies can increase the quality (from a user's perspective) and cost-effectiveness (from a provider's perspective) of interventions?
- What are the most promising intervention in the field of preventive care and integrated care?
- Which are the innovative interventions to support people coping with chronic diseases?
- What is the potential of the '-omics' technologies in developing new approaches for diagnosis and treatment of diseases?

ICT-supported informal caregiving

- How can ICT-based tools support informal caregiving?
- What is the role of ICT-based solutions in improving the quality of long-term care provided by informal carers, as well as their quality of life?
- Which impact can ICT have in reducing the direct and indirect costs attached to informal caregiving?
- Which ICT-solutions are most easily transferrable and implementable on a large scale, also in contexts in which no strong tradition nor digital competences exist in using ICT?

Reviewing and strengthening intergenerational solidarity and cooperation

- Which changes are needed to ensure that today's social and demographic context will not weaken solidarity between generations in the long-term?
- How can the contribution given by retired people to society be measured through their unwaged activities like grand-parenting and volunteering?
- What are the good practices aimed at increasing older people participation to such activities after their retirement?

See also: Inclusion and Participation in the Community and in the Labour Market.

AGEING WELL AT HOME AND IN COMMUNITY ENVIRONMENTS

Seven challenges and the main research questions related to future European ageing research in the area of physical-spatial-technical (PST) aspects of home and community environments are listed below:

Generation of differentiated knowledge on the enabling and constraining characteristics of PST environments at the home and community level

- What are the key enabling and constraining characteristics of PST environments for older adults, for example in terms of maintaining autonomy, well-being and identity?
- How important is the role of home characteristics including home adaptation as compared to person factors such as multi-morbidity and functional limitations?
- What role do major differentiating variables such as age, gender, ethnicity, mental status, functional impairment, region and culture play when it comes to the impact of PST environments on healthy ageing?
- What are the effects of implementing an as focussed as possible policy 'to stay in your own home as long as possible' to the ageing individual, to the care services, and to society at large?

Better understanding of the meanings of PST environments of older adults' lives

- What do home environments and neighbourhoods mean for current cohorts of older adults, for example in terms of cognitive and affective ties to the home, place attachment and their possible role of maintaining the ageing self and identity?
- How does meaning of home and neighbourhood vary when it comes to the diversity of older adults, including mental status and ethnicity? Can such evidence be efficiently used for intervention purposes?
- Is there evidence for cohort-related changes in what home environments and neighbourhoods mean to older adults?
- Will technology, for example home-based robotic systems, be accepted better by future older adults as a means to support and enrich quality of life?
- What meaning do specific places (e.g. kitchen, garden) hold as people age, and is there a change of the role and function of such places over time?

More research on the relationship between transport and ageing well

- What are the transportation needs of the future ageing population of Europe, and how are these needs related to health and quality of life?
- How can the needs in terms of out-of-home mobility of older adults with cognitive impairments be supported in optimal ways?
- What kind of technology is needed to serve the transportation needs of older adults in optimal ways, and how can such technology be implemented most efficiently?

Work environments as key PST environments for ageing societies

- What are the key elements of designing work environments in order to release older employees' potential in the best way possible (e.g. in terms of health, cognitive functioning)?
- What kind of role can technology play in order to optimally serve the needs and capabilities of older employees?
- Is there a relation between the characteristics of the work environment and older adults' innovativeness? How can such a linkage be optimised in the future?

See also: Inclusion and Participation in the Community and in the Labour Market.

Long-term care environments for vulnerable and frail older adults

- How can long-term care environments be designed in the future to support optimal ageing in old and very old age even in the situation of much reduced resources (such as dementia)?
- What synergies and possible risks are coming with future alliances between long-term care institutions and technology?
- What are the most convincing alternatives to traditional long-term care solutions for older adults with different degrees of frailty? What potential and limits do they have?

PST environments as supporting healthy ageing and increased life expectancy

- How can we create environments that optimise the exertion of physical activity in later life?
- How do we create mobilising environments that support health promotion and serve the empowerment of older adults?
- What are the implications of and what elements and resources are needed to create age-friendly communities within urban and rural areas?
- What kind of PST environments do best serve the maintenance and possibly the enhancement of cognitive functioning in old age?
- Can virtual environments be used to stimulate healthy ageing, and in which ways?

Healthy home and community environments for very old age

- What are key synergies between the characteristics of PST environments and older adults with dementia? Can such synergies be used better in the future and what is the potential?
- How can places counteract the pronounced vulnerabilities of extreme old age? What can different European countries learn from each other in terms of the creation and design of such places?
- How can optimal places for death and dying be created for old and very old adults and how can such environments support a possible new culture of death and dying in Europe at large?

UNEQUAL AGEING AND AGE-RELATED INEQUALITIES

There is considerable overlap between disciplines and research themes on the priorities for inequalities research. This is illustrated with reference to six broad research challenges and main research questions listed below:

Monitoring inequalities

- How cumulative advantages and disadvantages shape opportunities and risks, which ultimately influence health and other outcomes in older age?
- Do adverse circumstances in younger age have irreversible effects, or can early drawbacks be overcome at a later stage during the ageing process?
- What are the compensatory mechanisms along the life course that reduce the adverse impact of risks and disadvantages?
- What is the role of human agency and the impact of structural factors on inequalities in older age?
- What factors can strengthen resilience to potential stressors and disadvantages?

Health in work and retirement

- Can the workplace be considered as a suitable setting to develop effective healthy ageing interventions?
- How can work-related health inequalities be prevented? And those accumulated during the working life be reversed or compensated after retirement?
- Is there a link between inequalities in pension schemes and health status after retirement?
- How does retirement affect health? Are there commonalities/differences between social groups and occupations?

See also: Inclusion and Participation in the Community and in the Labour Market.

Inequalities and discrimination in the labour market

The research priorities in this field are covered in the section on: Inclusion and Participation in the Community and in the Labour Market.

Inequalities and discrimination on health

- In what ways does discrimination on the grounds of age have an impact on inequalities in health?
- What are the prevailing norms within the health and care sectors that potentially contribute to negative attitudes towards older people and inequalities? How do these attitudes deter effective health care interventions?
- How does the financial capacity of older people impact on their access to health care? Is there age discrimination within the financing of health care provision?
- Which are the prevailing risk factors for the exclusion of older people from health care provision? Are there any good practices addressing these risks?
- Are there age limits in clinical trials and pharmaceutical trials? Do such practices respond to the needs of the ageing population? Are there risks for older people's health care provision?

Ageing and migration

- What is the impact of migration trajectories in determining inequalities over the individual life course and within society?
- Which initiatives are most successful at national and regional level to address in a culturally sensible way the needs of migrants and minority ethnic elders?
- How can barriers of access to quality care services care for migrants and minority ethnic elders be prevented? And what are the roles played by professionals in this area?
- How can the collaboration between researchers, policy makers, practitioners and older migrants (organisations) be improved to inform ageing research, policies and practice, thus reducing migration-related disadvantages and increasing migrants' contribution to society?

Focus on the very old

- What methodological approaches allow achievement of a better inclusion of frail and dependent older people into clinical and socio-economic investigations?
- To what extent does the lack of representativeness of research samples in terms of older population limit the generalisability of results?
- To what extent do the very old population in Eastern Europe resemble or differ from its Western European counterparts? What are the similarities and specificities which can be found across countries?
- How prevalent is elder abuse and neglect across the EU27? What are the different kinds of abuse and neglect? How are they related?
- How is neglect and abuse experienced at the micro level? Do individual characteristics of the victim play a role in the detection, acknowledgement, prevention and tackling of elder abuse?
- What evidence is there for abuse and neglect within hospitals and long-term care settings?
- What are the features of the long-term care systems that have an impact on the prevalence of elder abuse and neglect?
- What is the link between the quality of care and the quality of the work of the healthcare workforce and elder abuse? Is the lack of support to caregivers (informal and professional) a contributory factor to elder abuse?

BIogerontology: FROM MECHANISMS TO INTERVENTIONS

The recently completed EU FP7 project WhyWeAge aimed to identify key elements of a European road map for research in biogerontology. Eleven scientific topics for future European research in the area of biogerontology were identified. These form the biogerontological theme in FUTURAGE and are summarised as follows (greater detail can be found in the WhyWeAge final report):

Biomarkers of ageing

- Can we identify a practically useful set of biomarkers of ageing capable of predicting future health and longevity in individual humans?
- Can we identify similar markers for non-human models that will facilitate translation of research on interventions from models to humans?
- How can we deliver the most effective infrastructure to underpin ageing biomarker research and development within Europe?

Telomere erosion, DNA damage and mitochondrial dysfunction

- What are the exact mechanisms by which telomere erosion, DNA damage and mitochondrial dysfunction contribute to cellular ageing?
- How do these mechanisms interact?
- How do the effects of these mechanisms at the cellular level give rise to age-related dysfunction and disease of tissues and organs?
- How can this knowledge be harnessed towards safe and effective intervention at the molecular and cellular level?

Oxidative stress, protein damage and protein maintenance

- Which proteins are most susceptible to damage and why, and how do protein modifications contribute to breakdown in protein homeostasis?
- How extensive are protein modifications in cells during ageing, and can we enhance techniques to detect random modification of proteins as powerful as those which now exist for DNA?
- What factors are responsible for protein aggregation and how exactly do protein aggregates contribute to age-related cellular pathology?
- What factors underlie age-related changes in protein synthesis and degradation and how might these most effectively be targeted?

Systems biology of ageing

- How do the multiple mechanisms of cellular and molecular interact to drive age-related pathobiology?
- How do the multiple maintenance and repair pathways interact to sense and respond to damage of the various kinds?
- How do the above two networks interact and where might be nodes that offer opportunities to target interventions that can improve health in old age?
- How best to configure and implement European infrastructure to support systems biology of ageing?
- How to generate the added value from currently disintegrated research activity by delivering the necessary integration for effective progress in systems biology of ageing?

Inflammation and impaired immune functions

- How does inflammation contribute to age-related pathology and how can these processes be targeted to reduce adverse effects of 'inflammaging'?
- What mechanisms underlie age-related deterioration of immune functions and how can effective function be maintained for as long as possible?
- What is the role of chronic infections such as with cytomegalovirus (CMV) in contributing to immune dysfunction?
- How can immune risk be defined using suitable biomarkers and can the immune risk profile be modified?

Metabolic factors

- How is metabolic homeostasis affected by diet, age and other factors?
- What metabolic sensing and signaling pathways have beneficial effects in animal models and might these exert similar effects in humans?
- How are metabolic gene regulatory networks configured and can systems biology reveal specific targets for effective interventions?
- How and in which organs do effects of metabolism exert their effects on ageing?
- How do neuro-endocrine signals influence and interact with metabolic factors affecting ageing?
- How do fat tissue and associated signals influence and interact with metabolic factors affecting ageing?
- What biological mechanisms contribute to the sex/gender differences in ageing and longevity?

Nuclear receptors

- What is the nature of the cross-talk between nuclear receptor signals and metabolic signalling pathways?
- To what extent do epigenetic modifications affect nuclear receptors and their impacts on ageing and health?
- What are the roles of nuclear receptors in the control of biological rhythms and their dysregulation during ageing?
- What links exist between metabolic signalling through nuclear receptors and homeostatic control of somatic stem cell functions?

Age-related disorders of blood circulatory (vascular) system

- What is the role of known molecular/cellular mechanisms of ageing (e.g. oxidative damage, cell senescence) in the aetiology of vascular stiffness and vascular calcification?
- How to identify protective genetic traits and their relationships to mechanisms of vascular cytoprotection?

Muscle weakness, sarcopenia and physical exercise

- What are the prevalence, causes and functional consequences of sarcopenia?
- What are the roles of muscle protein breakdown, oxidative stress and accumulation of modified proteins in muscle ageing?
- What are the most effective physical, nutritional and pharmacological strategies to combat sarcopenia and sarcopenic obesity?
- What are the effects of exercise, inactivity and inflammation on age-related regulation of skeletal muscle mass and function?

Age-related modifications of skin and elastic tissues

- What causes the changes in extracellular matrix during ageing?
- How does intrinsic ageing affect stem cell functions within skin?
- What are the most effective nutritional and pharmaceutical strategies to combat skin ageing?
- What are the effects of exercise, inactivity and inflammation on age-related regulation of skeletal muscle mass and function?

Connecting biogerontology with clinical ageing research

- Do common ageing mechanisms contribute to multiple age-related diseases?
- How can we explain mechanistically the differential vulnerability to different age-related diseases, including inverse epidemiological associations?
- What mechanisms underlie age-related frailty, and how can this syndrome best be prevented or delayed?

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THE FUTURAGE PROJECT



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FUTURAGE

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