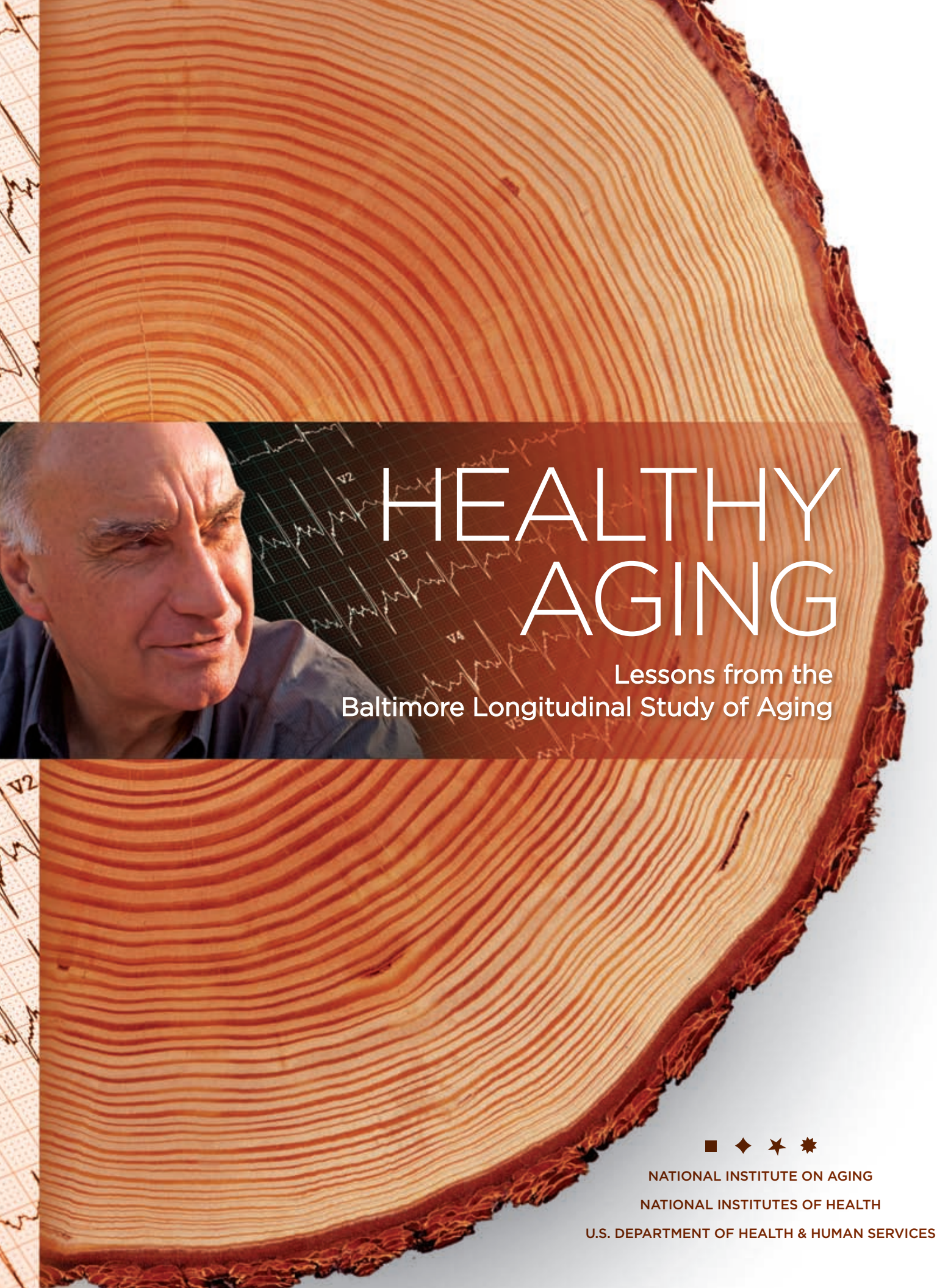
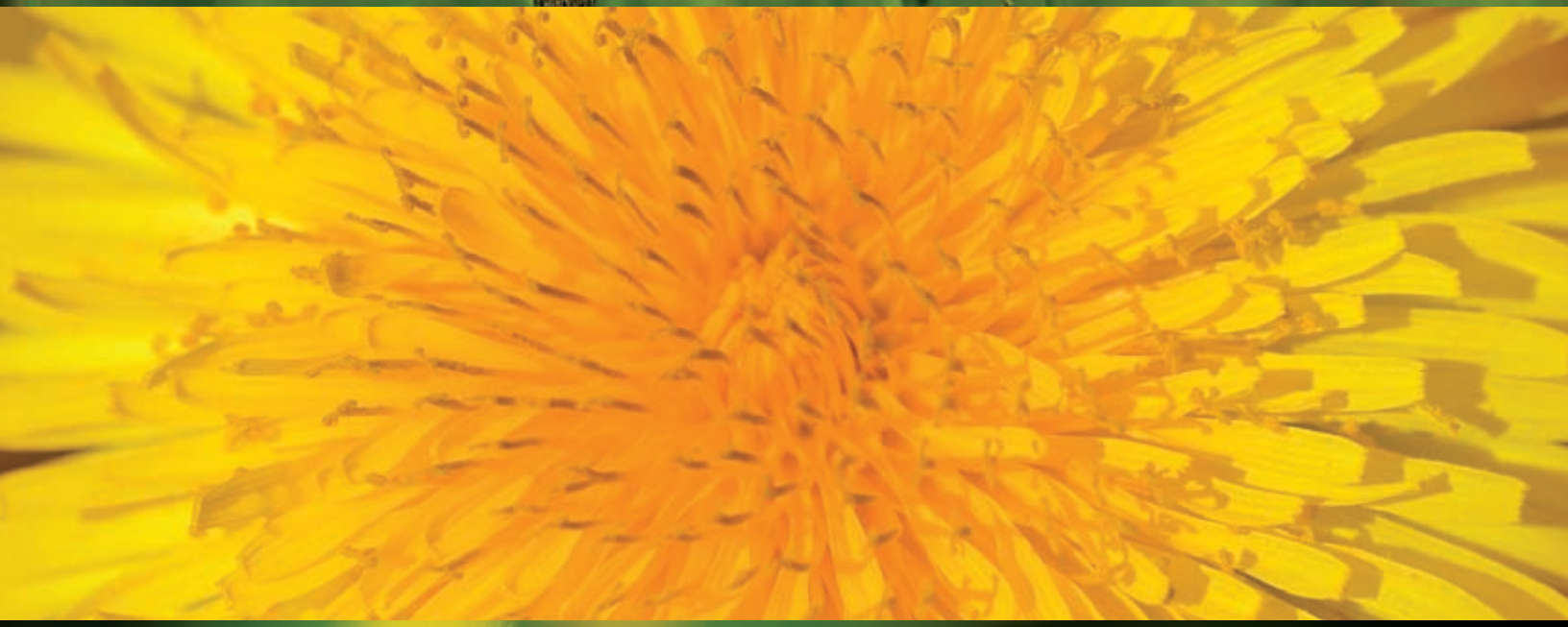


HEALTHY AGING

Lessons from the Baltimore Longitudinal Study of Aging

NATIONAL INSTITUTE ON AGING
NATIONAL INSTITUTES OF HEALTH
U.S. DEPARTMENT OF HEALTH & HUMAN SERVICES



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FOREWORD

Just like millions of Americans, the National Institute on Aging's (NIA) Baltimore Longitudinal Study of Aging (BLSA) celebrates its 50th birthday in 2008. The study was the first to ask a most basic question: What is normal aging?

There is still much to learn, but so far two major conclusions can be drawn from BLSA data. First, "normal" aging can be distinguished from disease. Although people's bodies change and can in some ways decline over time, these changes do not inevitably lead to diseases such as diabetes, hypertension, or dementia. A number of disorders that typically occur in old age are a result of disease processes, not normal aging.

Second, no single, chronological timetable of human aging exists. We all age differently. In fact, in terms of change and development, there are more differences among older people than among younger people. Genetics, lifestyle, and disease processes affect the rate of aging between and within all individuals.

These fundamental changes in our thinking about age and disease have led the BLSA and the field of aging research in important new directions. As we further pinpoint the influences on how we age, we can also think about new and more effective interventions that may prevent disease and promote healthy aging.

This booklet was developed to celebrate the 50th anniversary of the BLSA and the wealth of data and insights it has given us. It also provides an occasion to share some of what we know about aging and aging well from a large body of research, including the BLSA. As you read through this booklet, we hope you will find it useful in thinking about your own aging and steps you can take that might make a difference for maintaining your health.

We dedicate this booklet to the thousands of BLSA volunteer study participants, scientists, and support staff who have joined in a unique and sustained research enterprise over five decades. Their partnership has been a gift that benefits us all.

Richard J. Hodes, M.D.
Director
National Institute on Aging
National Institutes of Health

Dan L. Longo, M.D.
Scientific Director, 1995–2010
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Director, Baltimore Longitudinal Study of Aging
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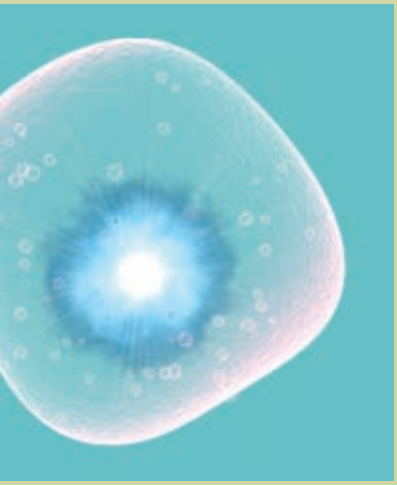
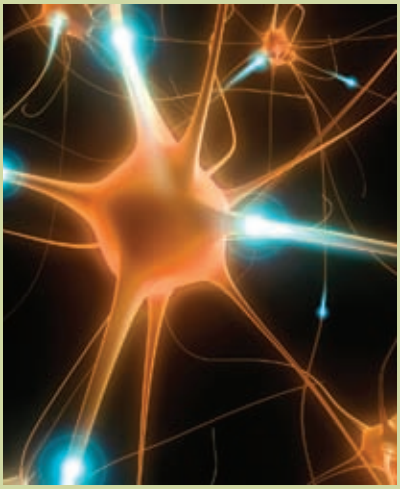
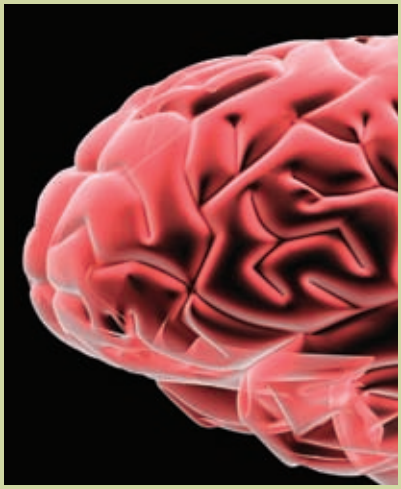
ABOUT THE NATIONAL INSTITUTE ON AGING


The National Institute on Aging (NIA), part of the National Institutes of Health, was established to improve the health and well-being of older people through research. As part of its mission, the NIA investigates ways to support healthy aging and prevent or delay the onset of diseases disproportionately affecting older adults. NIA's research program covers a broad range of areas, from the study of basic cellular changes with age to the examination of the biomedical, social, and behavioral aspects of age-related conditions. Although the main purpose of this research is to increase "active life expectancy" — the number of years free of disability — it may also promote longevity.

DR. LUIGI FERRUCCI

Studying aging processes and discovering solutions that can reduce the burden of disease and disability on older people has been the dream of my life. I started to pursue a career as a geriatrician and a gerontologist in Florence, Italy, in my early twenties when almost every exciting discovery about aging began at the BLSA. At that time, I confess that while my friends were idealizing rock stars and soccer players, Nathan Shock was my hero. So, you can imagine that when I moved to the U.S. in 2002 to become the new director of the Baltimore Longitudinal Study of Aging, I was proud, enthusiastic, and extremely frightened. Since then, my dedication and attachment to the BLSA has grown steadily and my fear has faded. I work with a team of committed, bright, creative, and hard-working scientists, nurses, health workers, and administrators. Of special joy are the connections I've made with the BLSA participants who are the true soul of the study. Listening to their stories, capturing the multifaceted aspects of their lives, and understanding their problems has taught me more about aging than reading any number of books or articles. I could never find words beautiful enough to thank each participant properly. I will not even try. However, I promise that their effort and their generosity will be fruitful, that everyone associated with the BLSA will work to produce the best possible science, and that we all are committed to translating these findings into actions to improve the quality of life for older people.

Of special joy are the connections I've made with the BLSA participants who are the true soul of the study.

Dorothy broke open her fortune cookie and read its contents: **"May you live a long, healthy life."** Who doesn't hope for longevity combined with good health in later years?

WHY STUDY AGING?

The Beginning of Something New— The Baltimore Longitudinal Study of Aging

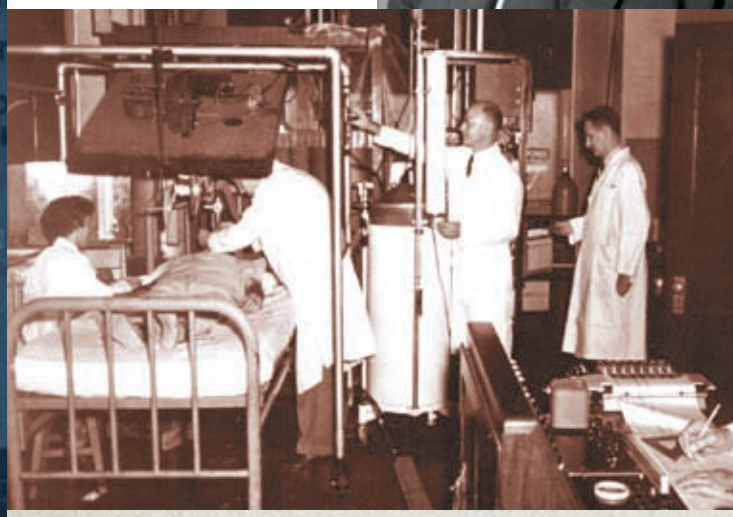
For the most comprehensive and longest running longitudinal examination of human aging in the world, NIA's Baltimore Longitudinal Study of Aging (BLSA) had a simple beginning. It started with a conversation in 1958 between Nathan Shock, Ph.D., Chief of the Gerontology Branch at the National Institutes of Health (NIH), and William W. Peter, M.D., a retired U.S. Public Health Service officer and missionary doctor. Peter had a long-established reputation for his dedication to medicine and wanted to know how he could make a final contribution — donating his body to science. But Shock had something else in mind. He wanted to discuss the direction he believed aging research should take. Breaking with scientific convention, Shock wanted to study normal aging, and he wanted to do it by repeatedly evaluating the same people over time. He hypothesized that important concepts pertinent to aging could only be understood by looking at healthy, independently living people at regular intervals over a number of years. Shock didn't just want bodies donated to study aging after death; he wanted living people participating in scientific studies. This was a radical concept that intrigued Peter. He volunteered to be the first participant. Soon, Shock and Peter were joined by study coordinator Arthur Norris, described by Shock as his "steady right hand." The three men outlined the new study's parameters. The BLSA would "observe and document the physical, mental, and emotional effects of the aging process in healthy, active people." Women were not originally part of the study design, but joined the BLSA in 1978, offering scientists

the opportunity to better understand the influence of sex on aging, especially important because at the time women lived 8 to 9 years longer than men. Many of the original female participants were wives or widows of male volunteers.

Currently, NIA's Intramural Research Program in Baltimore welcomes more than a thousand male and female BLSA participants ranging in age from their twenties to nineties, who come every 2 years for a variety of tests to help scientists observe changes over years of life. Participants receive a complete physical exam and tests of mobility, body composition, muscle strength, bone density and geometry, cardio-respiratory function, nervous system anatomy and function, glucose metabolism, inflammation, hormones, and more. Like pioneer participant Peter, volunteers often say they are proud of their contribution to science. Along with personal gratification, another benefit to BLSA participants is learning about their health. For instance, as scientists investigate bone density changes over time, participants learn how their individual risk for fractures from these changes may fluctuate with age.

As the BLSA answers many of its original questions about aging, scientists are formulating new ones. Keeping in step with emerging research interests, the study has turned its attention to increasingly prevalent health issues such as obesity, loss of muscle mass and strength (sarcopenia), disability, and cognitive disorders. For example, in 1993, BLSA investigators began a 9-year study using brain scans to learn if cognitive changes, like visual memory and mental skills, can be related to structural changes in the brain. They discovered that, over time, even very healthy older adults lose a significant amount of brain volume as part of normal aging. By introducing new areas of study and continually evolving, the BLSA maintains a steadfast influence on health research.

Below: **Gerontology Research Center dedication in 1968**

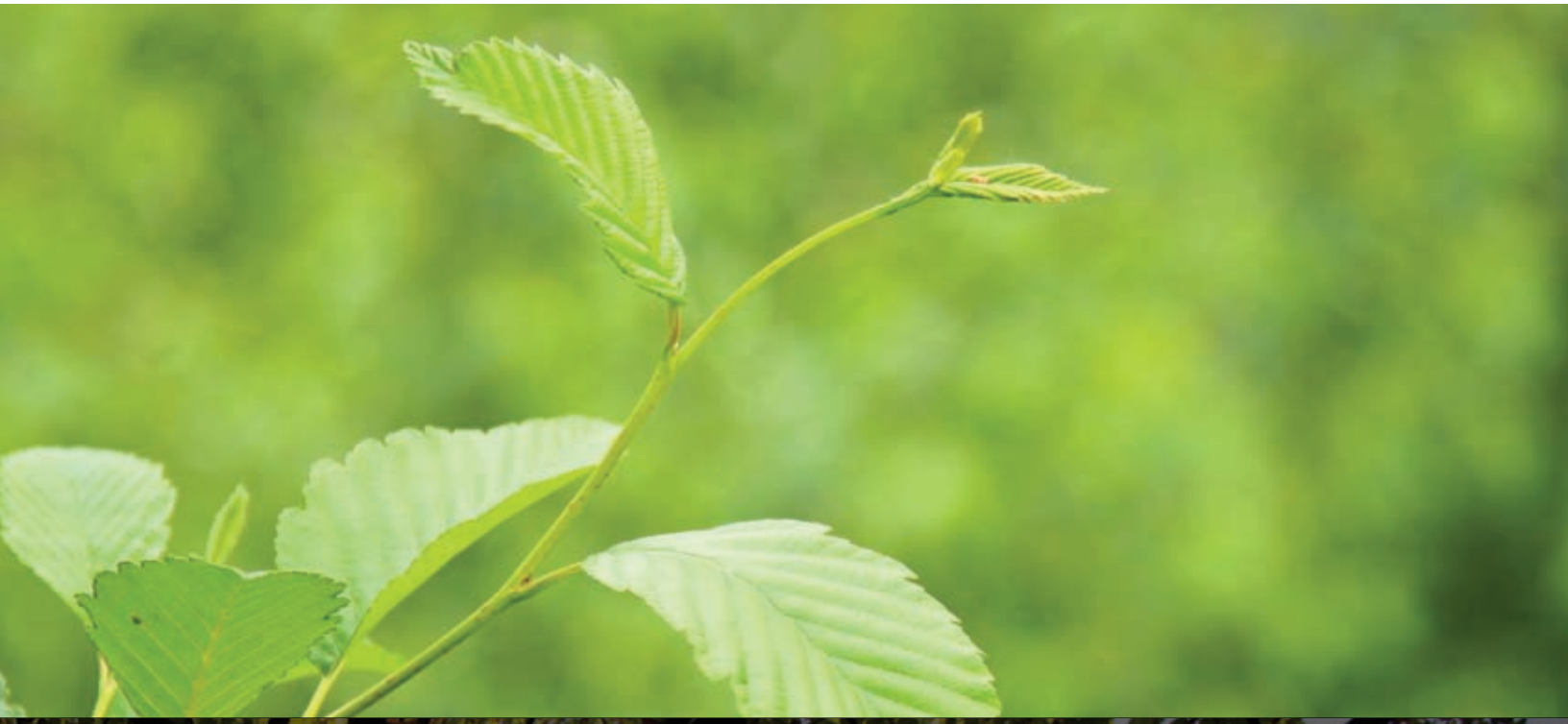


Left: **Nathan Shock, Ph.D.**

Above (top left): **William W. Peter, M.D.**

Above (top right): **Arthur Norris**

Above: **Nathan Shock, Ph.D., in clinical setting, 1953**



Designing a Different Look at Aging and Time

The BLSA's longitudinal design helps investigators piece together a more accurate picture of normal aging. Before the BLSA, scientists generally conducted cross-sectional studies, comparing participants in one age group to a different set of people in another age group. Most of the differences between these groups may not have been attributed to age but the result of life experiences, genetics, or environmental factors. Imagine comparing two people, one who has lived through two wars and the other who was raised in a peaceful and prosperous society. How each aged might be different but the effect of age alone would be difficult to sort out. By looking at the same individuals over time, external influences are reduced. Longitudinal research allows scientists to gather thousands of case studies of human aging.

*What Is **Normal** Aging?*

True to Shock's vision, the BLSA still looks for answers to the question, "What is *normal* aging?" This may seem like a simple question, but for scientists, it gets to the heart of something quite complex: how to identify the true effects of aging and how to separate factors such as disease, socioeconomic disadvantage, or lack of educational opportunity from the underlying biological or other mechanisms common to human aging.

The study of normal aging has helped change our understanding of what it means to grow older. Although, for the most part, people age differently, scientists have identified certain common changes experienced by nearly everyone. For example, BLSA scientists observed that people who have no evidence of hearing disorders or noise-induced hearing loss still lose some of their hearing with age — that's normal — but the pattern of this loss varies from person to person. The scientists also noted that hearing sensitivity declines earlier and faster in men than in women.

By studying normal aging, scientists disproved certain stereotypes associated with older adults. For instance, have you ever heard the myth that people become meaner as they get older? By analyzing long-term personality data, BLSA scientists learned, in fact, that an adult's personality generally doesn't change much after age 30. People who are cheerful and assertive when they are 30 will likely be the same when they are 80. This research finding runs contrary to the popular belief that people naturally become cranky, depressed, and withdrawn as they age. The finding suggests that marked changes in personality are not due to normal aging, but instead may be related to disease or dementia.

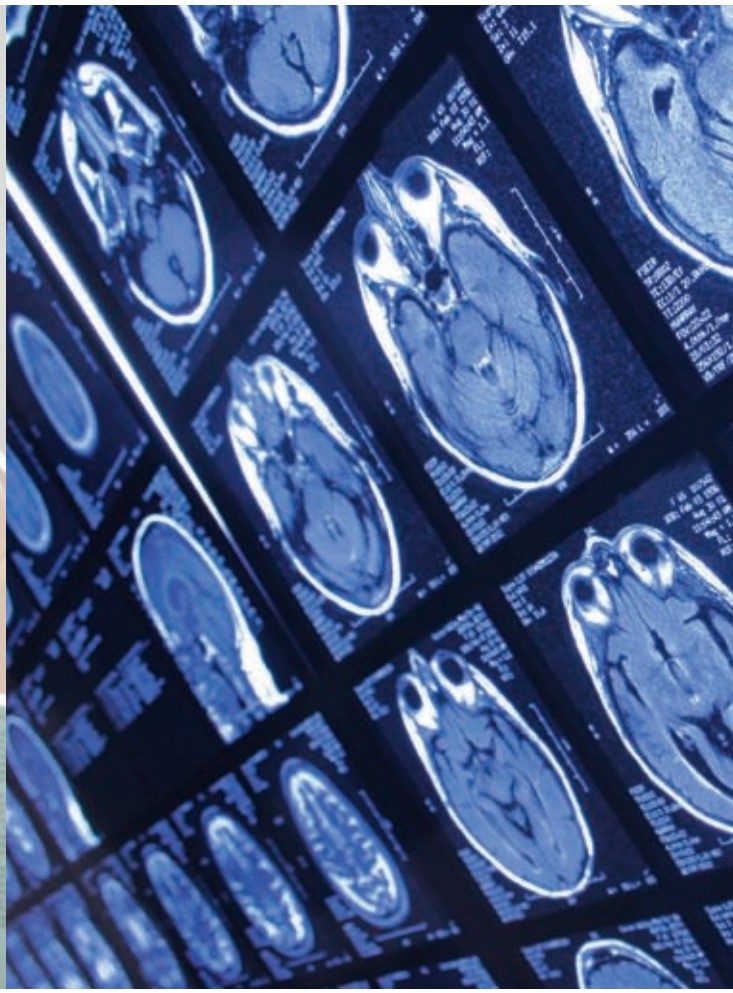
What Are the Links Between Aging and Disease?

To study normal aging, BLSA scientists originally attempted to cut out all diseases from their research. They found, as predicted, that "normal" aging is not synonymous with disease. But they also found that the two were probably not independent either. Because research is an iterative, cascading process, the answers to "What is normal aging?" led scientists to the question, "What is the relationship between aging and disease?" It is well established that the risk of developing many diseases increases with age. One of the BLSA's biggest contributions to biomedical science is its ability to investigate this relationship.

In this vein, the BLSA is changing our understanding of cardiovascular disease. Scientists looking at the aging heart found that age-related changes in the arteries, like arterial stiffening, do increase the risk for cardiovascular diseases. They also found that cardiovascular diseases, in turn, accelerate arterial aging. Given this correlation, scientists realized that they could not study the normal aging heart without considering heart disease. And, by studying the two together, they would be better equipped to identify strategies to prevent or slow arterial aging before cardiovascular disease occurred.

BLSA's longitudinal design supports the pursuit of links between aging and disease. Scientists can look back at information collected from participants over time, including data from years before a diagnosis, and attempt to identify the changes that precede and perhaps predict clinical symptoms, the so-called precursors of disease. They can determine what distinguishes two seemingly healthy people: one who will go on to develop a certain health problem, the other who will not.

The discovery of the relationship between prostate-specific antigen levels, or PSA levels, and prostate cancer illustrates the value of this "*retro*spective." While the medical community knew that the PSA enzyme tended to be elevated among men with prostate cancer, definitive information about the rate of this change in precancerous men was unknown. In 1991, BLSA researchers analyzed blood samples collected over a period of years from 54 men in the study (18 already diagnosed with prostate cancer), to see how the PSA levels changed over time. This small early study revealed there was a rapid rise in PSA levels about 5 years before the prostate cancer was diagnosed. The men without cancer, including those with benign prostate growth or hyperplasia, did not have this rapid rise in PSA levels. BLSA researchers also observed that the rate of PSA change is a more sensitive method of detecting prostate cancer than using



a fixed cutoff value. Furthermore, scientists determined that examining the ratio of free PSA (not attached to a protein) to total PSA helps reduce incorrect diagnosis; moreover, the percentage of free PSA in the blood can predict the aggressiveness of prostate cancer a decade before diagnosis.

The unique opportunity to look back at the participant's clinical history also benefitted research on dementia. BLSA measurements of cognition — the ability to think, learn, and remember — began in 1960. Scientists were then looking for natural changes with age. In 1985, the focus shifted to distinguishing normal cognitive decline from decline associated with dementias like Alzheimer's disease (AD). BLSA's longitudinal data was used by scientists to create a history map for the time preceding a participant's diagnosis of AD. These maps showed when participants experienced an accelerated decline in memory, verbal intelligence, and executive function (the ability to use past experiences to carry out cognitive actions like correctly categorizing animals, fruits, and vegetables or identifying and recalling important details). In 2008, BLSA scientists reported that almost everyone experienced a steady rate of natural decline in their cognitive abilities. However, the rate of decline among people who went onto develop AD varied over time. Memory decline, for example, increased (compared to normal) approximately 7 years before the AD diagnosis and then accelerated a second time 2 to 3 years before diagnosis.

KATY SWANSON

I have been with the BLSA since May 2001 as a Geriatric Nurse Practitioner. I'm responsible for overall clinical assessment and evaluation, which means that I collect history information and obtain consent from BLSA participants, do their physical exams, and explain BLSA test results. By being part of the BLSA team, I have grown in my clinical expertise and learned so much about the research process. I feel the atmosphere at the BLSA is invigorating and stimulates me to continue in this professional role. Each of us working on this study is made to feel we are an integral part and so important in achieving the goals of the BLSA.

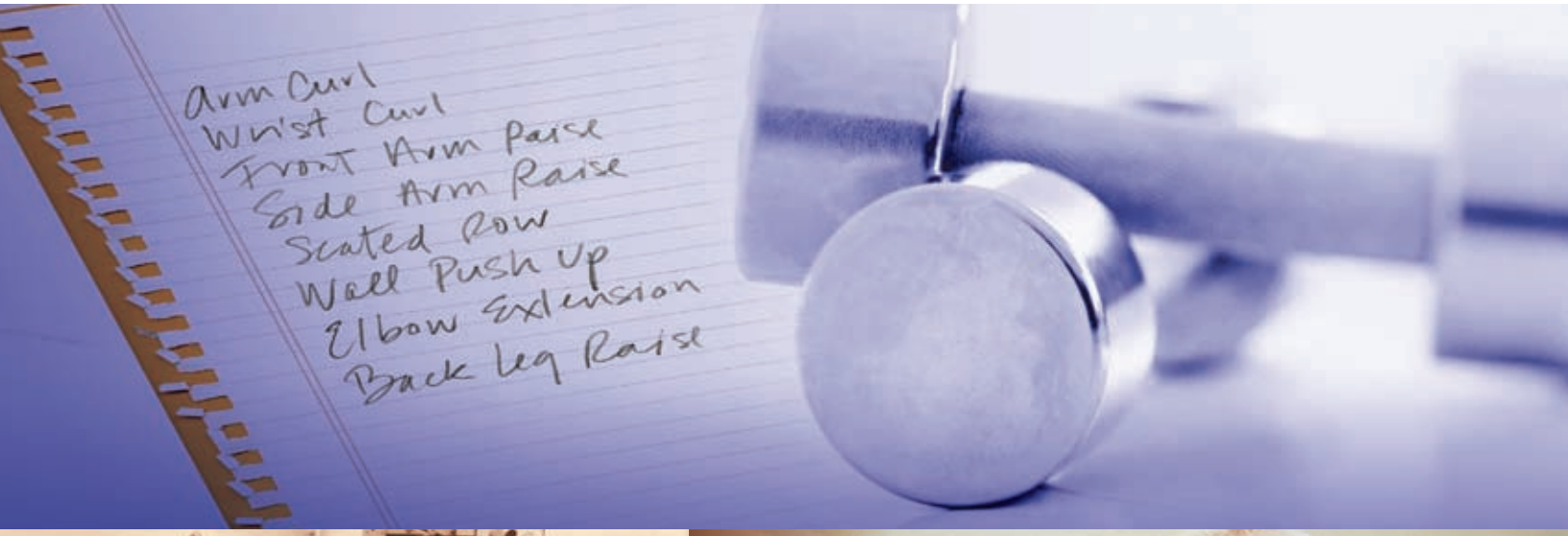
The participants are one of the primary reasons I stay with the study. Their continued dedication and commitment are so impressive.

When I was first hired to work with the BLSA, I planned on a 2-year commitment and then I thought I'd return to oncology nursing. Yet, I am still here. The participants are one of the primary reasons I stay with the study. Their continued dedication and commitment are so impressive. Many of them have more than 20 visits (that's over 40 years), all on a voluntary basis. I have had the opportunity to develop friendships with many participants. They set the standard for my motivation to stay healthy. Without the participants, there would be no study. There is no way that we can adequately thank them for their continued contribution.

Overall, by incorporating the study of disease into their understanding of normal aging, BLSA scientists have been able to:

- *Quantify certain areas of natural, age-related decline and compare these declines with changes related to disease.* For instance, researchers have studied natural versus disease-related changes in muscle quantity and strength, how these changes may be associated with other age-related physical and chemical changes, and the impact of these changes on longevity and physical ability.
- *Build knowledge of the relationship between health risk factors and aging.* Scientists have observed that the value of risk factors to predict disease may change with age. In one example, researchers calculated if the risk for heart disease could be better predicted by waist circumference along with body mass index (BMI, a measure of body fat based on height and weight), rather than by BMI alone. Waist circumference improved the predictive power of BMI for coronary risk in younger but not older people.
- *Track trends for behaviors that promote health or risk for disease.* In one BLSA study, scientists examined the dietary diaries of participants ages 27 to 88 from 1961 to 1987 to see how food choices changed over time. They found that in the late 1960's, fat and cholesterol in participants' diets declined while their consumption of fiber increased. Adults of all age groups followed this healthy eating trend. Older people were just as able as younger people to change their eating habits and benefitted from these changes as much as younger people.

Answering questions about aging and disease is still a priority for BLSA scientists. Understanding this connection may lead to recommendations that can counteract age-related decline in heath status and promote healthy aging.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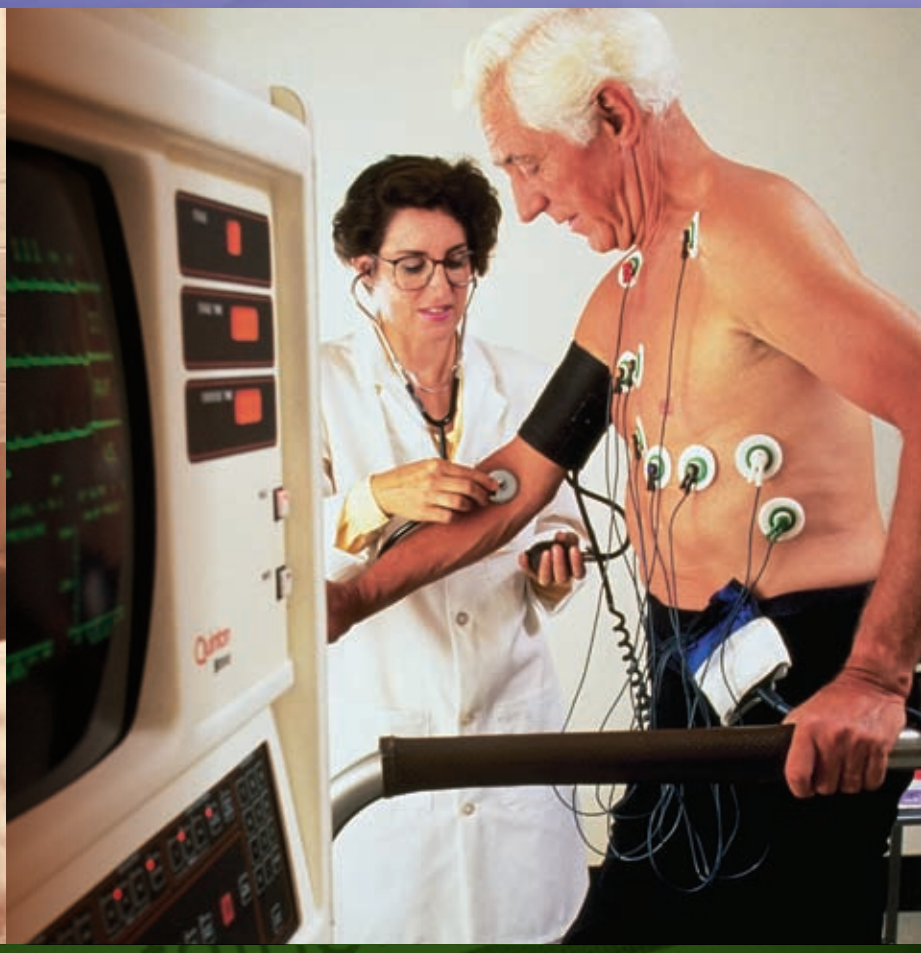
Wrist Curl
Front Arm Raise
Side Arm Raise
Seated Row
Wall Push Up
Elbow Extension
Back Leg Raise




Serving Size
Servings Per Contain
Amount Per Serving
Calories from Fat
100
% Daily Value

WHAT DOES ALL THIS MEAN FOR YOU?

Putting Research into Action

Over the years, BLSA scientists and other researchers from a broad range of disciplines have identified factors that influence healthy aging. From their research have come action steps we can take to maintain our health and function as we get older. From diet and physical activity to health screening and managing disease risk factors, these actions may influence different areas of our health.

The following review of selected findings from the BLSA and other studies describes in practical terms some of the evidence for actions that may lead to healthy aging. Not all the information will necessarily relate to your needs or fit with your lifestyle. But these findings will provide a context and general ideas for you to consider — and act on — as you think about your own aging. Before trying anything new, talk with your doctor about some of the approaches presented here to determine which might best apply to you.

Get Moving: Consider Exercise and Other Physical Activities

Some people love it, some people hate it, but regardless of your personal feelings, exercise and physical activity are good for you — period.

In fact, exercise and physical activity are considered a cornerstone to almost every healthy aging program. Emerging scientific evidence suggests that people who exercise regularly not only live longer, they live better. And, being physically active — doing everyday activities that keep your body moving such as gardening, walking the dog, and taking the stairs instead of the elevator — can help you to continue to do the things you enjoy and stay independent as you age.

Specifically, regular exercise and physical activity can reduce your risk of developing some diseases and disabilities that often occur with age. For instance, balance exercises help prevent falls, a major cause of disability in older adults. Strength exercises build muscles and reduce the risk of osteoporosis. Flexibility or stretching exercises help keep your body limber and give you the freedom of movement you need to do your everyday activities.