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Agricultural Research

Nurture Your Diet, Not Disease

Agricultural Research Service
Solving Problems for the Growing World

Nutrition and Your Health: ARS Studies Target Nutrition's Vital Roles

This issue of *Agricultural Research* magazine focuses on nutrition and your health, a topic that continues to make headlines. Indeed, First Lady Michelle Obama has been in many of those headlines for her work to boost awareness of, and help resolve, a nationwide nutrition-related health problem—the epidemic of childhood obesity.

Obesity is more than extra pounds and tight clothes. It is an underlying factor for chronic diseases including heart disease, some cancers, and diabetes.

But other health conditions may also be influenced by nutrition. As the U.S. population ages, we are increasingly confronted with declining eyesight, bone strength, and cognitive abilities. Recent studies suggest that diet is involved in these conditions.

In many ways, the 20th century was the "Nutrition Century." Numerous essential nutrients were discovered and characterized, and the amounts needed for good health were determined. Based on such findings, dietary sources of these nutrients were identified, and foods fortified with these nutrients were developed. As a result, nutrient-deficiency diseases all but disappeared in this country.

The Agricultural Research Service, which operates human nutrition research centers in Beltsville, Maryland; Boston, Massachusetts; Grand Forks, North Dakota; Little Rock, Arkansas; Houston, Texas; and Davis, California, was heavily involved in that research. Scientific studies conducted by ARS scientists at these centers were instrumental in many of the successes.

With deficiency diseases nearly eliminated, nutrition researchers set their sights on eliminating chronic disease. Based on the past record, quick progress was expected.

But chronic disease turned out to be a greater challenge. An example: In the 1980s, a prominent researcher suggested that diet accounts for up to 60 percent of all cancers. Numerous dietary recommendations aimed at reducing cancer were made. Several large-scale nutrition intervention trials were conducted.

The result?

Cancer remains one of our most prevalent chronic diseases. Many of the intervention trials failed. Some actually increased cancer, thus pointing out the difficulty of taking epidemiological observations—studies on the cause, spread, and control of diseases—and translating them into simple human nutrition interventions.

We may have done better with heart disease. But it is still hard to determine whether decreased incidence is mainly a result of improved nutrition or, alternatively, of pharmaceutical interventions.

So what makes research on the role of nutrition in prevention of chronic disease so challenging?

It turns out that links between diet and chronic disease are very complex. Much more research is needed to unravel these complexities. But as the articles presented here clearly show, ARS researchers are fully engaged in solving these intricate puzzles.

A major problem encountered by nutrition and medical researchers is that, in some people, nutrition interventions can help counter chronic disease, while in others, they may have little or no measurable effect. We have learned that much of this variability comes from mutations—called "polymorphisms"—in specific genes. Several of this month's articles discuss how diet interacts with a person's genes to influence chronic disease risk.

Nutrient timing may be critical; several articles address how nutrients consumed during one timeframe are beneficial, but, perhaps surprisingly, can be ineffective or even dangerous when consumed during another interval.

Nutrient-to-nutrient interactions are important, too. One article discusses how some nutrients are only protective for the eye if they are consumed as part of a particular diet. Lifestyle has an effect, as well. In this issue, for instance, you'll read about research into the interaction of sun exposure, skin tone, and our vitamin D requirements (page 8).

Studies such as these continue to show that nutrition researchers and health educators alike need to help consumers put research findings into a sensible overall perspective. For example, the article on heart health (page 12) shows that consumers have focused for too long on either low-fat diets or on eliminating specific types of fat from their diet, instead of emphasizing an overall healthy diet and, in instances of overweight or obesity, reducing total calories.

We need to continue to deliver solid information that makes a difference in public health. We need to adopt an "evidence-based" approach in which the goal is to make public recommendations based only on scientifically sound studies in humans. Studies done in cell cultures, with laboratory animals, with some types of epidemiological data, or with limited numbers of human volunteers can, of course, continue to give us excellent hypotheses, but they should not be used to make public recommendations affecting millions of Americans.

It is a brave new world for nutrition scientists. The answers we seek are complicated and come only after much hard work and, often, many setbacks. On the following pages, you'll see that we are indeed making very real progress.

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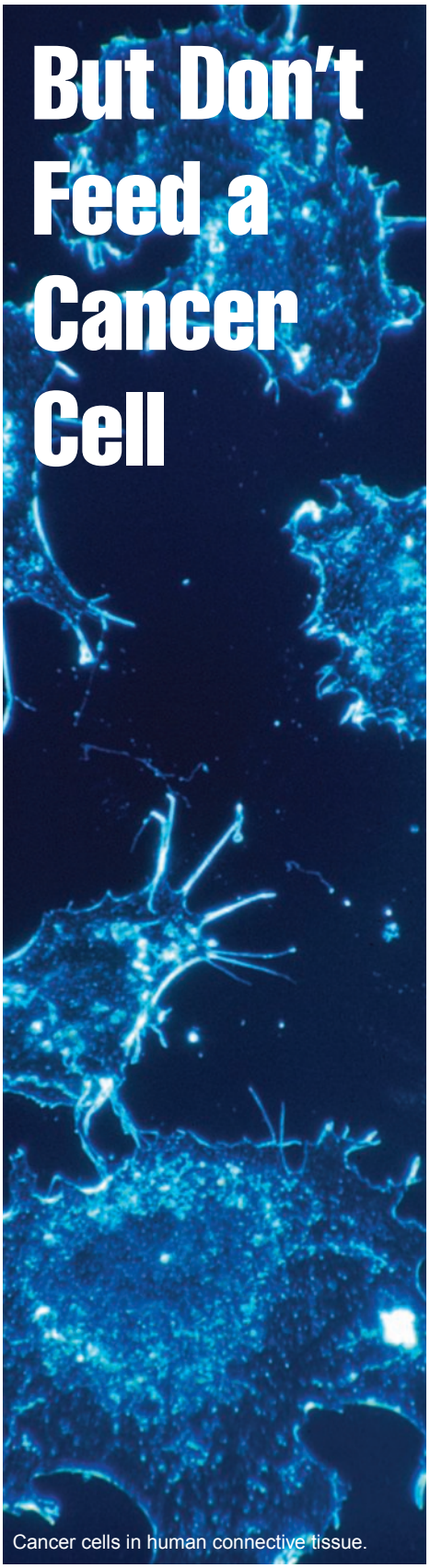
Cover: Choosing beverages and foods wisely can enhance your health. ARS nutrition research provides new, science-based information about the role of nutrition in helping prevent chronic diseases, including cancer, diabetes, cardiovascular disease—and more. See Forum, on opposite page, and articles on pages 4-21. Photo by Stephen Ausmus. (D1830-21)

In the Next Issue

CLEANING THE CHESAPEAKE—It's no secret that the Chesapeake Bay's health is in jeopardy from sediment, fertilizers, pharmaceuticals, and other contaminants draining through its 65,000-square-mile watershed. A recent Executive Order emphasized the importance of protecting and restoring the bay. ARS is partnering with experts throughout the public and private sectors to find ne technologies and improve existing tools for cleaning up this national treasure.

Eat Well, But Don't Feed a Cancer Cell



Cancer cells in human connective tissue.

NATIONAL CANCER INSTITUTE

Scientists do not know exactly why one person develops cancer and another does not. But Agricultural Research Service chemist Thomas Wang, who specializes in cancer prevention research, says that there are "layers" of factors involved in the development of the disease. Wang works at the ARS Diet, Genomics, and Immunology Laboratory, which is part of the Beltsville (Maryland) Human Nutrition Research Center.

Research shows that certain external risk factors increase the chance that a person will develop cancer. These include the molecules that are introduced into the human body by way of ingestion. "This layer involves peoples' diet complexity," says Wang. "Diet is a complex mixture of bioactive compounds that trigger huge amounts of biological activity."

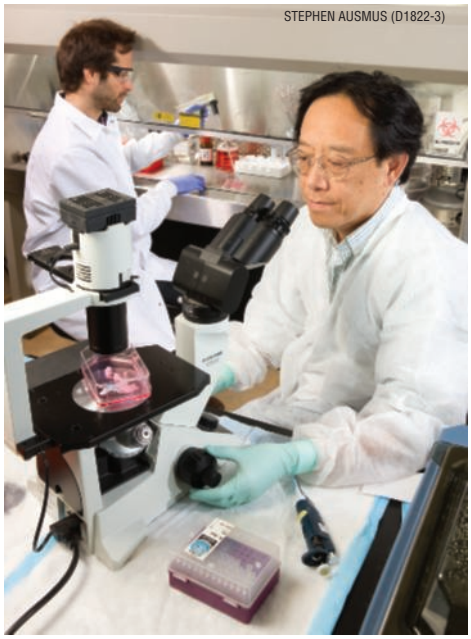
Another major layer is genetics. "People have their own individual genotypes that are dictated by their ethnicity, gender, and inherited traits," says Wang. Some of those traits involve susceptibilities to cancer.

While individual nutrients are sometimes touted in the media as being able to reduce the risk of developing certain cancers, in fact, such findings can only be confirmed through large clinical trials. Still, evidence from cell culture, animal models, and population studies suggests that interactions among combinations of certain plant chemicals are involved in slowing or possibly lowering the risk of cancer development.

Phytochemicals in Foods

While research suggests that diet can have a protective effect against some chronic diseases, other research is being conducted to learn what dietary components are linked to causing chronic diseases.

Vegetables, fruits, whole grains, beans, nuts, and seeds contain thousands of bioactive phytochemicals. Other compounds are found in some meats, poultry, and fish. Some of these compounds turn on genes that are protective against cancer and turn off other genes linked to cancer promotion.



STEPHEN AUSMUS (D1822-3)

ARS researchers are studying cell cultures to look at biological activity triggered by plant chemicals. Here, chemist Thomas Wang (right) and technician Steven Trasino check cell viability and prepare cell cultures.

"Gauging the benefits of consuming these dietary compounds involves careful tracking of concentration, timing, and interactions with other compounds," says Wang.

Wang published a complementary cell-culture and animal-model study showing that concentrations of resveratrol—a highly bioactive compound found in grapes and other plant foods—actually turned out to be a double-edged sword when it came to mitigating cancer risk.

First, Wang exposed human prostate cancer cells to resveratrol and found that it inhibited the cells' growth. He further tested the cells' gene expression. Exposures to male sex hormone are known to increase prostate cancer risk. Wang found that resveratrol actually inhibited male-sex-hormone-mediated pathways.

Wang then tested the effects of resveratrol on a group of laboratory animals that had sex-hormone-dependent tumor cells. Half of those animals were fed a daily diet that included 3 to 6 milligrams of purified resveratrol (equal to roughly the amount

Focusing too much on getting inordinate amounts of a few single nutrients might increase cancer risk.

in five glasses of wine or grape juice). At first, the tumor cells in the resveratrol-fed lab animals did not grow. But as the resveratrol consumption continued, blood vessels developed around the tumors, effectively setting up a system of feeding the tumors.

"This showed that the concentration of the plant compound is important, but so is length of exposure," says Wang. The study was published in *Carcinogenesis* in 2008.

A Balance of Nutrients

The *Dietary Guidelines for Americans* recommend eating a variety of foods. In addition, some studies have shown that supplementing individual nutrients indiscriminately can disturb the balance of nutrients in the body. "More research needs to be done in this area," says Wang. "But focusing too much on getting inordinate amounts of a few single nutrients might increase cancer risk."

Folic acid, for example, is the manmade form of folate, a natural B vitamin found in many vegetables, beans, fruits, and whole grains. Folate is essential for DNA synthesis. Some consumers might start the day getting 200 micrograms (mcg) of folic acid from a fortified breakfast cereal and another 400 mcg from a multivitamin. For them, it would take just one fortified "energy drink" with an additional 400 mcg of folic acid to reach the upper level of 1,000 mcg per day. Any further enriched foods consumed, such as bread, rice, or pasta, would result in the consumer exceeding the amount thought to be well tolerated biologically. The recommended dietary allowance for folate is 400 mcg daily.

"Precancerous and cancerous cells divide rapidly, so they require a lot of building blocks for synthesis of new copies of DNA," says Joel Mason, director of the ARS-funded Vitamin and Carcinogenesis Laboratory. "It has been shown that under select circumstances, an overabundance of folic acid promotes tumor growth. Studies in laboratory animals substantiate this." Mason described these concerns in the journal *Nutrition Reviews* in 2009.

The laboratory is part of the Jean Mayer USDA Human Nutrition Research Center on Aging (HNRCA) at Tufts University in Boston, Massachusetts.

Another Double-Edged Sword

Also in Boston, Jeffrey Blumberg, director of HNRCA's Antioxidants Research Laboratory, tackled the question of whether supplemental antioxidants, including vitamins C and E and beta-carotene, while protecting healthy cells, may also protect tumor cells during chemotherapy or radiation therapy. He and colleagues reviewed published data from randomized clinical trials addressing benefits versus risks of such antioxidant supplement use.

The researchers concluded that the use of supplemental antioxidants during cancer therapies should be discouraged because of the possibility of tumor protection. The commentary was published in the *Journal of the National Cancer Institute* in 2008.

Phytochemicals and other food components affect genes that trigger specific molecular mechanisms. Depending on the concentration and exposure over time, some of these mechanisms are similar to detoxification and some promote stress. For example, the food compounds that "turn on" detoxifying phase I and phase II enzymes can help clear the carcinogens.

Consuming a varied diet that provides adequate levels of all recommended nutrients from foods is the best way to eat well without upsetting the balance of individual nutrients in the body. A personalized eating plan and assessment of individual food choices based on the *Dietary Guidelines for Americans* can be found at MyPyramid.gov.—By **Rosalie Marion Bliss,** ARS.

This research is part of Human Nutrition, an ARS national program (#107) described at www.nps.ars.usda.gov.

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STEPHEN AUSMUS (D1803-7)

Nutritional biochemist Jeffrey Blumberg (left) and research assistant Carly Zampariello examine dietary antioxidants in a sample of human plasma measured by high-performance liquid chromatography.

Cancer-Fighting Roles
of Intriguing Plant Compounds

CANCER

An array of studies from scientists at the Agricultural Research Service's Western Human Nutrition Research Center in Davis, California, is yielding new clues about the roles that compounds from plants may play in preventing cancer and other diseases.

For example, molecular biologist Susan J. Zunino has investigated the role that certain compounds in strawberries may have in combating cancer. Her tests with lab-cultured cells of a cancer known as "acute lymphoblastic leukemia" have provided additional evidence that three compounds occurring naturally in strawberries—ellagic acid, kaempferol, and quercetin—can cause death, or significant damage, to certain lines of these leukemia cells.

The compounds' modes of action vary, as does their effectiveness, Zunino and coresearchers found. Each strawberry component was extracted and purified and then tested separately in a succession of doses extending over a 72-hour period.

The scientists point out that several key questions still need to be answered. Among them: Are the compounds as effective in humans as they are in lab-cultured cells? How bioavailable are the phytochemicals, that is, what amounts do our bodies actually take up, and use, from the foods that we eat?

Zunino and her ARS colleagues collaborated in the studies with medical researchers at the University of California-Los Angeles and published their findings in the *Journal of Functional Foods* in 2009. ARS and the Watsonville-based California Strawberry Commission funded the studies.

ARS colleague Daniel H. Hwang, also a molecular biologist at Davis, investigates the ability of plant chemicals to protect us from harmful inflammation. Unwanted inflammation can increase risk not only of cancer, but also of certain other disorders, including heart disease and insulin resistance.

Hwang and a team of coinvestigators have teased out precise details of how six natural compounds in plants—luteolin, quercetin, chrysin, eriodicytol, hesperetin, and naringenin—apparently act as anti-inflammatory agents.

Luteolin is found in celery, thyme, green peppers, and chamomile tea. Foods rich in quercetin include capers, apples, and onions. Oranges, grapefruit, lemons, and other citrus fruits are good sources of hesperetin, eriodicytol, and naringenin. Chrysin is from the fruit of blue passionflower, a tropical vine.

The scientists have provided new, specific, and previously unknown details about how these phytochemicals work indirectly to undermine and inhibit the expression of certain genes. Without that interference, the products of those genes might—in turn—trigger inflammation.

It's research that involves determining how the plant compounds send biochemical signals downstream, along some of the body's complex pathways. Then, researchers have to determine which molecules along the pathways are the phytochemicals' intended targets.

Hwang's team has shown, for the first time, that all six plant compounds target an enzyme known as "TBK1." Each compound inhibits, to a greater or lesser extent, TBK1's ability to activate a specific biochemical signal. If unimpeded, the signal would lead to formation of gene products known to trigger inflammation.

Of the six compounds, luteolin was the most effective inhibitor of TBK1. Luteolin is already known to have anti-inflammatory properties. But Hwang and his colleagues were the first to provide this new, mechanistic explanation of how luteolin exerts its anti-inflammatory effects.

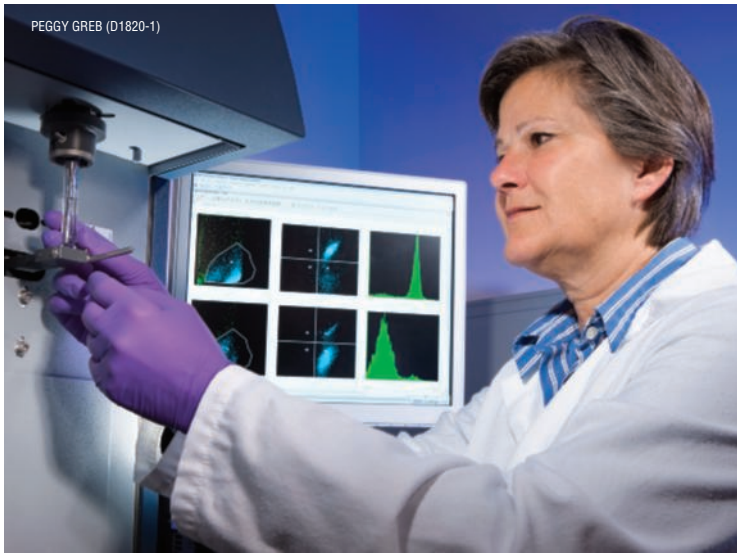
What's more, the approaches that the researchers developed to uncover these compounds' effects "can also be used, in the future, to identify additional anti-inflammatory compounds present in fruits and vegetables," Hwang notes.

The scientists' 2009 article in *Biochemical Pharmacology* has details.

The study expands on earlier work in which Hwang and colleagues provided a close-up look at how other plant chemicals also act as chemoprotectants by interfering with the flow of other biochemical signals.

Ongoing studies by Zunino and Hwang will yield even more insights into the phytochemicals that defend us against disease.—By **Marcia Wood,** ARS.

This research is part of Human Nutrition, an ARS national program (#107) described at www.nps.ars.usda.gov.



At the ARS Western Human Nutrition Research Center, Davis, California, molecular biologist Susan Zunino uses flow cytometry to evaluate anti-leukemia activities of strawberry compounds.

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Seeing is Believing

When Nutrition Saves Sight

VISION

While 20/20 vision has become a symbol of visual clarity, between now and the year 2020, more and more people will experience vision loss, according to the National Eye Institute (NEI), based in Bethesda, Maryland. That's due largely to the aging of the U.S. population.

In the next 10 years, millions of U.S. residents aged 40 and older are projected to experience some measure of vision loss due to age-related macular degeneration (AMD), glaucoma, cataract, and/or diabetes-related vision damage. The macula is a 3-millimeter-wide yellow spot near the center of the retina responsible for the central field of vision.

Significantly, Agricultural Research Service-funded researchers at the Laboratory for Nutrition and Vision Research are finding that healthy eating can reduce health care costs and the incidence of quality-of-life declines from these diseases. The laboratory, directed by Allen Taylor, is part of the Jean Mayer USDA Human Nutrition Research Center on Aging (HNRCA) at Tufts University in Boston, Massachusetts.

For one study, the researchers analyzed dietary intake and other data from 4,003 men and women, aged 55 to 80, who had participated in the long-term, NEI-funded Age-Related Eye Disease Study, or AREDS. Led by Chung-Jung Chiu, the researchers ranked intake of each of several nutrients consumed during the AREDS study, then calculated a compound score to gauge their combined dietary effect with links to risk of AMD. The scoring system allowed them to evaluate associations between individual—and combined—dietary nutrients. They also studied specific food-intake patterns and risk of AMD.

The study indicated that regularly consuming a combination of the protective nutrients and a low glycemic index diet provided an AMD-protective effect.

A food's glycemic index is an indicator of how fast the carbohydrate it contains will spike blood sugar levels. The nutrients that were found to be most protective in combination were vitamins C and E, zinc, lutein, zeaxanthin, and the omega-3 fatty acids known as "DHA" and "EPA."

As the eye ages, oxidized proteins—debris called "drusen"—begin to accumulate in the macula. A key indicator of AMD risk was finding measurable drusen deposits during a routine examination of the macula, conducted by an eye doctor. "Because drusen tend to increase in number and size over time, finding drusen at an early stage was significant," says Chiu.

The study was published in *Ophthalmology* in May 2009.

HNRCA researchers are also conducting human cell culture studies to better understand mechanisms behind nutrition-vision links. One study, led by Elizabeth Whitcomb, unearthed a new way that eye cell division and proliferation are controlled. When damaged proteins gather within the eye's lens, cloudiness occurs. That protein buildup could lead to cataract. Ubiquitin enzymes are involved in removal of these degraded proteins.

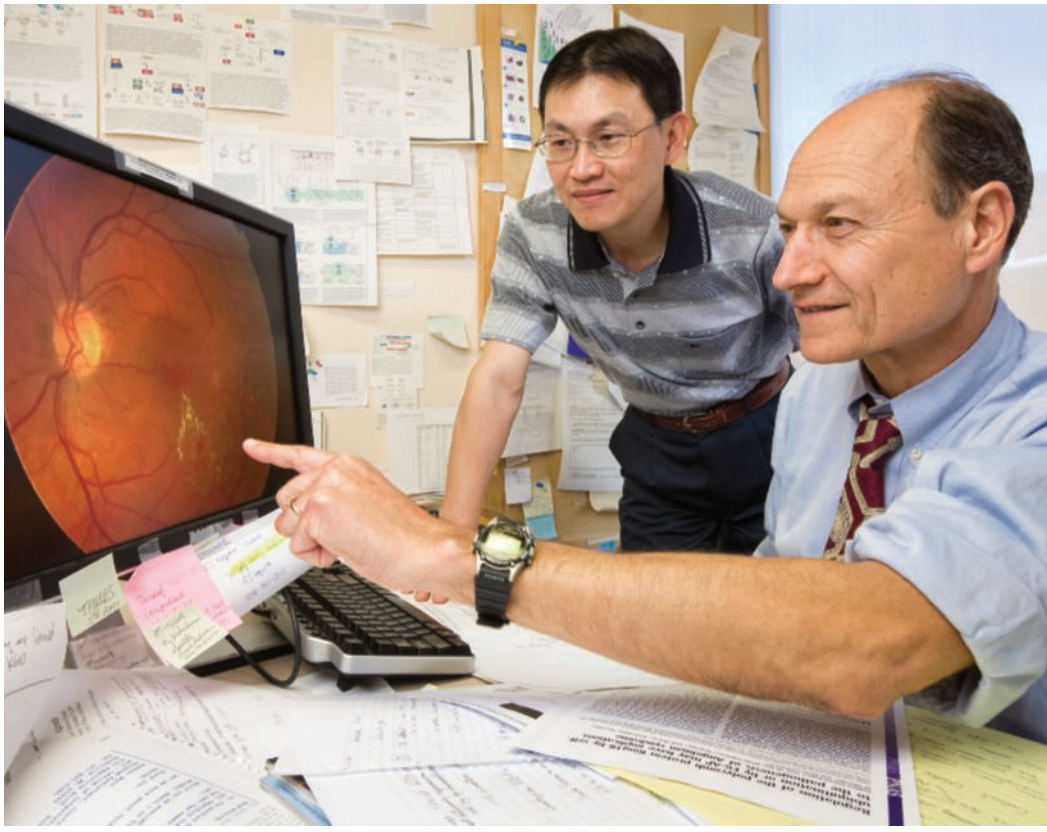
The researchers found that when ubiquitin-conjugating enzyme H7 was artificially decreased in cells, the cell phase during which DNA is synthesized prior to division, called "S phase," took longer. This resulted in less cell proliferation.

The study appears in *Molecular Biology of the Cell* in 2009.—By **Rosalie Marion Bliss,** ARS.

This research is part of Human Nutrition, an ARS national program (#107) described at www.nps.ars.usda.gov.

Allen Taylor is with the Laboratory for Nutrition and Vision Research, Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University, 711 Washington St., Boston, MA 02111-1524; (617) 556-3156, allen.taylor@tufts.edu.

STEPHEN AUSMUS (D1817-1)

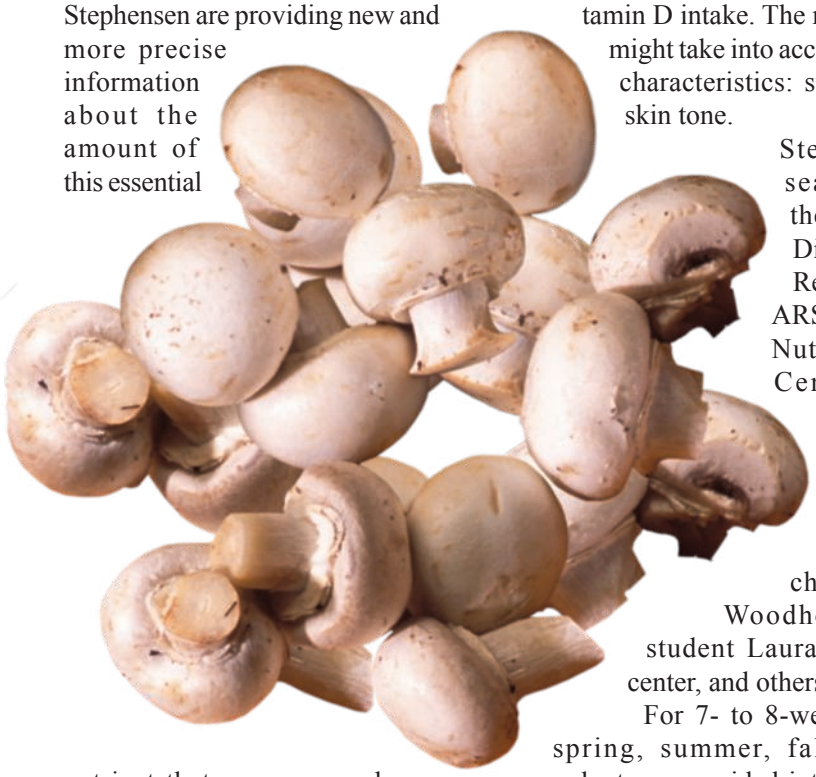


Epidemiologist Chung-Jung Chiu (left) and biochemist Allen Taylor review an image of the retina of a patient with macular degeneration, seen as the yellow spotting in the macula (the darker area in the center of the retina).

Boost Immunity With Food and Sun

Your immune system is your body's own powerful army. It puts up an array of sophisticated defenses against threats from within and without. Studies in the United States and abroad increasingly point to vitamin D as perhaps one of the immune system's strongest allies against disease.

Now, investigations by Agricultural Research Service physiologist Charles B. Stephensen are providing new and more precise information about the amount of this essential nutrient that we may need for optimal health—including a healthy immune system.



The research is timely. Millions of Americans don't get enough vitamin D—a deficiency that some have called one of the most serious public health issues facing the United States today.

Scientists have known since the early 20th century that our bodies are stimulated to make vitamin D when ultraviolet rays from the sun reach our skin. The amount of direct sunlight that we do—or don't—receive depends on the season, the latitude at which we live, the amount of time we spend in the sun, the pigmentation of our skin, and even the kind of protective clothing we wear.

We also get some vitamin D from foods, including salmon and some other fish, milk and breakfast cereals that are fortified with this nutrient, and supplements such as multivitamin tablets.

Findings from a preliminary, and apparently first-of-its-kind, study of 72 young adult volunteers in northern California might help pave the way to individualized recommendations—for the future—for vitamin D intake. The recommendations might take into account two personal characteristics: sun exposure and skin tone.

Stephensen is research leader of the Immunity and Disease Prevention Research Unit at the ARS Western Human Nutrition Research Center in Davis, California. He collaborated in the investigation with supervisory chemist Leslie R. Woodhouse, graduate student Laura M. Hall at the center, and others.

For 7- to 8-week stints during spring, summer, fall, and winter, volunteers provided intermittent records of what they ate and, once a week, wore photosensitive badges from 7 a.m. to 7 p.m. to record their exposure to the sun. Blood samples were taken three times each season so that scientists could monitor the volunteers' vitamin D levels, using serum 25-hydroxyvitamin D as their indicator.

From these measurements, the researchers developed a preliminary model that first of all assumes a vitamin D intake of 200 international units (IU)—the U.S. adult recommended daily allowance. Then, the model predicts the additional amount a person might need, based on the individual's sun exposure and pigmentation.

The data from volunteers—either African-American or of European ancestry—who had relatively low amounts of sun exposure suggests that they may need additional vitamin D to reach a target blood level of 75 nanomoles of vitamin D per liter of plasma.

Perhaps surprisingly, "low sun exposure" would be, for example, the amount received by a person spending no more than 20 minutes a day in direct sun, wearing long pants (not shorts), a short-sleeved (not sleeveless) top, and no hat. "That's similar to an average office worker's exposure," Stephensen notes.

Details are in an article published earlier this year in the *Journal of Nutrition.* Stephensen cautions that some of the intakes indicated by the experimental model exceed the level currently considered safe. He also notes that the findings are preliminary and that "more research, with a larger number of volunteers" is needed to refine the predictive power of the new mathematical model.

Nutrients Support Immunity

Among the many foods thought to play an important role in keeping the immune system healthy are mushrooms.

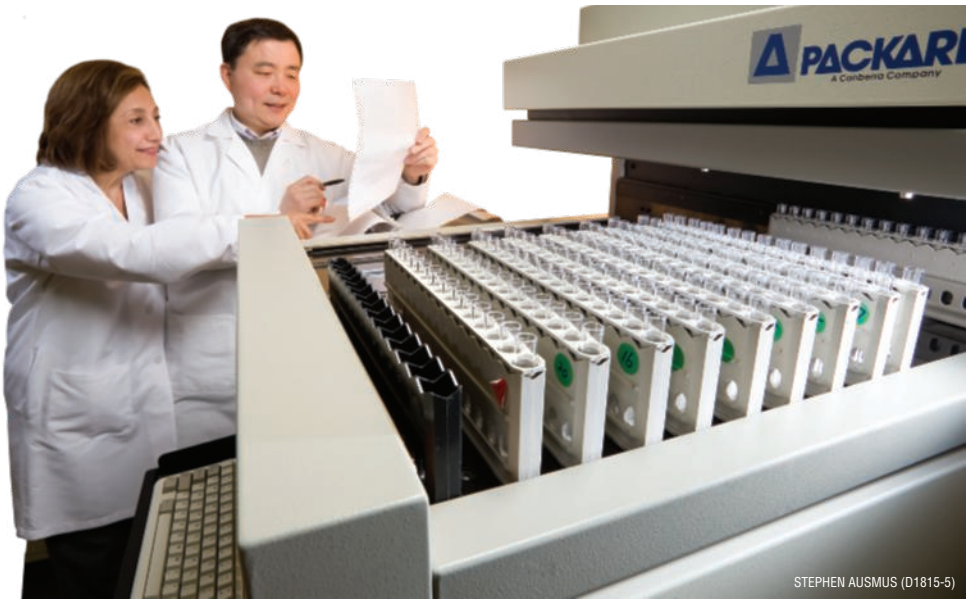
In the United States, white button mushrooms represent 90 percent of the total mushrooms consumed.

At the Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University, center director Simin Meydani, colleague Dayong Wu, and others conducted an animal-model and cell-culture study showing that white button mushrooms enhanced the activity of natural killer cells.

The results suggest that white button mushrooms may promote immune function by increasing production of antiviral and other proteins that are released by cells while seeking to protect and repair tissue.

Wu and co-investigators are with the HNRCA Nutritional Immunology Laboratory in Boston, Massachusetts. The study's cell-culture phase showed that white button mushrooms enhanced the maturity of immune system cells called "dendritic cells," from bone marrow. Dendritic cells

Volunteers who had relatively low amounts of sun exposure may need additional vitamin D to reach a target blood level.



Nutritional immunologists Simin Meydani (left) and Dayong Wu evaluate the capacity of immune cells to kill their target. Here, the researchers review data generated from a gamma counter.

For a study assessing the contribution of skin pigmentation, sun exposure, and diet to vitamin D status, graduate student Melissa Zerofsky uses a reflectance spectrophotometer to measure a volunteer's skin pigmentation at the ARS Western Human Nutrition Research Center in Davis, California.

can make T cells—important, specialized white blood cells that can recognize foreign substances from invading pathogens and eventually present them to other defense system cells.

"When immune system cells are exposed to disease-causing pathogens, such as bacteria, the body begins to increase the number and function of immune system cells," says Meydani. "People need an adequate supply of nutrients to produce an adequate defense against the pathogen. The key is to prevent deficiencies that can compromise the immune system."

The study appears in a 2008 issue of the *Journal of Nutrition.*

IMMUNITY

Zinc and Vitamin E Power

HNRCA researchers are also conducting observational studies in the area of immunology. They are studying immune response in about 600 elderly residents in 33 nursing facilities in the Boston area.

Meydani and colleagues previously reported that among the facility residents, those who consumed 200 IU of vitamin E daily for 1 year were 20 percent less likely to get upper respiratory infections, such as colds, than those who took a placebo.

A secondary analysis of data from the same clinical trial showed a high proportion of the residents had low serum (blood) zinc concentrations at baseline and after 1 year of follow-up. All participants had been supplemented with half of the recommended dietary allowance of essential vitamins and minerals, including zinc, during the trial.

The researchers found that those with normal blood zinc concentrations were about 50 percent less likely to develop pneumonia than those with low concentrations. Those with normal zinc status also had fewer new prescriptions for antibiotics, a shorter duration of pneumonia, and fewer days of antibiotic use compared with residents who had low zinc levels.

The study appears in a 2007 issue of the *American Journal of Clinical Nutrition.*

While the study suggests that supplementation of zinc-deficient elderly may result in reduced risk of pneumonia, the authors note that controlled clinical trials are needed to test efficacy of zinc supplementation as a low-cost intervention to reduce mortality due to pneumonia among vulnerable populations who already have low zinc levels.—By **Marcia Wood** and **Rosalie Marion Bliss,** ARS.

This research is part of Human Nutrition, an ARS national program (#107) described at www.nps.ars.usda.gov.

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Bolstering Bone Health Through Nutrition Research

Agricultural Research Service nutrition researchers are intent on discovering more about the role nutrition can play in boosting bone health. In one study, for example, physiologist Marta D. Van Loan collaborated with scientists from Purdue University and elsewhere in exploring young girls' perceptions of lactose intolerance. The 291 volunteers, ages 10 to 13, were participants in a larger study called "Adequate Calcium Today."

The millions of Americans who are lactose intolerant may suffer digestive discomfort when they eat dairy products or foods made with those products. But dairy foods such as milk are an excellent source of calcium, an essential mineral that provides the structural support needed for strong bones.

Lactose-free products, from which milk sugar (lactose) has been removed, are designed to provide an alternative, so that lactose-intolerant kids and adults may enjoy calcium-rich dairy foods without incurring digestive problems.

The scientists found that volunteers as young as age 10 who "perceived that they were lactose intolerant" had already begun limiting the amount of milk that they drank. "The bone mineral density of their spines was significantly lower than that of some of the other girls," Van Loan says.

In some instances, perception and biochemical reality were different. Results from the standard breath-hydrogen test for lactose intolerance showed that some girls who thought they *were* lactose intolerant actually *weren't*. Other girls who actually were lactose intolerant didn't know they had the condition until they tested positive during the study.

"We're concerned," says Van Loan, "that misperceptions about lactose intolerance can lead girls—in early adolescence—to cut back on milk. To do that during this phase of their critical bone-forming years could have lifetime consequences on the health of their bones."

Van Loan is a coauthor of the 2007 article in *Pediatrics* that documents the study.

Weight-Bearing Exercise Really Does Work

In another study, published in *Medicine and Science in Sports and Exercise* in 2007, Van Loan and coresearchers took a closer look at how leisure-time physical activity affected the bone strength and bone geometry of 239 postmenopausal women. The decreased production of estrogen during postmenopausal years may increase risk of osteoporosis, cardiovascular disease, and other conditions.

The researchers found that a minimum of 30 minutes a day—or, alternatively, 4 hours a week—of walking, jogging, weightlifting, or other weight-bearing leisure-time activity was needed to maintain two key indicators of bone health: cortical bone density (the thickness of bone's hard outer layer) and functional geometry (such as the inner and outer diameter of the bone).

Soy Isoflavones: Still Controversial

While calcium and weight-bearing exercise are unarguable aids to bone health, soy's role remains unclear. "Ever since conventional steroid hormone replacement therapy was shown to cause certain kinds of cancer and other side effects," says Van Loan, "researchers have been looking for a safe and effective alternative for postmenopausal women." Soy, as one potential candidate, has been the subject of more than two dozen studies conducted in the U.S. and abroad during the past decade. Some of those investigations have suggested that soy enhances bone health.

One such study, a 6-month investigation led by Iowa State University researcher

GRAND FORKS HUMAN NUTRITION RESEARCH CENTER (D1828-1)

GRAND FORKS HUMAN NUTRITION RESEARCH CENTER (D1827-1)

The dual energy x-ray (DXA) bone mineral density scan on the left shows the skeleton of a 24-year-old female athlete, while the one on the right shows the skeleton of a 72-year-old woman. Neither has any known disease, but the bones of the younger woman are solid and show up bright white, whereas the bones of the older woman appear almost transparent.

Calcium and weight-bearing exercise are unarguable aids to bone health.

BONE

STEPHEN AUSMUS (D1829-43)

Researchers found that at least 30 minutes a day of walking, jogging, or other weight-bearing activity is needed to maintain two key indicators of bone health—cortical bone density and functional geometry.

D. Lee Alekel in 2000, showed that soy protein prevented bone loss in tests with 69 women volunteers who were entering menopause. That research paved the way for a 3-year investigation in which Alekel, Van Loan, and others studied whether isoflavones—estrogenlike compounds extracted from soy protein—protect postmenopausal women against bone loss.

Volunteers in the isoflavone study—the longest of its kind—took either a placebo tablet or a tablet containing one of two moderate amounts of the isoflavones—80 milligrams (mg) or 120 mg—every day.

Overall, the isoflavones "had no significant positive effect on preventing bone loss," says Van Loan, "but there was a modest benefit of the 120-mg isoflavone treatment when evaluated in conjunction with lifestyle factors.

"The body's response to isoflavones extracted from soy proteins may be different from its response to isoflavones in their natural matrix of soy protein or soy foods or in a soy-protein supplement," she says. "It's also possible that some soy-protein compound other than the extracted isoflavones was responsible for the bone-protecting effects seen in some studies. Or the doses of the isoflavones in our study may not have been high enough to produce a bone-sparing effect."

An article published by the team earlier this year (2010) in the *American Journal of Clinical Nutrition* has further details.

The Calcium Needs of Adults

Other ARS researchers are taking a new look at the calcium requirements for adults.

The body's skeleton clearly needs adequate dietary calcium to reach its full potential in terms of bone mass. But other factors also affect bone mass, such as smoking and vitamin D intake.

Currently, calcium intake recommendations vary markedly between countries. For example, for adults over age 50, the recommended calcium intake is 1,200 mg daily in the United States—but in the United Kingdom, it is 700 mg daily.

A study led by former ARS biologist Curtiss Hunt and statistician LuAnn Johnson suggests that the current recommended amount of dietary calcium for American adults may be greater than actually needed.

Hunt and Johnson analyzed data collected from 155 male and female volunteers, ages 19 to 75, who participated in at least 1 in a series of 19 controlled feeding studies conducted at the Grand Forks (North Dakota) Human Nutrition Research Center.

The modeling of the data suggests that the average amount of dietary calcium needed to maintain a neutral calcium balance is about 741 mg per day. "Calcium balance" is the condition wherein the amount of calcium consumed equals the amount of calcium lost through elimination.

"The same model suggests that a calcium intake of 1,035 mg per day would cover the needs of 95 percent of the American adult population," says Johnson.

The volunteers' bodies tried to maintain a relatively stable amount of calcium even though their daily intakes of calcium varied widely—415 mg on the low end to 1,740 mg on the high end. When fed the lower amounts, for example, the body was more efficient in keeping calcium. When fed the higher amounts, the extra calcium was simply eliminated.

The study was published in the *American Journal of Clinical Nutrition* in 2007.—By **Marcia Wood** and **Rosalie Marion Bliss,** ARS.

This research is part of Human Nutrition, an ARS national program (#107) described at www.nps.ars.usda.gov.

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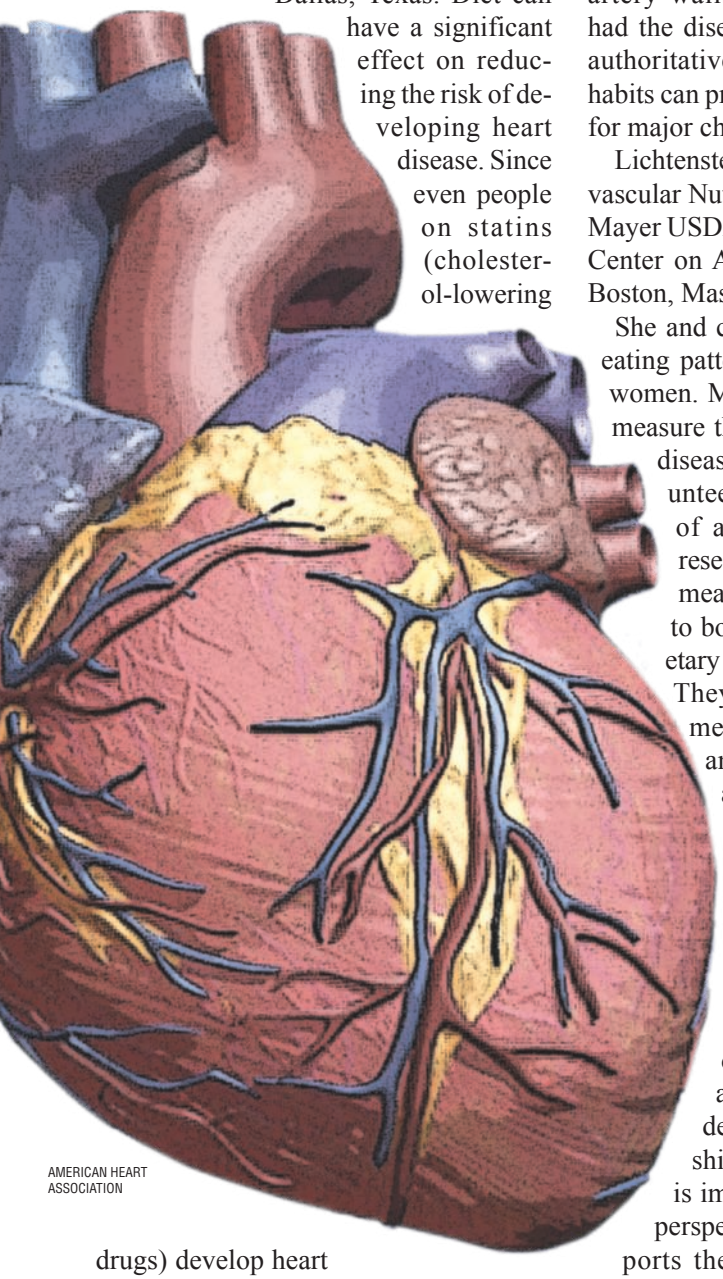
PEGGY GREB (K10310-1)

Using a DXA machine, physiologist Mary Gustafson measures the bone density of a research volunteer's spine.

Eat Smart for a **Healthy Heart**

An estimated 80 million American aduts—one in three—have one or more types of heart disease, says the American Heart Association (AHA), based in Dallas, Texas. Diet can have a significant effect on reducing the risk of developing heart disease. Since even people on statins (cholesterol-lowering drugs) develop heart attacks, dietary interventions should not be underestimated.



AMERICAN HEART ASSOCIATION

Dietary Components Are Key

Evidence suggests that dietary patterns have a lot to do with the development of heart disease. A study conducted by nutritional biochemist Alice Lichtenstein and colleagues has found that sticking to the 2005 *Dietary Guidelines for Americans* reduced the progression of arterial plaque—the buildup of fatty deposits in artery walls—in women who already had the disease. The guidelines provide authoritative advice about how dietary habits can promote health and reduce risk for major chronic diseases.

Lichtenstein is director of the Cardiovascular Nutrition Laboratory at the Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University in Boston, Massachusetts.

She and colleagues examined data on eating patterns of 224 postmenopausal women. Multiple angiographs—which measure the degree of coronary artery disease—were taken of each volunteer at the beginning and end of a 3-year study period. The researchers used a comprehensive measurement to score adherence to both individual and overall dietary components of the guidelines. They also used a mathematical method known as "regression analysis" to assess diet-disease associations. The women who showed a greater adherence to the overall guidelines had less progression of their atherosclerotic lesions over the 3-year period.

"We established that individual dietary components do not have the same weight as the total diet in terms of describing diet-disease relationships," says Lichtenstein. "This is important from a public health perspective, because the work supports the development of effective dietary guidance for preventing health problems."

The findings highlight the need for more sophisticated approaches to assessing the effect of dietary recommendations on various chronic diseases, wrote the authors.

The 2009 study was published in the *American Journal of Clinical Nutrition.*

Food Chemical Findings

Some consumers clearly are striving to eat well as a way to prevent or delay heart problems that eventually could require taking prescription medications. In response, food companies are adding naturally occurring nutrients to foods in higher-than-natural concentrations as a way of helping consumers.

The term "phytosterols" refers to sterols and stanols, which are compounds found in small quantities in plants. When consumed by humans in large quantities, phytosterols reduce arterial plaque buildup. In plants, these compounds are similar in structure and function to cholesterol, and in humans, they work by blocking the absorption of cholesterol in the small intestine.

"Phytosterols are not naturally found in any one food serving in high enough levels to have an effect on cardiovascular disease," says Lichtenstein. Numerous clinical trials have shown that consuming foods enriched with at least 0.8 grams and up to 3 grams of plant sterols or stanols daily lowers serum low-density lipoprotein (LDL "bad") cholesterol. By comparison, a consumer would have to eat at least 100 or more carrots to get the equivalent of 0.8 grams of plant sterols, depending on size and composition estimates.

Significantly, plant sterol-supplemented food products—such as margarine spreads and orange juice—are now widely marketed to consumers for eating once a day with breakfast. "Studies are needed to examine the effects of plant sterol consumption *frequency* on circulating blood cholesterol as part of a diet low in saturated and trans fats," says Lichtenstein. She and colleagues studied the effect (on blood cholesterol levels) of giving volunteers plant sterols once in the morning compared with giving sterols three times a day.

Lichtenstein analyzed lipid (blood fat) profiles of 19 study volunteers from blood samples taken after each of three 6-day study phases—a relatively short intervention period. For the control phase, the volunteers were given a precisely

Consuming plant sterols once a day—in the morning—was not as effective at lowering plasma LDL cholesterol as consuming them three times a day.

HEART

controlled weight-maintaining diet, with no plant sterols. For the second phase, the volunteers were given the same diet, but with a standardized amount, 1.8 grams, of plant sterols in margarine with breakfast. For the third phase, the volunteers were given the same diet, but also 1.8 grams of plant sterols divided equally and given during each of the three meals per day.

Volunteers consumed their regular, habitual diets for 2 weeks in between each study phase.

The study found that consuming a single morning dose of plant sterols was not as effective at lowering plasma LDL cholesterol concentrations as was consuming the plant sterols three times per day. Among the three-times-per-day group, measures of cholesterol absorption decreased by 6 percent compared to controls.

The authors concluded that, based on the study, plasma LDL cholesterol is lowered most when plant sterols are consumed in smaller amounts given more often, rather than in one large amount.

The 2009 study appears in the *European Journal of Clinical Nutrition.*

Good Food Components—and Not

Not all food components affect blood lipid chemistry positively. Before the 1990s, public health recommendations to use less animal fats and tropical oils spurred food producers to partially hydrogenate fats—a process that introduces trans fatty acids (or trans fats) into fats of vegetable origin. Multiple research studies conducted throughout the 1990s show that partial hydrogenation and resulting trans fatty acids raise serum cholesterol levels. And a 1999 study headed by Lichtenstein shows a linear relationship between increased dietary intake of partially hydrogenated fat and increased levels of LDL cholesterol.

A more recent study led by Lichtenstein shows that substituting corn oil for partially hydrogenated soybean oil during a 35-day diet lowers risk factors for heart disease in women who already had moderately high cholesterol. Thirty women aged 50 or older participated in this fat-consumption study.

"For this study, we were not looking at any one specific amount of partially hydrogenated fat; instead, we wanted to know whether a shift in the type of fat used in food preparation would have a significant effect on plasma lipid levels," says Lichtenstein. "We were interested in documenting how much of a difference would occur if a relatively large number of producers made this switch. And what we found was that, yes, it does make a significant difference."

The 2009 study was published in *Atherosclerosis*.

STEPHEN AUSMUS (D1812-8)

Research volunteers are provided with experimental diets for 5-6 weeks per phase. Here, nutrition technician Chervonte Hernandez (left) and nutritional biochemist Alice Lichtenstein (right) discuss a study diet with a participant.

STEPHEN AUSMUS (D1811-5)

Study coordinator Janey Ronxhi (left) and Metabolic Research Unit nurse Margaret Vilme obtain a blood sample from a volunteer for determination of lipoprotein profile.

STEPHEN AUSMUS (D1805-24)

Graduate student Shannon Washington prepares a plasma sample for determination of fatty acid profiles.

The Right Fats, in the Right Amounts

Not surprisingly, AHA is working to increase awareness among consumers about the health benefits of reducing intakes of trans fatty acids without increasing intakes of saturated fats. AHA commissioned a tracking survey between 2006 and 2007 to measure changes in consumer awareness, knowledge, and behaviors in regard to fats and oils and their perceived impact on heart disease. Both surveys included a representative sample of the American population—1,000 adults, ages 18 to 65.

The 2006 AHA consumer research survey revealed that while 84 percent had heard the term "trans fats," close to half were unaware of the negative health effects they cause.

"We want people to get the right message about eating fats as part of a balanced dietary approach to reducing the risk of cardiovascular disease," says Lichtenstein, who co-chaired AHA's 2006 "Trans Fat Conference" and coauthored the conference report in *Circulation* in 2007. "The message is that a moderate-fat diet relatively low in trans and saturated fats but richer in monounsaturated and polyunsaturated fats is what people should be consuming."

The authors concluded that collaboration between the food industry and nutrition professionals is important to addressing future food development, processing, and technology issues.

In another published study, Lichtenstein and coauthors reported an improvement in consumer awareness of trans fats. Among the 2007 AHA survey respondents, 92 percent were aware of trans fats—up from 84 percent in 2006. But overall consumer awareness, especially regarding food sources of saturated and trans fats, remains relatively low, according to the study authors. They published the findings in the *Journal of the American Dietetic Association* in 2009.

"The message that total fat alone is important, such as when low-fat diets were wildly popular, is oversimplified. If you simply consume a low-fat diet, then triglyceride levels go up, HDL ("good" cholesterol) levels go down, and a positive effect on body weight is not necessarily achieved," says Lichtenstein.

This year, an estimated 1.2 million Americans will have a new or recurring heart attack, and nearly 200,000 more will have an undiagnosed or "silent" heart attack. Reducing risk factors such as elevated cholesterol and blood pressure through lifestyle changes can help avoid chronic health problems down the road. Such changes in daily routine can help save money on prescription drugs and overall healthcare costs while improving the quality of life for individuals.—By **Rosalie Marion Bliss,** ARS.

This research is part of Human Nutrition, an ARS national program (#107) described at www.nps.ars.usda.gov.

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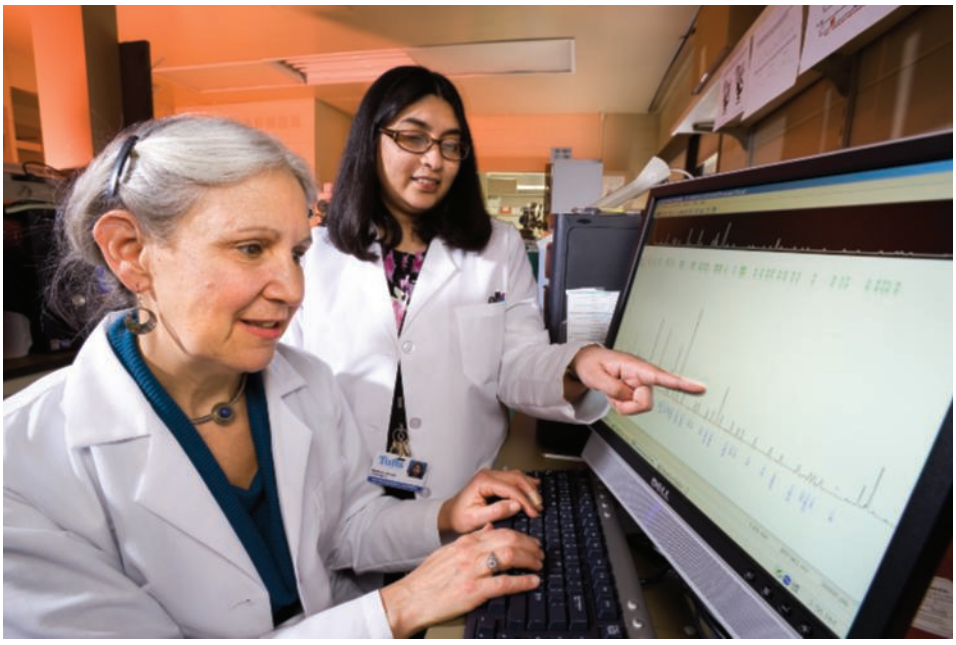
STEPHEN AUSMUS (D1810-1)



Nutritional biochemists Alice Lichtenstein and Nirupa Matthan evaluate a chromatograph of fatty acids in a plasma sample.

Nutrition and Your Health

Sources Suggested by the National Agricultural Library

Looking for authoritative, user-friendly sources of information about nutrition and your health?

Check out the selections on this list, compiled by registered dietitian and nutrition information specialist Lorraine Butler, who is with the Food and Nutrition Information Center at the ARS National Agricultural Library in Beltsville, Maryland, and Washington, D.C.

Food and Nutrition Information Center *at the National Agricultural Library*

Heart Nutrition and Recipes

fnic.nal.usda.gov/consumer/heart

Links posted here guide you to cardio-savvy recipes (including delicious desserts), tips on choosing heart-healthy foods, and more.

Osteoporosis and Bone Health

fnic.nal.usda.gov/consumer/bone

These sources can help you create and keep strong bones. Among them: the kid-friendly **Best Bones Forever** (www.bestbonesforever.gov), which guides young girls to make informed food choices during critical bone-forming years.

Diabetes and Prediabetes

fnic.nal.usda.gov/consumer/diabetes

Hand-picked by registered dietitians at the National Agricultural Library, the links displayed here, like the National Institutes of Health's **What I Need To Know About Eating and Diabetes** (diabetes.niddk.nih.gov/dm/pubs/eating_ez), help you prevent or cope with diabetes.

Diet and Disease: Cancer

fnic.nal.usda.gov/cancer/

Select from an array of links to credible sources, including a handy dictionary of more than 5,000 cancer terms.

Other Websites

American Optometric Association

www.aoa.org/x11813.xml

Learn how to eat right to save your vision at this attractively formatted venue, complete with recipes and references to relevant scientific studies

Osteoporosis: A Report of the Surgeon General, Chapter 6

tinyurl.com/surgeonbone

America's No. 1 physician reviews nutrition's impact on bone health in this informative, factual report.

American Dietetic Association

eatright.org/diseasemanagement

At this easy-to-use site, registered dietitians share their expertise on eating well to forestall and manage disease.

Office of Dietary Supplements, National Institutes of Health

ods.od.nih.gov/factsheets

Food sources are the best way to meet nutrient needs, but if supplements are used, the more than 75 factsheets offered here can inform you about the sometimes-confusing array of vitamins, minerals, botanicals, and other supplements vying for your attention at your drugstore or supermarket.

Diabetes: Nutrition Research Tackles Widespread Disease

In one way or another, type 2 diabetes affects nearly every household in America. Though you may not have the disease, you probably know someone who does.

Agricultural Research Service nutrition researchers are leading an array of studies to discover more about this complex disorder and—especially—to determine how better nutrition and regular physical activity might help prevent it.

Better Biomarkers Needed

Some of these studies are yielding new indicators, called "biomarkers," of the disease. In time, physicians and other health care professionals might be able to use these biomarkers to identify—sooner—kids and adults who are at risk for developing this type of diabetes. Nutrition scientists would be able to use the markers to monitor the progress of experimental nutrition- and exercise-based strategies designed to prevent diabetes.

A study led by ARS physiologist Sean H. Adams and collaborators underscores the potential of natural compounds in the body, known as "fatty acylcarnitines," to serve as biomarkers of type 2 diabetes. The team determined this after finding telltale molecules in blood samples from diabetic and nondiabetic African-American women who volunteered for the research.

In some instances, levels of certain fatty acylcarnitines were almost 300 percent higher in the diabetic volunteers than in those without the disease. The higher levels "apparently result from incomplete or inefficient fat oxidation in the diabetic volunteers," says Adams.

Incomplete oxidation of fats has already been associated with insulin resistance, a hallmark of type 2 diabetes. This new study adds important detail to what Adams describes as "the emerging picture of abnormal fatty acylcarnitine levels in blood as potential biomarkers of type 2 diabetes." Adams is research leader of the Obesity and Metabolism Research Unit, part of the ARS Western Human Nutrition Research Center at the University of California-Davis.

Adams collaborated in the research with Daniel H. Hwang and John W. Newman at the center, and with co-investigators at the University of Alabama-Birmingham and Case Western Reserve University in Cleveland, Ohio. The scientists documented the study in a 2009 issue of the *Journal of Nutrition.*

Chromosomes Hold Clues to Type 2 Diabetes Risk

Other researchers are scrutinizing DNA samples from Houston-area youngsters to identify genetic variations—in their chromosomes—that are associated with predisposition to type 2 diabetes. Once generally regarded as a disease of adulthood, type 2 diabetes is now often seen in America's young, too.

Nancy F. Butte, professor of pediatrics with the ARS Children's Nutrition Research Center at Baylor College of Medicine, Houston, Texas, and co-investigators have found an apparent relation between high blood glucose levels and variations in genetic material in a region on chromosome 13.

They found the association by running a genome scan and a fasting blood glucose test of 1,030 Hispanic children, ages 4 to 19. All were volunteers in the "Viva La Familia" study. That multiyear investigation "addresses childhood obesity and obesity-related disorders—such as type 2 diabetes—among young Hispanics," according to Butte.

Fasting blood glucose levels were measured in this research because they may be indicative of diabetes risk. "There may be a gene or genes in this chromosomal region that influence blood glucose levels and increased susceptibility to type 2 diabetes," says Butte. She and colleagues from SAS Institute, Cary, North Carolina, and the Southwest Foundation for Biomedical Research in San Antonio, Texas, describe the research in the *Journal of Clinical Endocrinology and Metabolism* in 2007.

Building on that study, the scientists are learning more about the region of interest on chromosome 13 through fine-scale

ARS researchers are looking at how increasing fitness may improve blood sugar control and help prevent diabetes. Here, physiologists Sean Adams and Mary Gustafson examine results of University of California-Davis clinical specialist Caitlin Campbell's calorie consumption and fat oxidation while she test-rides a cycle ergometer.

DIABETES

mapping. ARS and the National Institutes of Health are funding the investigations.

The work may reveal genes that accurately signal susceptibility to type 2 diabetes in Hispanic youngsters and perhaps in kids of other racial or ethnic groups as well. In earlier work, done elsewhere, this region was associated with risk of obesity in adults. But the region had not, until Butte's investigation, been aligned with type 2 diabetes risk in either kids or adults.

Extracts Hold Potential

In Maryland, ARS researchers have published findings that suggest certain spices may be beneficial to some people with diabetes. Chemist Richard Anderson, at the Beltsville Human Nutrition Research Center (BHNRC), and colleagues are studying water-soluble extract of cinnamon.

PEGGY GREB (D1818-1)

Components of cinnamon are being purified, characterized, and evaluated for their beneficial effects on insulin levels and related functions. Here, chemists Richard Anderson and Marilyn Polansky extract compounds from cinnamon.

Among several diabetes-focused studies conducted and published in the last 5 years by BHNRC researchers, one involved looking at a potential interplay between the extract and insulin or blood glucose levels. Insulin is a key hormone that "opens a door" within cells and then escorts glucose into those cells, thus providing fuel to them. Without a sufficient insulin supply, or ability to use available insulin, glucose builds up in the blood instead of going into cells where it can be metabolized and used for fuel. Over time, damage occurs to the eyes, kidneys, heart, and nerves.

The study, conducted in Ohio with collaborators, involved 22 volunteers with "metabolic syndrome," which increases the chances of developing diabetes. Volunteers were randomly assigned to supplement their diets with either water-soluble cinnamon extracts or a placebo for 12 weeks.

Volunteers in the extract group had significant decreases in fasting blood glucose and small increases in lean muscle mass when compared with the placebo group. Improvement in lean muscle mass is considered a marker of improved body composition. A before-and-after analysis of the extract group also uncovered small but statistically significant decreases in body fat and blood pressure. But other characteristics of metabolic syndrome, such as abnormal blood LDL or HDL cholesterol levels or triglycerides, did not improve.

This study—among a series of published studies looking at potential nutritional benefits of water-soluble cinnamon extracts—was published in December 2006 in the *Journal of the International Society of Sports Nutrition*.—By **Marcia Wood** and **Rosalie Marion Bliss,** ARS.

This research is part of Human Nutrition, an ARS national program (#107) described at www.nps.ars.usda.gov.

To reach scientists mentioned in this article, contact Marcia Wood, USDA-ARS Information Staff, 5601 Sunnyside Ave., Beltsville, MD 20705-5129; (301) 504-1662, marcia.wood@ars.usda.gov.

Adventure Video May Help Kids Dodge Diabetes

Archimage, Inc.

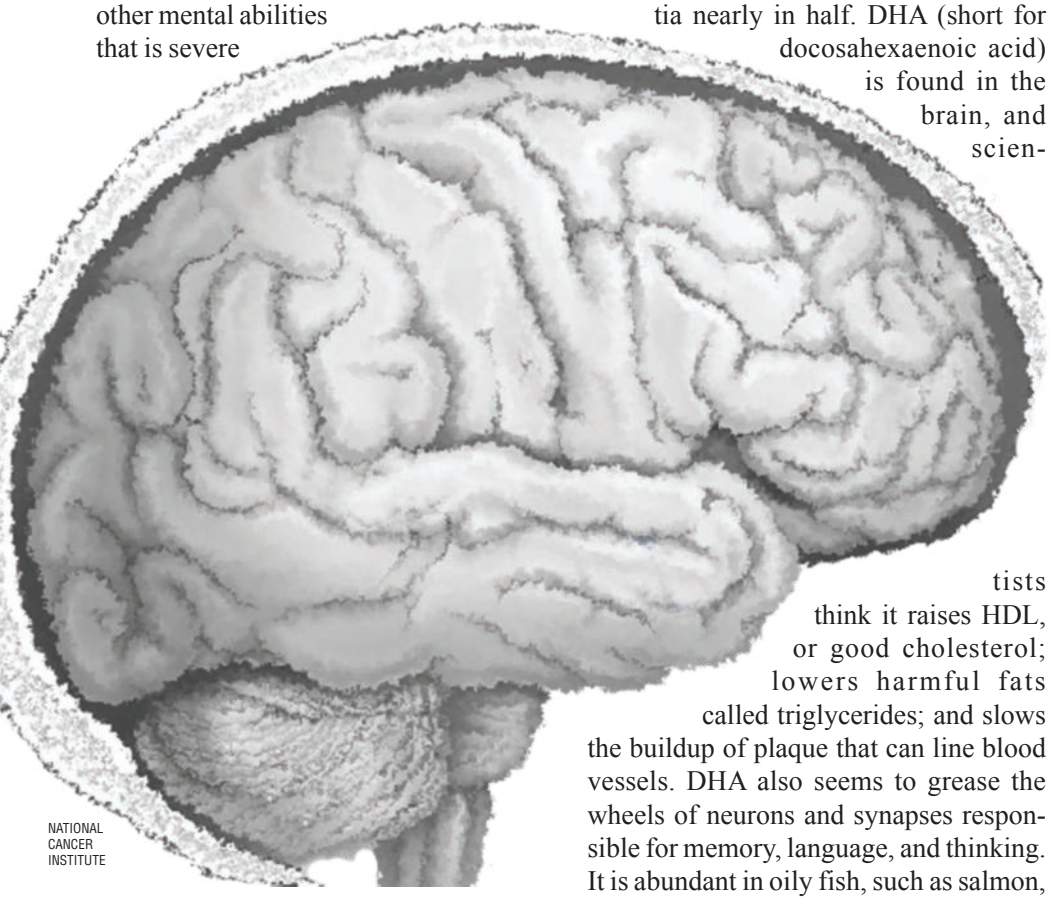
In the action-packed video game "Escape From Diab," kids break free from the evil, diabetes-inducing Kingdom of Diab by making wise food choices. The fast-paced, educational-yet-entertaining game is the work of Tom Baranowski, professor of pediatrics and specialist in behavioral nutrition, and colleagues at the ARS Children's Nutrition Research Center at Baylor College of Medicine in Houston, Texas. His results from testing the video with 153 young volunteers should be ready to report later this year.

See "Diab" characters and a short interview with Baranowski at **tinyurl.com/diabgame.**

—By **Marcia Wood,** ARS.

Food Discoveries for **Brain Fitness**

Eating a nutrient-dense breakfast has long been touted as a way to boost the brain's memory and creativity. Now, Agricultural Research Service studies are showing that eating a healthful diet over a lifetime can improve the condition of the brain as people reach their twilight years. "Dementia" is a general term for a loss of memory and other mental abilities that is severe enough to interfere with daily life. It is caused by physical changes in the brain. While Alzheimer's disease is the most common type of dementia, there are other forms, including mild cognitive impairment.



NATIONAL CANCER INSTITUTE

Reducing Alzheimer's Risk

Every 70 seconds, someone develops Alzheimer's disease, says the Chicago, Illinois-based Alzheimer's Association. Direct and indirect costs of Alzheimer's and other dementias to Medicare, Medicaid, and businesses amount to more than $148 billion each year. To understand links between inadequate nutrition and brain degeneration, scientists use different approaches that involve cell culture, animal model, and human clinical studies.

A long-term study headed by physician Ernst Schaefer found that people who ate the greatest amount of oily fish rich in an omega-3 fatty acid, DHA, on a weekly basis appeared to cut their odds of dementia nearly in half. DHA (short for docosahexaenoic acid) is found in the brain, and scientists think it raises HDL, or good cholesterol; lowers harmful fats called triglycerides; and slows the buildup of plaque that can line blood vessels. DHA also seems to grease the wheels of neurons and synapses responsible for memory, language, and thinking. It is abundant in oily fish, such as salmon, tuna, mackerel, and herring.

Schaefer is the director of the Lipid Metabolism Laboratory at the Jean Mayer USDA Human Nutrition Research Center on Aging (HNRCA) at Tufts University in Boston, Massachusetts. He and colleagues analyzed the DHA blood levels of the nearly 900 men and women, ages 55 to 88, participating in the Framingham Heart Study. All participants were free of dementia at the beginning of the 9-year study.

The researchers ranked the participants into four groups, or "quartiles," based on highest to lowest DHA blood levels. Participants with plasma DHA levels in the upper quartile experienced a significant 47-percent lower risk of developing dementia compared with participants with levels in the lower three quartiles. There was also a significant correlation between plasma DHA levels and both fish intake and DHA intake.

Participants who ate the greatest amount of oily fish averaged about three servings a week, which is equivalent to an average daily DHA intake of 180 milligrams. The study suggests that relatively higher oily-fish consumption over time correlates with a lower incidence of dementia in people over 75, according to Schaefer.

The study appears in a 2006 issue of the *Archives of Neurology.*

Genetics Still a Barrier

While ARS researchers are reporting links between various food components and reduced risk of different forms of dementia, other research studies have shown that the risk of developing some cognitive problems is inherited. For example, people who carry the APOE epsilon 4 (APOE e4) gene variant (about 20 percent of the population) are known to have a greater chance of developing Alzheimer's disease and all-cause dementia.

Former HNRCA neuroepidemiologist Tina Huang compared links between types of fish intake and dementia in relation to the APOE genetic status of 2,547 study volunteers. Huang and colleagues looked at the APOE e4 status of each study participant, all of whom were dementia-free at the beginning of the 8-year study. They found that those with the APOE e4 allele did not enjoy a significant oily-fish-eating benefit found among other study participants.

Consuming fatty fish more than twice per week (compared to less than once per month) was associated with a reduced Alzheimer's risk by just over 40 percent. It was also associated with a lower risk of dementia by nearly 30 percent. Consuming lean fried fish did not show a protective effect. Further, linking oily, or fatty, fish—but not lean fried fish—with a reduction in dementias supports the idea that DHA

The study suggests that relatively higher oily-fish consumption over time correlates with a lower incidence of dementia in people over 75.

is the primary protective nutrient in fish. "We only found a protective effect with fatty [non-fried] fish," says Huang.

The study results were published in *Neurology* in 2005.

Brain-Boosting Food Nutrients

Other HNRCA researchers are adding to a limited but growing body of evidence of a link between vitamin D and cognitive function. Metabolic pathways for vitamin D, for example, have been found in the hippocampus and cerebellum, areas of the brain involved in planning, processing, and forming new memories. This suggests that vitamin D may be implicated in cognitive processes.

In a study of more than 1,000 participants receiving home care, the researchers evaluated associations between measured vitamin D blood concentrations and neuropsychological tests. Elders requiring home care have a higher risk of not getting enough vitamin D because of limited sunlight exposure and other factors.

The participants, ages 65 to 99 years, were grouped by their vitamin D status, which was categorized as deficient, insufficient, or sufficient. Only 35 percent had sufficient vitamin D blood levels. They had better cognitive performance on the tests than those in the deficient and insufficient categories, particularly on measures of "executive performance," such as cognitive flexibility, perceptual complexity, and reasoning. The associations persisted after taking into consideration other variables that could also affect cognitive performance.

The study appears in the *Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* in 2009.

Challenging B's Brain Power

Several of the B vitamins have long been known to nourish the brain. B12 is essential for brain and nerve cell function, B6 is essential to nerve tissue, and folate (a B vitamin) is essential to cell and tissue growth. Now, HNRCA neurobiologist and lead author Aron Troen and physician Irwin Rosenberg are reporting that a B-vitamin deficiency may cause cognitive impairment. Rosenberg heads the Nutrition and Neurocognition Laboratory.

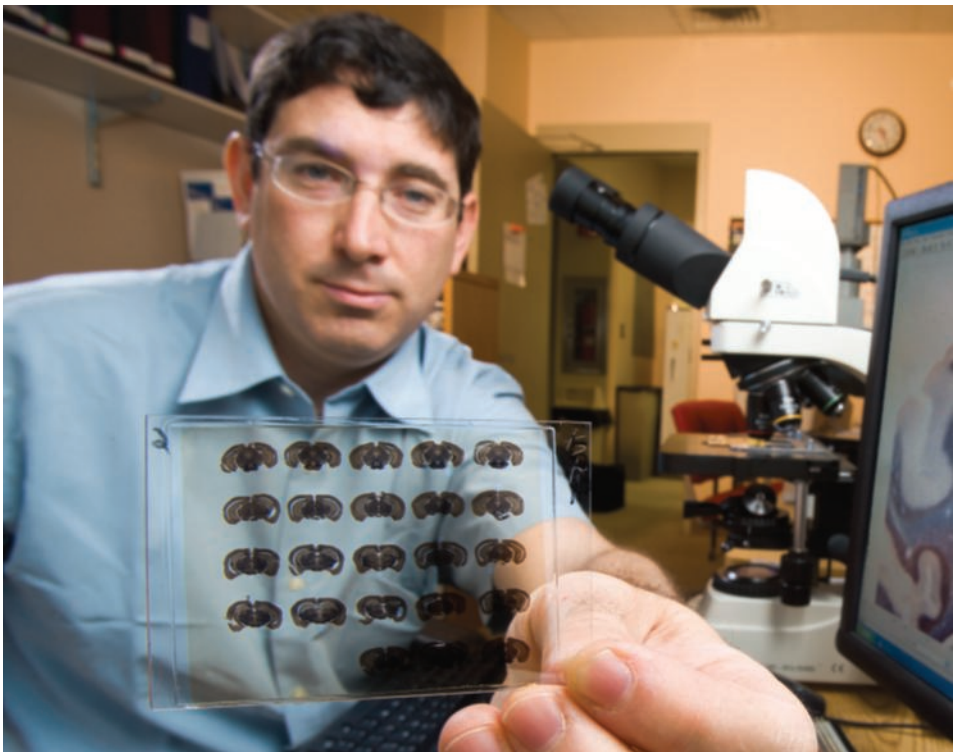
The researchers fed a group of mice a diet deficient in all three vitamins—B12, B6, and folate—and found that the mice had lower cognitive function.

The authors theorize that a deficiency of B vitamins induces a metabolic disorder that manifests with dysfunction of the brain's blood vessels and circulation, as well as with high homocysteine levels.

The elevated levels of homocysteine and reduced levels of B vitamins that were associated with blood supply-related cognitive impairment in the mice mimic conditions that are associated in older adults with an increased risk for Alzheimer's disease. The findings provide a much-needed model system in which to study the role of the brain's blood vessel network and circulation in cognitive function, according to Troen.

The study is in a 2008 issue of *Proceedings of the National Academy of Sciences*.

STEPHEN AUSMUS (D934-1)



Neurobiologist Aron Troen reported that a B-vitamin deficiency may cause cognitive impairment. Here, Troen is examining brain images to assess diet-induced changes.

Folate Findings in Latino Study

The B vitamins and their role in preventing decline in brainpower are also being newly explored through human nutrition studies conducted by university researchers and ARS nutrition scientist Lindsay H. Allen. The investigations, led by Mary N. Haan of the University of California-San Francisco, are part of the multiyear Sacramento (California) Area Latino Study on Aging (SALSA). Begun in 1996, the study attracted nearly 1,800 Hispanic seniors, ages 60 to 101, as volunteers.

The research "is needed," Allen says, "because many studies of B vitamins and brain function have given inconsistent or conflicting results." Allen directs the ARS Western Human Nutrition Research Center in Davis, California, just outside Sacramento. Scientists from the University of California-Davis (UCD), the UCD Medical Center, and Kaiser Permanente

STEPHEN AUSMUS (D1806-17)

DHA, an omega-3 fatty acid, is abundant in oily fish, like salmon. Physician Ernst Schaefer (left) reported that higher oily-fish consumption may cut odds of dementia over time. Here, Schaefer visits with Elizabeth Ventura, owner of a fish market in Boston.

Division of Research in Oakland also collaborated in the studies.

The analysis of volunteers' blood samples showed that lower levels of folate were associated with symptoms of dementia and poor brain function—also called "cognitive decline"—as determined by standard tests of memory and other factors. The impairments were detectable even though very few (less than 1 percent) of the volunteers were actually deficient in folate.

Volunteers with higher concentrations of folate in their red blood cells had lower risk of impaired cognitive function and dementia. Even so, having low plasma folate at the outset of the study did not increase volunteers' risk of further cognitive decline or dementia during the next 5 years of the research.

In women, but not men, low levels of folate were associated with symptoms of depression. In fact, female volunteers whose plasma folate levels were in the lowest third were more than twice as likely to have symptoms of depression as volunteers in the highest third. This finding provides new evidence of an association between lower blood folate and depression. Depression is already known to affect brain function.

New Assignment for HoloTC?

In related research with another nutrient—vitamin B12—the scientists determined that holotranscobalamin (holoTC), a protein that carries this vitamin in the bloodstream, might be key to a new approach for detecting cognitive decline earlier and more accurately.

The SALSA team found a correlation between cognitive decline, greater depression, and a low holoTC-to-vitamin B12 ratio in plasma, suggesting the possible value of this ratio as a convenient, reliable biomarker. In particular, depressed volunteers whose holoTC-to-B12 ratios were in the lowest third, meaning they had relatively less holoTC, were more than three times more likely to have symptoms of cognitive decline.

The scientists have published these and other findings in the *American Journal of Clinical Nutrition, Clinical Chemistry and Laboratory Medicine,* and the *Journal of Nutrition, Health, and Aging.*

These findings add to the body of evidence of how healthful components in foods help protect the brain against disease.—By **Rosalie Marion Bliss** and **Marcia Wood,** ARS.

This research is part of Human Nutrition, an ARS national program (#107) described at www.nps.ars.usda.gov.

To reach scientists mentioned in this article, contact Rosalie Bliss, USDA-ARS Information Staff, 5601 Sunnyside Ave., Beltsville, MD 20705-5129; (301) 504-4318, rosalie.bliss@ars.usda.gov.

STEPHEN AUSMUS (D1807-11)

Technician Ivor Asztalos (front, left) runs an immunoassay on plasma samples from the Framingham Heart Study. Assay results are being reviewed by postdoctoral fellow Thomas van Himbergen (center) and Ernst Schaefer.

ARS Research
on Preventing Diseases Through Nutrition

LOCATIONS

The Agricultural Research Service's research program on preventing diseases through nutrition is part of the agency's national program on Human Nutrition (#107).

There are many, many pieces in the complex puzzle of how nutrition and preventing diseases fit together, especially with chronic conditions such as cardiovascular disease and osteoporosis that result from multiple risk factors. ARS is one of the leaders in this area of nutrition research, and we are filling in the picture bit by bit.

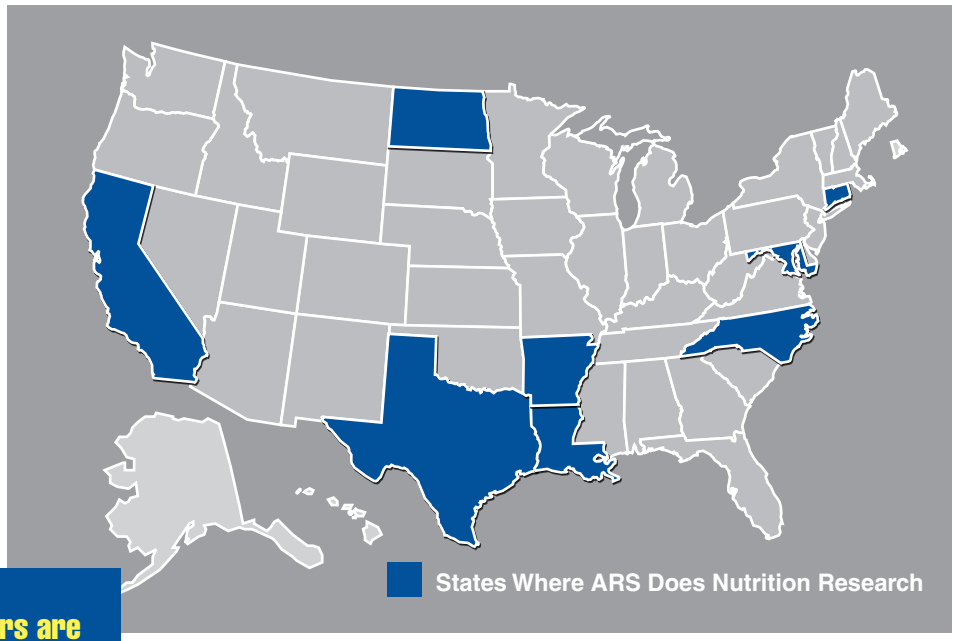
We know nutrition can have an impact on inflammation and the body's immune response, but the mechanisms by which certain nutrients interact with each other and the body to lower the incidence of cardiac lesions or bone loss remain to be delineated. And we know obesity increases the likelihood of any number of diseases. But can consuming some level of specific nutrients change the likelihood of having those conditions? ARS scientists are trying to find out. Another example is whether eating antioxidants can decrease the incidence of cancer and, if so, how.

Researchers are developing our understanding of how nutrition may prevent diseases—in childhood or later in life.

The picture becomes even more complex when you add in our growing understanding of chronic diseases. Now ARS scientists are working to discover whether eating certain amounts of nutrients like vitamin D and calcium at certain points in your life can overcome the likelihood of osteoporosis.

When it comes to determining the interrelation of nutrition, aging, and health, ARS has a special ongoing partnership with Tufts University in Boston through the USDA Jean Mayer Human Nutrition Research Center on Aging. But just as important is developing our understanding of how childhood nutrition may prevent diseases, either in childhood or later in life. That is one of the major focuses of research at the ARS Children's Nutrition Research Center at Baylor College of Medicine in Houston, Texas, and the Arkansas Children's Nutrition Center in Little Rock.

ARS scientists are not pursuing the idea of nutrients as medicine so much as they are researching how what you eat can help guide the body away from certain disease conditions. Once that picture is clarified, we could be on the track to healthier dietary patterns that reduce the prevalence of chronic diseases with healthier diet patterns.



USDA--FOOD & NUTRITION SERVICE

DANIEL WREN (D1757-1)

How To Make a Wave Behave

In the lower Mississippi Delta, farmers often build ponds for aquaculture and for storing surface water to irrigate crops. But erosion generated by wind-driven waves can reduce reservoir levee widths by a foot every year, and repairs can be needed as soon as 5 years after a reservoir is completed.

It's not simple—or cheap—to patch up a reservoir with silt loam levees that can stretch over a mile and that are 25 to 30 feet wide. The costs can average $3 per foot, which adds up to around $15,000 per structure.

People have tried to stabilize the levees with tires, construction materials, or vegetation, but hydraulic engineer Daniel Wren is experimenting with another approach. "We wanted to see if we could find a way to cut down on the erosive energy hitting the levees," he says.

Wren, who works at the Agricultural Research Service's Watershed Physical Processes Research Unit in Oxford, Mississippi, partnered with ARS hydraulic engineer Carlos Alonso (now retired) and University of Mississippi research associate Yavuz Ozeren for his research. The team gathered data about wind and wave dynamics from a 70-acre irrigation reservoir in Arkansas. Then they took their data into the lab and designed several wave barriers that they tested in a 63-foot-long wave flume.

Lab results indicated that a floating barrier held in place by two rows of pilings would provide the most effective embankment protection from wave action (see diagram).

The barrier was made of a 9½-inch-diameter tube that was attached to a 4¾-inch-diameter tube with a 24-inch length of smaller tubing. Since it was confined between the two rows of pilings, the barrier was able to rise and fall with fluctuating water levels—unlike a barrier tethered to the bottom of the pond, which might end up below the water surface as reservoir levels rise.

The team found that this two-tube barrier was able to dissipate 75 percent of wave energy for waves within the design range before they washed against the levees. The waves lost some of their force when they broke against the first tube and then lost even more energy as they broke against the second tube.

Wren's team calculated the costs of using different materials for constructing the wave barriers, including the logistics of transporting materials to the site and the labor involved in assembling and installing the barriers. A key to the barrier's effectiveness was its total combined diameter. The engineers found that bundling several lengths of smaller tubing together to obtain an optimal diameter worked as well as one tube with a larger diameter. And transportation costs were lower for the smaller tubing.

"The cost savings could be significant when you need to protect several hundred yards of levees," Wren observes.—By **Ann Perry,** ARS.

This research is part of Water Availability and Watershed Management, an ARS national program (#211) described at www.nps.ars.usda.gov.

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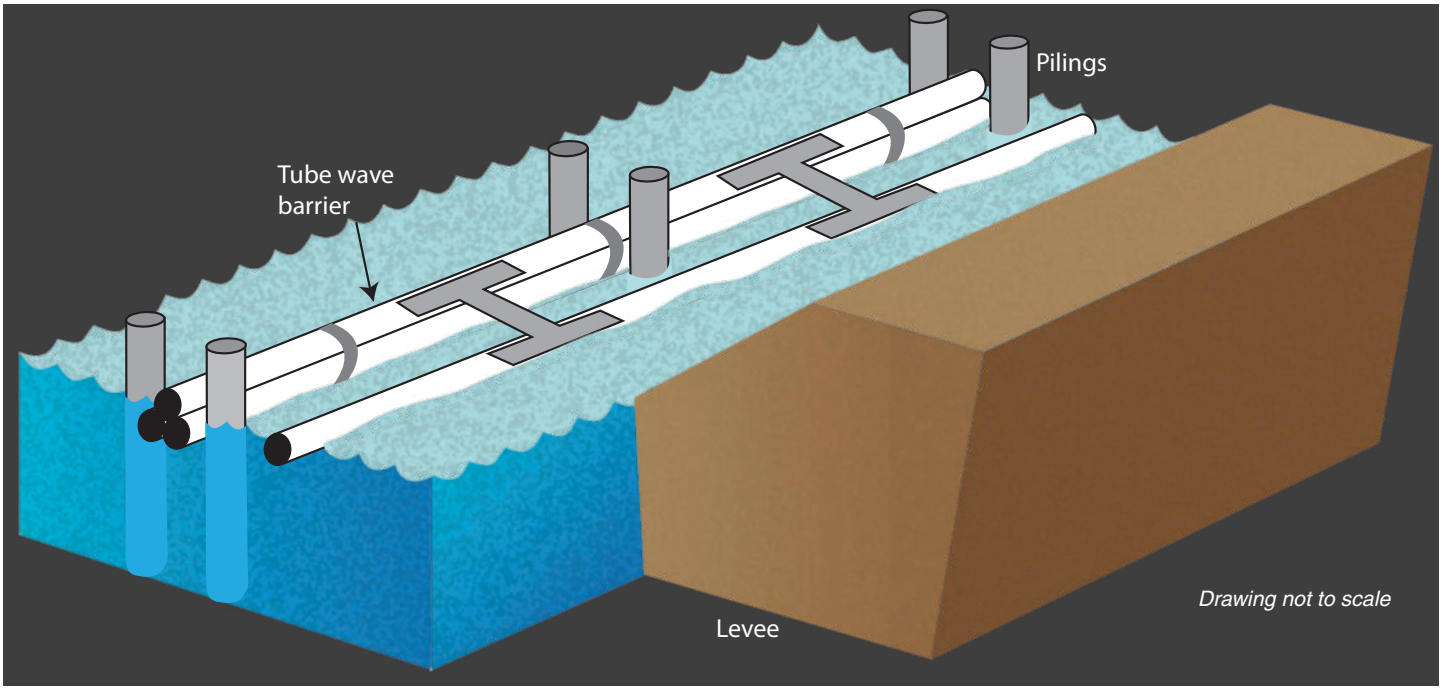
C. BEUCHERT-ARS



Integrated Worm Control in Lambs

Comparison of the lamb's eyelid color with the FAMACHA card containing photos of sheep eyelids at five levels of anemia will determine whether deworming is necessary. Combining the FAMACHA system with rotational grazing reduces the need for deworming in lambs.

The blood-sucking barber pole worm, *Haemonchus contortus,* costs livestock producers millions of dollars in losses worldwide. Animals shed worm eggs in their manure, and the larvae that hatch can be consumed by other grazing livestock, continuing the harmful cycle.

Deworming is an important management tool, but unnecessary deworming is costly and can speed the development of parasiticide resistance in the worms. Deworming of lambs can be minimized by the use of rotational grazing and by checking the animals' inner eyelid color for signs of anemia, according to Agricultural Research Service scientists and cooperators.

Animal scientist Joan Burke of ARS's Dale Bumpers Small Farms Research Center in Booneville, Arkansas, and colleagues collaborate with scientists, veterinarians, and extension agents from the Southern Consortium for Small Ruminant Parasite Control. The consortium was formed in response to the threat posed by worms that have developed resistance to parasiticides.

"Using alternatives to conventional parasiticides fits well into organic and grass-fed management systems and meets consumer preferences of minimizing chemical residues in the meat," says Burke.

The researchers used a tool called "FAMACHA" to determine whether to deworm their study animals. They compared the lambs' eyelid color with FAMACHA photos of the eyelids of sheep at five levels of anemia. The stages range from the red eyelids of healthy livestock (Stage 1) to almost white eyelids of severely anemic livestock (Stage 5).

FAMACHA is named after its developer, South African livestock parasitologist François "Fafa" Malan, and is used by farmers or ranchers to determine when to deworm their animals.

In a study that involved 71 lambs naturally infected with the barber pole worm, deworming was only done to those that reached FAMACHA Stage 3. The researchers used an alternative dewormer—a gel capsule filled with copper oxide wire particles. Only one lamb did not respond to the copper oxide and required the conventional treatment. Nineteen lambs did not need any deworming.

Rotational Grazing Helps

Some of the lambs grazed on bermudagrass in the same pasture all season, and some were rotated to a different pasture every 3.5 to 7 days. They returned to the initial pasture 28 to 35 days later and three times over the 105-day grazing season. The lambs that rotated pastures needed fewer dewormings.

"This is the first study of rotational grazing that used lambs that had worms," Burke says. "This is the only way you can find out whether rotational grazing has any advantages over continuous grazing for organically managed animals."

Rotational grazing may prevent animals from concentrating worm larvae because they are not bedding down in the same area every night. Also, neither pasture was overgrazed, an important consideration in both minimizing reinfection of livestock and maintaining healthier pastures.

This work was published in the July 7, 2009, issue of *Veterinary Parasitology*.—By **Don Comis,** ARS.

This research is part of Animal Health (#103) and Pasture, Forage, and Range Land Systems (#215), two ARS national programs described at www.nps.ars.usda.gov.

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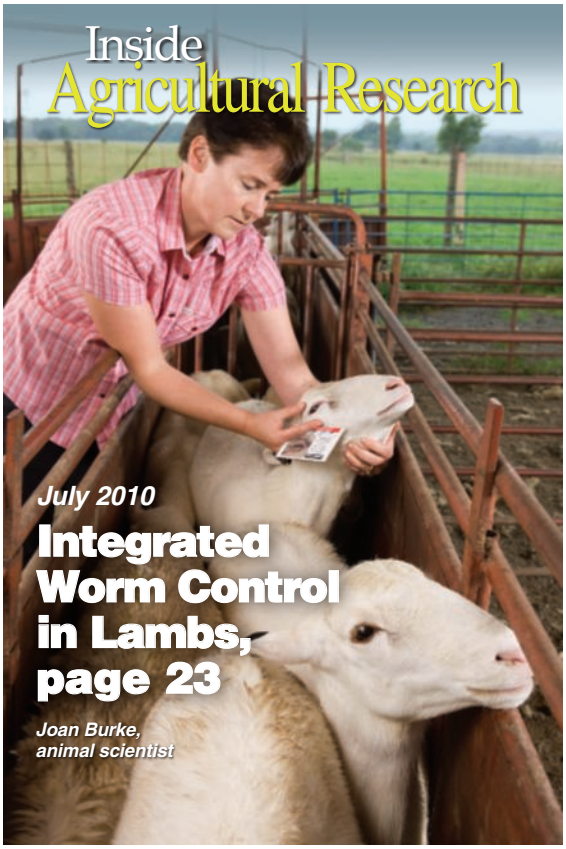

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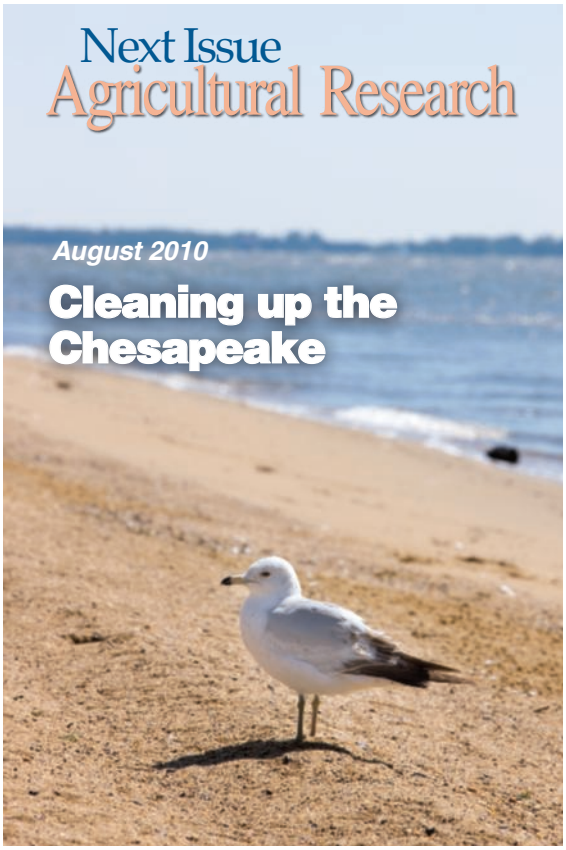

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