

LINUS PAULING INSTITUTE

OREGON STATE UNIVERSITY
RESEARCH NEWSLETTER
FALL–WINTER 2016

READ INSIDE for details on our new look ►

VITAMIN E AND PREGNANCY

Why this misunderstood nutrient may be the twenty-first century equivalent to folic acid

Back in the 60s, it was first hypothesized that low folate levels may be tied to serious birth defects involving the neural tube. It wasn't until the 90s that randomized controlled trials could confirm the relationship between this crucial nutrient and a healthy pregnancy, a discovery that spurred the rise of food fortification programs across the globe. Now it is a standard public health recommendation in the U.S. that all women capable of becoming pregnant take a daily folic acid supplement, as well as eat fortified foods.

Linus Pauling Institute Principal Investigator and Ava Helen Pauling Professor Maret Traber, Ph.D., is interested in whether there is a similar story to be told about the importance of vitamin E to early development. If there is, she is certainly the one to tell it, given that she helped develop the national dietary requirements for vitamin E and has led the field over the past decade toward a better understanding of this essential vitamin. Unlike other well-characterized nutrients like C and A, vitamin E remains somewhat misunderstood, with little

known about how it works in the body and how much of it is needed for optimum health over the course of a lifetime.

Traber's lab has been instrumental in filling in these knowledge gaps, and a driving force behind her work is the fact that 90% of Americans do not get the current recommended dietary allowance (RDA) of vitamin E. "I believe this is a really overlooked public health issue—we need to be looking closely at vitamin E levels in the population," said Traber. "Vitamin E plays a critical role in nerve, brain, and liver function, and it's important to have adequate intake at any age," she said. It is especially important for women of childbearing age to get enough E because of the role it plays in embryonic development at the very onset of pregnancy, before a woman is likely even aware of the pregnancy or has started taking prenatal vitamins or making diet/lifestyle changes.

Working in zebrafish—an excellent model because they share similar genes and metabolic pathways with humans—Traber's lab found a clear connection between vitamin E levels and embryonic brain development. Vitamin E-deficient zebrafish embryos had deformed heads and displayed behavior changes that indicated

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Oregon State
UNIVERSITY



Jan Frederik Stevens, Ph.D.

Professor and Interim Director
Linus Pauling Institute

FROM THE DIRECTOR

It is my pleasure to report that LPI is thriving, with numerous research studies underway and academic scholarship at its prime, during this notable period of transition for the institute. It is a time of new leadership and new partnerships, and I am honored to be a part of it. After Balz Frei, Ph.D., retired from the institute and the university this past June, the university selected me to act as interim director until a permanent director is appointed.

This is an important period for us at LPI to reflect on where we want to go next and the best way to get there. Our strengths and expertise remain to be in molecular nutrition relevant to aging, cardiometabolic health, and cancer prevention. More so now than in the past, we are reaching out to regional medical schools to partner with collaborators with clinical expertise and resources. For example, our partnership with Western University of Health Sciences in Lebanon, Oregon, allowed my research group to conduct and complete a human study on the health benefits of an experimental beverage fortified with the hop polyphenol, xanthohumol. We partnered with the Oregon Clinical and Translational Research Institute at Oregon Health & Science University (OHSU) in Portland, Oregon, to facilitate molecular nutrition research involving humans. In those partnerships, we contribute to the molecular understanding of disease and how it can be prevented through dietary means. A good example is the research of principal investigator Emily Ho, Ph.D., on prevention of breast and prostate cancer by consumption of cruciferous vegetables (you can read more about one of her studies in this issue of the newsletter). Together with other OSU units, we partnered with the Knight Cancer Institute at OHSU. I am hopeful that these and other partnerships will bring synergistic interactions to the institute, which will make us even stronger contenders in the fierce competition for federal research dollars.

Our research focus continues to be on vitamins, essential minerals, and dietary phytochemicals, and we have recently expanded our interests to include the gut microbiome. The complexity of food in terms of chemical diversity and composition is further enhanced by gut microbial metabolism. Bacteria and other microorganisms in the human gastrointestinal

tract can dramatically alter the health properties of food constituents. Eight laboratories at OSU, including the Gombart, Stevens, Bobe, and Maier labs in the LPI, have teamed up to unravel the interactions of gut microbiota with vitamin D and xanthohumol, and *vice versa*. This project, funded by the National Center for Complementary and Integrative Health, brings together expertise in microbiology, immunology, mammalian physiology, metabolomics, and systems biology. Metabolomics, or metabolic profiling, was pioneered by Linus Pauling, Ph.D., in the early 1970s and has become an integral technology at LPI to uncover the molecular mechanisms of action of vitamins and dietary phytochemicals. For example, metabolomics helps the Traber and Stevens labs to understand the molecular consequences of vitamin E and C deficiency using zebrafish models. It helps the Ho lab to answer the question of how broccoli phytochemicals are metabolized by gut microbes and affect human metabolism in beneficial ways. The Oxidative/Nitrative Core Laboratory at LPI, in collaboration with the OSU Mass Spectrometry Center, has been instrumental in developing isotope-tracer methods in conjunction with metabolomics to investigate diet exposure and effect.

Besides research, outreach is also part of our mission. Both our Micronutrient Information Center (MIC) and our Healthy Youth Program (HYP) serve important functions in the LPI, and they are highly valued by the public. As a case in point, no less than 1.7 million people from all over the world visit the MIC annually. We are grateful to private and corporate donors for making it possible for us to maintain the scientific and professional rigor of both programs, as well as to launch new initiatives such as the MIC's disease index (see an article by Giana Angelo, Ph.D., on page 12 for more details). That said, it is critical for us to explore additional funding sources to sustain both programs. In collaboration with colleagues in the College of Business, we are exploring crowd funding, development of MIC-based courses targeted toward health care professionals as part of their continuing education, and internet advertising to cover basic operations. Our goal is to keep the threshold for general access to the MIC and HYP programs as low as possible without sacrificing content quality.



The Stevens lab studies a variety of different natural compounds, including a polyphenol found in the hops plant, called xanthohumol.

Save the date! LPI is planning the 2017 Diet and Optimum Health conference to be held September 12-15, 2017. This conference, chaired by Maret Traber, Ph.D., will be a tribute to Distinguished Professor Emeritus Balz Frei, Ph.D., who directed LPI from 1997 to 2016. We are looking forward to an outstanding conference with speakers from around the world who will share their latest scientific information on diet and health.

And finally, please join me in celebrating the accomplishments of four LPI investigators. Maret Traber, Ph.D., is the new holder of the Ava Helen Pauling Professorship. David Williams, Ph.D., received the Helen P. Rumbel Professorship for Cancer Prevention. Gerd Bobe, Ph.D., was granted indefinite tenure with promotion to associate professor. And last but not least, Cristobal L. Miranda, Ph.D., was promoted to research associate professor. With your generous support, these and other researchers in the LPI are continuing the important work that two-time Nobel Prize winner Linus Pauling started. Thank you!

Jan Frederik Stevens, Ph.D.
Professor and Interim Director
Linus Pauling Institute

Continued from cover — Vitamin E and Pregnancy

defective neuromuscular responses. “By day five, instead of being nice healthy swimmers, half died,” said Traber. Her team discovered the probable reason behind this effect: vitamin E acts as a potent defender of critical omega fatty acids needed for the brain to develop, and continue functioning, properly. Without that defender in place, the embryos failed to thrive.

Professor Traber is now furthering her research to understand the full cascade of reactions that happen in early development with a lack of vitamin E. Preliminary answers point to a spiraling effect in multiple metabolic pathways. Could an inadequate amount of vitamin E in early pregnancy be a factor behind miscarriages? There is already a known

association between vitamin E deficiency and a higher risk of miscarriage, and with the U.S. miscarriage rate at 15-20%, research into this area is of vital public health concern.

Like with folate, gaining a better understanding of how and why vitamin E impacts early development will allow for more informed health recommendations for women capable of becoming pregnant, and could pave the way for healthier pregnancies worldwide. For now, Traber recommends women who may become pregnant be sure to consume a multivitamin, as a way to get folic acid and vitamin E. She also recommends consuming foods high in vitamin E, such as nuts, seeds, avocados, canola/olive oil, and whole grains.

LPI NEWS

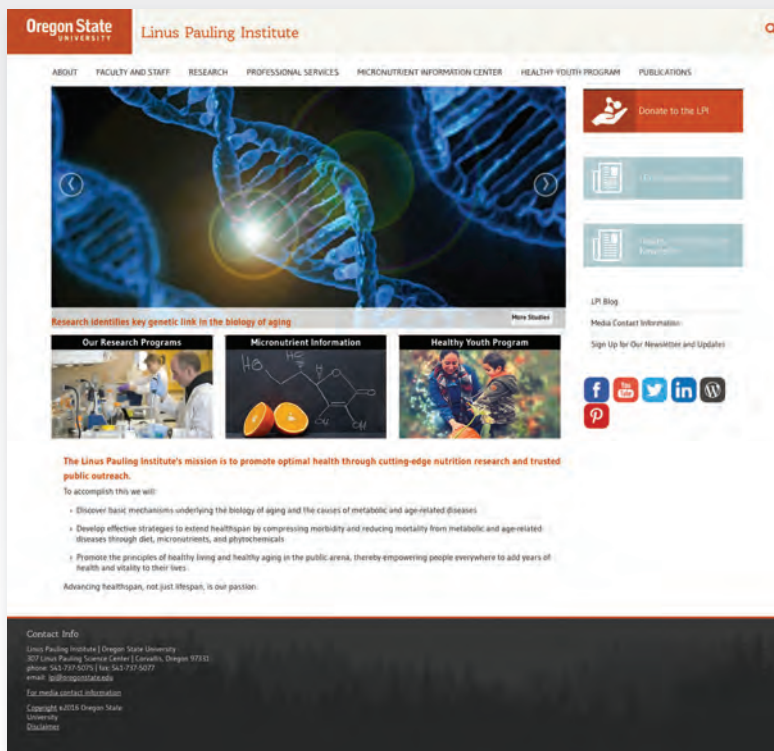
As one of his last projects at the helm of the institute, former director Balz Frei, Ph.D., launched an initiative to redesign the look and feel of the Linus Pauling Institute's online and print presence. This "refresh" was undertaken to more closely align the institute's unique strengths with its visual identity. Top graphic designers from Oregon State University developed an identity system that captures the essence, personality, and breadth of the institute, bringing to mind such words and phrases as vitality, optimum health, food-based nutrients, prevention, micronutrients, and of course Pauling's signature message of "how to live longer and feel better."

This edition of the Research Newsletter is the first print element we've rolled out using our new visual identity (we also have redesigned our website). We hope you like it! Please feel free to let us know what you think via email (lpi@oregonstate.edu) or through social media. As supporters and friends of the institute, we welcome and appreciate your thoughtful comments.

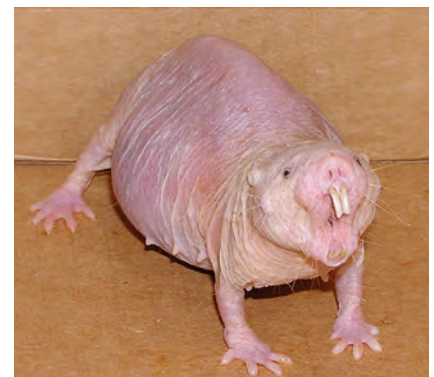
We also appreciate those of you who took the time to answer our reader survey, included in the last edition of the newsletter.

Thank you! We closed the survey at the end of September and will be taking some time to carefully review all your responses (as well as do the prize drawings!). Your input will be instrumental in helping us determine the institute's outreach and communication priorities going forward.

One more bit of news: the institute's signature health website, the Micronutrient Information Center, is introducing a new online feature. Starting in November, you'll see a new tab on the top of the Micronutrient Information Center called "Health & Disease." Click here and you'll find a variety of health topic pages, each of which has information about micronutrients as they relate to disease prevention and treatment. Essentially, it is the same kind of objective, evidence-based information about micronutrients and dietary factors that you've come to rely on from the Micronutrient Information Center, but now the information is organized by disease and the language is more accessible to a wider audience. You can learn more about it on page 12, in an update from nutrition scientist Giana Angelo, Ph.D.



The naked mole rat is an odd-looking creature, with big buck teeth and a nearly transparent pink body. It is also unusual in another way: it lives much longer than it ought to.



UNCOVERING THE SECRETS OF THE NAKED MOLE RAT



Photo credit: Smithsonian National Zoo

Patterns in nature show that, in general, the larger an animal is, the longer it tends to live. With every doubling of species body mass, there is roughly a 16% increase in maximum species life span. The giant tortoise, for instance, can live well past 100 years old; a dormouse is lucky to see past its fourth birthday.

“But there are outliers to this logarithmic relation,” said institute Principal Investigator Viviana Pérez, Ph.D. The naked mole rat should, by body mass, live to five years old, but it ends up living a maximum lifespan of 31 years. Bats, same thing: they should live to be around six, but instead live a maximum of 34 years.

Pérez’s laboratory at the institute is focused on studying these animal outliers, asking what makes them so capable of that long life, of defying the ecological norm. She’s honed in on proteins, and their tendency to get “sticky” with age. When proteins stick to each other, this is known as protein aggregation. “You don’t want your proteins to be aggregating,” says Pérez, “you want each protein to be working individually, doing its job.”

This comparative biological approach has important ties to human health and longevity.

Alzheimer’s and Huntington’s, for instance, are both diseases where certain proteins go awry, clump together, and cause problems. But in all people, proteins are more prone to aggregation as they age, even without one of these specific diseases. “The quality of your proteins play an important role in aging and disease,” said Pérez.

Her research asks the questions: how does protein quality and resiliency impact longevity? For long-living species like the naked mole rat, what’s going on with protein aggregation? Do they have cellular strategies for keeping their proteins in good shape?

She recently received a federal grant from the National Institutes of Health to further pursue this line of inquiry. Previous research has shown that the naked mole rat has potentially excellent defenses against protein aggregation; now she’s putting this theory to the test. Early results from her cell culture experiments indicate that cells from naked mole rats are more resilient to the toxicity induced by protein aggregates than cells of short-living species like mice. However, and contrary to all expectations, naked mole rat cells accumulate *more* of a specific type of

protein aggregate (called polyglutamine; it’s the protein implicated in Huntington’s disease) than mouse cells. Moreover, cells from the naked mole rat cause protein aggregates to accumulate in a very specific region of the cell: the perinuclear region, which is not observed in short-lived mice. Based on these data, they hypothesize that longevity is modulated not only through resistance to protein toxicity, but also by the capacity of the cell to clear protein aggregates via a special “garbage deposit.”

The next step is to find out which specific mechanisms within the naked mole rat are responsible for this protective effect, and zero in on them. Once mechanisms are identified, then it opens up the possibility of modifying that mechanism in another animal, like the mouse, to see if one can impact the aging process and disease trajectory. This work, while still in the early stages, could pave the way for a human intervention that would maintain the quality of proteins as people age, contributing to healthier aging and possibly providing therapies for protein-aggregation diseases, like Alzheimer’s.

“We know the naked mole rat is a weird animal,” said Pérez, “we want to find out its secrets.”

NEW HOPE FOR TREATING LOU GEHRIG'S DISEASE (ALS)

ALS, also known as Lou Gehrig's disease or motor neuron disease, is a devastating illness characterized by relentless progressive paralysis with death occurring typically after 1-5 years.

It has no cure. For years, researchers have been thwarted in finding new approaches to treat the disease. Now, through the work of Linus Pauling Institute Principal Investigator and Burgess and Elizabeth Jamieson Chair in Healthspan Research Joseph Beckman, Ph.D., a possible avenue has opened up, though it is still in the early stages.

Using a specific type of copper compound, Beckman's laboratory was able to essentially stop the progression of amyotrophic lateral sclerosis (ALS) for nearly two years in one type of mouse model used to study the disease – allowing the mice to approach their normal lifespan. His findings were recently published in the journal *Neurobiology of Disease*.

"We are shocked at how well this treatment can stop the progression of ALS," said Beckman. In decades of work, no treatment has been discovered for ALS that can do anything but prolong human survival less than a month. The transgenic mouse model used in this study is one that scientists believe may more closely resemble the human reaction to this treatment, which consists of a compound called copper-ATSM.

It's not yet known if humans will have the same response, but clinical collaborators are moving as quickly as possible toward human clinical trials, testing first for safety and then efficacy of the new approach. It appears likely that the Phase I trial for copper-ATSM will start recruiting in Australia and then in the U.S. in a few months (for more, please see clinicaltrials.gov).

ALS was identified as a progressive and fatal neurodegenerative disease in the late 1800s, and gained international recognition in 1939 when it was diagnosed in American baseball legend Lou Gehrig. It's known to be caused by the death and deterioration of motor neurons in the spinal cord, which in turn have been linked to mutations in the enzyme known as "copper, zinc superoxide dismutase."

After years of research, scientists have developed an approach to treating ALS that's based on bringing copper into specific cells in the spinal cord and mitochondria weakened by copper deficiency. Copper is a metal that helps to stabilize superoxide dismutase, and is important for its function as an antioxidant protein. But when it lacks its metal co-factors, the enzyme can partially "unfold" and become toxic, leading to the death of motor neurons.

Copper-ATSM is a known compound that has low toxicity, easily penetrates the blood-brain barrier, is already used in human medicine at much lower doses for some purposes, and is well tolerated in laboratory animals at far higher levels.

However, this approach is not as simple as taking a traditional dietary supplement of copper, which can be very harmful to the body. Such supplements would be of no value to people with ALS, researchers said. Although copper is an essential micronutrient, even a small excess of copper is toxic. The Linus Pauling Institute's online Micronutrient Information Center provides a good summary of the body's requirements for copper, dietary sources, and toxicity issues (lpi.oregonstate.edu/mic/minerals/copper).

"We have a solid understanding of why the treatment works in the mice, and we predict it should work in both familial and possibly sporadic human patients," Beckman said. "But we won't know until we try."

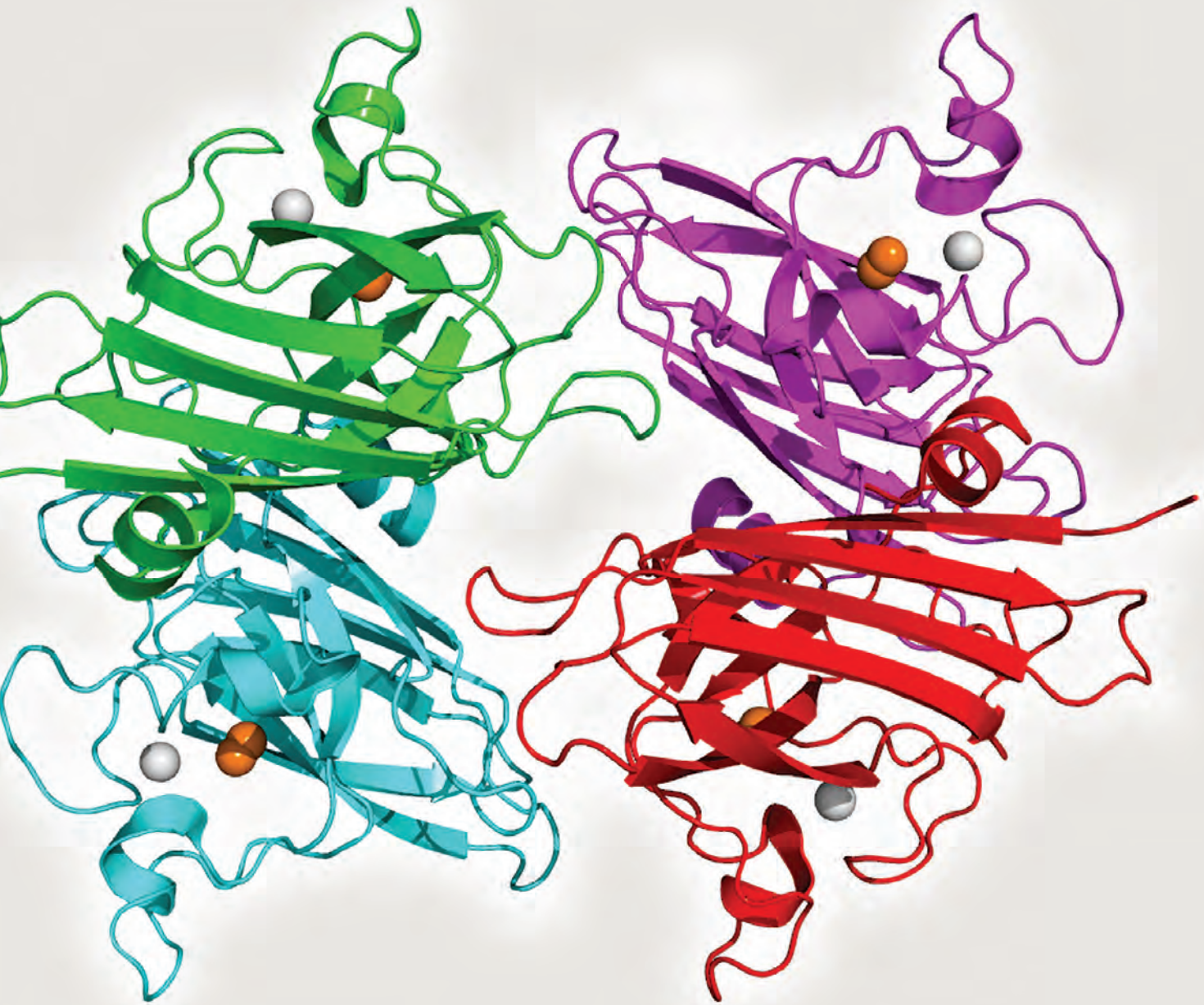
Familial ALS patients are those with more of a family history of the disease, while sporadic patients reflect the larger general population. Only 2-7% of ALS patients have mutations in the enzyme superoxide dismutase. There is evidence that this approach, which also works in part by improving mitochondrial function, may have value in Parkinson's disease and other conditions. Research is progressing on those topics as well.

The treatment is unlikely to allow significant recovery from neuronal loss already caused by ALS, the scientists said, but could slow further disease progression when started after diagnosis. It could also potentially treat carriers of mutant superoxide dismutase genes that will eventually cause ALS to develop.

For more information, please read this follow-up blog written by Professor Beckman: tinyurl.com/BeckmanALS.

This work has been supported by the Department of Defense's Congressionally Directed Medical Research Program, the National Institutes of Health, the Amyotrophic Lateral Sclerosis Association, the Australian National Health and Medical Research Association, and gifts by Michael Camillo and Burgess and Elizabeth Jamieson to the Linus Pauling Institute.

NEW HOPE FOR
TREATING LOU GEHRIG'S
DISEASE (ALS)



Mutations in the enzyme superoxide dismutase are associated with ALS, and a new copper compound may help address this problem.



LPI investigators are studying whether daily consumption of hazelnuts boosts health in older adults.

LPI'S CLINICAL TRIALS LOOKING AT MICRONUTRIENT STATUS IN OLDER ADULTS

BY ALEX MICHELS, PH.D., CLINICAL RESEARCH COORDINATOR

It's an unfortunate fact that many people in the United States are still not getting the vitamins and minerals they need from the food they choose to eat. According to national surveys, people fall short in several key nutrients. For example, close to 9 out every 10 adults in the U.S. don't get enough vitamin E. More than half don't get enough magnesium.

The problem can get worse for people as they age. Food preferences and eating habits may shift as the sense of taste and smell changes, thus older adults may eat fewer nutrient-dense foods. Also, biologically, some micronutrients are absorbed less efficiently.

The problem is worsened by the fact that the body's demand for certain nutrients may actually increase with age. So the end result is that many older adults are at risk of not getting the vitamins and minerals necessary for good health.

As a way to fill in micronutrient gaps, the Linus Pauling Institute has long recommended people of all ages take a daily multivitamin that contains the recommended levels of all the required vitamins and minerals.

But do multivitamins actually change nutritional status in older adults? It sounds like

an obvious question that must already have an answer, but it is one that hasn't been answered using rigorous research techniques.

Our new multivitamin study, led by Tory Hagen, Ph.D., Helen P. Rumbel Professor for Aging Research, has been designed to answer that question. Focusing on older men, the research study will compare micronutrient levels in participants taking a multivitamin tablet to levels in participants taking a placebo—a tablet not containing vitamins or minerals. A second goal of the study will examine whether taking a multivitamin also changes levels of energy or cognitive function in older adults; if so, these findings will lay the groundwork for other human trials in the future.

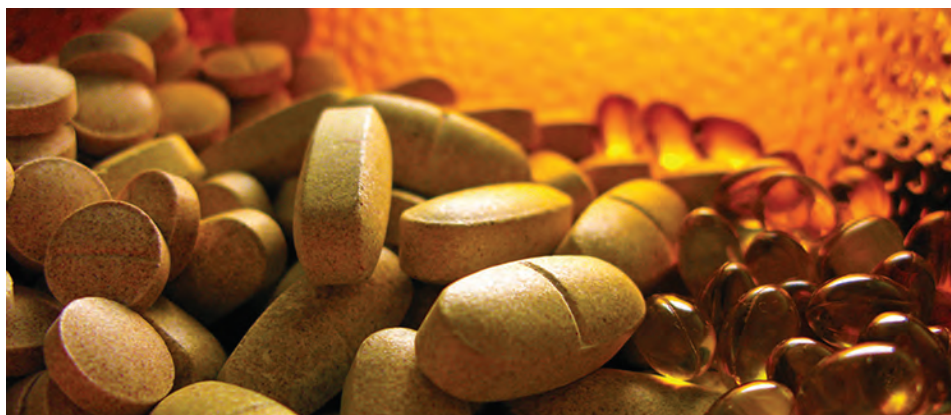
And what about older adults who don't want to take a supplement? This is being addressed by the second clinical study at the institute. Led by Maret Traber, Ph.D., Ava Helen Pauling Professor, this clinical trial looks at the nutritional effects of a signature Oregon crop: hazelnuts. Since hazelnuts are a good source of vitamin E, magnesium, fiber, and unsaturated fat, hazelnuts could serve as a tasty way to get several important nutrients. The research study asks the following question: does eating

hazelnuts boost blood levels of vitamin E and magnesium in older men and women who eat the nuts daily?

Other nutrition scientists have previously shown that hazelnuts can be beneficial in maintaining good blood cholesterol (HDL) levels, suggesting they are a heart-healthy snack. What LPI researchers want to know is if these effects can be related to changes in vitamin and mineral levels. Since older adults may also benefit from the fiber and fatty acids that come in hazelnuts, the research team also plans on looking at how eating these nuts may affect things like blood pressure and body weight.

With these studies, the Linus Pauling Institute hopes to better understand nutrition in older adults, an area of science that is in need of much more in-depth research. We look forward to updating everyone with the results of these important trials.

Clinical studies at the Linus Pauling Institute are recruiting only local subjects from the greater Corvallis area at this time. If you would like to know more about the progress of these studies or lend your financial support, please contact us at lpi@oregonstate.edu.



Q: I'M IN MY 50s. SHOULD I CONSIDER TAKING A LIPOIC ACID SUPPLEMENT?

A: PERHAPS, BUT IT IS GOOD TO KNOW MORE ABOUT IT FIRST.

Lipoic acid is a naturally-occurring compound that is found in small amounts in food and is also synthesized in small amounts by humans.

The amount of lipoic acid available in dietary supplements (200-600 mg) is likely as much as 1,000 times greater than the amount that could be obtained from the diet alone.

Taken as a dietary supplement, lipoic acid appears to act as a weak stress on the body—which, surprisingly, is a good thing. It is an example of a fascinating concept in medicine known as “hormesis,” which means to give a little bit of something bad in order to evoke something good. Think of lifting weights—it weakens muscles in the short term but the response over time is a healthier, stronger body.

In a similar fashion, lipoic acid launches a cascade of reactions that ultimately strengthens the body's own defenses against toxins and harmful free radicals that damage cells and genetic material and increase the risk of chronic disease.

This mechanism of action was discovered in large part by researchers at the Linus Pauling Institute, but it is important to note that more trials in humans are needed to investigate lipoic acid's role in supporting health.

What can be said conclusively about lipoic acid is that several human clinical trials have demonstrated its effectiveness in treating nerve damage among diabetic patients, when administered intravenously (in Germany it is approved for treatment of this condition, known as peripheral neuropathy).

But there is reason to hope for more health benefits from this compound. Recent findings from a human clinical trial conducted by the institute, in collaboration with Oregon Health & Science University, show that lipoic acid promoted modest weight loss among overweight women, compared with those who did not take it. In addition, lipoic acid supplementation lowered markers of inflammation and free-radical damage. “These beneficial effects of lipoic acid are remarkably consistent with preclinical findings showing that lipoic acid inhibits weight gain, accelerates fat metabolism, lowers triglycerides, and exerts anti-inflammatory and anti-oxidant effects



in laboratory animals,” said Balz Frei, Ph.D., the trial's principal investigator.

This accumulating evidence points to a possibly important future role for lipoic acid in preventing or treating obesity, heart disease, stroke, dementia, and other conditions.

Linus Pauling Institute Principal Investigator and Helen P. Rumbel Professor for Aging Research Tory Hagen, Ph.D., studies lipoic acid and recommends it as a dietary supplement, especially for older adults because the body becomes more inflamed and less resilient with age. “I see very few downsides in taking lipoic acid for most people, except those prone to hypoglycemia (low blood sugar) or stomach upset,” said Hagen. He says people should aim to take lipoic acid half an hour before a meal, if possible.

BOTTOM-LINE:

Lipoic acid supplementation at moderate doses (less than 600 mg) appears to have few serious side effects. Based on a growing body of clinical evidence, lipoic acid shows promise as a dietary supplement to support a variety of measures related to healthy aging. Talk with your doctor before taking this supplement, especially if you are on diabetes or thyroid medications, as lipoic acid may interfere with these drugs. If you decide to supplement with lipoic acid, the Linus Pauling Institute recommends older adults take a daily dose of 200-400 mg.

For more tips on healthy living and dietary supplements, check out the Linus Pauling Institute's *Rx for Health*:

lpi.oregonstate.edu/rx-health.

Q & A

New research indicates the potential usefulness of lipoic acid supplementation.

NEW, FREE RESOURCE FOR FINDING DIET AND HEALTH INFORMATION ONLINE

BY GIANA ANGELO, PH.D.

We are inundated with nutrition information on a daily basis, and much of it seems conflicting and confusing. Since its founding in 1973, the Linus Pauling Institute has strived to be a source of trusted information to help people navigate the many headlines, articles, and media reports that pop up daily. In addition to doing cutting-edge scientific research, the institute is committed to helping people make informed decisions about food, dietary supplements, and their health.

Many of you may already know about the Micronutrient Information Center (lpi.oregonstate.edu/mic), the institute's free online resource for scientifically accurate information regarding the roles of vitamins, minerals, and other dietary factors in promoting health and preventing disease. The Micronutrient Information Center contains a wealth of information, but it can be daunting to sift

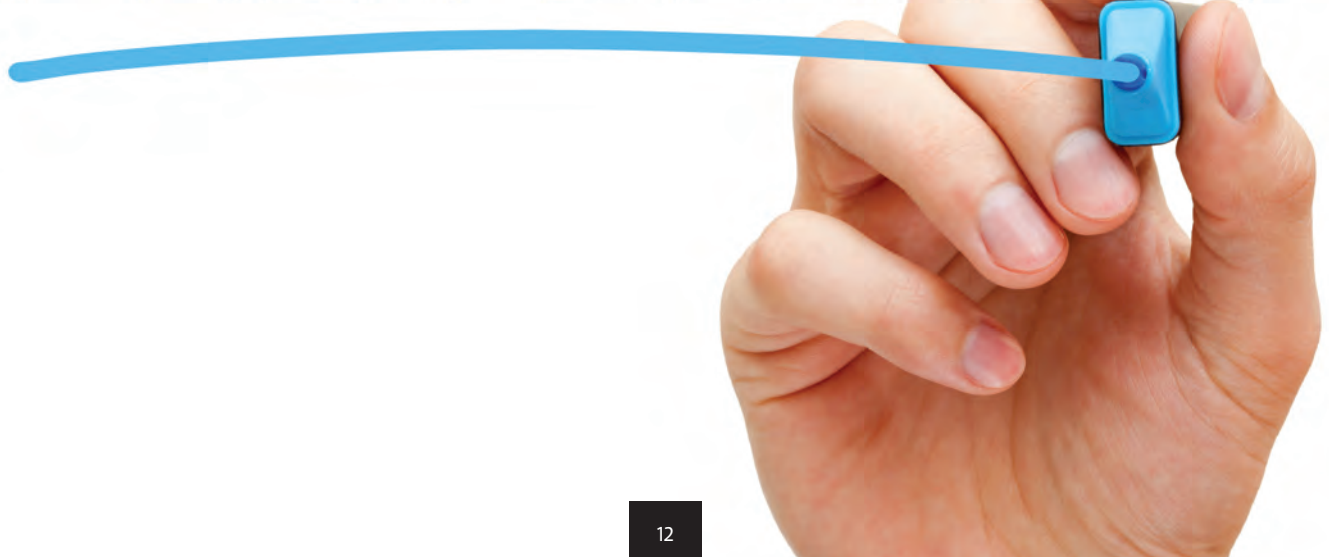
through the in-depth, text-heavy articles. Additionally, the website is organized predominantly by nutrient, so one must hop around between articles to learn about all the nutrition research related to a specific health or disease condition.

In an effort to make information from the Micronutrient Information Center more accessible to more people, we developed a new branch of the website. This new section, found by clicking on the tab called "Health & Disease," has the following three distinct characteristics: (1) information is organized by health or disease condition, (2) take-home messages are summarized in bullet-point format, and (3) infographics are used to reinforce important concepts. As with the rest of the Micronutrient Information Center, the maintenance of scientific accuracy is of the utmost importance. Content in this new section will continue to

be written and reviewed by LPI scientists, as well as undergoing an additional review by an external medical doctor or Ph.D. scientist before publication on the website.

This new feature goes live in November, before all the conditions and graphics are complete. The upside of this early release is that it allows us to gather valuable feedback from readers before we get too far along (please let us know what you think by emailing the Micronutrient Information Center at lpi.mic@oregonstate.edu). In the meantime, here is a glimpse of an infographic on high blood pressure from the new section of the website. You can find the full infographic (and accompanying article on high blood pressure) online by visiting the Micronutrient Information Center homepage, clicking on the "Health & Disease" tab, and pulling up the page on high blood pressure. Please check it out and stay tuned for more!

PREVENTION



HIGH BLOOD PRESSURE (Hypertension)

HIGH BLOOD PRESSURE AFFECTS:

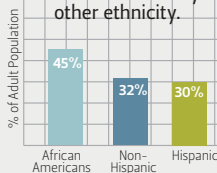
About **1 in 3** adults in the US



About **7 in 10** adults over the age of 65.



More African Americans than any other ethnicity.



HIGH BLOOD PRESSURE INCREASES YOUR RISK FOR:



STROKE

About **8 in 10** adults having their first stroke have high blood pressure.



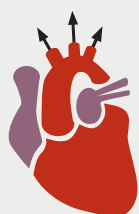
HEART ATTACK

About **7 in 10** adults having their first heart attack have high blood pressure.

HEART FAILURE

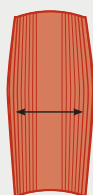
About **7 in 10** adults with chronic heart failure have high blood pressure.

What is blood pressure?



Blood pressure is the force exerted against arterial walls as the heart pumps blood.

What is high blood pressure?



High blood pressure stretches arteries beyond a healthy limit.

Arteries are muscular-walled blood vessels that carry blood away from the heart.

HOW DOES HIGH BLOOD PRESSURE AFFECT YOUR HEALTH?

Chronic overstretching of arteries has many negative effects:

- Tears and scarring
- Weak spots that rupture easily
- Blood clot formation
- Increased workload on the heart
- Plaque build-up

BLOOD PRESSURE	NORMAL	AT RISK	HIGH	
SYSTOLIC BLOOD PRESSURE (SBP) Pressure exerted as the heart contracts, during a heart beat	< 120 mm Hg	120-139 mm Hg	140-159 mm Hg	≥ 160 mm Hg
	AND	OR	OR	OR
DIASTOLIC BLOOD PRESSURE (DBP) Pressure exerted when the heart is at rest, between heart beats	< 80 mm Hg	80-89 mm Hg	90-99 mm Hg	≥ 100 mm Hg
	Normotensive	Prehypertensive	Hypertensive Stage 1	Hypertensive Stage 2

HOW CAN YOU LOWER YOUR BLOOD PRESSURE?

Diet and lifestyle changes can reduce your blood pressure and improve your health.

HEALTHY EATING



HEALTHY OILS



VEGETABLES

FRUIT



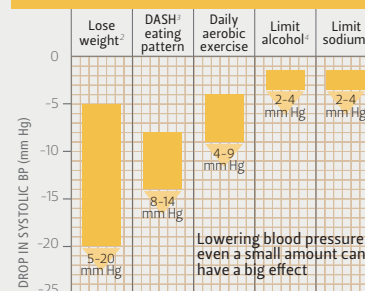
WHOLE GRAINS

HEALTHY PROTEIN



WATER

APPROXIMATE REDUCTION IN SYSTOLIC BP with diet and lifestyle changes¹



¹Chobanian AV, et al. JAMA 2003; 289:1560-73

²10 kg (22 lb) weight loss in overweight/obese adults

³Dietary Approaches to Stop Hypertension

⁴Maximum one drink/day for women, two drinks/day for men

⁵Sodium reduced by approximately 1,200 mg/day

1

Adopt the Dietary Approaches to Stop Hypertension (DASH) eating pattern

- Eat lots of vegetables, fruit, and whole grains.
- Enjoy lean protein, low-fat dairy, and nuts.
- Limit saturated fat, added sugar, and "junk food."

2

Increase potassium and decrease sodium

- Eat nine servings of fruit and vegetables each day.
- Consume less than 2,300 mg of sodium/day (equivalent to one teaspoon of table salt).

3

Supplement with vitamin C

- 500 mg/day of supplemental vitamin C.





A compound in broccoli sprouts may help slow cancer cell growth.

A REASON TO ASK FOR SECONDS OF BROCCOLI?

Principal Investigator Emily Ho, Ph.D., recently published a paper in the journal *Cancer Prevention Research* that showed the power of a compound in broccoli sprouts to inhibit the growth of cancer cells.

The compound is called sulforaphane, and researchers gave it to study participants in supplement form, in a dose equivalent to about one cup of broccoli sprouts per day.

This research was done with 54 women with abnormal mammograms who were scheduled for a breast biopsy and were studied in a double-blind, randomized, placebo-controlled trial. They received either a placebo or supplements that provided sulforaphane.

“Our original goal was to determine if sulforaphane supplements would be well tolerated and might alter some of the epigenetic mechanisms involved in cancer,” said Ho. “We were surprised to see a decrease in markers of

cell growth, which means these compounds may help slow cancer cell growth,” said Ho, a co-author on the study. “This is very encouraging. Dietary approaches have traditionally been thought to be limited to cancer prevention, but this demonstrated it could help slow the growth of existing tumors.”

A number of studies in the past have found that women with a high intake of cruciferous vegetables—such as broccoli, cauliflower, cabbage or kale—have a decreased risk of breast cancer. Research has also shown that sulforaphane, which is found at the highest levels in such foods, can modulate breast cancer risk at several stages of carcinogenesis

and through different mechanisms.

In particular, sulforaphane appears to inhibit histone deacetylases, or HDACs, which in turn enhances the expression of tumor suppressor genes that are often silenced in cancer cells.

When better understood and studied, it’s possible that sulforaphane or other dietary compounds may be added to traditional approaches to cancer therapy, whether to prevent cancer, slow its progression, treat it or stop its recurrence.

This research was supported by the National Cancer Institute, the National Institutes of Health, and the National Institute of Environmental Health Sciences.

DEVELOPMENTS

Dear Friends,

There are numerous exciting health discoveries taking place in Linus Pauling Institute labs each day. Many rely on support from our very generous friends. **Did you know there are many ways to make gifts to the institute?** Through charitable giving, like Sandy and Joanie Sandborg's, these exciting discoveries will continue for generations.

For years, Sandy and Joanie were faithful supporters of research at the Linus Pauling Institute. They believed in Pauling's work and his vision for better health through better nutrition. They took vitamin C. And they enjoyed a long, happy life, ending their years together in a small, beautifully crafted house they built on the shore of Washington's Puget Sound.

They joked that their house would be a great retreat center for stressed-out institute scientists. But although that would be one good use for the property, they said, they figured it could probably be even more useful to the institute.

They decided to bequeath their beloved home to the Linus Pauling Institute through the Oregon State University Foundation, the institute's parent charity. Its proceeds are now supporting critical health research.

A bequest is just one way your gift of real estate can benefit the Linus Pauling Institute. In fact, your generous gift—whether it's a home, farm, rental, vacation home, or timberland—can provide you with powerful tax benefits and even an income stream for you and/or your loved ones. You can:

- **Increase your retirement income** by turning real estate into a Charitable Remainder Trust that provides you with regular payments.
- **Free up your time** from managing a rental, farm, timberland, or a vacation home.
- **Eliminate capital gains taxes** on highly appreciated property and reduce or eliminate estate taxes.
- Transfer ownership of your home to the OSU Foundation through a Retained Life Estate while retaining the right to live in it as long as you like—and **take a significant tax deduction for your gift right away.**
- Give an illiquid asset, such as appreciated timberland, while **freeing up an easier, tax efficient asset for your heirs.**
- **Create a legacy in your name at the institute** by establishing a graduate fellowship or supporting a research program that is important to you.

If you are interested to learn more about creative ways to support the Linus Pauling Institute, I'd be happy to visit with you.

Sincerely,

HEATHER E. BRUST

Senior Director of Development
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Heather Brust
Director of Development



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Information on giving is available from the OSU Foundation by calling 1-800-354-7281, going online to osufoundation.org/GiveToLPI, or by writing to the institute

