https://www.postandcourier.com/news/special_reports/how-we-cook-our-food-is-killing-us-scientists-in-sc-know-why/article_1a528150-660c-11e9-b22a-cffocf48136a.html

TOP STORY

THE AGES PUZZLE

How we cook our food is killing us. Scientists in SC know why.

1. The puzzle

Groundbreaking science takes time, especially when it's about something as complex as our bodies. If you're a scientist, you might spend years on a medical mystery, years before a spark lights a path to help others and maybe your own career.

Then you must fan the spark so it doesn't fizzle — test your discovery with mice and microscopes, and then on human beings. Then other scientists must repeat what you did, because repetition is proof, and this takes time. And money.

And years can pass and people can die before a discovery burns bright in the public's mind. Which is what happened to David Turner, a cancer sleuth in Charleston. And also to a growing number of medical detectives elsewhere — all working on one of the world's most important health puzzles: the rise of many chronic diseases.

Today, more than half of all Americans have at least one chronic condition, such as diabetes, Alzheimer's and cancer. One in three has two or more chronic diseases. Diabetes alone will cost the United States **$3.35 trillion** in the next decade.

These diseases surprise few when they strike the elderly. But now many are found in the young.

Why?

Like most mysteries, there are clues, and some involve a collection of sugar-related substances that even many doctors are unfamiliar with.

We create these substances when we bake and fry and reprocess foods at high heat levels.

These chemicals build up in our tissues. Over time, they harden arteries and make joints ache; they may trigger **erectile dysfunction** and add wrinkles to our skin; they promote protein **tangles** in the brain, and those snarls can destroy memories and futures.

In the past four decades, scientists have made startling discoveries about these substances. Yet their work has often gone unnoticed outside academia, cloaked in part by the mystery's complexity.

And their findings run headlong into two other powerful forces: One is the trillion-dollar food industry — conglomerates that spend billions to promote food that makes us fatter and sicker. The second is our own appetite for food we know isn't good for us but tastes fantastic.

Because, sadly, one of the suspects in this mystery smells like bacon.

What are AGEs? Read more below about how 5,000 to 8,000 AGEs a day is bad news. Grace Beahm Alford/Staff

BY GRACE BEAHM ALFORD GBEAHM@POSTANDCOURIER.COM

2. The sleuth

Long before colleagues called him "the Bacon Killer," David Turner loved science, but fun took precedence, which explains why his academic career took so long to incubate.

Turner is a cancer researcher at the Medical University of South Carolina, in his 50s now, wearing dark-rimmed glasses below salt-and-pepper hair. His British accent is rooted in his childhood in Northern England, where he grew up poor. His father was a postal worker who left home when he was 10, and his mother struggled to pay the bills. Turner still remembers the sound of a bill collector's knock. Would the man take his radio? The one he'd bought by saving his milk money?

He thrived in school, until he didn't. And, looking back, he said he could have used some fatherly guidance in his late teens. Instead of college, he decided to party and do odd jobs. He worked on a farm, as a taxi driver, as an electroplater in a factory and then as a salesman at a shop that sold mobile home parts. But as his 30th birthday neared, he saw that his career path led nowhere, so he decided to go to college.

He'd always been curious about how living things ticked, so biology became his focus. At a technical college first, then the Newcastle University in the U.K., where he drank his younger classmates under the table. He learned molecular biology by day and worked as a parking attendant at night.

Time passed, and he met Victoria Findlay, another cancer researcher who spoke about her work in excited bursts. They moved to Charleston, lured by grants from the Medical University of South Carolina. But after several years their funding dried up. By then it was 2010, and they worked 70 hours a week on new grant proposals, growing less hopeful that something would come through. They reluctantly made plans to return to England.

Then, late one night, Turner was in their home West of the Ashley, on the living room couch, laptop open, working on yet another last-ditch grant. He was looking into the background of a potential partner, a professor at South Carolina State University named Dr. Mahtabuddin Ahmed.

Dr. David Turner in his lab at the Medical University of South Carolina, where he researches the effects of glycotoxins, also known as AGEs. Grace Beahm Alford/Staff

BY GRACE BEAHM ALFORD GBEAHM@POSTANDCOURIER.COM

Turner read about Ahmed's discoveries and stumbled across an unusual acronym: AGEs.

It stood for "advanced glycation end products."

AGEs? Turner had never heard of them.

He knew that glycation described a chemical reaction between blood sugar and proteins.

But what were those "end products"?

Curious, he called up studies that referenced AGEs. *Amazing.* He found remarkable breakthroughs involving AGEs and diabetes and heart disease. What about cancer?

He punched in more search words. Nothing. *That's odd.* Inflammation was a big piece of the cancer puzzle, and tumors gobbled up glucose. Why hadn't he heard of AGEs?

Maybe it was the numbing scientific term: advanced glycation end products.

And that acronym AGEs didn't help. Was it a chemical? Something to do with aging?

As he dug deeper, one thing was clear: The AGEs story began with a killer.

A beef frankfurter broiled at 450 degrees creates a meal of 10,100 AGEs — far more than the daily limit of between 5,000 to 8,000 AGEs, according to a major study. Grace Beahm Alford/Staff

BY GRACE BEAHM ALFORD GBEAHM@POSTANDCOURIER.COM

3. The crime

Diabetes had long been a death sentence, a disease that seemed to speed up the aging process. It made your arteries stiff and turned your eye lenses yellowish brown. It ravaged your kidneys and made your limbs throb.

Its cause had long been elusive, though doctors in the 1800s knew that glucose (sugar) was a prime suspect. In the mid-1800s, doctors sometimes diagnosed patients by tasting their urine. A sugary flavor meant diabetes.

There was no cure, and people often died within a year or two of contracting the disease. In desperation, doctors in the early 1900s tried starving patients. It prolonged a few lives. But, as one doctor **wrote then**, “it was no fun to starve a child to let him live."

In the 1920s, a Canadian doctor made a **key discovery**: insulin regulates blood sugar. By injecting insulin, you could reduce damage to kidneys, eyes and the liver. Thanks to these injections, some diabetics lived normal lives. But many still succumbed to blindness or kidney failure. A cure seemed as elusive as ever.

Fortunately, **diabetes was rare**. One measure in 1920 found only 3.1 deaths per 100,000 people.

Then something changed.

In the 1950s and 1960s, diabetes rates began to rise, and then soar.

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Scientists raced to learn more about its deadly chemistry.

One leading research center was The Rockefeller University in New York City.

In the 1970s, Rockefeller's faculty included several Nobel laureates and drew ambitious young researchers from across the world. And one of its stars was **Anthony Cerami**.

Cerami had grown up on a small chicken farm in New Jersey, where he watched animals suffer from wasting diseases. *Why would nature allow this to occur?* He’d also watched family members fight diabetes. He knew that insulin regulated blood sugar. Why didn’t insulin injections solve the problem?

By the mid-1970s, he and his collaborators had discovered that sugar molecules glommed onto red blood cells like glue. Chemists called this process glycation.

Glycation was like fire, with potential for good and evil. The body needed glucose for fuel, but too much sugar and the body fried itself. It made the blood sticky and kicked the body's immune system into overdrive, triggering inflammation.

Cerami, along with his colleagues Helen Vlassara and Michael Brownlee, invented a new blood test to measure glycation. It was different than blood sugar tests diabetics did by pricking their fingers. This one measured how much sugar latched onto your red blood cells. Called the A1C, the test became one of the most important diagnostic tools in medicine.

Then, as Cerami and his colleagues dug deeper into the glycation process, they noticed chemicals they hadn't seen before. The glycation fire generated these mysterious substances like fumes and sparks.

These chemicals seemed to turn living tissues brown, as if cooking them.

French fries have moderate levels of AGEs, about 1,500 for a small size. Grace Beahm Alford/Staff

BY GRACE BEAHM ALFORD GBEAHM@POSTANDCOURIER.COM

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In 1977, Vincent Monnier, one of Cerami's young colleagues from Switzerland, was reading up on glycation when he had a novel thought. He'd been thinking about how the lenses in people's eyes turned yellowish over time, especially in diabetics. He thought about how cooking turned food brown.

In chef circles, this browning was called the Maillard reaction, after the French chemist Louis Camille Maillard who first analyzed it in 1912. Maillard had found that high heat from a stove or grill caused sugar and proteins in food to do a chemical dance, one that spawned new compounds. Some of these chemicals turned food brown and made it taste better. Other molecules flew into the air and made it smell good.

In fact, the Maillard reaction is what made fried food crispy; it browned bread in the toaster. You saw the Maillard reaction in hamburgers and steaks on the grill, when you fried eggs in a pan, and especially when those slices of bacon sizzled.

The Maillard reaction also was the foundation for the modern food industry. High heat killed bacteria, preventing food-borne illnesses. Food companies also used high heat to bake and process foods into powders and new shapes, from cereal to cookies to baby formula.

Monnier rushed to Cerami's office. Maybe this browning happened inside the human body? Maybe we cooked ourselves as we aged, just more slowly than food on a burner?

"I was all pumped up," he said.

Excitement levels at the lab already were high. That same day, television crews had arrived to do stories about the groundbreaking A1C blood test. When Monnier described his ideas, Cerami immediately saw their potential.

The Rockefeller researchers began their experiments. Over time, they learned that the sugar in our bloodstream made these brownish substances, just like sugar and proteins did in a hot cooking pan.

They discovered that diabetics, with their high blood sugar levels, generated more of these brown chemicals, as if their bodies' internal burners were set on high.

They found that older people had more browning agents in their tissues, another clue.

More experiments showed that kidneys, the body’s filters, removed these browning substances to a point. But the ones left behind caused havoc. They stuck to cells like Velcro, creating snarls that led to stiff joints and wrinkles. They damaged kidneys and nerves. Did these mysterious brown chemicals make us old?

At this point, the Rockefeller researchers had failed to make a key connection. They thought food had little to do with the slow-burning glycation fire in our bodies — that the caramelization in a creme brulee or the char on a slice of fried bacon didn't end up in our bloodstream.

They also didn't have a name for these brown substances, both in food and our bodies, so Cerami and his team cooked up their own: advanced glycation end products.

It was a mouthful, but it created a recognizable acronym: AGEs.

A McDonald's Big Mac has nearly 8,000 AGEs, a full day's worth in one burger. Grace Beahm Alford/Staff

BY GRACE BEAHM ALFORD GBEAHM@POSTANDCOURIER.COM

4. The discoveries

As David Turner dug deeper into the history of AGEs research, he could trace its arc, from diabetes to dementia. It was a hunt that hinted at amazing possibilities. Unlock the secrets to AGEs and you might find a doorway to slow or even reverse the aging process.

And that night on the couch in his West Ashley home, he'd noticed how researchers from South Carolina had made a pivotal find.

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In the early 1980s, John W. Baynes, a chemist at the University of South Carolina, followed the Rockefeller AGEs work with growing interest.

But the chemical composition of these AGEs remained an unsolved riddle. It was like knowing a tree was in a forest but having no idea what kind of tree it was, much less what its bark and leaves looked like.

“We were at a crossroads,” Baynes said.

That changed after one of Baynes’ research fellows saw something odd in an experiment.

Mahtabbuddin Ahmed had recently arrived from Bangladesh. Oxford-trained, Ahmed was “a hard-core chemist,” Baynes said. And Ahmed had burrowed deep into his data.

“Suddenly, one day, I saw a blip in the reaction I was doing,” Ahmed said.

He’d analyzed a substance with a mass spectrometer, which spit out data in a series of vertical bars. The bars created a chemical fingerprint that scientists use to identify specific compounds. But one of the bars on the unknown browning substance was much taller. He did more tests.

Mahtabbuddin Ahmed, a South Carolina State University professor of biological and physical sciences, in his lab Monday, May 6, 2019, in Orangeburg. Ahmed discovered the first AGEs in 1985. Grace Beahm Alford/Staff

BY GRACE BEAHM ALFORD GBEAHM@POSTANDCOURIER.COM

Yes, he soon realized, he had discovered the chemical structure of one of those unknown AGEs.

Discoveries come with naming rights, and Ahmed and Baynes gave this AGE a name based on its molecular structure: carboxymethyl-lysine, or CML. It was like finding a new plant species.

Ahmed's **find** generated a flurry of excitement. Now, scientists could run tests on AGEs. Now, scientists had the fingerprint of a chemical that seemed to cause incredible harm.

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Mahtabbuddin Ahmed, South Carolina State professor of biological and physical sciences, in his lab in Orangeburg. Ahmed identified the first AGEs in 1985. Grace Beahm Alford/Staff

BY GRACE BEAHM ALFORD GBEAHM@POSTANDCOURIER.COM

Moving from diabetes, researchers found that AGEs were associated with heart disease. Moving from heart disease, they learned that these substances entered the brain.

Inside the brain, AGEs attached to proteins, forming plaques in Alzheimer's patients. Researchers also found high levels of AGEs in patients with Parkinson's and Lou Gehrig's disease. In tests on mice, they linked AGEs to frequency of strokes. After Ahmed's discovery of CML, scientists identified more than 30 other AGEs. Sometimes scientists used the term AGEs; other times they called them "glycotoxins."

But, by the early 1990s, important questions still lingered over the AGEs field:

Did AGEs build up naturally over time? If so, was this buildup merely part of the aging process?

A name appeared over and over in science journals: Helen Vlassara at Rockefeller University.

She'd discovered the answers, thanks, in part, to an off-hand comment from a German who loved pudding.

Black coffee has hardly any AGEs. Just hold the sugar. Grace Beahm Alford/Staff

BY GRACE BEAHM ALFORD GBEAHM@POSTANDCOURIER.COM

5. The missing link

Helen Vlassara grew up in Greece, in a modest neighborhood in the shadows of the Acropolis. She lost her father when she was 6 to kidney failure and filled that loss with questions: How could such a young man die? Then later: How do these diseases kill?

She arrived in Cerami's lab at Rockefeller University in 1974, a bit starstruck by the energy and ambition of her colleagues. Soon, she was doing groundbreaking work of her own, studying how sugar, fat and heat created AGEs.

She studied how these substances welded onto hemoglobin proteins in blood cells. And once attached, these AGEs sent signals to the body's immune system: orders to mutiny.

She never forgot the moment she looked through a microscope and watched AGEs transform guardian cells into vicious turncoats. Instead of protecting tissues against foreign invaders, these rogue immune cells bit into healthy nerves. The bites reminded her of the Pac-Man game that was all the rage at the time.

But it was no game. These bites damaged nerves, leading to chronic pain. Watching them through the microscope, it was as if she was seeing the mechanics behind the aches and pains of old age.

Like many in her scientific circle, Vlassara wondered why the body naturally produced AGEs. The human body cooked them up like a chef grilling a hamburger, though this usually happened over decades. An inside joke in the lab was that "all of us are slowly cooking."

By the mid-1990s, the number of new AGEs discoveries had begun to tail off. Efforts to create an anti-AGEs drug hadn't borne fruit. And without a blockbuster pharmaceutical in the offing, grants were hard to nab.

Then she went to Japan and saw a spectacular buffet.

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It was 1995, and by then Vlassara was one of the world's leading diabetes researchers. She'd been invited to give an important lecture in Osaka. After her presentation, she and a German doctor, Theodor Koschinsky, chatted near a buffet table.

It was no ordinary buffet. Their Japanese hosts had created their vision of a Western dessert table, decorating it with rows of beautiful pastries — elaborate chocolate concoctions with whipped cremes. Vlassara wondered if she should help herself. Then again, it was a diabetes conference.

Look at all those AGEs, she said with a laugh.

Koschinsky told her not to worry. Researchers in the AGEs field had long thought that the Maillard reaction in food had nothing to do with AGEs in our bodies. Everyone knows we don't get AGEs from food, he told her.

Wait, Vlassara answered, what if we do?

Koschinsky thought for a moment. His wife made a wonderful pudding: sugar, protein from egg yolks and other ingredients all heated at high temperature. The Maillard reaction in action, a tasty bowl of AGEs. He volunteered to do an informal test on himself.

Dr. Helen Vlassara, author of **The AGE-less Diet**." Provided

Back in Germany, Koschinsky's wife made the pudding, and he gobbled it up. He took blood samples before and after the meal and sent them to Vlassara in New York.

Vlassara tested the samples for AGEs and was stunned by the results.

"I called him immediately with the news."

The AGEs level in Koschinksy's blood spiked immediately after he ate the pudding.

Was this an aberration? Back in Germany, Koschinsky fed his wife's high-AGE pudding to colleagues and tested their blood. Their AGEs levels also shot up.

"That was the moment of the missing link. No question about it," Vlassara said.

We could get AGEs from our food.

These informal tests led to proper **clinical studies** and more discoveries. They found that even a single meal full of AGEs had a noticeable effect on diabetics' arteries. And food wasn't the only AGEs source. Cured **tobacco** also contained AGEs, along with tobacco smoke's already well-documented roster of carcinogens.

The evidence grew: We naturally generated AGEs in our bodies, but AGEs in food also was a source. And if you ate foods with lots of AGEs, they built up in your tissues until your body rebelled.

But which foods?

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No one knew the answer because researchers had no easy way of measuring AGEs in food. So Vlassara and her colleagues invented a test and went shopping.

Everyone in the lab seemed to be curious about the results.

"Not just the scientists, the secretaries and others were all interested," she said.

Funding was limited.

"But it was so crucial that we did it on the side, on our own time, for several years."

By then, she had moved from Rockefeller University to Mount Sinai Health System, also in New York. There, she worked closely with **Jaime Uribarri**, a respected nephrologist and professor there, and Gary Striker, a professor and expert on geriatrics who she eventually married.

The database grew by the year. After a decade, they'd analyzed more than 550 common foods. They published their work in a **science journal in 2010** and later in a book, **"Dr. Vlassara's AGE-less diet."** The pattern was clear: Some of our most popular foods contained the most AGEs.

Their experiments showed that if you took in more than 5,000 to 8,000 AGEs units a day, AGEs built up in your tissues. And just one McDonald's Big Mac had 7,800 AGEs, a stomach-full in a meal.

A serving of fried chicken nuggets had 7,000 AGEs. A broiled hot dog had about 10,000 AGEs. And a thin-crust pizza had 6,825 AGEs.

A single slice of processed American cheese had 2,600 AGEs, and a single teaspoon of margarine clocked in at nearly 900 AGEs.

But one of the worst offenders was bacon.

Dr. Jaime Uribarri, a clinical nephrologist at Icahn School of Medicine at Mount Sinai Department of Medicine. Tony Bartelme/Staff

BY TONY BARTELME TBARTELME@POSTANDCOURIER.COM

Bacon is stuffed with fats and protein and often cured with sugar, a perfect AGEs storm. Just two slices fried for five minutes contained about 12,000 AGEs, two days' worth in a few bites.

It wasn't all bad news. Vegetables, fruits, yogurts, untoasted breads, pasta and rice all had low AGEs counts. A veggie burger measured only 200 AGEs, and Campbell's chicken noodle soup had just 4 AGEs, as did coffee. And a can of Budweiser beer had even fewer: 3 AGEs.

They also found that you could reduce the formation of AGEs with different cooking techniques. Instead of baking, frying or grilling meats, you could cook foods by poaching, steaming, stewing and boiling.

A grilled chicken, for example, had 4,400 AGEs, while poached chicken had just 800.

At times, friends and colleagues sighed when Vlassara and Uribarri told them fried and grilled meat and poultry were packed with AGEs.

"They said, 'C'mon, this is what makes food good and interesting, and you think this is bad?' " Vlassara said.

She and Uribarri knew they were butting up against powerful fast food retailers and food manufacturers — industries with business models based on grilling and frying meat and poultry at high heat. Experts have estimated that McDonald's spends upward of $2 billion a year just on advertising.

"Most of the diseases are a result of how we live and eat," Uribarri said. "But many people would prefer to take a pill rather than be told not to eat a certain way."

Vlassara's and Uribarri's findings represented a new frontier in nutrition and chronic diseases.

But one major chronic disease field had yet to be explored.

A slice of pizza has a day's worth of AGEs, a Mount Sinai study found. Grace Beahm Alford/Staff

BY GRACE BEAHM ALFORD GBEAHM@POSTANDCOURIER.COM

6. The aha moment

For Charleston's David Turner, that night in 2010 had been the spark, the one that sent his mind spinning with possibilities.

Decades of research in AGEs had shown that it made the blood sticky, that this caused inflammation — that it made the body's immune system turn on itself.

But cancer?

Almost no one had looked at any links with AGEs.

He'd gone to his wife, Victoria. Had she heard of AGEs?

She hadn't.

He explained what he learned. She nodded as he spoke. In many ways, she was more detail-oriented; she saw the trees; he saw forests. This generated lively debates. Her excitement soon mirrored his. Yes, she told him, these AGEs must have an effect on the immune system and cancer.

Dr. David Turner in his lab at the Medical University of South Carolina, where he researches the effects of glycotoxins, also known as AGEs. Grace Beahm Alford/Staff

BY GRACE BEAHM ALFORD GBEAHM@POSTANDCOURIER.COM

That night, they decided to shift their research, apply for grants to explore AGEs and cancer. It could be just the niche to get more funding and continue their careers in America.

They fired off new proposals and landed small grants from the National Institutes of Health. They teamed up with other MUSC researchers and Mahtabuddin Ahmed, the chemist who identified CML. By then, he was at South Carolina State, an hour north of Charleston, where he'd set up his own lab.

They focused first on how AGEs might affect cancer patients who live in poverty, especially in minority populations. This appealed to Turner's sense of economic justice, rooted in his own modest upbringing.

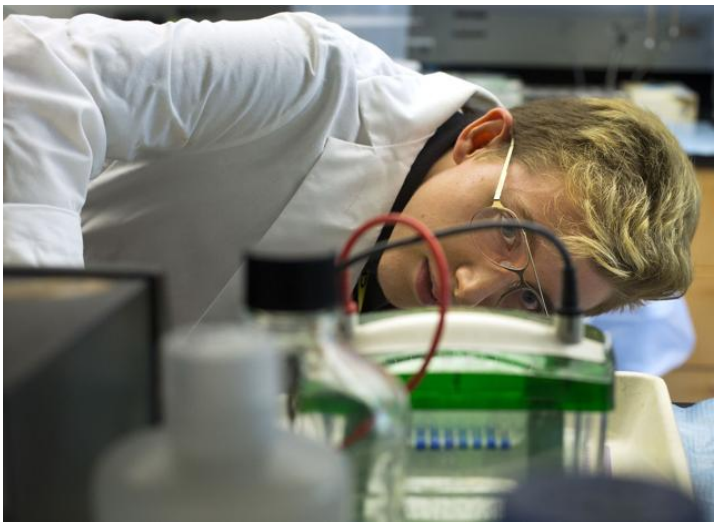
Previous studies had documented how many people in poverty relied on processed and fast food — cheap but jam-packed with AGEs and sugar. And African Americans had the highest **death rates** of any ethnic group for most cancers, especially prostate cancer.

Turner and his colleagues measured AGEs in African American and white prostate cancer patients, and the results were shocking: Black cancer patients had much higher AGEs levels than white ones.

They published their results in a science journal in **2014.** It was among the first papers to argue that high-AGEs diets were associated with higher cancer rates and more aggressive tumors. Colleagues began to call Turner "the Bacon Killer."

From prevalence of AGEs, they targeted the mechanics — how AGEs might trigger cancer.

They did more experiments, and the pieces of the puzzle formed a clearer picture: Eating foods with high levels of AGEs seemed to send signals to prostate cancer tumors — signals like keys to locks. Once opened, tumors became sugar-devouring killers. And not just with prostate cancer.



Masters student Callan Frye performs an experiment to test how AGEs impact the cells that crowd tumors on stroma AGEs macrophages at MUSC. Grace Beahm Alford/Staff

BY GRACE BEAHM ALFORD GBEAHM@POSTANDCOURIER.COM

They saw similar patterns in **breast cancer** experiments. AGEs built up in breast tissues, especially during puberty. As breasts formed, AGEs made these tissues more fibrous. This seemed to set the stage for **tumors** years or decades later.

Meantime, at South Carolina State, Mahtabuddin Ahmed analyzed breast tissues in two groups of women, ones with advanced cancer and ones without. He found higher AGEs levels in the women who had cancer. And older women with cancer had the most AGEs. The results have yet to be published, but it's more evidence that "AGEs are involved in the progression of cancer," he said.

Other experiments at MUSC's Hollings Cancer Center showed that a high-AGEs diet might reduce the effectiveness of a chemotherapy drug. Michael Lilly, a MUSC professor, began clinical trials with a chemical in ground-up shrimp shells. Preliminary work had found it might reduce AGEs levels in prostate cancer patients.

They did experimental work on how fasting and exercise affected AGEs levels and cancer, how high-AGEs diets promoted tumor growth. The results were tantalizing. New findings led to more questions, more grant proposals. Could eating better reduce tumors? Could fasting? Exercise?

Tomatoes and other vegetables have very few AGEs. Grace Beahm Alford/Staff

BY GRACE BEAHM ALFORD GBEAHM@POSTANDCOURIER.COM

7. The challenge

Turner and other AGEs detectives talk about their work with a sense of urgency, as if they're just a few puzzle pieces away from solving a big one.

Yet telling that hopeful story can be a challenge.

Earlier this year, Turner gave a **TEDxCharleston** talk. It was at the Charleston Music Hall, in front of a thousand people. He was nervous but excited, a chance to talk about AGEs outside the lab. He tried to explain AGEs in simple terms, leading to a punchline: Bacon had sky-high AGEs levels.

The audience groaned louder than any stomach. They groaned again when Turner mentioned AGEs had been linked to erectile dysfunction.

“Think about that the next time you're eating your BLT or bacon double cheeseburger," he said.

TED, the parent organization, took months to review Turner's talk. And when the video finally went on **YouTube** in July, TED added a disclaimer that the talk fell outside its guidelines. The disclaimer said that Turner had made sweeping claims about AGEs, which was "still an emerging field of study."

True, the field was emerging in the 1970s and 1980s, when scientists at Rockefeller made one discovery after another. But since 1990, more than 60,000 papers and academic articles have referenced AGEs, a search of Google Scholar shows. Turner was miffed but knows that it takes time for advances in science to enter the public bloodstream.

At the same time, he and other AGEs researchers are convinced people are suffering and dying because of these substances. So, as the evidence about AGEs has grown, they've made changes in their own lives.

Helen Vlassara and her husband, Gary Striker, follow the low-AGEs diet outlined in their book.

“It’s not about how much you you eat, but what you eat and how you cook food,” Striker said.

Which means less grilled and fried meat, and more fruits and vegetables.

Jaime Uribarri, the Mount Sinai kidney expert, has done the same. And he’s seen encouraging improvements in diabetes patients who went on low-AGEs diets.

Turner and his wife, Victoria, also cut back on fried, processed and other high-AGEs food. They said they're especially careful about feeding their children. They cut way back on trips to fast-food joints.

But then the Bacon Killer pointed to his belly and made a confession: On occasion, he still eats bacon.

"You gotta live." •

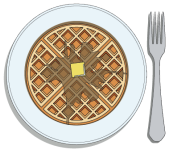
Some of our most popular foods contain the most AGEs. How many are you eating?

Pick the options that are closest to what you ate yesterday.

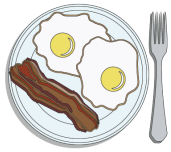
Breakfast

Cereal

Granola



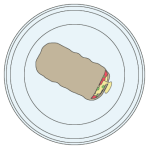
Toaster waffle



Bacon and eggs

Lunch

Pasta salad



Hot Pocket

Ham sandwich

Hamburger and fries

Dinner

Chicken soup

Pasta with

Bookmark our **AGEs calculator** to keep a running total of your daily AGEs intake.

Data for these calculations come from a **2010 study published in the Journal of the Academy of Nutrition and Dietetics** by J. Uribarri, Helen Vlassara, et. al.

(Clicking on any video link constitutes consent to collection and sharing of your personal video viewing data with various Post and Courier partners.)

AGEs, or advanced glycation end products, explained in 90 seconds.

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Reach **Tony Bartelme** at 843-937-5554. Follow him on Twitter @tbartelme.

9 easy ways to eat fewer AGEs: A stress-free guide

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TONY BARTELME

Tony Bartelme, senior projects reporter for The Post and Courier, has earned national honors from the Nieman, Scripps, Loeb and National Press foundations and is a four-time finalist for the Pulitzer Prize.
tbartelme@postandcourier.com 843-790-0805