00:00 Speaker 1: This week's episode is brought to you in part by the American Dental Association, "Teeth Tell a Story." We know what ancient civilizations ate, drank, even where they lived, all from looking at their teeth. What story will your teeth tell about you? Your ADA dentist can help you find out, and give you the tools to keep your teeth healthy for years to come. Use the American Dental Association's Find-a-Dentist tool to find the right dentist for you. Go to ada.org/sciencemag today. This week's episode is also brought to you by StarTalk All-Stars podcast. In a world filled with fake news, flat earthers, and conspiracy theories, what's a thinking person to do? Think like a skeptic of course. On this episode of StarTalk All-Stars, neuroscientist Heather Berlin and her comic co-host, Ari Shaffir, investigate the importance of skeptical thinking, with their guests Cara Santa Maria and Dr. Steven Novella of The Skeptics Guide to the Universe. Remember, trust no one, question authority, and listen to StarTalk All-Stars, wherever you listen to podcast for the rigorous scientific thinking you crave.

[music]

01:14 S1: Welcome to the Science Podcast, for November 16, 2018. I'm Sarah Crespi. In this week's show, news writer Ann Gibbons discusses what could be the worst year ever. I'll give you some clues. We've got volcanic eruptions, months of darkness, and a plague. Meagan Cantwell talks with Andrea Di Francesco about his review on fasting and metabolism. Could we fast our way to a healthier old age? And David Malakoff, editor for the policy blog, Science Insider, talks with Senior Reporter Jeffrey Mervis about science and the recent US elections.

[music]

01:54 S1: Now we have Ann Gibbons and she's here to tell us about a contender for the worst year in the last 2,000 years. I'm Sarah Crespi. Hi, Ann.

02:03 Speaker 2: Hi, Sarah.

02:04 S1: I can think of some contenders for the worst year. You mentioned in your story, 1349 pretty terrible year with the Black Death, and also 1918, which saw a ton of deaths by a very virulent flu. What makes the year that you name in your story stand out as a potential worst year ever?

02:25 S2: 536, according to medieval historians, was the darkest hour of the Dark Ages, or what used to be called the Dark Ages. And that was the year where there's several historic reports that a mysterious cloud came wafting over Europe, and punched it into darkness, in the spring of 536. From basic reports from Byzantine scholars, apparently, the light dimmed, the sun gave forth its light without brightness like the moon. It was as if there was an eclipse. There was no summer that year. The temperatures dropped 1.5-2.5 degrees Celsius which initiated the coldest decade in the past 2,000 years.

03:03 S1: Wow.

03:04 S2: Crops failed, people starved, there was famine. It was not a good year.

03:08 S1: That was a bad year. And some of these reports came from, well, not completely confirmed but from China, from Ireland, all over the world, people were not happy in 536.

03:20 S2: There's reports in China that the crops were failing there. There are reports that Scandinavians left a cache of gold as an offering to the gods, to ward off starvation. In Mesopotamia, where there are people that are complaining that their wine tastes like sour grapes.

[chuckle]

03:36 S1: Oh, no. Besides written accounts, there are physical clues elsewhere that this was a terrible time. For an example, tree rings indicating cold during this period. And now there's this new ice core evidence that's much more refined and specific. Can you tell us where that ice core is from, and what kind of analysis is being done on it?

03:57 S2: Yes, so the new evidence is coming from an ice core that was drilled in the Colle Gnifetti glacier in the Swiss Alps. Most of the research in the past has come from polar ice cores like in Greenland, or Antarctica. This time though, they were able to go to an ice core that was right smack in the middle of Europe during this really dark period, and it preserves between 2,000 and 4,000 years of events in the atmosphere. Whether they're climate change, storms, Sahara dust storms, meteor impacts, whatever it is, whatever produced any kind of pollution or chemical changes in the atmosphere was captured as snow fell in the Alps.

04:33 S1: This record isn't just long, it's also very detailed. So, they were able to with this new technique, to look at very, very thin, I guess you'd say, slices of time, going back over this 2,000-year period.

04:47 S2: They use a laser to ablate or carve out little tiny 120 micron slivers of the ice along the length of the core, they were able to get something like 50,000 samples from each meter. At that very fine resolution, getting so many samples from each layer, even the layers at the bottom of the glacier that are more collapsed and squished together, they're able to get enough samples that they can see, not only every year, but they can even see at a resolution, snow that fell down sometimes to the month or week. And with that kind of fine scale resolution, they can detect all sorts of discrete events, year-to-year, season-to-season.

05:25 S1: What kind of molecules, what kind of minerals, what kind of isotopes were they looking for in these minuscule ice slices?

05:33 S2: So at the University of Maine with their new methodology they can look for about a dozen different elements in the ice core including sulfur and bismuth which are tossed up by volcanoes. They can look for lead, which is produced when you mine silver. They can look for all sorts of elements that show whether there are dust storms in the Sahara. There's dust that goes

across Europe every summer, and that will tell them they're seeing a signal of summer. They can pick up all these different elements, and that can help them tease out ancient climate or volcanoes, or pollution.

06:08 S2: Researchers have long known that 536 was a bad year, but they didn't know what the source was, and they looked for comets, they looked for volcanic explosions, they just weren't sure. But then with ice cores in Greenland and the Arctic, they were able to look at those, and they could see that there was big increases in sulfur and so they began to get a hint that there was some major volcanic explosion around 536-540, but they weren't sure where it was. It was hard to sort of track it from those polar ice cores. So what has happened now is researchers at the University of Maine in Orono, famous glaciologists and volcanologists have gotten together with historians at Harvard, and archaeologists in Europe, and they are studying an ice core that was drilled in the Swiss Alps, right in the middle of where all the pain and suffering was.

06:57 S1: So how does this illuminate the story of the worst year ever recorded? [chuckle] What does it tell us about the volcano or the volcano eruptions, and where they were located?

07:09 S2: A graduate student, Laura Hartman, at the University of Maine in Orono, found two little microscopic particles of volcanic glass, in the Swiss ice core, right at about the time of 536. And they saw that these little volcanic glass particles had a chemical fingerprint that was more like that of glass particles found in lakes in Europe, and those matched, most likely matched rocks in Iceland. And so that countered an earlier idea that originally people thought it was a tropical volcano that caused 536 then later some people proposed it's North America. So this is strong evidence that suggests that the volcano actually erupted in Iceland, and then that the clouds wafted over Europe after that. Not everybody's convinced yet. Some climatologists wanna see some more evidence before they are completely convinced.

08:00 S1: What about the plague? I'm just gonna throw that out there because there was at this time, this worst year and the few years that followed, there was volcanic eruption, the darkened skies, crops dying, and then also this Justinian Plague showed up. How does that tie in with what was happening with the climate?

08:17 S2: So that's really interesting. There was the eruption in 536, and then it looks like there was a second eruption in 540, and that one-two punch just prolonged the cold and the dark and the misery, and probably set people up not to be as healthy. But then also, the plague broke out along the Nile River, and the Mediterranean in Egypt. And probably because the Byzantine emperor, the Eastern Roman emperor, Justinian was the emperor, started shipping more grains because of the famine. That included rats on the boats, and so that spread the plague coming out of this major port city where grains were farmed along the Nile and helped spread the plague. So you sort of see this concatenation which is such a great word. Concatenation...

09:00 S1: Yes.

09:00 S2: Of all these events happening: The darkness and the cold, crops fail, people are hungry, their health isn't as good. You start bringing, shipping in more grain from more distant places. The

climate change sets people up for illness. And then we had 35% to 50% of Europe dying from the Justinian Plague. And that changes the entire way of life and economy in Europe, and it takes almost a century for people to recover.

09:25 S1: The recovery of the continent is also visible in this ice core.

09:30 S2: Yes, it's really interesting. So around 640, they see a surge in lead in the ice core which means that the silver mines are producing more silver again, and that's probably because they're adding silver to gold coins because trade is going up and they need more coins to make that trade happen. And then in 660, there's another much bigger surge of lead which means they're really cranking up the silver mines, and that's because there's a switch from the gold standard to the silver standard.

10:00 S1: Wow.

10:00 S2: Because they need more money, because there's a lot more trade going on in the ports in Europe at that time, driven by merchants. So, that's the beginning of the medieval economy, which is very interesting.

10:08 S1: Yeah, we can see the medieval economy in an ice core. That's just amazing. This really seems to be almost a new era, as one researcher also mentioned in your article. We can look at such fine scale resolution of these ice cores, and look at all these different isotopes and contaminants in the ice. Do you think we're gonna continue to see more records like this going forward?

10:32 S2: Absolutely, this is gonna start a whole surge of researchers trying to get the ice cores from glaciers that are melting all around the world before they melt, right?

10:41 S1: Oh yeah, yeah.

10:42 S2: From Africa to Europe, wherever they can get these ice core records before they're gone, because there's so much important information in them. I'm going to a workshop next week at Harvard where they're gonna talk about some other findings.

10:53 S1: Are people saving some of these cores for when we get better at analysis or are they getting the cores and then basically destroying them in the process of figuring out what is in each layer or in each time point?

11:07 S2: So, the very cool thing about this new methodology used by the team is that their new method they use does not destroy the ice core. They take such tiny slivers of ice. The computer helps them track to write where they took it from, the precise spot, and a lot is preserved, most of it's preserved. So, this is a new method where they're not melting it to do the analysis, which is fantastic, so it will be there for future analysis.

11:30 S1: That's great. Thank you so much, Ann.

11:32 S2: You're welcome, my pleasure.

11:34 S1: Ann Gibbons is a contributing correspondent based in Pittsburgh. You can read her story at news.sciencemag.org. Stay tuned for Meagan Cantwell's interview with Andrea Di Francesco on his review "A Time to Fast," which is part of a special issue this week on "Metabolism."

[music]

11:55 S1: This week's episode is also brought to you by the NSA. Almost every day we hear something on the news about a cyber attack. Sometimes it's just a bunch of pranksters, but more often, it's a foreign country with vast cyber resources trying to hack the power grid, the banking systems, or the military's information networks. The National Security Agency plays a big part in protecting the country from cyber attacks, and you can help. The NSA is hiring technical professionals to serve on the frontlines of information security. If you work in computer science, networking, programming, or electrical engineering, you can help keep the country safe, design new hardware systems and networks, write faster, smarter programs, protect America's a critical infrastructure, or help uncover what its adversaries are planning to do next. Learn more about careers at the National Security Agency today. Visit intelligencecareers.gov/nsa, that's intelligencecareers.gov/nsa.

12:56 S1: This week's episode is also brought to you by Opsgenie. Incidents happen, and they require a complex coordination between operations and software development teams who are putting out fires everyday, that's why getting alerts immediately is critical. Thankfully, there's Opsgenie by Atlassian. Opsgenie empowers dev and ops teams to plan for service disruptions and stay in control during incidents. It also gives teams the power to respond quickly and efficiently to unplanned issues. It helps to notify all the right people through a smart combination of scheduling and escalation pass that account for things like time zones and holidays. Better yet, Opsgenie allows for deep flexibility in how, when, and where alerts are deployed. With over 200 integrations like JIRA, Amazon CloudWatch, Datadog, New Relic and more. Plus, it tracks all activity and provides useful insights to improve future incident responses. With Opsgenie, your next incident doesn't stand a chance. Visit opsgenie.com to sign up to get a free company account and add up to five team members. That's opsgenie.com, O P S G E N I E.com. Never miss a critical alert again with Opsgenie.

[music]

14:14 Speaker 3: I'm with Andrea Di Francisco to discuss how adjusting meal size and/or frequency could contribute to a healthier and longer life. Hey Andrea.

14:23 Speaker 4: Hi, how are you?

14:24 S3: Doing well, how are you?

14:25 S4: I'm good, thanks.

14:27 S3: So, when did researchers began to investigate this link between dietary interventions and reduced chronic illnesses associated with aging?

14:35 S4: These studies started almost in the '40s, '50s ever shown that in rats that were fed a limited amount of calories can have a longer lifespan. Those studies were repeated in several other organisms ranging from very simple yeast, round worms, fruit flies to higher animals, including mammals.

15:00 S3: This research kind of started in rodent models and then moved on to other mammals?

15:04 S4: Yes.

15:05 S3: What are the types of chronic diseases that have been shown to be impacted by dietary intervention?

15:12 S4: Protection from cardiovascular disease and diabetes, hypertension, these are all benefits that are told to be associated with caloric restriction.

15:26 S3: And your review doesn't just discuss caloric restriction, also known as CR, but it also explores other types of dietary interventions like fasting, right?

15:35 S4: There are other forms of dietary intervention that can be used, and this include the time restricted feeding which refers to the reduction of exposure to food within 24 hours. And then there are other forms that are called intermittent fasting or periodic fasting, when people or animals, alternate days of normal feeding, two days of fasting. The last intervention we discussed has been recently developed, it is called fasting mimicking diet.

16:07 S3: Mm-hmm. And so that last one, how is it different than the other forms of fasting?

16:11 S4: Instead of having a complete fasting, you have a significant reduction of calories, and this regimen is adopted in a periodic way. So, the fasting mimicking diet is adopted for five days, and let's say, every month, or every three months, or two times a year, it depends on who needs this type of diet.

16:35 S3: So, what are these specific mechanisms in the body driving these reduced risks for chronic disease?

16:41 S4: In response to fasting or caloric restriction, the organism respond to stress. It activates systems where the organism is allowed to repair damaged tissues at the intracellular level to get rid of damaged molecules. This is seen in pretty much all the, for intervention.

17:05 S3: Were there any adverse side effects that anybody found in these studies?

17:10 S4: Yes, actually, one of the cautious notes that we add to the review is that people should not adopt these regimens without medical supervision. For the caloric restriction, we know that it

may impair the immune system, so it can delay wound healing, it may have effect on osteoporosis and sarcopenia. The timing of this intervention in terms of what age people should start or stop this intervention is very important because for example, in old people, caloric restriction can be actually detrimental.

17:49 S3: Yeah, that was one question I had from the review is that since most of these experiments were conducted on non-human models, how does it translate to human models? Is it something you would have to do when you're younger or this is something that once you're reaching an older age you start this kind of intervention?

18:06 S4: Well for example, in mice, what we know is that when you start caloric restriction early on in life, after the organism is completely developed, you have lifespan extension. This is not always true. The mice that are able to live longer are those that are able to keep higher reserves of fat. This is because the mouse metabolism is somehow very different from the human metabolism. And so people should be careful when they try to translate the observation obtained in mouse, animal models to humans.

18:48 S3: Are there any cultures that naturally have this low-calorie diet or fasting lifestyle? And as a result, have experienced better health outcomes as they age?

18:57 S4: In Honduras, in people that have mutation in the growth hormone receptor, they are significantly protected from a number of disease, and they have a small stature. And this is also true in the Okinawan population, with these specific population in Japan, these people, they adopt caloric restriction. These people have some of the resemblance, some of the characteristic of models of CR. The number of centenarians in the Okinawan population more than doubled than other population in Japan.

19:32 S3: Right, so you've seen through how people who are fasting or restricting calories just because that's culturally what they're doing, have aged healthier or live longer, but are there challenges to seeing this through actual human experimentation? Is it hard to get humans to participate in these trials?

19:51 S4: In humans, of course, it's very hard to have lifespan studies like we do in mice. So, there are short-term clinical trials. And here, we see a reduction in body temperature, reduction in body weight, it is typically associated with the CR, reduced inflammation, reducing metabolic rates. So, there are some aspect that we see in animals are also seen in humans. Whether now this will translate into lifespan extension, we cannot say that.

20:22 S3: Okay, these results are pretty promising, but like you said, this would have to be done under supervision of a doctor, making sure that you're doing it the right way. What are the next steps for this research that would potentially allow it to become more adopted by mainstream population?

20:39 S4: People that consume their meals within a 12 hours window in the day are protected and show some of the metabolic protective alteration that are seen in people on caloric restriction, even

if they eat the same amount of calories. And this is very important because in this case you don't have a demanding intervention for the individual that has to adopt, basically that can play just on the timing of eating.

21:08 S3: So, just eating from 9 o'clock in the morning to 9 o'clock at night, and that would be the fasting period so to speak.

21:13 S4: Correct, correct. And vice versa, we also know that in studying people where that have a night shift or have an erratic life style, and so they eat in a window of time of 15 hours. They typically also are more likely to develop metabolic disease. And this has something to do with the alteration of our internal clock that regulates cycles of fasting and feeding, resting, and activity. So, there are studies, especially by Satchin Panda that have shown how in mice, when you mutate some of the element of the clock, mice are having issues in terms of their metabolism.

22:00 S3: So, essentially, there are ways to do this without being as extreme as some of the other previous ways you've mentioned, and could still yield some of the similar benefits?

22:09 S4: Yes, so the idea is to have intervention that are more feasible, that can involve periods of fasting within the 24 hours or two days in a week. It's clearly more feasible than your entire life on caloric restriction.

22:28 S3: Right, for sure. Thank you so much for speaking with me.

22:30 S4: Oh, thank you for having me.

22:32 S3: Andrea Di Francesco is a post-doctoral fellow at the Experimental Gerontology Section and Translational Gerontology Branch at the National Institute of Health. You can find a link to his review at sciencemag.org/podcasts.

22:46 S1: Stay tuned for David Malakoff and Jeff Mervis's policy discussion on the US election. Which scientists, candidates won the day and what are the implications of the election for science funding and policy?

[music]

23:03 S1: Now, we have Science Deputy News Editor David Malakoff and senior reporter Jeffrey Mervis discussing the results of the US election and the future of science policy.

23:13 Speaker 5: Thanks Sarah. So, I'm here with Jeff Mervis, a senior correspondent at Science. I'm David Malakoff, a deputy editor on the news staff. Jeff, big election last week. Millions and millions of people went to the polls. So, let's start with the big picture. What happened?

23:28 S6: The big picture was that the Democrats regained control of the House of Representatives, and at the same time, the Republicans held control of the Senate.

23:38 S5: So, you and I have been tracking about 50 candidates this year who have some kind of technical background, they might be an engineer, they might be a physician to science and research. So, how did they do in the end? Who won? Who lost?

23:52 S6: Well, out of those 49, seven won last week. Now, the first cut, of course, were the primaries, and only about 19 of them made it through. And each of those victories were unique to their district, but they ran in part on their scientific training. They wanted voters to know that, they felt that would be an asset when they entered Congress.

24:16 S5: Yeah, so on our website, we list the seven winners. Let's talk a few, a little bit about those winners. Who would you like to start with?

24:23 S6: Well, there's Sean Casten in the Sixth District of Illinois outside of Chicago. This is one of the most expensive races in the country. Each candidate raised and spent over $6 to $8 million.

24:37 S5: Wow.

24:38 S6: He won a tough primary, and then in the general election, he talked a lot about energy efficiency, he talked a lot about climate, he criticized his opponent incumbent Peter Roskam for his votes on healthcare, which was an issue that all Democratic candidates hammered. But he injected a fair amount of science and climate policy as well.

25:04 S5: Since election day, you've talked to Sean Casten. What did he tell you about what he wants to do now that he's a member of Congress?

25:10 S6: As all of the candidates that won told me, even though they're scientifically trained, they represent their district, first and foremost. And so if their district has a large military presence, they wanna be on Armed Services. If they're interested in healthcare they wanna be on the Energy and Commerce Committee, or Ways and Means, to set tax policy. It doesn't mean they're going to abandon their scientific training, but they're not necessarily going to wanna serve on the House Science Committee.

25:39 S5: Yeah, let's come back to the committee in a minute. I was curious about another candidate that I believe you talked to, Joe Cunningham down in South Carolina. He was one of the upset winners on election night. Nobody really expected him to win that race in red South Carolina. But he used environmental issues to his great advantage, it appears, during that contest.

26:00 S6: He did indeed, David. As you said, it was a very Republican district. It's also a very coastal district. Covers much of the coastline of South Carolina. And his opponent early on made a comment during a candidate forum saying she supported President Trump's proposal to lift the ban on offshore drilling. Well that gave Joe Cunningham the opportunity. She later reversed herself, but it seems to have been a very potent issue. In fact, not only did Joe Cunningham emphasize it, but a new group that was formed a couple of years ago to help scientists who wanted to run for office. A group called 314 Action put nearly one quarter of all of their money from their political action committee into a last minute campaign that emphasized the Republicans' position on offshore

drilling. Most people think that was decisive.

26:54 S5: Yeah. So there's a case where 314 Action made a difference, potentially, in a big race. So you did mention earlier that this Democratic win in the House is gonna mean big changes there, in part for the House Science Committee, which is the committee that oversees the science agencies. It doesn't set their budgets, but it does help determine policy. And traditionally, the leader of that committee has sort of set the agenda for some of the science policy issues that are being discussed. Under the Republican leadership of Lamar Smith from Texas, who's retiring, that committee became sort of persona non grata in the scientific community.

27:28 S6: The new presumed chair, Eddie Bernice Johnson, a psychiatric nurse from Texas, says that one of her goals, one of her first goals is to restore the credibility of the Science Committee. Now, on the face of it you'd think, "Oh my goodness, what does she mean?" What she means is that the committee sometimes became the laughingstock and the butt of jokes on late night television because some of its members, driven by ideology, would throw out comments like, "The sea levels are rising because of erosion of cliffs and rocks going into the water."

28:05 S5: Right. Representative Mo Brooks made that remark. Yeah.

28:07 S6: That was just an example of how the hearings that the Science Committee held were often so ideological that they weren't interested in exploring the issue. They weren't interested in hearing the facts from nonpartisan scientists, so much as hearing representatives of industry or representatives of a particular faction. And then in contrast, the Democrats would criticize those views, and the impact of the witnesses was nil because it didn't... They never changed anyone's mind. A lot of stakeholders, the community itself, just sort of threw up their hands and said, "There's no point interacting with this committee. We're not gonna get a fair hearing and they're not going to move any legislation that is based on science."

28:53 S5: So a big change in tone and substance of House Science Committee. All of the other committees will also get Democratic leaders, the appropriations panels that set spending levels. But Jeff, what does it mean in terms of prospects for real legislation? In other words, the house is gonna be controlled by Democrats, Republicans are gonna control the Senate, President Trump still sits in the White House. Is this gonna just be a time of gridlock with nothing getting done, or are there chances for some bipartisan deal making?

29:19 S6: Well, I think most people feel that in terms of climate change and energy policy, it's going to be gridlock at best. What the Science Committee and other committees can do is key up issues, and hope, if they're Democrats, that a Democrat wins the White House in 2020 and they can move legislation. There are some other issues, infrastructure being among them, where I think some people still hold out hope. That was something that President Trump said he was interested in, his plan has gone nowhere. But it's an important issue because scientific infrastructure was part of the stimulus bill from 10 years ago, and scientists are hoping that any infrastructure bill that moves through this Congress or the next Congress could include money for scientific facilities.

30:03 S5: So one with highways and dams, you get a couple of scientific laboratories, maybe a new

collider.

30:07 S6: Correct.

30:08 S5: For the physicists.

30:09 S6: It doesn't even have to be shovel-ready, which was the term a decade ago. It just has to be important for keeping up with the infrastructure needed to continue to innovate, and for the US to continue to be a scientific leader.

30:22 S5: So Jeff, to close out, we've talked about the winners on election day, and we talked about what's likely to happen in Congress. But what about the folks with technical training who ran, put their heart and souls and often a lot of money into these races, and then came up short on election day?

30:36 S6: Right. Well, the quintessential candidate in that category is a professor of biochemistry at the University of Mississippi named Randy Watkins. He was the Democratic nominee, but he was facing more than an uphill battle. It was a mountain. Running not just against an incumbent, but in a district where the incumbent had won by some 40 points. The Democratic party was moribund, and he had a very hard time raising money. So he had three strikes against him. But what he feels is that it may have been the most important thing he's ever done science-wise. And this is someone who's been a professor for 25 years. And by that he means he got people out speaking about science, speaking up for science, as well as helping to rebuild the Democratic party. And the way he puts it, he said, "This is not the end of scientists running for Congress, it's just the beginning."

31:29 S5: Well, I think that's a good note to end on.

31:31 S1: That was deputy news editor David Malakoff talking with Jeffrey Mervis, a senior correspondent for Science News.

[music]

31:40 S1: And that concludes this edition of the Science Podcast. If you have any comments or suggestions for the show, write to us at sciencepodcast@aaas.org. You can subscribe to the show anywhere you get your podcasts or you can listen on the Science website, that's sciencemag.org/podcasts. To place an ad on the Science Podcast, contact midroll.com. The show was produced by Sarah Crespi and Meagan Cantwell and edited by Podigy. Jeffrey Cook composed the music. On behalf of Science Magazine and its publisher AAAS, thanks for joining us.