JOHN ROSENTHAL

TOO MUCH OF A GOOD THING

DANIEL E. LIEBERMAN ON HOW CIVILIZATION MAKES US SICK

TRACY FRISCH

Harvard University professor Daniel E. Lieberman looks to human evolution for clues as to why our bodies function the way they do. His curiosity has led him to study a wide range of disciplines, from physiology, to biomechanics, to experimental biology. In the process he's found evidence that the conditions of modern life are leading to higher rates of chronic illnesses and injuries.

In The Story of the Human Body: Evolution, Health, and Disease, *Lieberman proposes that understanding evolution might help us tackle seemingly intractable medical problems such as obesity or heart disease. The way we live today is "recent and abnormal," he says. He believes that many physiological disorders arise because, although our living environment has changed considerably, our genes have changed very little. For example, the lack of physical activity in modern life can lead to decreased bone mass and thus higher rates of osteoporosis. And the easy availability of sugar and simple carbohydrates can cause weight gain, which is associated with Type 2 diabetes. These conditions are sometimes referred to as "mismatch diseases."*

Educated at Harvard and Cambridge Universities, Lieberman taught at Rutgers and George Washington Universities before he was appointed to the Harvard faculty in 2001. He is trained in paleoanthropology — the study of prehistoric humans — and serves as chair of the Department of Human Evolutionary Biology and principal investigator of the Skeletal Biology Lab. He is the author of one previous book, The Evolution of the Human Head, *and he conducts field research among present-day hunter-gatherers and subsistence farmers in Kenya and Mexico to better understand how we all lived prior to the modern way of life.*

Another area of Lieberman's research is humans' ability to walk upright — and run. He has proposed that we evolved to run long distances and is an avid runner himself. Though he did not excel in sports as a boy, he began jogging in high school because he liked the way it made him feel. "If I didn't run a few times a week," he says, "I would go nuts." He has stuck with it and is now "addicted" to marathons. At the age of fifty he runs one or two a year.

Around ten years ago at the Boston Marathon, Lieberman met a Harvard grad who ran barefoot, and he invited the man to his lab to examine his "collision-free" technique. Lieberman himself soon started running without shoes or with only minimal foot covering. He has found that, by landing on the forefoot rather than the heel, barefoot runners can greatly reduce the impact on their bodies, and he hypothesizes that some running injuries might be a result of how people run, which in turn can be affected by wearing shoes.

On the day I met Lieberman for this interview, I spent several hours among the anthropological exhibits at the famed Peabody Museum at Harvard. Then I went upstairs to Lieberman's office, which is in the same building. When I arrived, he and a graduate student were immersed in an animated exchange, which he broke off with a promise to pick it back up later.

Lieberman impressed me as a down-to-earth scientist driven by a desire to help humanity. Given the current trajectory of human health, he fears that, unless people change their diets and become more physically active, we will only suffer more.

Frisch: In *The Story of the Human Body* you describe how some of the adaptations that enabled early humans to survive in the Paleolithic era — about 2.5 million years ago up to around ten thousand years ago — are causing health problems for us today, because they aren't compatible with the modern environment in which we live. It's an idea known as the "mismatch" theory.

Lieberman: Let me start by saying that I did not come up with the concept. It's been around for some time. I'm simply trying to explore it further, to compare the evolutionary story of humans with the mismatch theory and see if it continues to hold up.

The two people who really put the mismatch theory on the map are George C. Williams and Randolph M. Nesse, who wrote a book in the 1990s called *Why We Get Sick: The New Science of Darwinian Medicine.* It inspired a lot of people, including me, to look at how evolution is relevant to medicine.

Frisch: What are some examples of mismatches?

Lieberman: There are so many that it's hard to know where to start. In the book I try to list all the diseases that might be a result of a mismatch. Even leaving out infectious diseases, it's a long list and ranges from relatively innocuous problems such as nearsightedness, flat feet, and tooth cavities to deadly diseases such as Type 2 diabetes, heart disease, and many cancers. All these illnesses are caused to a large extent, but not completely, by the fact that our bodies are poorly adapted to the environments in which we now live. It's not that people didn't get these diseases in the past; it's just that more people are getting them now because we don't eat the diets that we evolved to eat, we aren't as physically active as we evolved to be, and we spend more time indoors, especially in chairs.

On the evolutionary time scale, many things we take for granted are actually new developments. For example, I was talking with somebody today about how computers have changed the act of writing, and the person said, "Of course, we didn't evolve to write using computers. We evolved to write by hand."

Frisch: We didn't evolve to write at all!

Lieberman: That's correct. Writing is a relatively recent human behavior. You could argue that writer's cramp is the result of a mismatch. And nearsightedness can be made worse by reading.

Frisch: You write that, in the modern, industrialized nations, "we have created an environment that makes people sick through a surfeit of energy and then keeps them alive without having to turn down the energy flow." How does that work?

Lieberman: We have created a kind of positive-feedback loop that I call "dysevolution." I'm not a fan of neologisms, but I think we need a name for this process. As I said, we are eating

diets and leading lives that contribute to poor health. Then, when we get sick, instead of treating the causes of those diseases, we treat the symptoms, enabling the disease not only to continue but also to become more prevalent. I think that's why the rates of obesity and Type 2 diabetes and various kinds of cancer are going up — because we are not dealing with the causes of these problems. We believe if we throw enough money at the National Institutes of Health, somebody in a white lab coat is going to figure out how to cure diabetes and heart disease and the rest. Then we can literally have our cake and eat it, too.

DANIEL E. LIEBERMAN

The main culprit is sugar. There's just no question about it: our bodies cannot cope with the high-sugar diets we are now eating. Sugar has a number of pernicious effects on our biology, especially in the absence of fiber. Fruits have moderate sugar but also high fiber. If I eat an apple for lunch, I have to break down the fiber of the cells that encase the sugar, which slows the rate at which it gets into my bloodstream. But if I eat a fruit roll-up snack made from apples combined with high-fructose corn syrup, I get lots and lots of sugar that's no longer bound up in any fiber. So that sugar goes straight into my digestive system. Even if you go to a natural-foods store and get a fruit roll-up made with sucrose — table sugar — it's still junk.

Many people worry about high-fructose corn syrup, but table sugar is 50 percent fructose, and your body doesn't care whether the fructose came from corn syrup or sugar. It cares only how much fructose there is, how much fiber there is, and how rapidly it all gets to your system.

Fructose is broken down by your liver, which can handle only a small amount at a time. The rest turns into fat in your liver and gives you what's known as "nonalcoholic fatty-liver disease," which is as bad as it sounds.

Frisch: Is that what happens to the livers of geese who are force-fed to produce foie gras?

Lieberman: Yes, people who eat huge amounts of fructose in the absence of fiber have basically turned their liver into pâté.

Our ancestors didn't get much fructose. Most wild fruits aren't very sweet. Occasionally early humans would get fructose from honey, but they didn't eat much honey. If you get the fructose at a slow drip, you can tolerate it. But too much too fast is a real problem.

Frisch: What about fruit juice?

Lieberman: It's essentially bad for you, because there's little or no fiber but lots of sugar.

All in all, sugar as a modern, industrialized product has created an incredible amount of human misery, starting with slavery and the plantation system. Today it is increasing rates of disease and death because our bodies simply can't handle it. But we love it. We're addicted to it. I enjoy the taste of sugar, just like everybody else. And it's so cheap and readily available that we can get as much as we want. The obvious solution is to eat less sugar and more fiber, and many people are trying to do that, but it's hard. To fight heart disease, Type 2 diabetes, and various kinds of cancers, we need to focus our efforts less on treatment and more on eliminating high-sugar diets. If we don't turn off the source, we will have to keep treating these diseases.

Frisch: Is exercise enough to counter the effects of eating too much sugar?

Lieberman: Exercise has potent effects. It fights insulin resistance — a prediabetic condition. Some people who are very active can actually reverse insulin resistance and even cure themselves of Type 2 diabetes. People who don't regularly do moderate to vigorous exercise will have negative health consequences. We are not well adapted to being physically inactive.

Frisch: In your book you say that "to grow properly, almost every part of the body needs to be stressed." What do you mean by "stressed"?

Lieberman: When you're born, your body doesn't yet know how much it should develop any particular organ. How large should your liver be? How strong should your bones be? How much muscle should you have? How big should your heart be? There's a normal range of variation for each, of course, but we can't predict in advance from a person's genes exactly how everything will turn out, because our bodies grow in response to stress, by which I mean excess demand on the system. The body adjusts its capacity according to demand. Most of us know that if we lift a lot of weights, our muscles will grow stronger. It turns out the same is true for many other parts of your body. Your bones have to carry loads in order to grow properly. That's why if kids don't get enough exercise, their bones get weak. People who sit for long periods of time, especially when they're young, are at greater risk of osteoporosis when they get older. Your heart is a muscle, and it needs to work in order to develop. People who exercise more have a slower resting pulse and lower blood pressure. Your immune system, too, responds to demand, and when you decrease that demand — as we have done by creating relatively germ-free environments — the system loses capacity. If you're not using something, your body sort of "decides" you don't need it, and gives it fewer resources. With all the modern conveniences that we've created for ourselves, we've reduced demand to the point where we have weak hearts, weak bones, and various other problems.

We also process our food so much — grind it, purée it, cook it — that we chew less. When we don't use our jaws as much, they don't grow as long. Over time our faces have actually shrunk.

Frisch: Is that why people don't have room for their wisdom teeth?

Lieberman: That's right. There's just no room for the last teeth to come in because we don't chew our food as much. We've done experiments in which we've raised animals on soft diets and shown that their jaws don't grow as long. There's no question that impacted and crowded teeth are more common today because we eat so much cooked, chopped, and ground-up food.

Frisch: You mentioned that sitting too much increases our risk of osteoporosis. What are some other ways that sitting is bad for our health?

Lieberman: We don't totally understand the effects of sitting, but there are several issues. One is that sitting means being inactive, which burns less energy and increases the amount of inflammation in our bodies.

Frisch: Why is that?

Lieberman: It's not entirely understood, but being physically active represses inflammation.

The physical act of sitting in a chair also shortens our hip flexors and makes our backs weak. The more comfortable the chair, the less work our muscles have to do to keep us sitting up. When we don't use those muscles, they begin to atrophy. I use chairs occasionally, but more often I stand. I have a standing desk at home.

Frisch: You've likened early humans to endurance athletes.

Lieberman: Most creatures are adapted for speed and strength. Chimpanzees, for example, cannot run long distances, but they can run fast. Even Usain Bolt, the world's fastest person, isn't very fast compared to most dogs. Humans, because of our unique evolution, have traded speed and strength for endurance. We evolved to travel long distances, foraging and hunting. Before the invention of the bow and arrow, or even the sharpened-stone spear tip, many humans practiced "persistence hunting": they chased their prey in the hottest part of the day until it literally collapsed from heat stroke. To do that, humans had to be able to run not faster than their prey but longer and farther.

Frisch: Speaking of running, we all know that poor-fitting shoes cause foot problems, but you've said that well-cushioned athletic shoes actually make us more prone to injuries.

Lieberman: This is a subject we're studying in my lab now. The evidence I have so far is that most shoes make our feet weak.

Athletic shoes are comfortable because, when you wear them, the muscles in your feet no longer have to do as much work. Almost all shoes have what's called a "toe spring": they're curved up, so you don't have to push off as much with your toes. And they've got cushioned heels so that when your foot lands on the ground, the impact is nice and soft. And they have arch supports, which means the muscles in your arch don't have to do any work. These shoes are sort of addictive. Once you start wearing them, you have to keep wearing them, because your feet need them. Yet in barefoot communities, people don't get flat feet.

The shoes I'm wearing are false-bottom shoes. They have a very flexible sole with no arch support and basically no heel, although it looks like there's one.

Sugar as a modern, industrialized product has created an incredible amount of human misery, starting with slavery and the plantation system. Today it is increasing rates of disease and death because our bodies simply can't handle it. But we love it. We're addicted to it.

I'm not opposed to shoes. There are many benefits to protecting your feet, but they come at a cost. When we wear shoes, we're less sensitive to the world around us. We crash harder into the ground, and we don't feel the forces that we're applying to our body.

Frisch: But our bodies are still experiencing those forces?

Lieberman: That's correct. Hundreds of thousands or even millions of these impacts may be no big deal, but 30, 40, or 50 million over a lifetime? To what extent do they cause injury? We don't know, but we're studying it.

Frisch: Tell me about your experience with barefoot running.

Lieberman: At first I thought barefoot running was kind of a crazy idea, but as we began studying barefoot runners in the U.S., it started to make sense. If humans evolved to run, then it stands to reason that we evolved to run without shoes, which are a relatively recent invention. And I'd seen plenty of barefoot people in Africa, so I knew there was nothing unusual about humans being shoeless. After watching how people in the lab were able to run barefoot without hurting themselves, one day I just took my shoes off and tried it myself. I was tentative at first, but I quickly realized that it feels great. Most of the time I still wear minimal shoes when I run, but I like to take my shoes off occasionally.

Frisch: It doesn't change where you can run?

Lieberman: I'll run barefoot on hard surfaces like pavement, but they have to be smooth. I'm not interested in running on gravel without shoes.

My experience is that barefoot running can help teach you to run properly. When you don't wear shoes, you have to learn to step lightly. You can't slam your foot into the ground and depend on the sole's padding to compensate for your poor form. The reliance on shoes to cushion our feet may explain some of the injuries that runners get. The flip side is that there are people who become so enthusiastic about barefoot running that they just throw away their shoes, and then they get injured, because they didn't give their body time to adapt. It's like starting to lift weights with huge barbells. You'll hurt yourself.

I often hear . . . that somehow we're "designed" — as in, "The human body is designed to eat meat." Natural selection has resulted in our eating meat, but there's no design. We're hodgepodges of conflicting adaptations.

There are a lot of "barefoot shoes" on the market, which is an oxymoron. Even the slightest bit of cushioning under your heel will change how you run, because you won't get the same sensory information from the sole of your foot. If you're going to run barefoot, I say take the shoe off, but be careful and transition slowly. And if you don't want to do it, don't.

Frisch: Let's back up a bit and talk about early humans. When did they emerge?

Lieberman: It depends on how you define *humans*. The species *Homo sapiens* evolved sometime between two hundred and three hundred thousand years ago in Africa. The human genus *Homo*, which includes *Homo erectus* and *Homo habilis*, evolved at least 2 million years ago. The human lineage split from the apes probably around 6 million years ago, give or take a million.

Frisch: You've said that one characteristic that distinguishes humans from the great apes is the high quality of the food we eat. What do you mean by "high quality"?

Lieberman: It's not the same as "healthy." High-quality food gives you a lot of energy for little effort because it's high in calories and low in fiber. In other words, it doesn't have much roughage. A cow eats almost all roughage and spends most of its day just digesting it. Chimpanzees eat a lot of fruit, which is also high in fiber. They spend half their time eating. They basically fill their bellies, wait until the food passes into their intestines, and then fill their bellies again. Early humans had to hunt and gather all their food, but they probably spent just 5 percent of their day eating, which freed up time for other activities. They were able to do that in part because they cooked their food, making it easier to digest, and also because they ate foods that are high in energy, such as roots and tubers and bulbs. And they ate meat and honey, which are both low in fiber and high in energy.

Frisch: Why do humans need all that energy?

Lieberman: For one thing, we reproduce more often. A chimpanzee has a baby about every six years. Human hunter-gatherers typically have babies every three years. And they have huge territorial ranges. A typical chimpanzee travels maybe three to five kilometers a day total. The average hunter-gatherer covers nine to fifteen kilometers a day. Humans also have these enormous brains that use a lot of energy. A typical chimpanzee brain burns about 100 to 120 calories a day. A human brain burns 300 to 400. That's a lot of energy day after day. The majority of the calories we burn are just to take care of our brains, our guts, our livers, and so on. These are expensive organs.

Frisch: What kinds of environmental pressures produced our bigger brains?

Lieberman: Nobody has a definitive answer to that question. Another way of asking it is: Why don't more animals have big brains? We assume that having a big brain must be a good thing.

Frisch: Because we have one, right?

Lieberman: Right. And obviously big brains do make us more intelligent, which can be a benefit. They also enable language and cooperation and many other amazing feats. The problem is that big brains are costly. As I said, you spend maybe two hundred more calories a day on your brain than a chimpanzee does. That adds up to a vast sum every year. And that energy doesn't come for free. Most animals can't acquire the necessary resources.

Frisch: Like the cow.

Lieberman: Right. Where's the cow going to get the energy to grow a bigger brain? It can't. But bigger brains also present all kinds of challenges. The size of a newborn's head makes passage through the birth canal difficult. And a bigger brain takes longer to develop. A chimpanzee reaches maturity after about twelve years. Present-day hunter-gatherers can take eighteen years to reach puberty — longer than Americans, because our caloric intake is much higher. Slower growth means more risk that a given individual will not live long enough to reproduce. So bigger brains come at a cost.

Frisch: You mentioned meat as a high-quality food. In the debate over whether early humans were physiologically adapted for eating meat, where do you stand?

Lieberman: There's no debate. Early humans did eat meat.

Frisch: How do we know that?

Lieberman: We have archaeological evidence: carcasses with marks from stone tools on them; bones broken in such a way as to extract the marrow. Chimpanzees are our closest evolutionary relatives, and they aren't vegetarians either. They hunt colobus monkeys. They'll kill bush babies occasionally. They'll eat small bush pigs. About 3 percent of their diet is meat.

I would guess that when humans initially began walking upright on two legs, we had a harder time than chimps obtaining meat, because we became slower. That's probably why there's not a lot of evidence of human meat-eating in our first few million years of existence. It likely happened on an occasional basis, with easy-to-catch prey. But there's no question that, starting around 2.5 million years ago, meat-eating just took off. All hunter-gatherers living today eat meat. Maybe 30 percent of a tropical hunter-gatherer's diet comes from meat. In some cold environments, where there's little vegetation, hunter-gatherers get maybe 70 to 80 percent of their calories from meat. Meat played an incredibly important role in human evolution.

Frisch: But I've heard that our digestive system didn't evolve to handle meat.

ROY ARENELLA

Lieberman: On the contrary, I think the evidence shows we're actually quite good at digesting meat. What's interesting is the extent to which cooking has altered our digestive system. There's debate about when we started cooking. At this point the oldest evidence for humans using fire to cook regularly is from about five hundred thousand years ago.

Cooking has changed our biology in all kinds of fascinating ways. For one, it kills a lot of the microbes in food that would otherwise make us sick. So it has probably modified our microbiomes — the population of microorganisms in our bodies. Cooking also increases the amount of nutrients you can extract from food. We don't know for sure, but the evidence suggests that humans today cannot survive on a raw diet unless they spend an enormous amount of energy processing foods that have been bred to have lots of nutrients — in other words, most raw foodists are using blenders to purée domesticated fruits and vegetables. No hunter-gatherer could possibly survive on a raw diet, because he or she would be spending too much time and energy eating and digesting.

Frisch: What about the Paleo diet, which calls for a lot of meat and seafood but excludes all grains, legumes, dairy, sugar, and processed food?

Lieberman: There are good and bad aspects of the Paleo diet. I object to some of its prohibitions. If my ancestors evolved genes that have enabled me to digest dairy, why shouldn't I have it? Furthermore, the idea that early humans never ate legumes or cereals is just wrong. We have plenty of evidence for hunter-gatherers eating both. So the Paleo diet is based on a simplistic idea of what our ancestors ate.

More important, I object to the notion that, if our Paleolithic ancestors ate it, it must be good for us. That logic displays a profound misunderstanding of how natural selection works and the meaning of the word *adaptation*. We did not evolve to live long and healthy lives. Natural selection cares about only one thing: reproductive success, so that our genetic material is passed on. We do many things that increase our reproductive success but aren't necessarily good for our health. For example, we are adapted to put on weight, even unhealthy amounts of it, because it increases fertility.

Another problem with the so-called Paleo diet is that there is no one true version of it. Are you going to eat the Inuit diet, which is almost all caribou and seal? Or are you going to eat what a hunter-gatherer from eastern Africa eats, which would be a fair amount of honey but also meat and tubers and bulbs and roots? Or will you eat what a hunter-gatherer in the Mediterranean would have eaten?

That said, there's no question that we get sick now from eating foods that we did not evolve to eat. And the Paleo diet's ad-

vocates are correct that people should avoid high-carbohydrate diets and processed food.

Frisch: Besides the idea that we evolved to be healthy, what are some other common misconceptions about evolution and the process of natural selection?

Lieberman: One that I often hear is that somehow we're "designed" — as in, "The human body is designed to eat meat." Natural selection has resulted in our eating meat, but there's no design. We're hodgepodges of conflicting adaptations. We're adapted to be lazy, and we're also adapted to enjoy exercise. We're adapted to crave sugar, but we're also adapted to make smart decisions about what we should eat.

Frisch: How did humans fare during the transition from being hunter-gatherers to being farmers, and what conditions allowed for the shift?

Lieberman: There are two extreme views when it comes to farming. One is that agriculture is the biggest mistake we ever made, and it's been downhill ever since. The other is that agriculture is humanity's greatest achievement, because it enabled us to have civilization. There's an element of truth to both.

The move into agriculture was a complex transition that happened at least seven different times in seven different parts of the world, the earliest being around twelve thousand years ago in the Fertile Crescent. For the most part, the evidence suggests that humans made the switch not so much because they wanted to but because they had to in the face of a population boom and the resulting demographic pressures. If you have to feed more people in a smaller space, farming is the way to go, because a farm can produce a lot more food than hunting and gathering.

Frisch: But you've debunked the idea that hunter-gatherers were always starving, correct?

Lieberman: That's right. Hunter-gatherers were able to feed themselves well because they lived at very low population densities — small populations in large territories. But if you start having more children, as humans did about twelve thousand years ago, and you have physical barriers that keep you from spreading out, such as mountains or jungles or bodies of water, then you're better off doing some farming. And once you've started farming, it's hard to stop. There's a positive feedback loop: you can feed more people, so you start having more children, and you then become more and more reliant on agriculture to keep everyone alive.

Frisch: What were some of the earliest crops?

Lieberman: In the Middle East it was initially cereals. In Mexico it was maize. In China it was rice. Eventually there were other foods such as squash and lentils.

The negative effects of farming didn't show up right away, because humans' diet didn't come entirely from cereals and grains. They probably still ate a very diverse diet. And they weren't initially living at the sort of population densities that promote epidemics of infectious diseases. Those came later. In the Middle East, for example, animals didn't become part of farming until a few thousand years after cereals. So those early farmers weren't living cheek by jowl with domesticated animals, which is where a lot of infectious diseases originated.

Frisch: And they weren't part of a big empire with gross inequality that restricted access to food for some.

Lieberman: All that came later. So the first farmers actually did as well as or better than the last hunter-gatherers. It wasn't until farming had been around for a while that plagues from infectious diseases and famine from crop failures emerged. Warfare probably increased with farming, too, although hunter-gatherers were not and are not totally peaceful.

The point is that farming began for reasons that made sense, but once it had taken hold, problems arose. By that time, however, farmers couldn't go back.

Frisch: How do we know which infectious diseases humans had both before and after the agricultural revolution?

Lieberman: We can detect some diseases, like tuberculosis, in fossil skeletons. The diseases leave telltale signatures, and we can get a sense of their effect from looking at how old people were when they died. We can also look at the evolutionary history of the diseases themselves, tracing how old they are. Finally we have health data from existing foraging populations, and we know the diseases that they suffer from. Of course, they get some of those diseases from neighboring farmers. All in all, the evidence shows that the burdens of most common diseases caused by infectious agents and malnutrition didn't grow large until after humans had been farming for thousands of years.

Frisch: You say in your book that the emergence of *Homo sapiens* was a result of climate change. That caught my attention. What does the fossil record suggest happened?

Lieberman: Probably climate change was the dominant driver of most evolution on the planet. We don't have much good data about the origins of *Homo sapiens*, but the genus *Homo* appeared around 2 million years ago with the onset of the last ice age, which affected not only habitats near the poles but also the equatorial regions, altering how much moisture was available there. In Africa, for example, there was a dramatic increase in grasslands.

Frisch: Because the rain forest dried out?

Lieberman: Exactly. Drying and cooling trends created more-open landscapes, which changed what resources were available. That's really when humans became serious hunters, adding more meat to the diet. In the arid grasslands of the savanna, animals are a more available food source than fruit trees.

If you go on a safari, many of the animals you'll see first appeared around the same time as the genus *Homo*. There are species that evolved to eat the grasses of the Serengeti, and there are species that evolved to eat those species. We're part of this larger evolutionary picture.

Frisch: You've written that humans are specifically adapted to gain weight and that storing a relatively substantial quantity of body fat is normal for us. Why did natural selection favor this adaptation in humans but not in other primates?

Lieberman: It goes back to our big brains and more-frequent reproduction. Because of those factors, we need more energy in reserve than, say, chimps. Imagine you're a mother a million

years ago, and you're pregnant or nursing, so you're not getting as much energy as you did before becoming a mother. Plus it's metabolically costly to produce breast milk. So you're burning more calories than you are consuming — what's called "negative energy balance." But you can't just stop producing milk, because then your kid will die, and your reproductive "investment" is gone. (I'm speaking in the cold calculus of natural selection here.) So how do you protect your investment during those times of less energy? You burn reserve fat. The typical adult primate has maybe 5 to 8 percent body fat, but even thin hunter-gatherer females have about 20 to 25 percent body fat.

Frisch: How long do you think early hunter-gatherers nursed their babies?

Lieberman: About three years. And they tended to reproduce every three years. So a typical hunter-gatherer mother might be nursing an infant and also have a four- or five-year-old to take care of. In short, human mothers need a lot of energy to provide for both their own body's needs and the needs of their kids who can't hunt or gather yet. The human reproductive strategy requires not only help from fathers and grandparents but also large energy reserves in the form of fat. We are exquisitely adapted to storing fat, because early humans needed it to survive and reproduce, but natural selection never prepared us to deal with the abundance of high-energy foods available today. Hunter-gatherers weren't starving all the time, but they weren't having an easy time of it either.

Frisch: They weren't killing big game every other day.

Lieberman: That's correct. They also couldn't walk to the local supermarket and buy cookies and other foods that provide lots of energy very quickly. So they put on fat to store energy for later use. Getting rid of excess fat wasn't a problem they faced. So we're not adapted to losing weight; we're adapted to keeping it on, which is why dieting is so often futile.

When we diet, we create a negative energy balance and go into what's called a famine response. We become less interested in being physically active, because our body is trying to discourage us from exercising. Reproduction slows or even shuts down. The immune system is dampened.

Frisch: So we're more apt to get sick while on a diet?

Lieberman: Absolutely.

Frisch: What factors in a person's individual makeup and history would predispose him or her to put on weight?

Lieberman: We don't know all of them. Personally I think we worry too much about weight. There's no question that obesity is a problem, but the *kind* of fat you have matters more than how much fat you have. It's belly fat we should be concerned about. Fat in your buttocks, for example, is fine. We evolved to store fat there in large amounts. Stress promotes the storage of belly fat, which is more likely to cause heart disease and diabetes and various other problems. When you exercise, it's the belly fat you burn first. Even if physical activity doesn't make you lose weight overall, it will help redistribute the weight, storing it as the more healthy kind of fat.

Frisch: Should we be looking for a gene for obesity?

Lieberman: I don't think there's anything wrong with doing that. It's important to understand the genetic basis for disease.

Wealthy people tend to be able to afford to be physically active and to eat healthy foods and to reduce stress and to get enough sleep and to stop smoking. There have always been disparities in health between classes, but I worry they are going to widen.

What I worry about is that we will try to cure diseases solely through genetic means. I'm skeptical that genetic research will ever lead to major improvements in terms of obesity and illnesses caused by lack of exercise. The more we look for genes for diabetes and various kinds of cancer, for example, the more we find that there are actually lots of genes for these, and that each individual gene tends to be rare. If you and I both had a single gene that made us prone to diabetes, we would likely have different ones. Many, many genes are involved in a genetic predisposition, and few of them have much of an effect on their own. We're just not going to find easy targets and cure those diseases.

Even if we do, there will be side effects. Let's say you could take a drug that would prevent you from getting fat. And let's imagine, for the sake of fantasy, that this drug had no side effects. You could pop a pill every morning and eat whatever you wanted and never gain weight. Do you honestly believe that you would still exercise for the mental and cardiovascular benefits? I think it would be the Midas curse. We would solve one problem and create a whole host of others.

I'm all in favor of trying to alleviate suffering from the major chronic diseases, but I worry that too much money goes toward treatment rather than prevention. Why can't we spend more money on preventing cancer, which is, to a large extent, a partly preventable disease?

Frisch: Does eating too much contribute to the risk of cancer?

Lieberman: Obesity increases your risk for some cancers — breast cancer and colon cancer among them. When men and women consume excess energy in calories, they shunt more toward reproduction, and their reproductive-hormone levels go up. Reproductive hormones help us to have babies, but they also increase the risk of some cancers in both sexes. Add to that the fact that women today go through many more menstrual cycles than they used to — because they are using birth control and spending less time being pregnant — and the risk for them goes up further. So having more energy, combined with other factors in our environment, is leading to higher rates of certain types of cancer. But exercise helps. If I run five miles

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a day, that's less energy I'm going to send toward elevating reproductive hormones. By some estimates we could halve rates of colon cancer if people exercised more. And breast-cancer rates could go down by as much as 30 percent with more physical activity. How many women know that?

Frisch: Isn't it possible that hunter-gatherers weren't afflicted by cancer and heart disease simply because they didn't live long enough to get them?

Lieberman: There's plenty of evidence that they did live long enough. We can look at the remaining hunter-gatherers today for proof. For example, fully a quarter of the Hadza, who live in Tanzania, are grandparents. The Hadza suffer from high infant mortality, but the ones who don't die in childhood often live into their seventies and eighties.

Frisch: And heart disease and cancer are pretty rare for them?

Lieberman: Heart disease is extremely rare. Among present-day hunter-gatherer populations, we do not see hardening of the arteries or high blood pressure or hypertension with any frequency. In the U.S. we think it's inevitable that our blood pressure increases as we get older, but in a lot of these indigenous populations, older and younger individuals have the same blood pressure. Researchers have even done CT scans on ancient hunter-gatherers preserved as mummies and found evidence of plaque buildup in their arteries, but there's no indication that any of those people died from heart disease.

It's harder to be sure about cancer rates. Hunter-gatherers must get cancer occasionally. It's just a byproduct of multicellular life. There's evidence that dinosaurs got cancer. And as people get older, they're more likely to get cancer. So, to some extent, increased rates of cancer in the U.S. can be attributed to the fact that people are living longer.

Frisch: But that doesn't fully explain the rates of cancer that we're seeing today?

Lieberman: No. Cancer did exist in the past, but at much lower rates. And I have never heard of a hunter-gatherer being diagnosed with Type 2 diabetes.

Frisch: The Pima Indians in southern Arizona and northern Mexico are famous for their high rates of Type 2 diabetes, but reintroducing foods from their native diet can prevent or alleviate it.

Lieberman: If you compare the Pimas on both sides of the border, you'll find that the ones who live in the U.S. have much higher rates of diabetes than the ones on the Mexican side of the border. It's because of the modern American diet. The Pimas are especially susceptible to diabetes because of their genetic makeup; they are less able to handle high-carbohydrate diets and physical inactivity than many other populations.

Frisch: You've also examined changes in our sleep habits. How does what you call "industrial sleep" differ from the sort that humans enjoyed before we became wage workers?

Lieberman: We lock ourselves in quiet rooms, remove all

sensory input, and sleep on soft mattresses. Our ancestors slept on hard mattresses amid a certain degree of chaos: animals howling in the distance, people coming and going around the campfires, and so on. A professor at Emory University named Carol Worthman argues that maybe all that modest chaos sends cues to the brain that enable us to sleep better. Then, of course, there are the effects of electric lights and looking at TV or computer screens before going to bed, which alter hormone levels.

It doesn't help that we get anxious about sleep in this country. We worry about waking up in the middle of the night, which is actually normal. Most populations of the world recognize that there's a first sleep and a second sleep. When they wake, they get up and do something and then go back to bed. But TV commercials tell us that if we wake up in the middle of the night, it means we have insomnia and need to take a sleep aid.

Frisch: Do you think some mental conditions are becoming more common as a result of mismatches? I'm thinking of attention-deficit hyperactivity disorder (ADHD), depression, anxiety, autism.

Lieberman: That's a great question. I'm not an expert on mental health, but there's compelling evidence that physical activity plays a major role in many of these disorders. For example, studies show that if kids can run around instead of being forced to sit in chairs for long periods of time, they don't have problems with ADHD. But do we let them be more active? No. We give them Ritalin.

Frisch: Might ADHD also be caused by eating excess sugar?

Lieberman: I'm sure there are dietary factors as well. The main question is: Are the rising rates of ADHD — or anxiety, or depression, or insomnia — caused primarily by our environment, or are we simply getting better at diagnosing them? We don't have any data from two hundred years ago on ADHD. Is that because people were too ignorant to figure out there was a problem, or is it because the disorder didn't exist?

Frisch: You've suggested that a rise in autoimmune diseases might be the result of the great strides we've taken in minimizing the spread of infectious diseases.

Lieberman: People are still trying to figure this one out. Take Crohn's disease, for example. It used to be very rare. Now it's a modern epidemic. Type 1 diabetes and rheumatoid arthritis are also autoimmune diseases that are becoming more common. Nobody can pinpoint the exact cause of either, but a reasonable hypothesis is that we've altered the population of bacteria and other microorganisms in our environment, yet we still have prehistoric immune systems designed to combat potential invaders. The analogy that's often used is that the immune system is like a teenage boy: if you don't give him something to do, he's going to get into trouble. If you don't give the immune system something to do, it may falsely recognize your own cells as foreign invaders and attack them.

The sterile environments we've created have many benefits. My house is pretty clean. There are no feces lying around. But, again, there's a price to be paid for that. I'm not using my immune system so much, yet it evolved to be used.

Frisch: There have been studies that show asthma rates are lower among children who grow up on farms.

Lieberman: Correct. The most common form of asthma is considered an autoimmune disease. It's likely another mismatch.

Frisch: People seem to be developing allergies to formerly innocuous substances.

Lieberman: We need to figure out how to help our immune systems function better rather than trying to rid the world of potential allergens. That approach is not going to work. We won't solve this problem without taking an evolutionary perspective, because this is, at heart, an evolutionary problem. If you just study the mechanisms of disease, you're never going to come up with a solution.

Frisch: What about Ebola and virulent strains of influenza?

Lieberman: Infectious diseases still kill people, but they are much less prevalent today than they were a few hundred years ago. If you had gone to the hospital around 1900, you'd have found many more people dying from influenza and pneumonia than from heart disease and cancer. But we should still continue to worry about infectious diseases, because they're not gone. They are an enormous problem in the developing world. And hopefully people there will someday get to enjoy the luxury of worrying about cancer and heart disease instead of tuberculosis, malaria, and other infectious diseases.

Frisch: With the rise of antibiotic-resistant pathogens due to the overuse of antibiotics, aren't we creating a new generation of super infections?

Lieberman: Yes, it's a perfect example of why we need to consider evolution. We've ignored the fact that, by producing so many antibiotics, we are promoting the evolution of new antibiotic-resistant microbes.

Frisch: What are your predictions for the future health of the human race?

Lieberman: There's growing attention to the importance of nutrition and physical activity, which is a cause for hope, but my concern is that these trends are very much class driven. Wealthy people tend to be able to afford to be physically active and to eat healthy foods and to reduce stress and to get enough sleep and to stop smoking. There have always been disparities in health between classes, but I worry they are going to widen. Just as we have income inequality, we're heading toward a world in which we see an increased burden of noninfectious chronic diseases in the lower classes.

Frisch: It already exists. Type 2 diabetes is largely a disease of poverty.

Lieberman: I worry that it's getting worse. We're developing a two-tiered system.

The human body is continuing to evolve. We need to think about problems like obesity and cancer in terms of evolutionary processes that have occurred not just in the ancient past, but in the recent past. Geneticist Theodosius Dobzhansky said that nothing in biology makes sense except in the light of evolution. That statement was never more true than it is today. ■