with, including the disk. They see the possibility of treating a host of diseases beyond cancer, including administering stem-cell treatments, with this novel delivery method.

Even if the clinical trials result in something more modest than a cure, says Ali—if the technique enhances survival rates or gives chemotherapy a better chance to work—it could be a huge advance in the fight against cancer, exciting enough for him to postpone a planned move to Malaysia's burgeoning biotech community. The *in situ* approach is "very easy to reproduce" and inexpensive, "so it could be used in both developed and developing countries." Yet he retains a healthy cynicism. "I'm always a bit skeptical," he explains, "because we haven't made the translation" from mice to humans. ~DAN MORRELL

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INDULGENT ENVIRONMENTS

"Dissing" Evolution

PROFESSOR of anthropology Daniel Lieberman believes we can better understand the history and future of human evolution by pondering a single theme: how we take in and expend energy. This theme, he suggests, is crucial to understanding why the human lineage thrived, and influential in modern social and individual ills.

Lieberman's own research focuses on how evolution shaped the human body. The book project he is just beginning aims to synthesize his own and others' recent work in evolutionary biology, including new discoveries from genetics and the fossil record, in an attempt to frame the big picture in a new way.

That story begins seven million years ago, with climate change in Africa at the end of the Miocene Era. As the milieu changed from dense forest to a more open habitat of trees and brush—dispersing customary food sources—our ancestors' anatomy and physiology changed, too. They became bipeds—an ingenious strategy on nature's part, Lieberman notes, because walking upright uses 75 percent less energy than knuckle-walking.

Then, between two and three million years ago, during the late Pliocene Era, the continent cooled still more, and vegetation became even less dense. This time, evolution provided a different response to the changing foodscape: our ancestors became endurance runners, and that enabled them to become carnivores. Gradually, *hominins* (the preferred term for primates—such as the extinct Neanderthals and australopithecines—more closely related to humans than to chimpanzees) also lost their fur and gained an enhanced ability to sweat. That allowed them to stay cool while running long distances at speeds that force animals to gallop and thus eventually overheat and collapse (because they can't simultaneously pant to cool themselves). These physical changes were critical because spear points, the earliest hunting implements, first appear millions of years later. Lieberman believes the high-arched feet and springy legs that enable us to run marathons are not mere flukes of evolution or byproducts, but among the crucial features that enabled the human genus to go forth and prosper.

Becoming meat-eaters not only gave our ancestors the energy to cover more ground but also released a caloric constraint on brain size. The shift enabled them to eat and store the fuel needed to power big brains and the attendant benefits: speech, memory, the use of complicated tools. Once that constraint was released, *Homo* brains grew quickly: the fossil record shows little difference in brain size between australopithecine and other early hominin specimens, but modern human brains are twice that large.

With the genus *Homo*, evolution devised a way of living that was more costly in terms of energy—breast-feeding australopithecines (with their very high energy needs) required about 1,600 calories a day, while the lactating *Homo erectus* female required 2,500—but also more productive, because of the larger brain. Comparison to chimpanzees (our closest living primate relatives) reveals another way modern humans use energy intensively: we produce offspring more frequently. Chimps can give birth only once every five to six years.

All this leads to the current era—which Lieberman casts as an energy crisis in more ways than one. Humans' evolved taste for energy-rich foods, high in sugar and fat, no longer gives a competitive advantage; when food is abundant and procuring it doesn't require physical activity, diseases such as diabetes result. Treat-

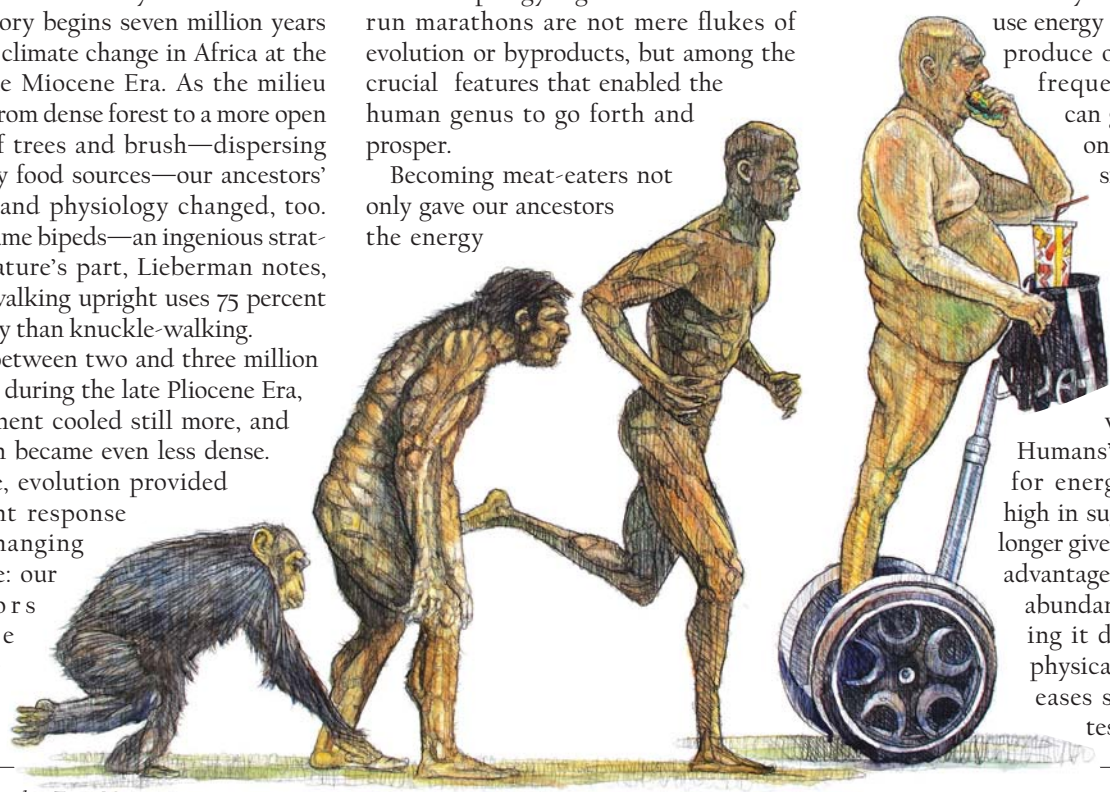

Illustration by Tom Mosser

ments such as insulin injection do protect us from natural selection, which might otherwise filter vulnerability to diabetes out of the gene pool, but they also limit our need, and willingness, to take preventive lifestyle measures. "Our bodies," says Lieberman, "are not well designed for the world that we've created."

The Pima Indians, among whom diabetes was virtually nonexistent at the beginning of the twentieth century, offer an extreme example. Today, roughly half of all Pima adults in the American Southwest are diabetic, yet the tribe's genetic makeup cannot possibly have changed enough in such a short time to explain this rise in disease. Rather, their health changed when they abandoned their traditional diet and became sedentary: environmental changes interacted disastrously with a genetic vulnerability. Returning to a low-fat, low-sugar diet, high in vegetables and low in processed foods, reduces the disease rate even in the presence of that vulnerability.

This case illustrates what Lieberman calls *dys*evolution: we treat symptoms, rather than root causes, of the modern problems caused by adaptations that helped our hunter-gatherer ancestors. And by neglecting root causes, we not only perpetuate the problems, but compound them. Thus we use ever more energy to produce food and run vehicles, for example, and spend ever more money on medical treatments when excess food and inactivity make us sick.

Lieberman is not saying natural selection has ceased to affect humans altogether. It acts—and probably always will act—on traits that affect an individual's chances of reproduction (although, thanks to technology, medicine, and modern conveniences, the number of traits on this list has dwindled.) But we may find ourselves buffeted again by natural selection if we don't change our habits, he warns. The global-warming trend caused by our excessive energy use could lead to major climate changes like those that drove evolution in the Miocene and Pliocene.

To avoid such a fate, he is convinced that we must address modern ills' root causes by changing our lifestyles and thereby altering gene-environment interactions. He emphasizes that he does not advocate genetic engineering or social Darwinism, but, he says, "the ratio of what we spend on treatment versus what we spend on prevention is wrong."

Lieberman recommends policies and practices that would bring us closer to the way our ancestors lived: drive less, take the stairs, raise the gas tax, outlaw corn-fed beef. He advocates more and longer physical-education classes in school, with a focus on endurance exercise. And he believes in giving children the logic behind health advice: don't just tell them not to drink soda and eat potato chips, tell them *why*—sugary beverages and simple starches upset the body's natural balance of hormones that govern the use and storage of energy.

To those who view his ideas as radical, Lieberman says, "It's a question of how alarmed we have to get before we act."

—ELIZABETH GUDRAIS

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