



# Shedding light on **SKIN COLOR**

Nina Jablonski explores how it evolved—and what happens when it does not match the environment

By Ann Gibbons

A few years ago, anthropologist Nina Jablonski faced off with comedian Stephen Colbert on his late-night talk show. He proclaimed that his skin was so white, he could hide in a snow bank. Was it really true, he asked her, that *his* ancestors had dark skin?

Certainly, Jablonski said. If researchers were to “dissect his DNA” they would find evidence that he was descended from black Africans. Colbert, in his conservative persona, feigned shock: “Is it possible that I am

blacker than Barack Obama?”

In her 7 minutes on the show, Jablonski, a biological anthropologist at Pennsylvania State University (Penn State), University Park, got her point across: “Skin color is not about race,” she told Colbert. “It’s about sun and how close our ancestors lived to the equator.” As modern humans spread out of Africa in the past 60,000 years, they adapted to the varying natural light they encountered, from the twilight of northern winters to the blazing sun of the equator, and their

dark skin evolved into a sepia rainbow. It’s a story Jablonski has told in countless radio and TV interviews, two popular books, and a TED talk viewed by nearly 700,000 people online (<http://bit.ly/1tx8Jbs>).

Although skin color is a poor way to classify humans, Jablonski says it does have real implications for health. She argues that in the modern era, as humans of various shades have moved rapidly across hemispheres, their skin has not had time to adapt to different amounts of ultraviolet (UV) light. “You have this lovely gradient of skin color—then, people start moving around,” she says. “Often we’re unaware that we’re living in environments to which our skin is inherently poorly adapted.”

Most white people know that if they live near the equator, they risk skin cancer unless they use sunscreen. But Jablonski argues that other consequences of skin color played crucial roles in its evolution. In the tropics, she says, light-skinned people may face a higher risk of having babies with birth defects, because intense sunlight can destroy folate in the blood. Meanwhile, dark-skinned people who bundle up in frigid northern winters or stay indoors all day in the tropics risk vitamin D deficiency, making them susceptible to rickets, infectious diseases, heart disease, and other health problems. “You can have a desk job in Nairobi, or be a woman wearing the veil in Yemen, or any number of fairly serious scenarios where you don’t get enough vitamin D,” Jablonski says. “This is an enormous game changer for health.”

Some of Jablonski’s ideas remain unproven. Yet her work is injecting a shot of evolutionary perspective into medicine and influencing researchers to test how sunlight affects health. Jablonski has “opened my eyes to so many things I hadn’t thought about,” says perinatal epidemiologist Lisa Bodnar of the University of Pittsburgh in Pennsylvania. Radiation epidemiologist Michael Kimlin of the Queensland University of Technology in Brisbane, Australia, agrees. “We have this brand-new field in which people are suggesting that when we put our bodies in the sun, there are complex interactions,” he says. “What Nina’s doing is not only contributing to evolutionary science ... she’s creating ripples in [biomedical] science and giving people like me hypotheses to test.”

**IF YOU HAD TOLD** Jablonski when she was a girl that she would travel the world giving lectures and be a sought-after speaker on TV, she wouldn’t have believed it. Painfully shy, she grew up collecting butterflies and fossils near her family’s farm, half a mile from the nearest neighbor in western New York. She flubbed her first organized

talk—a 4-H presentation on how to make a crudité tray—because she was so nervous.

Encouragement from her mother and female mentors, including those at Bryn Mawr College, where she earned her undergraduate degree in biology, boosted her confidence and speaking skills. In graduate school at the University of Washington, Seattle, she studied how extinct monkeys in the *Theropithecus* genus, which includes baboons, adapted to grazing on grass. Then she worked at universities in Asia and Australia, studying fossil monkeys in China and Africa for clues to how they adapted to their environment. She became “the reigning expert on Old World monkeys,” says paleo-anthropologist Jay Kelley of Arizona State University, Tempe.

In 1990, a colleague asked her to give a class lecture on an unfamiliar topic: the evolution of skin. As she prepared, Jablonski was surprised by how little was known. Back in the 1930s, researchers had proposed that light skin evolved to provide vitamin D where sunlight was scarce. Skin needs to be struck by sunlight to synthesize the vitamin—essential for bone strength and other aspects of health—and dark skin contains melanin, a remarkably effective natural sunscreen that also reduces vitamin D synthesis. As for dark skin, many researchers believed protection from sunburn and skin cancer was its key advantage.

But Jablonski, like other evolutionists before her, quickly spotted the flaw in that logic: Skin cancer strikes people late in life, after the age when they reproduce. Why would natural selection favor dark skin?

A few weeks after giving her talk, Jablonski heard a lecture on how neural tube birth defects such as spina bifida are linked to deficiencies in folate, a naturally occurring form of vitamin B; she also read that sunlight can destroy folate circulating in the tiny blood vessels of the skin. In a flash of insight, she realized that sunlight would be more likely to zap folate in light-skinned people than in people with dark skin, protected by melanin. Thus natural selection would favor darker skin in environments with strong sunlight. “I sat there literally bouncing around in my chair,” Jablonski recalls. “This is a connection between pigmentation and reproductive success.”

She and her husband, geographer George Chaplin, also of Penn State, compared the worldwide distribution of skin tone with that of ground-level UV light, mapped from satellite data (see graphic, p. 936). In a paper

in 2000, they were able to show quantitatively that skin color is darkest where light is most intense, and palest in dim high latitudes. In Africa, for example, people in humid and cloudy environments are a lighter shade of brown than those at high altitude or along the coasts, where glare from the water boosts UV light. The match between skin tone and UV intensity within the tropics also disproved then-current theories that dark skin evolved in the tropics because it was a better barrier to microbes.

In that paper, Jablonski proposed an evolutionary scenario for dark skin: Like chimpanzees, our ancient ancestors in Africa originally had fair skin covered with hair. When



Nina Jablonski measures the light reflected by a Cape Town woman's skin to test how skin tone can affect vitamin D levels.

they lost body hair in order to keep cool through sweating, perhaps about 1.5 million years ago, their naked skin became darker to protect it from folate-destroying UV light.

This idea is still controversial. “It’s a valid theory and it’s intriguing, but it’s obscure to the folate community,” says Robert Berry, a pediatric epidemiologist at the Centers for Disease Control and Prevention in Atlanta. “There’s virtually no evidence to prove it or disprove it.” In medical circles, the idea that dark skin is an adaptation to skin cancer is still received wisdom, Kimlin says. But Jablonski says that the circumstantial evidence for her hypothesis is growing. One 1996 study found that several women exposed to UV light in tanning beds had babies with spina bifida. Then in February, Kimlin and colleagues reported that the more time healthy white women in Queensland spent in the sun, the less folate circulated in their blood. Given these and other studies, Kimlin concludes, “the idea that darker skin tones could have developed in order to protect folate makes sense.”

Meanwhile, additional research continues to confirm that light skin was favored in dimmer regions, presumably to boost vitamin D synthesis. For example, recent genetic studies show that in the past 70,000 years, Europeans, Asians, and Neandertals independently evolved white skin, using at least three different genes, says Penn State geneticist Mark Shriver, whose team dated when those genes arose. Jablonski is spreading an evolutionary perspective that many still haven’t quite absorbed, says Harvard University immunologist Barry Bloom. “The message that people still don’t understand that just knocks your socks off is that we were all born white on the planet and then we all became black,” he says. Then “some of us got to Europe where being black wasn’t a great advantage, and we became white again.”

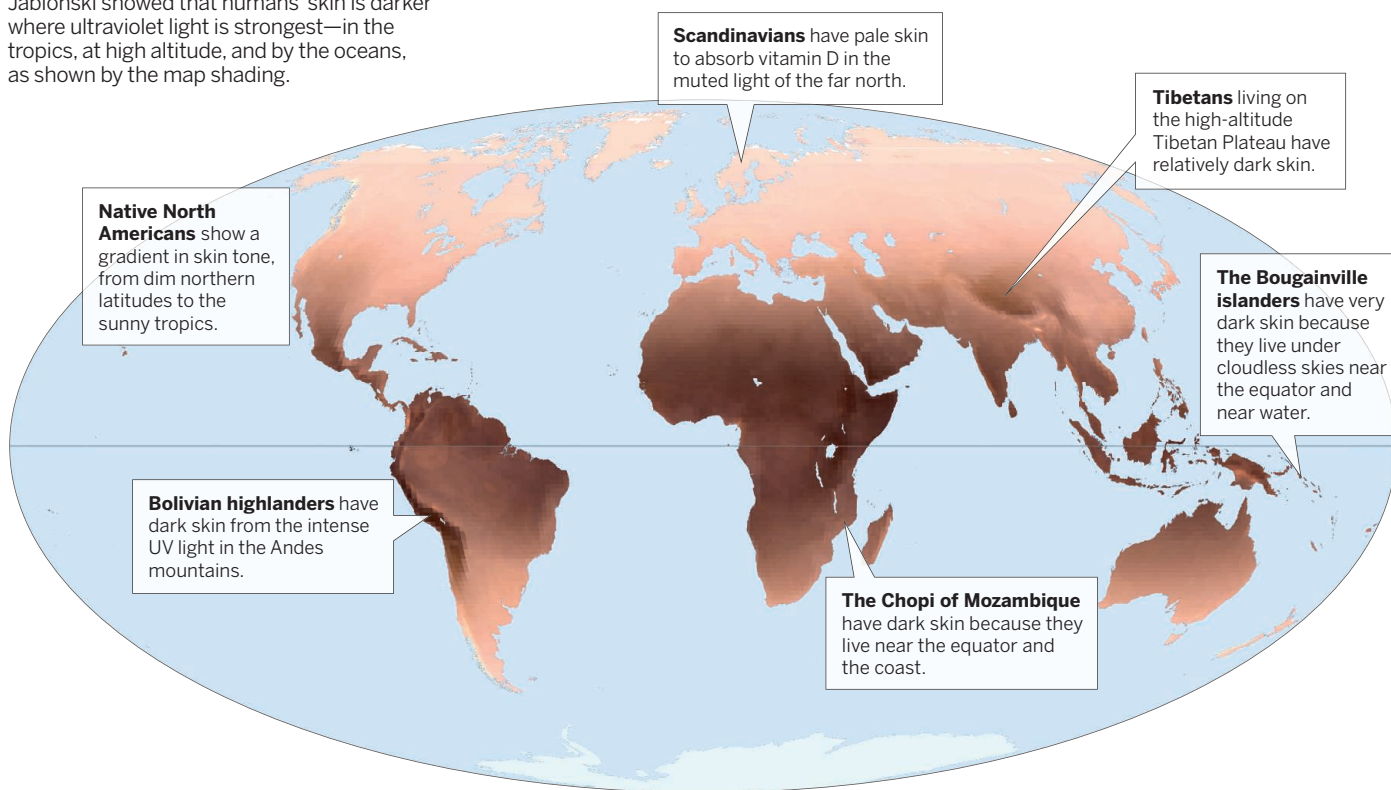
These days, though, people do not always live in the conditions for which evolution equipped them.

**STRUNG ALONG THE MAIN** highway leading to the international airport in Cape Town are the Cape Flats townships, where 600,000 people crowd into makeshift houses of tin, cardboard, and wood. These vast slums, first settled during apartheid when black Africans moved to Cape Town to find work and were forced to live in tents or huts, have improved in the last 20 years. But they are still dangerous, with rampant crime and diseases such as tuberculosis (TB) and AIDS. “This is not a garden spot,” Jablonski says. But it has provided a natural laboratory to test portions of her hypotheses.

In the winter, sandstorms blast the flimsy houses and streets sometimes flood, forcing people inside day and night. The lack of sunshine may explain an additional health hazard facing dark-skinned people in the townships: They have too little vitamin D in their blood, according to an 8-year study of 370 township dwellers. In the study, published in 2011 in the *Proceedings of the National Academy of Sciences*, vitamin D dropped by a mean of 46% in 63% of participants during the winter months of July to September. Then, from October to December, just after these seasonal declines in vitamin D, TB surged citywide, according to study leaders Adrian Martineau and infectious disease physician Robert Wilkinson, both of the MRC National Institute for Medical Research in London. South Africa is third in the world for TB cases, and Cape Town has the nation’s highest incidence.

## Sunshine and skin color

Jablonski showed that humans' skin is darker where ultraviolet light is strongest—in the tropics, at high altitude, and by the oceans, as shown by the map shading.



Lower vitamin D weakens the immune response to the mycobacterium that causes TB, Wilkinson explains. Earlier this year, Harvard's Bloom and his colleagues identified a new molecular pathway in the immune response that requires vitamin D to kill tuberculosis (<http://scim.ag/Montoyaetal>). Wilkinson believes the seasonal drop in vitamin D is a "significant factor" in TB among black Africans, as it is in Europeans.

As in most major cities around the world, Cape Town is home to a spectrum of skin tones. Jablonski predicted that darker skinned township dwellers exposed to little sunlight would produce less vitamin D and get more TB and other infectious diseases than lighter skinned people in the same environments. "This is an evolutionary problem that has very high stakes for health," she says.

Her team joined Wilkinson's in 2012, and they designed a new study, now under way, to test this prediction. Khayelitsha Clinic health care workers draw blood and interview young dark-skinned and moderately pigmented Cape Flats residents about their diet, clothing, work hours, time spent in

doors and outdoors, and other factors. The team also measured how much UV radiation hits the ground close to the Cape Flats.

Jablonski, now analyzing the data, predicts that seasonal fluctuations in UV light will be more important than diet for vitamin D levels, because few people in the

Back in the United States, "overwhelming" data now show that African-Americans are more likely to be deficient in vitamin D than white people and that the health consequences can hit pregnant women particularly hard, says the University of Pittsburgh's Bodnar. In a large analysis of vitamin D levels in 50,000 pregnant women in the United States in the 1960s, she found that low vitamin D was common in blacks—but not whites—and was associated with preterm birth.

Such information needs to be spread more widely, Jablonski says. She and Harvard historian Henry Louis Gates Jr. have teamed up to help teach middle school kids about evolution; as part of the project, they are spreading the message that dark-skinned African-Americans are still paying a health price for being moved to North America. That's true even for those at the highest levels. As Jablonski noted in her TED talk, President Obama, with his "moderately pigmented skin," has a desk job indoors. "So let's all wish for his great health and his awareness of his own skin pigmentation." ■

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**Nina Jablonski**, Pennsylvania State University

study supplement their diet with vitamin D-rich foods, such as oily fish. Surprisingly, many doctors in South Africa have not realized how important it is for dark-skinned people to get enough vitamin D, she says.

She also predicts that the team may end up recommending that South Africa fortify dairy foods with vitamin D, as is done in the United States, or make cheap vitamin D supplements available. (Some researchers question how well supplements work, however [*Science*, 21 September 2012, p. 1476].)