More than skin deep, tanning product of sun's rays

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People who remain pale and never tan can blame their distant ancestors for choosing to live in the northern reaches of the globe and those who easily achieve a deep tan can thank their ancestors for living in the subtropical latitudes, according to Penn State anthropologists.

"The variation of ultraviolet radiation, especially in the middle and high latitudes is great," said Nina Jablonski, professor of anthropology and chair of Penn State's anthropology department. "Tanning has evolved multiple times around the world as a mechanism to partly protect humans from harmful effects of ultraviolet radiation."

Jablonski, working with George Chaplin, senior research associate in anthropology and an expert in geographic information systems, looked at the way the sun illuminates different parts of the Earth. They looked at levels and angles of incidence of both ultraviolet A and B radiation at various latitudes. Ultraviolet B radiation is much more variable than ultraviolet A as latitude increases due to atmospheric scattering of the light and absorption by oxygen.

Ultraviolet B radiation produces vitamin D in human skin. Ultraviolet radiation can, however, destroy folate. Folate is important for the rapid growth of cells, especially during pregnancy where its deficiency can cause neural tube defects.

"What we now recognize is that some of the medical problems seen in darkly pigmented people may be linked at some level to vitamin D

deficiency," said Jablonski. "Things like certain types of cancer in darkly pigmented people and in people who use a lot of sunscreen or always stay inside could be partly related to vitamin D deficiency."

Scientists have understood for years that evolutionary selection of skin pigmentation was caused by the sun. As human ancestors gradually lost their pelts to allow evaporative cooling through sweating, their naked skin was directly exposed to sunlight. In the tropics, where human ancestors evolved and where both ultraviolet radiations are high throughout the year, natural selection created darkly pigmented individuals to protect against the sun.

"Past arguments about the selective value of dark pigmentation focused on the protective effects of melanin against sunburn, skin cancer, and overproduction of vitamin D. These factors can no longer be considered significant selective pressures," the Jablonski and Chaplin report in a recent issue of the Proceedings of the National Academy of Sciences.

Sunburn and most skin cancers do not alter an individual's ability to procreate, so they are not selection factors. The human body also has a mechanism to prevent overproduction of vitamin D.

Previously, the researchers concluded that dark skin pigmentation in the tropics protects people from folate destruction by ultraviolet B, but, because levels of ultraviolet B are high year round, the skin can still allow enough in to manufacture vitamin D.

As humans moved out of Africa, they moved into the subtropics and eventually inhabited areas up to the Arctic Circle. Ultraviolet radiation in these areas is neither consistent nor strong. North or south of 46 degrees latitude, which includes all of Canada, Russia, Scandinavia, Western Europe and Mongolia, there is insufficient ultraviolet B through most of the year to produce vitamin D. Populations in these areas evolved to

have little skin pigmentation.

In the latitudes between 23 and 46 degrees, an area that encompasses North Africa, South America, the Mediterranean and most of China, ultraviolet B radiation is much more variable. Heavily pigmented skin in the winter would block the development of vitamin D, and lightly pigmented skin during the summer would allow destruction of folate.

"We actually demonstrate that in those middle latitudes where highly fluctuating levels of ultraviolet radiation occur throughout the year, tanning has evolved multiple times as a mechanism to partly protect humans from harmful effect of the sun," said Jablonski.

The tanning process evolved for humans who by and large were naked all the time. As the ultraviolet B radiation began to increase in the early spring, the skin would begin to gradually darken. As the sun became stronger, the tan became deeper. During the winter, as ultraviolet B waned, so did the tan, allowing Vitamin D production and protecting folate.

The researchers note that the ability to tan developed in a wide variety of peoples and while the outcome, tanablity, is the same, the underlying genetic mechanisms are not necessarily identical. They also note that depigmentated skin also developed at least three times through different genetic mechanisms.

Implications for today focus on the fact that depigmented people now live in tropical and subtropical areas where besides getting sunburned they run the risk of losing folate. Highly pigmented people live in higher latitudes where they may become vitamin D deficient, especially if they use sunscreens.

"It is a conspiracy of modernity," said Jablonski. "The rapidity at which

we can move long distances and live far away from our ancestral homelands. The fact that we can live and work indoors. All this has happened within the last 500 years and especially within the last 200 years."

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