# Human Skin Pigmentation: Evolution and Significance for Health and Understandings of Race

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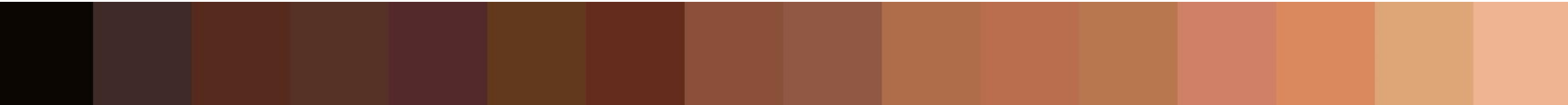

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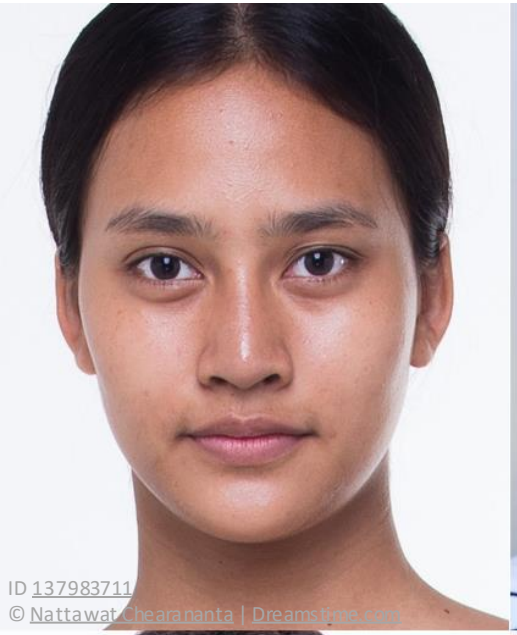
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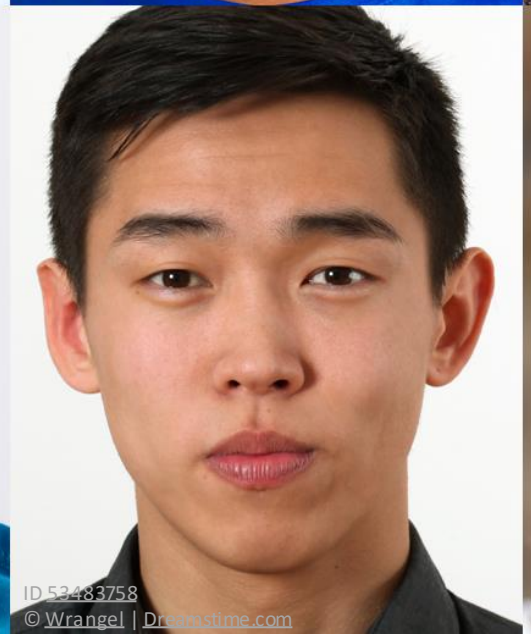
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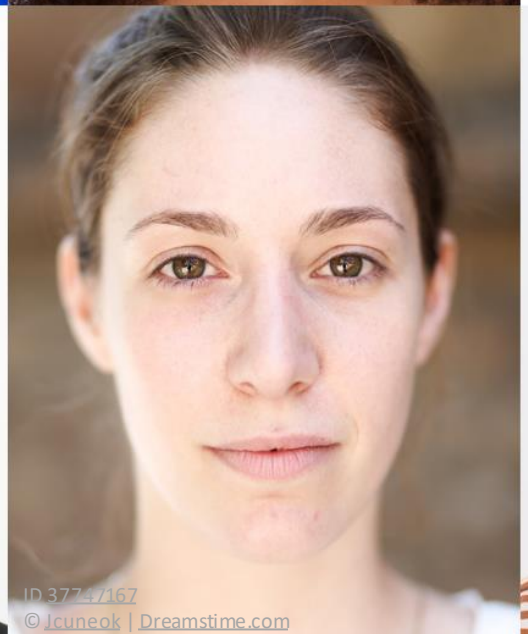
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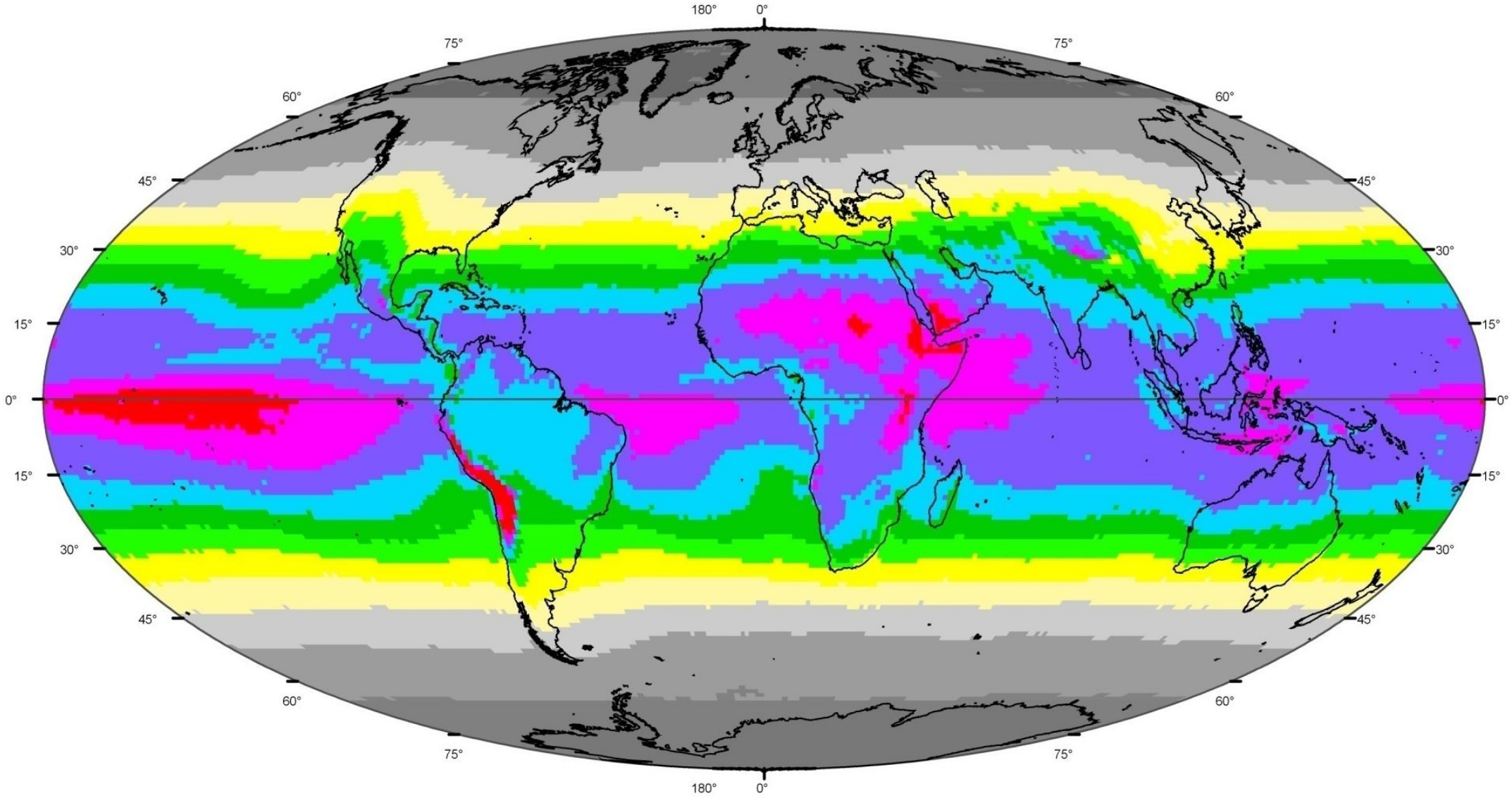
# Annual Average Ultraviolet Radiation (UVMED)




Credit: George Chaplin based on NASA TOMS 7 satellite data. See also: Chaplin, G. (2004). Geographic distribution of environmental factors influencing human skin coloration. *American Journal of Physical Anthropology, 125*(3), 292-302. https://doi.org/10.1002/ajpa.10263

# Skin color measured by skin reflectance is highly correlated to UVMED.

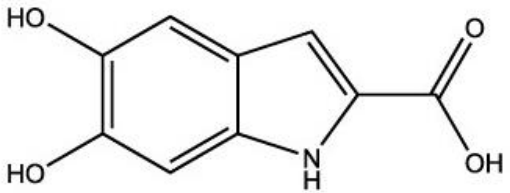
**UVR alone accounts for 86% of variation.**


Jablonski, N. G., & Chaplin, G. (2000). The evolution of human skin coloration. *Journal of Human Evolution, 39*(1), 57-106. https://doi.org/10.1006/jhev.2000.0403

Jablonski, N. G. (2004). The evolution of human skin and skin color. *Annual Review of Anthropology, 33*(1), 585-623. https://doi.org/10.1146/annurev.anthro.33.070203.143955

Chaplin, G. (2004). Geographic distribution of environmental factors influencing human skin coloration. *American Journal of Physical Anthropology, 125*(3), 292-302. https://doi.org/10.1002/ajpa.10263

# Eumelanin is a heterogeneous polymer that absorbs strongly in UV and visible wavelengths

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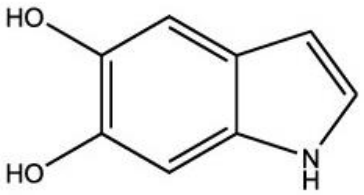


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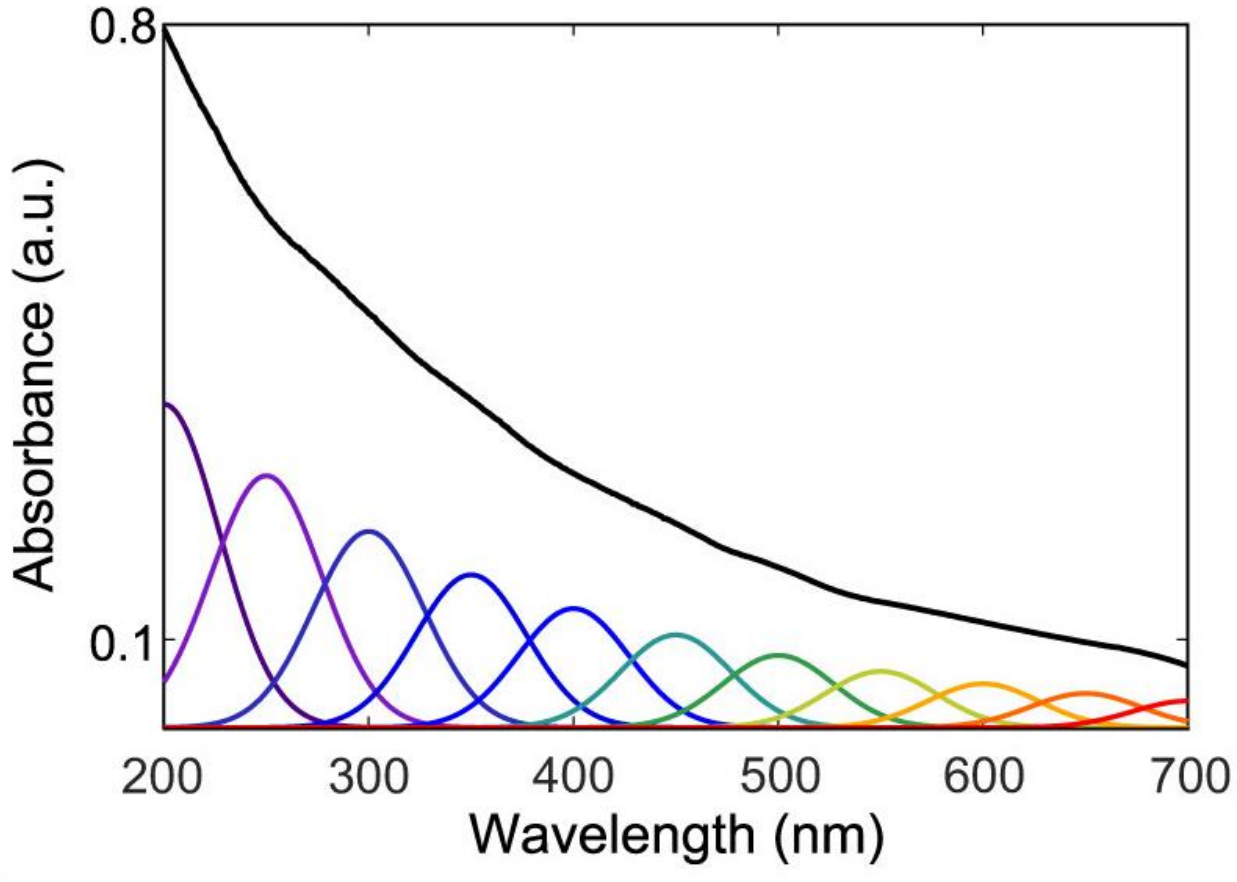
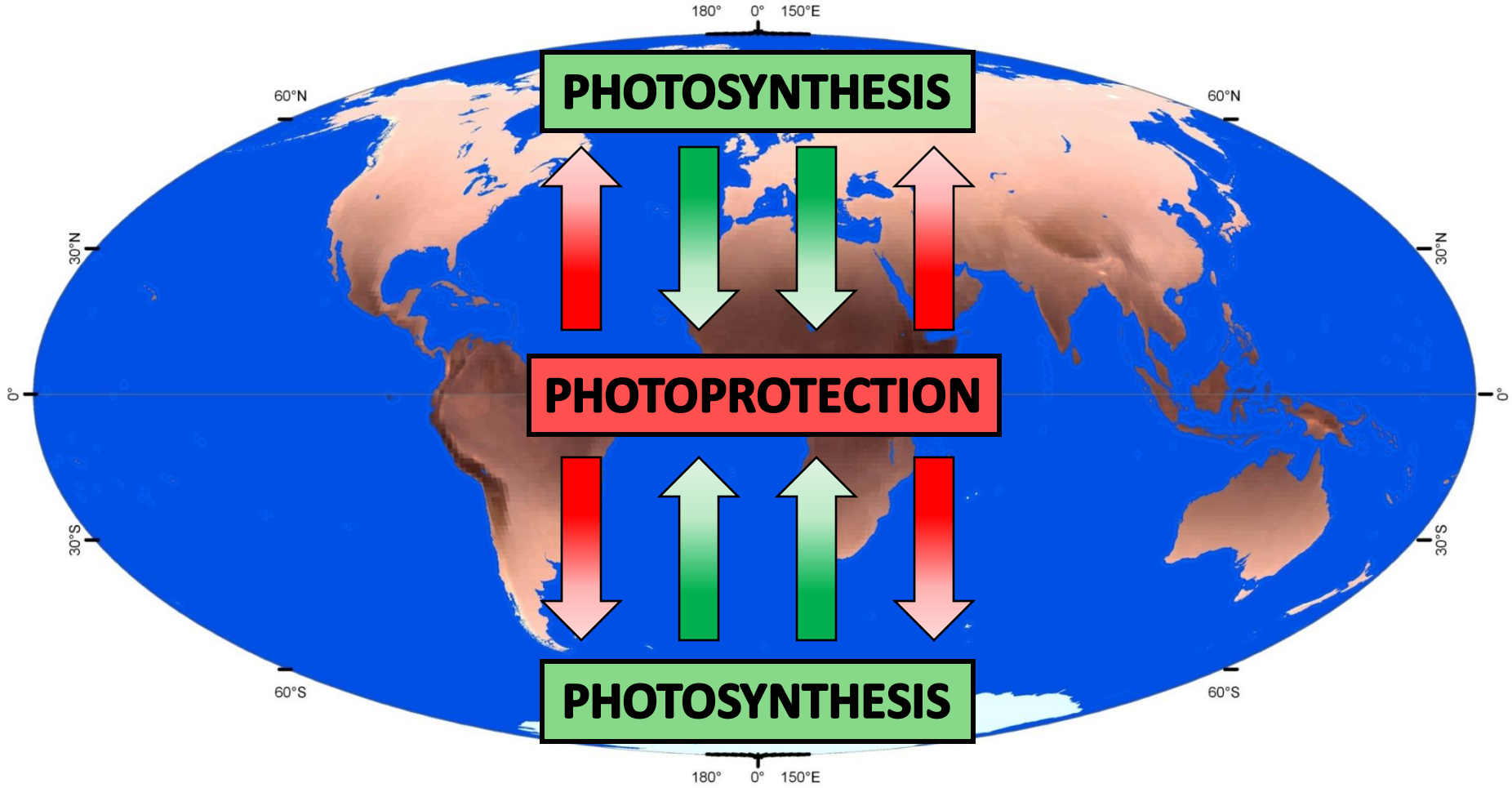



Excerpt from Figure 1. Eumelanin is a heterogeneous ensemble of chromophores: Ilina, A., et al. (2022). The photoprotection mechanism in the black–brown pigment eumelanin. *PNAS, 119*(43), e2212343119-e2212343119. https://doi.org/10.1073/pnas.2212343119

# Skin pigmentation is an evolutionary compromise




Jablonski, N. G., & Chaplin, G. (2010). Colloquium paper: Human skin pigmentation as an adaptation to UV radiation. *PNAS, 107 Suppl 2*, 8962-8968. https://doi.org/10.1073/pnas.0914628107

# Photoprotection against strong UVR:

- Against UVR-induced breakdown of bioactive folates
- Against direct and indirect damage to DNA

# Photosynthesis of vitamin D:

- UVB-induced conversion of 7-DHC to pre-vitamin $D_3$ in the skin

# Together, folate (vitamin B9) and vitamin D play essential roles in maintaining health.

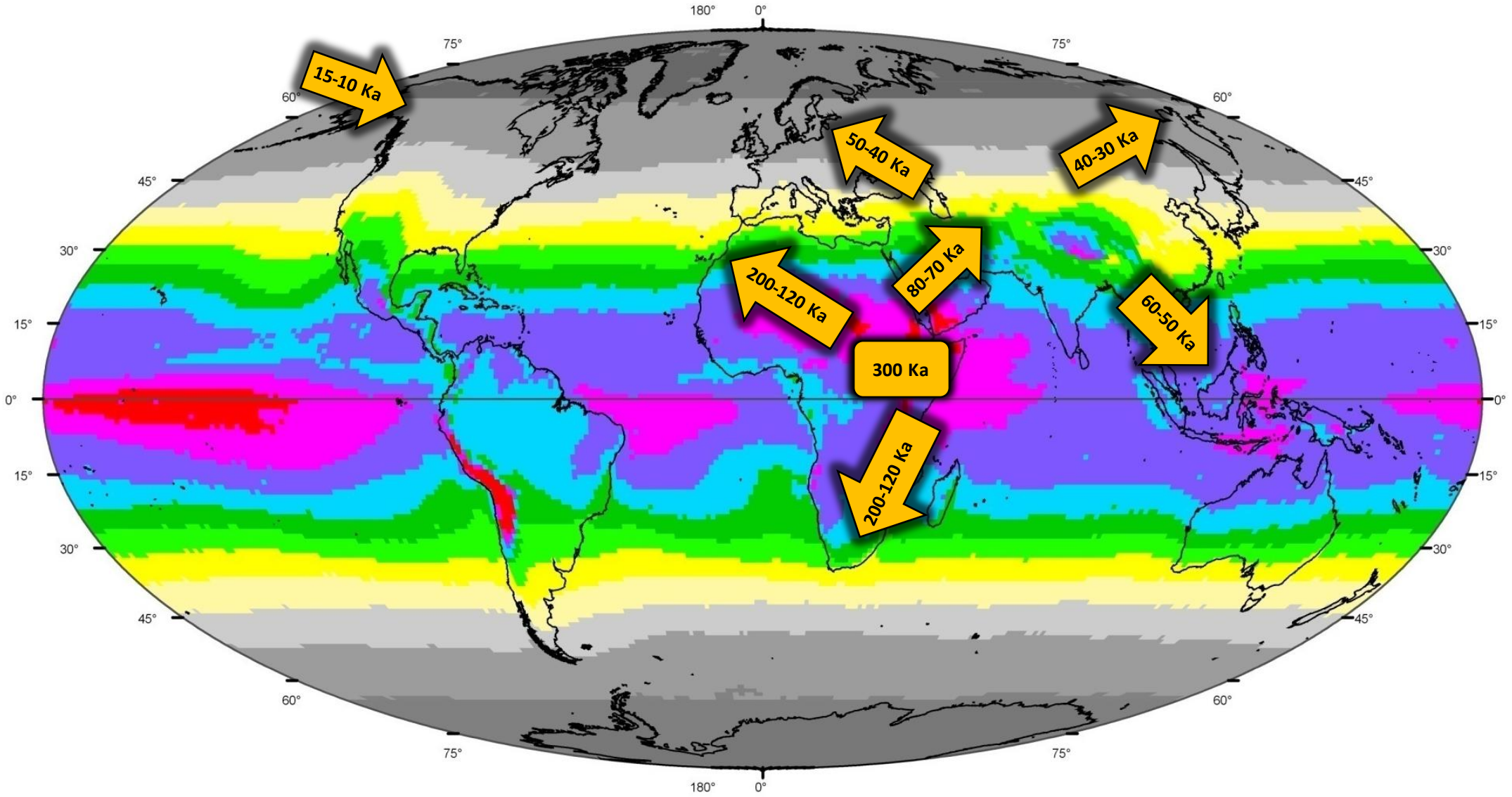
- **Folate is required for protein and nucleic acid synthesis, and thus essential for cell division.**

- **Vitamin D regulates serum calcium and phosphate levels metabolism and is essential for bone health; it also has important roles in immune function and cell proliferation.**

- **Together, folate and vitamin D promote vascular endothelial health and may therefore help mitigate the development of cardiovascular disease.**

Wolf, S. T., Jablonski, N. G., Ferguson, S. B., Alexander, L. M., & Kenney, W. L. (2020). Four weeks of vitamin D supplementation improves nitric oxide-mediated microvascular function in college-aged african americans. *American Journal of Physiology. Heart and Circulatory Physiology, 319*(4), H906-H914. https://doi.org/10.1152/AJPHEART.00631.2020

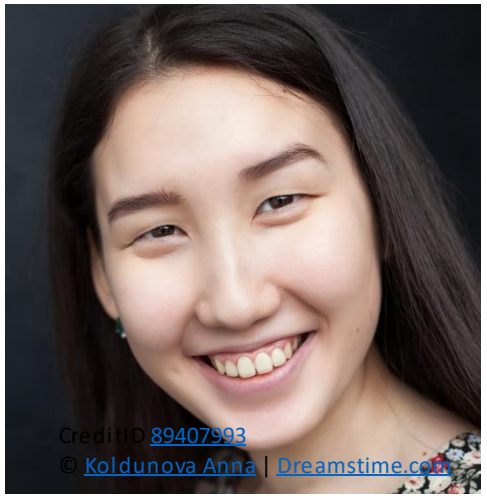
# Annual average UVMED and *Homo sapiens* dispersals




Credit: George Chaplin based on NASA TOMS 7 satellite data

# Similar skin color phenotypes evolved multiple times from different suites of genetic variants under similar UVR conditions.

Jablonski, N. G. (2021). The evolution of human skin pigmentation involved the interactions of genetic, environmental, and cultural variables. *Pigment Cell and Melanoma Research, 34*(4), 707-729. https://doi.org/10.1111/pcmr.12976


- **Lightly pigmented**
- **No or limited tanning ability**




- **Moderately to darkly pigmented**
- **Significant tanning ability**

# Many genes and gene variants (SNPs) affect the production, transport, and persistence of melanins in the skin.

| Gene | Function |
|---|---|
| | |
| *TYR* | |
| *GMR5 (TYR)* | Possible regulation of *TYR* expression |
| *IRF4* | Regulation of *TYR* expression |
| *TYRP1* | Melanogenic enzyme |
| *OCA2* | Regulation of melanogenesis |
| *HERC2 (OCA2)* | Regulation of *OCA2* expression |
| *APBA2 (OCA2)* | Possible regulation of *OCA2* expression |
| *SLC24A5* | Regulation of melanogenesis |
| *SLC45A2* | Regulation of melanogenesis |
| *MC1R* | Promotion of eumelanin synthesis |
| *ASIP* | *MC1R* antagonist |
| *KITLG* | Regulation of melanocyte migration |
| *MFSD12* | Possible suppression of melanin content in melanocytes |
| *DDB1/TMEM138* | Ultraviolet response and DNA damage repair |
| *OPRM1* | Opioid receptor |
| *EGFR* | Epidermal growth factor receptor |
| *BEND7/PRPF18* | Possible regulation of gene expression |
| *UGT1A* | Influence on bilirubin conjugation |
| *BNC2* | Possible regulation of expression of pigmentation genes |
| *SMARCA2/VLDLR* | Possible regulation of expression of pigmentation genes |
| *SNX13* | Involvement in intracellular trafficking |

Excerpt from Table 1 Genes and polymorphisms associated with skin color variation: Rocha, J. (2020). The evolutionary history of human skin pigmentation. *Journal of Molecular Evolution, 88*(1), 77-87. https://doi.org/10.1007/s00239-019-09902-7

**Skin color has no value in human classification.**

## Linnaeus (1740)

**Homo variat:**

- Europaeus alba
- Americanus rubescens
- Asiaticus fuscus
- Africanus niger

## Kant (1775-1778)

**Races:**

- The race of the Whites
- The Negro race
- The Hunish race (incl. Americans)
- The Hindu or Hindustani race

## Blumenbach (1779)

**Five races:**

Caucasian or white race
Mongolian or yellow race
Malayan or brown race
Ethiopian or black race
American or red race

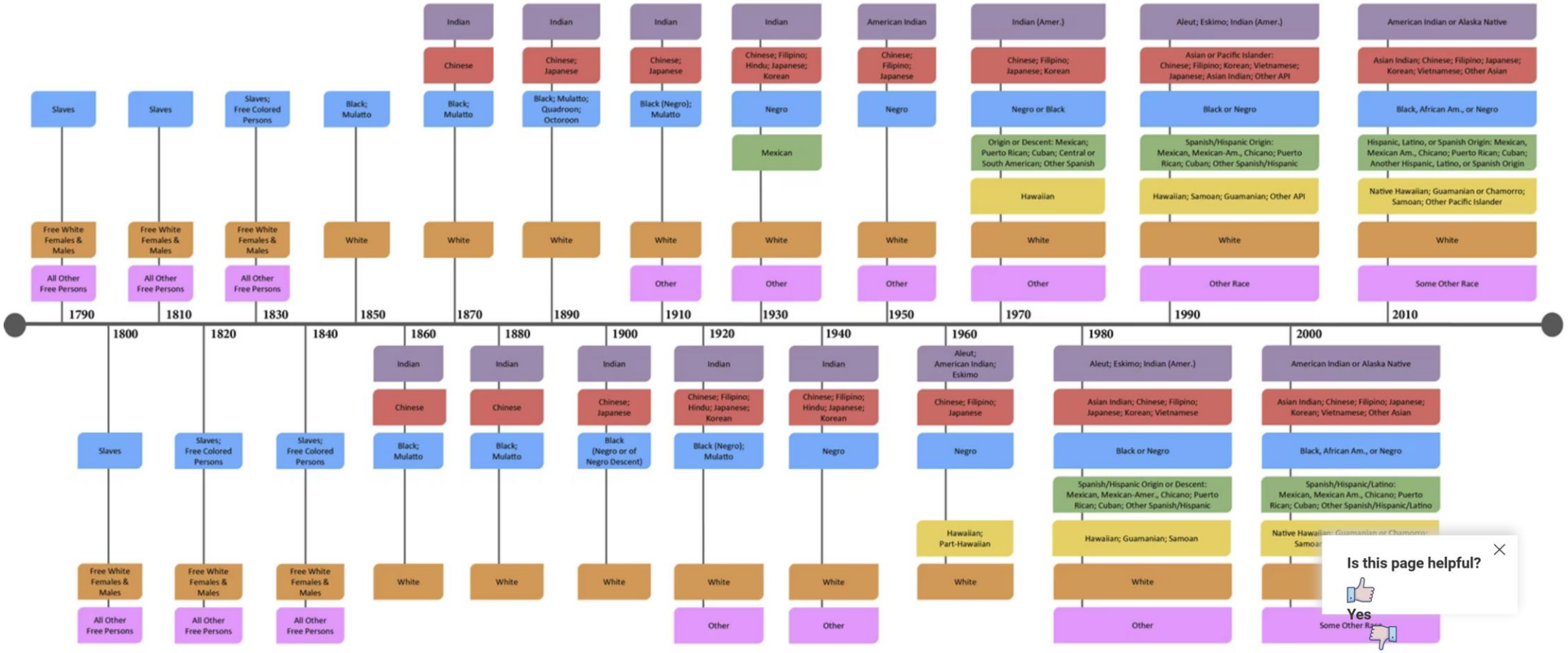
Jablonski, N. G. (2021). Skin color and race. *American Journal of Physical Anthropology, 175*(2), 437-447. https://doi.org/10.1002/ajpa.24200

United States Census Bureau

https://www.census.gov/data-tools/demo/race/MREAD_1790_2010.html

# Measuring Race and Ethnicity Across the Decades: 1790–2010

## Mapped to 1997 U.S. Office of Management and Budget Classification Standards




Gibson, Campbell, and Kay Jung. 2002. "Historical Census Statistics on Population By Race, 1790 to 1990, and By Hispanic Origin, 1790 to 1990, For The United States, Regions, Divisions, and States."
Humes, Karen, and Howard Hogan. 2009. "Measurement of Race and Ethnicity in a Changing, Multicultural America."
Humes, Karen R., Nicholas A. Jones, and Roberto R. Ramirez. 2011. "Overview of Race and Hispanic Origin: 2010."
Office of Management and Budget. 1978. "Statistical directive no. 15: Race and ethnic standards for federal agencies and administrative reporting."
Office of Management and Budget. 1997. "Revisions to the standards for the classification of federal data on race and ethnicity."
U.S. Census Bureau History Questionnaires. (2014, March 31).



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**Infographic**:
"MEASURING RACE AND ETHNICITY ACROSS THE DECADES, 1790-2010"

- **Categorical classifications and hierarchies of skin color-based races exist in different countries.**

- **These systems were promoted by economic forces supported by race science and pseudo-theology, and by networks of influential people.**

- **Color-based races became fixed as the result of census categorization, physical segregation, ongoing racism, and practices of self-identification.**

Jablonski, N. G. (2021). Skin color and race. *American Journal of Physical Anthropology, 175*(2), 437-447. https://doi.org/10.1002/ajpa.24200

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