How a dermatopathologist can integrate new insights in hair genetics

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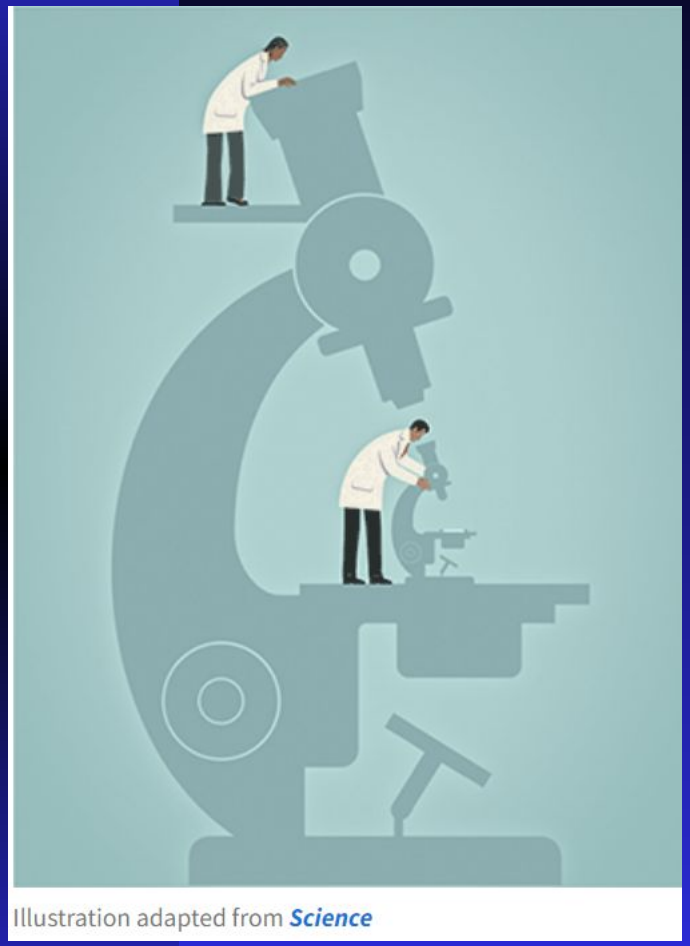
www.barcelonahair.org

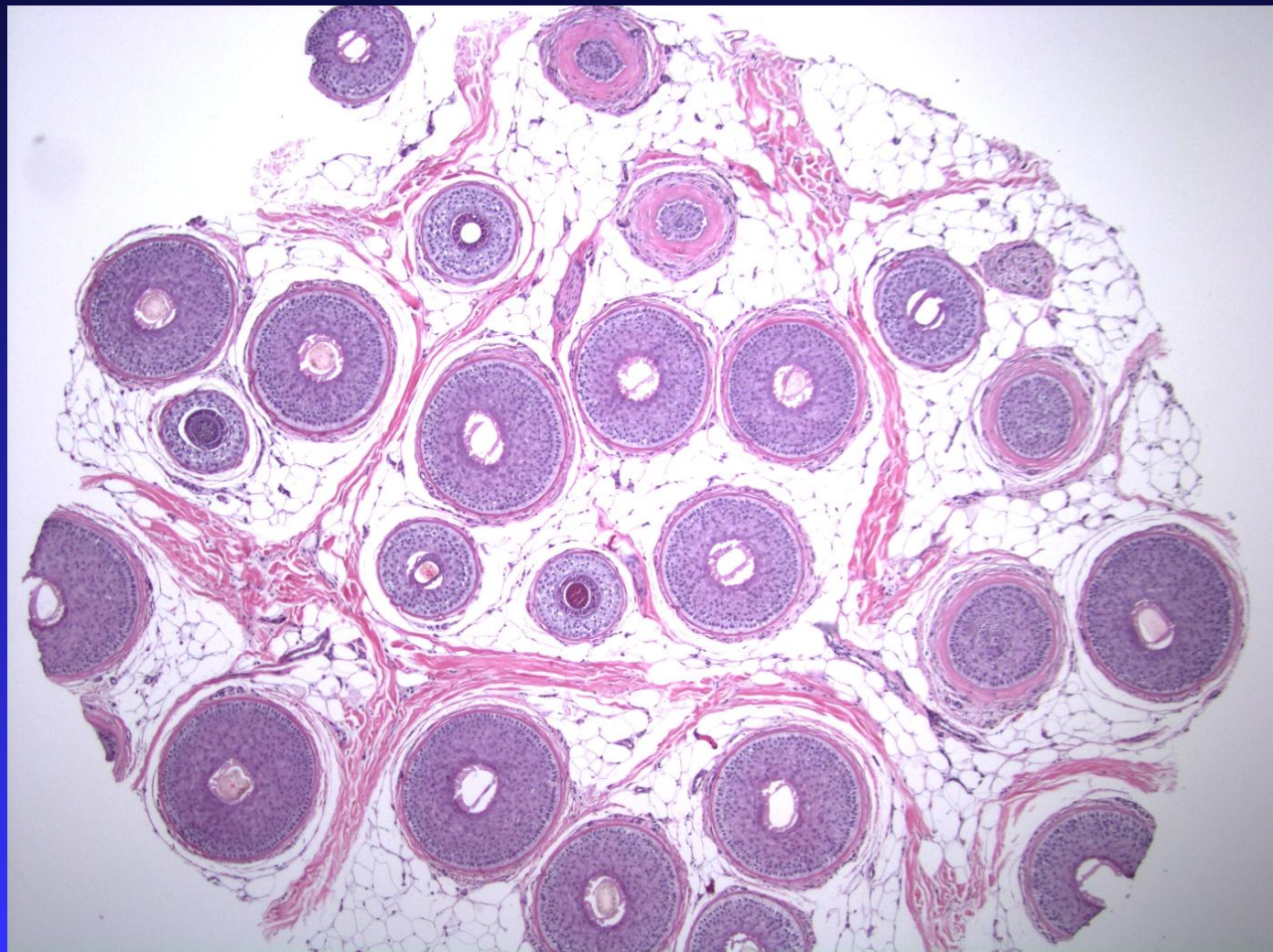


- Size
- Growth cycle
  - (Anagen/catagen/telogen)
- Density

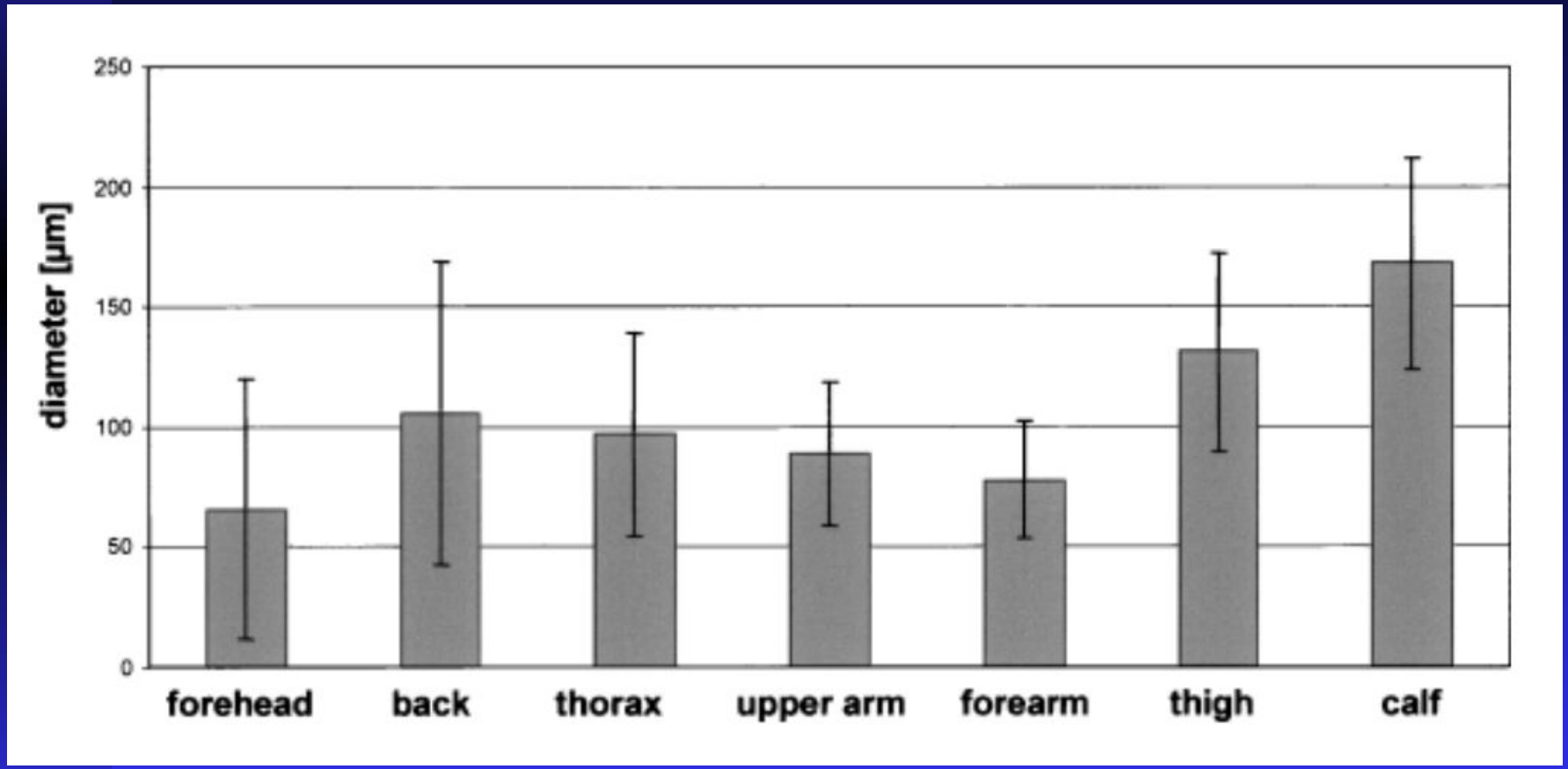
Normal Follicular Size

- 4:1 Terminal:Vellus
  - Terminal
    - Bulbs in subcutis
    - Thicker than 0.06mm
  - Vellus or Miniaturized
    - ½ diameter of terminal (0.03mm)
    - Inner root sheath as thick as hair shaft
    - Not pigmented

Normal

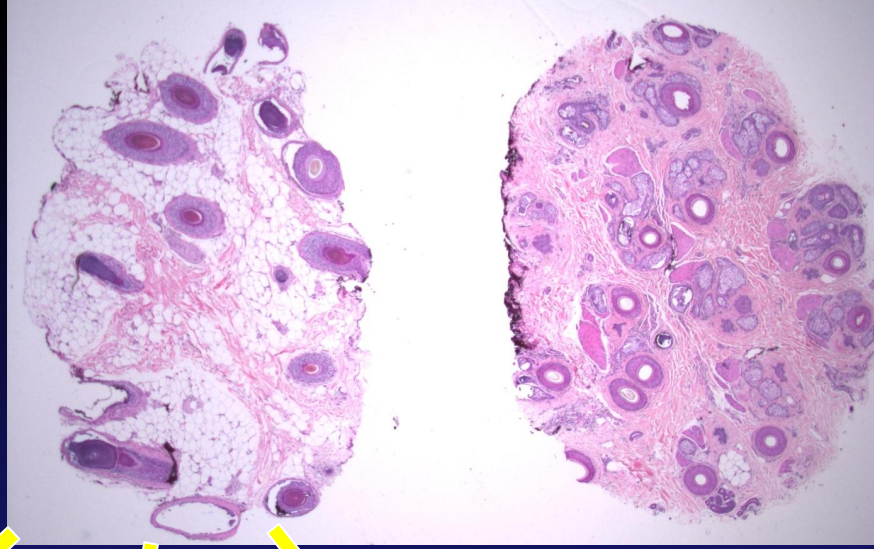


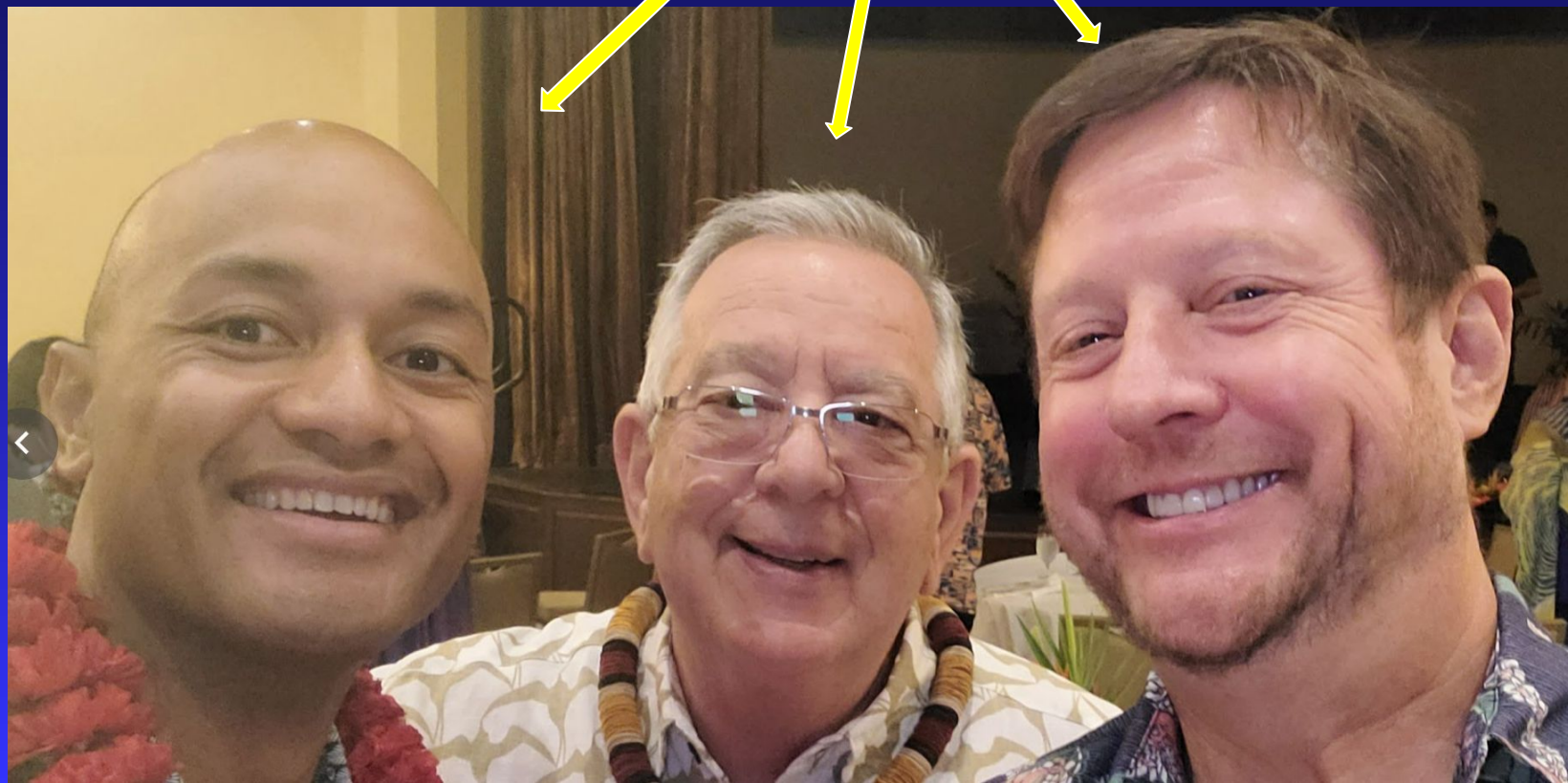
Anatomic site variation in size



Otberg N et al. Variations of Hair Follicle Size and Distribution in Different Body Sites. J Invest Dermatol 122:14-19, 2004.

Miniaturization

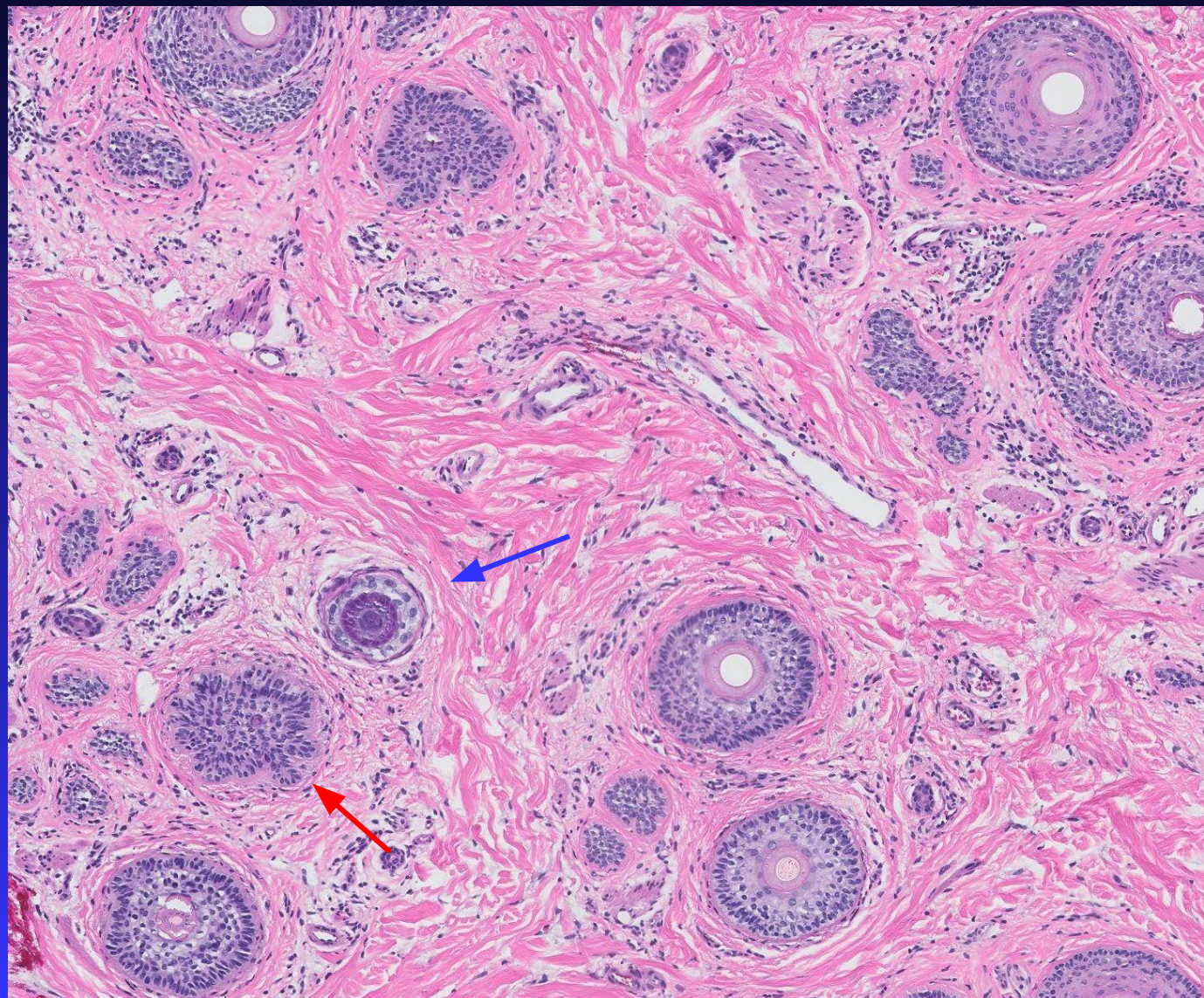




Miniaturization
Two primary diagnoses

- Female/male pattern hair loss
  - Androgenetic
  - Senescence
- Alopecia areata

Alopecia areata?



Alopecia Areata-like Pattern

- Psoriasis
- Lupus erythematosus
- Syphilis
- Permanent chemotherapy induced alopecia (pCIA)
- Systemic amyloidosis
- Linear morphea (en coup de sabre)

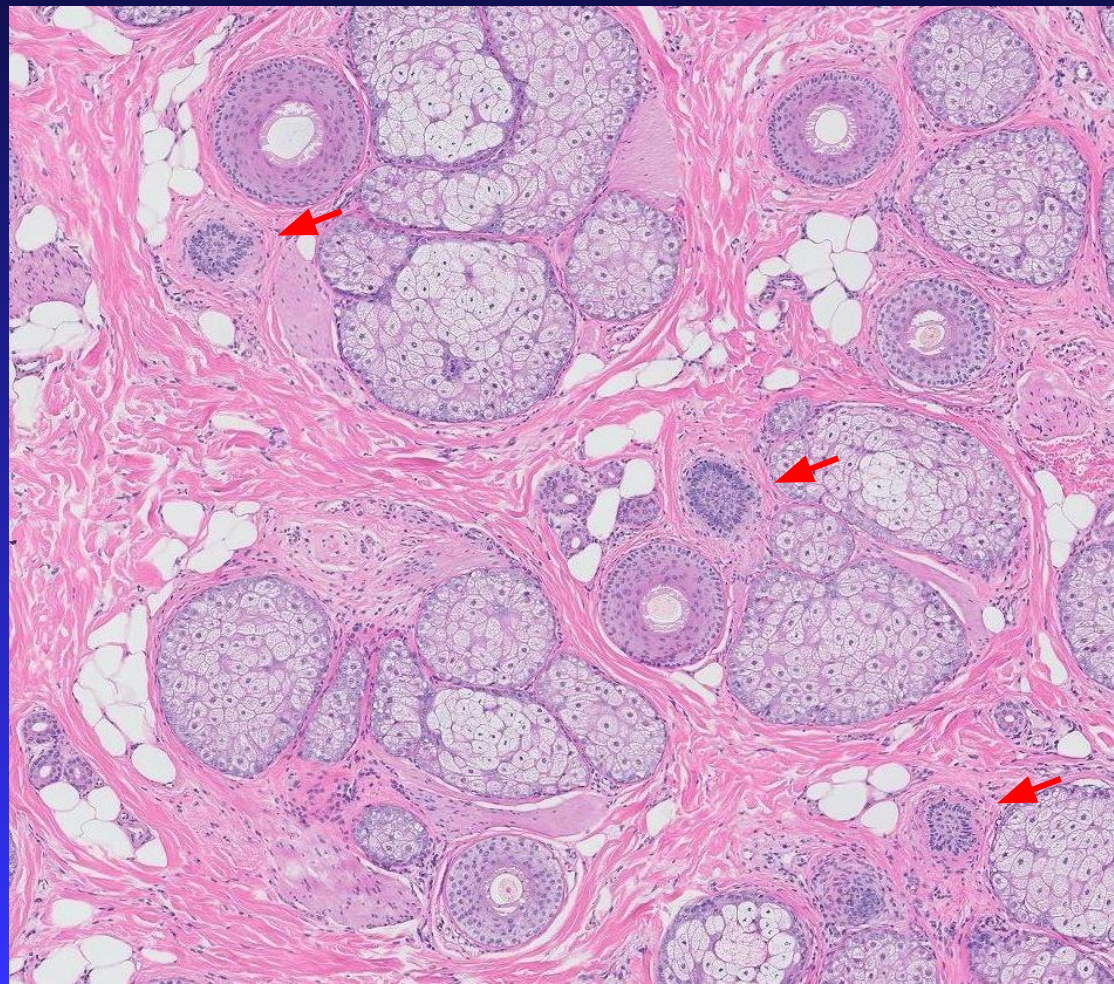
Science. 1998 Jan 30;279(5351):720-4. doi: 10.1126/science.279.5351.720.

Alopecia universalis associated with a mutation in the human hairless gene

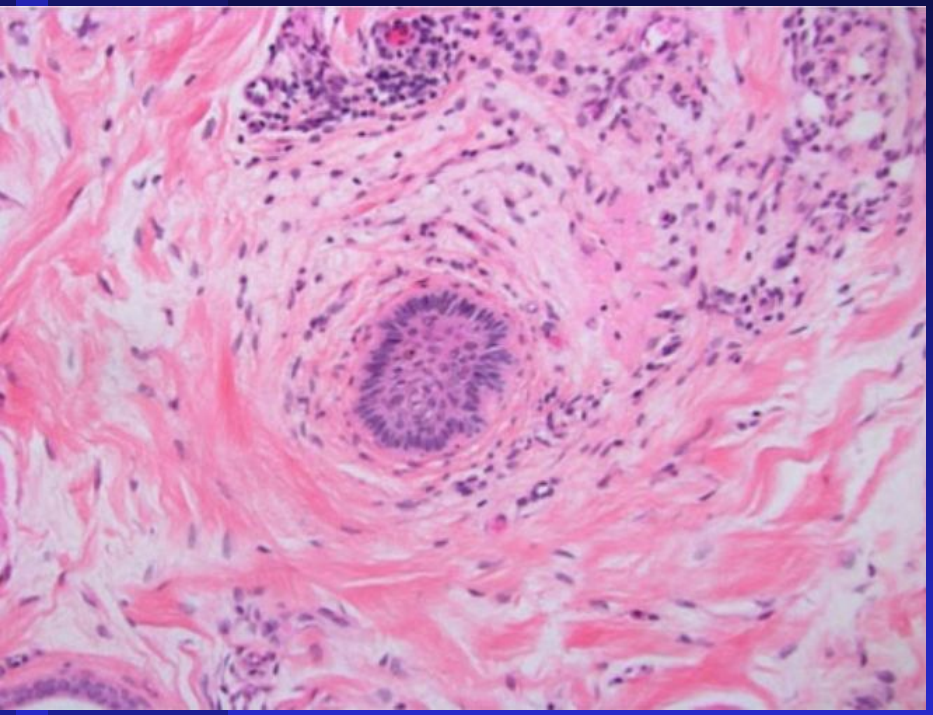
W Ahmad [1], M Faiyaz ul Haque, V Brancolini, H C Tsou, S ul Haque, H Lam, V M Aita, J Owen, M deBlaquiere, J Frank, P B Cserhalmi-Friedman, A Leask, J A McGrath, M Peacocke, M Ahmad, J Ott, A M Christiano

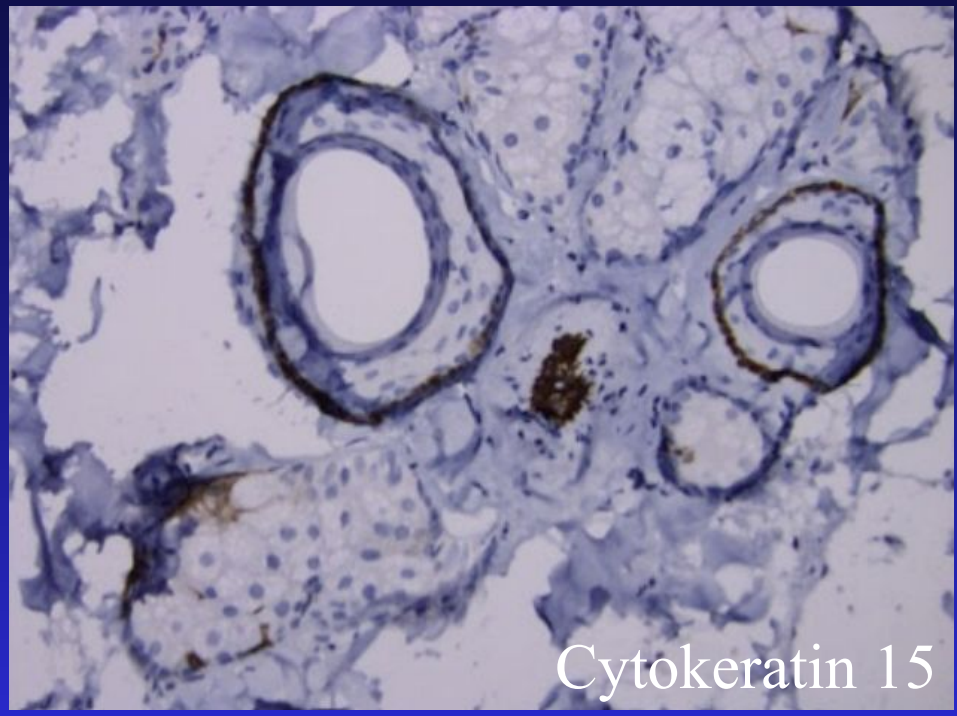
http://www.dermweb.com/hairnailsmucousmembranes/sideviewbaldmanpage.htm

Cell cycle phases

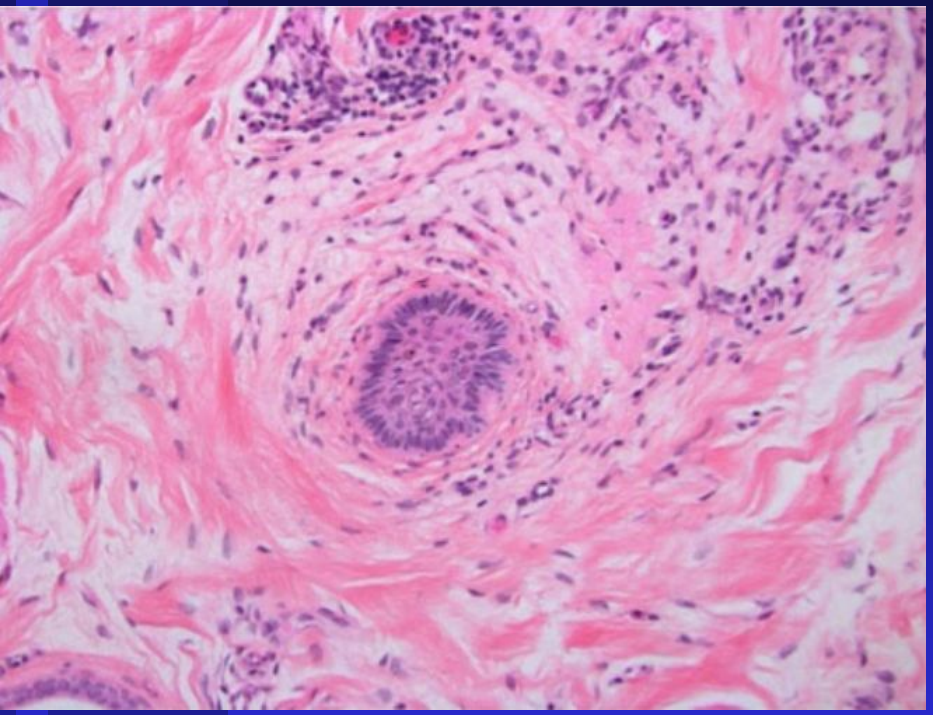


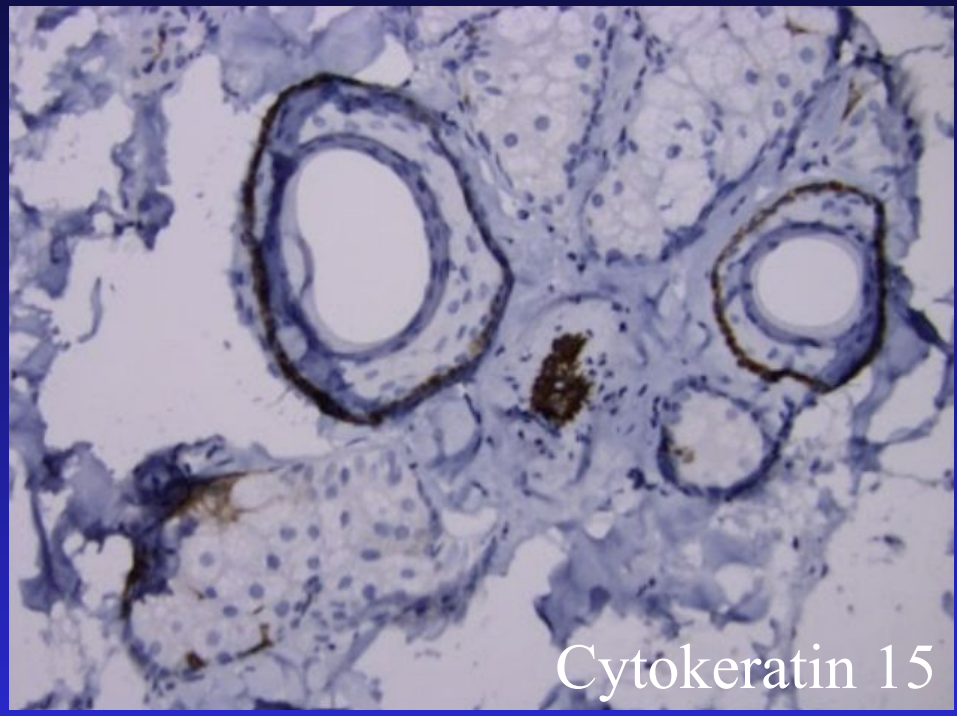
Anagen phase = Hair length





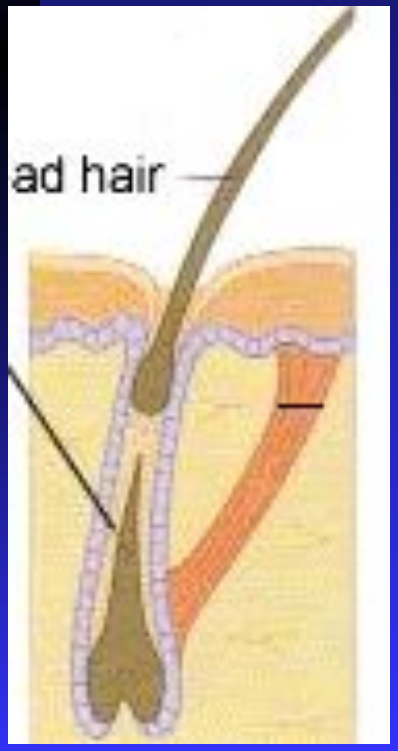
More catagen = Shorter hair

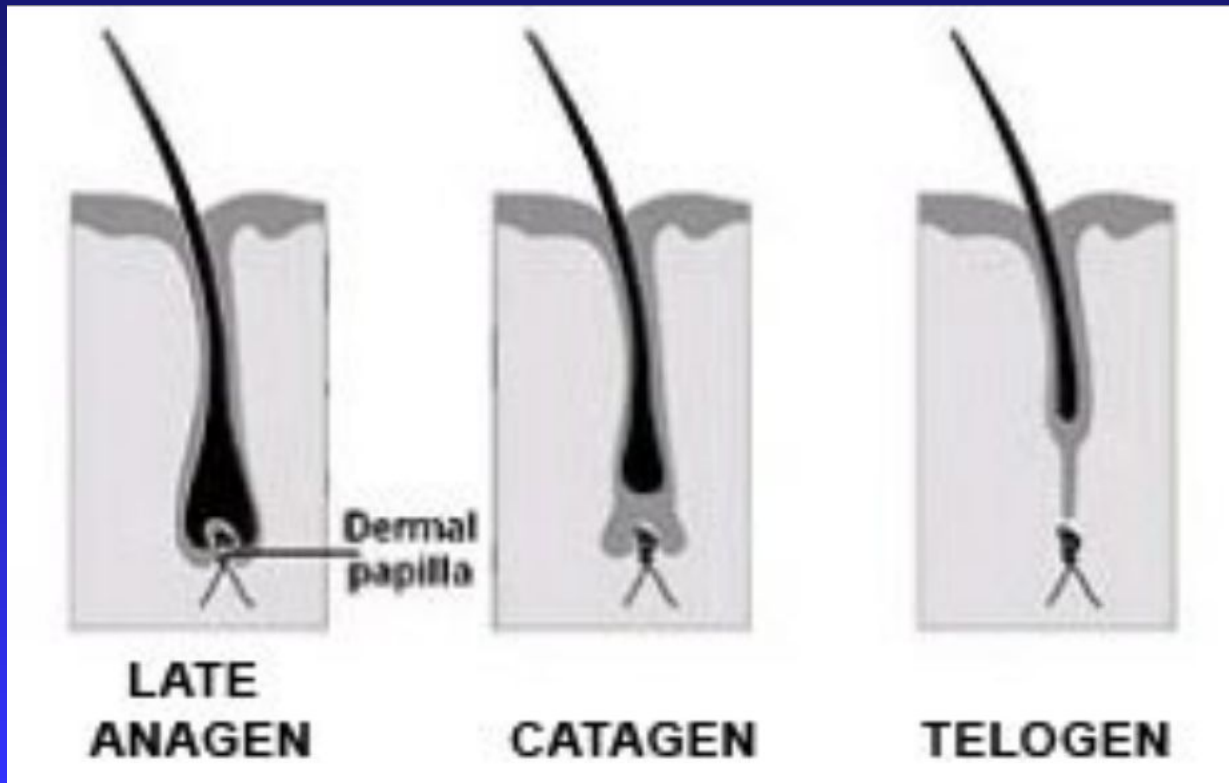




Meaning of catagen/telogen

- Shorter growth cycle
- Stuck in catagen/telogen





Evolution toward human hairlessness

- Decreased hair cover
- Increased eccrine sweat gland density
- Increase subcutaneous fat thickness

Kamberov YT et al. Comparative evidence for the independent evolution of hair and sweat gland traits in primates. J Hum Evol 125:99-105, 2018.

Hair density

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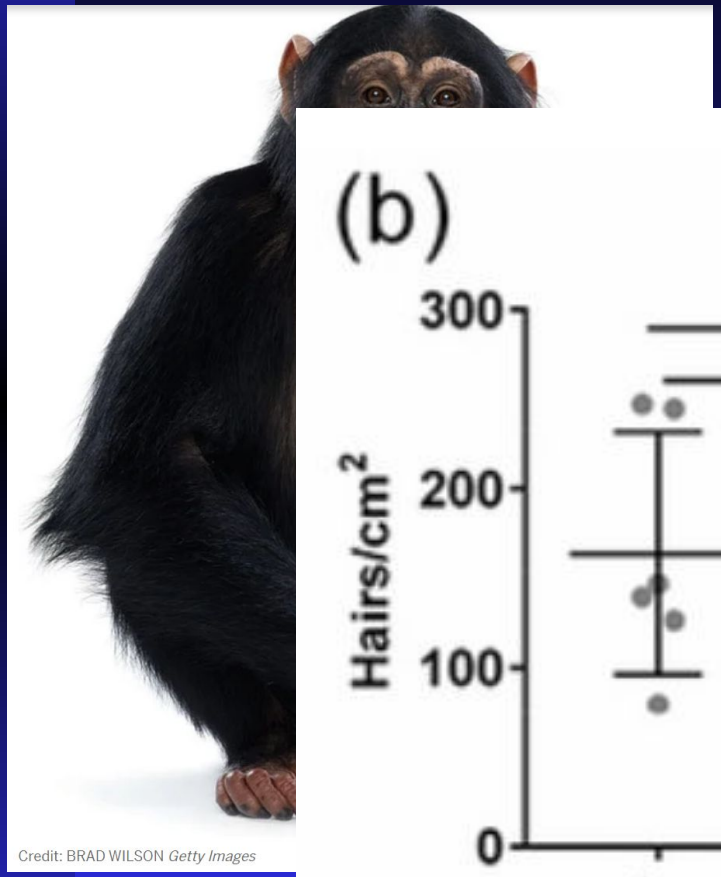
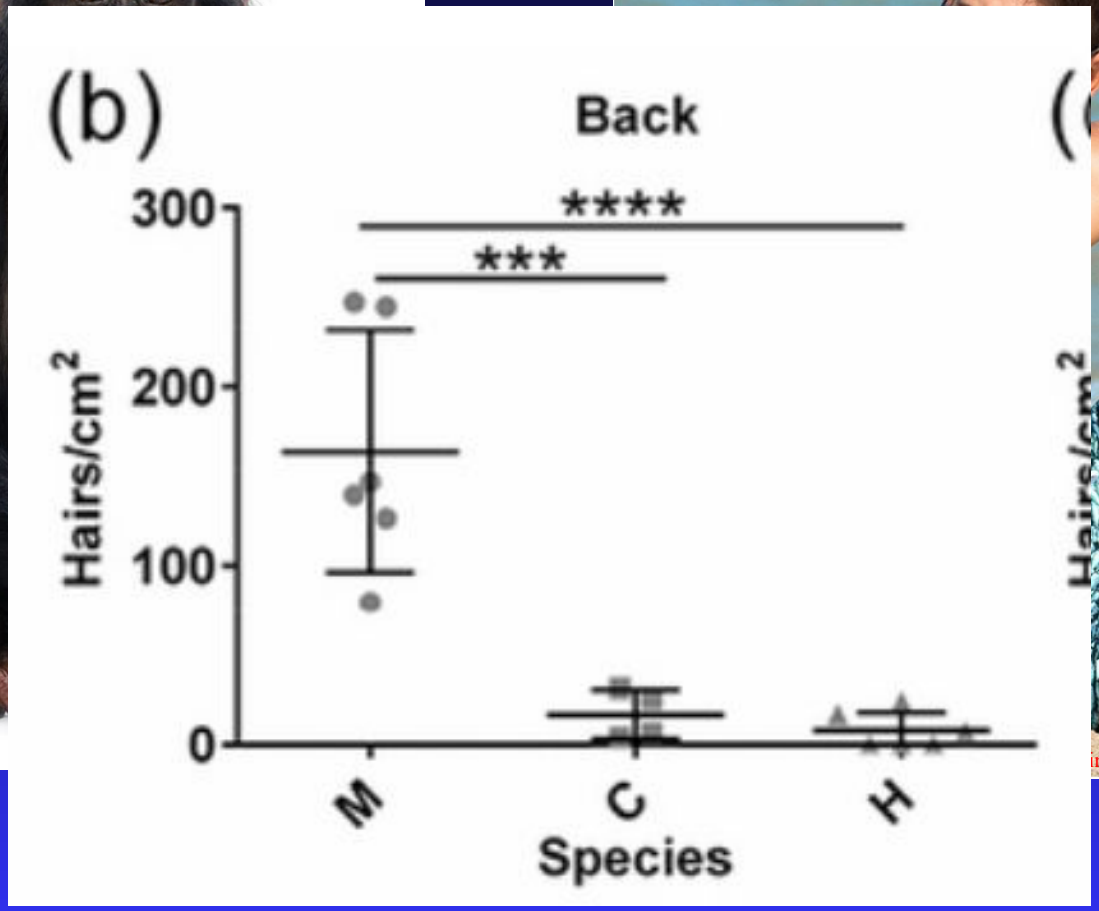
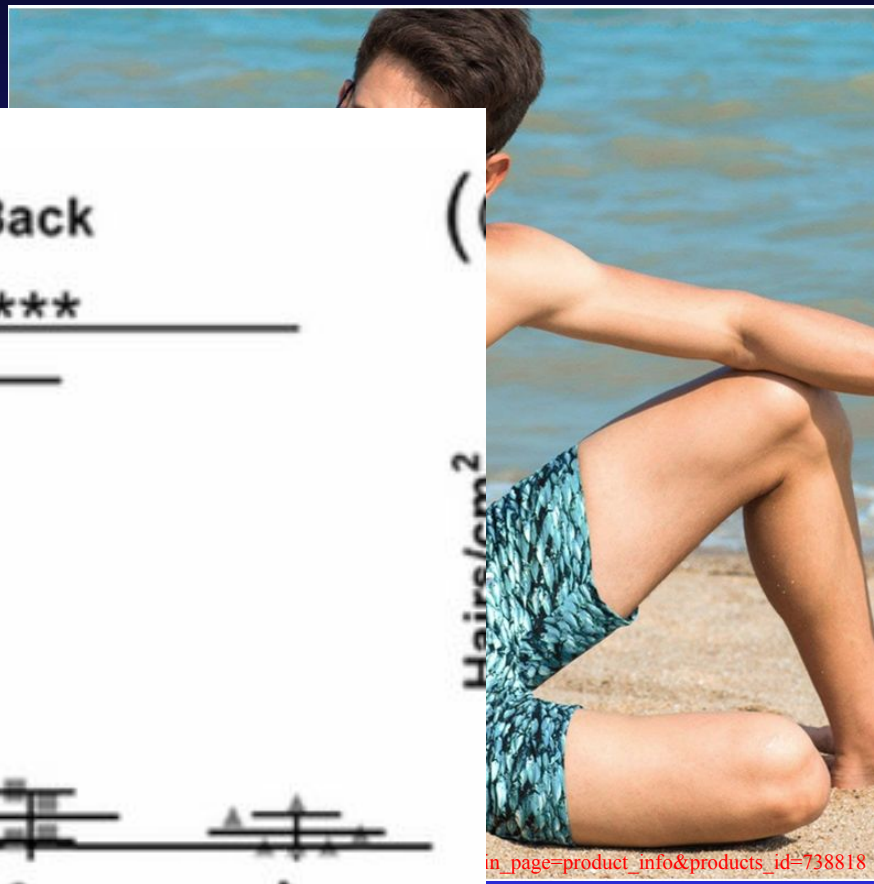
Hair density







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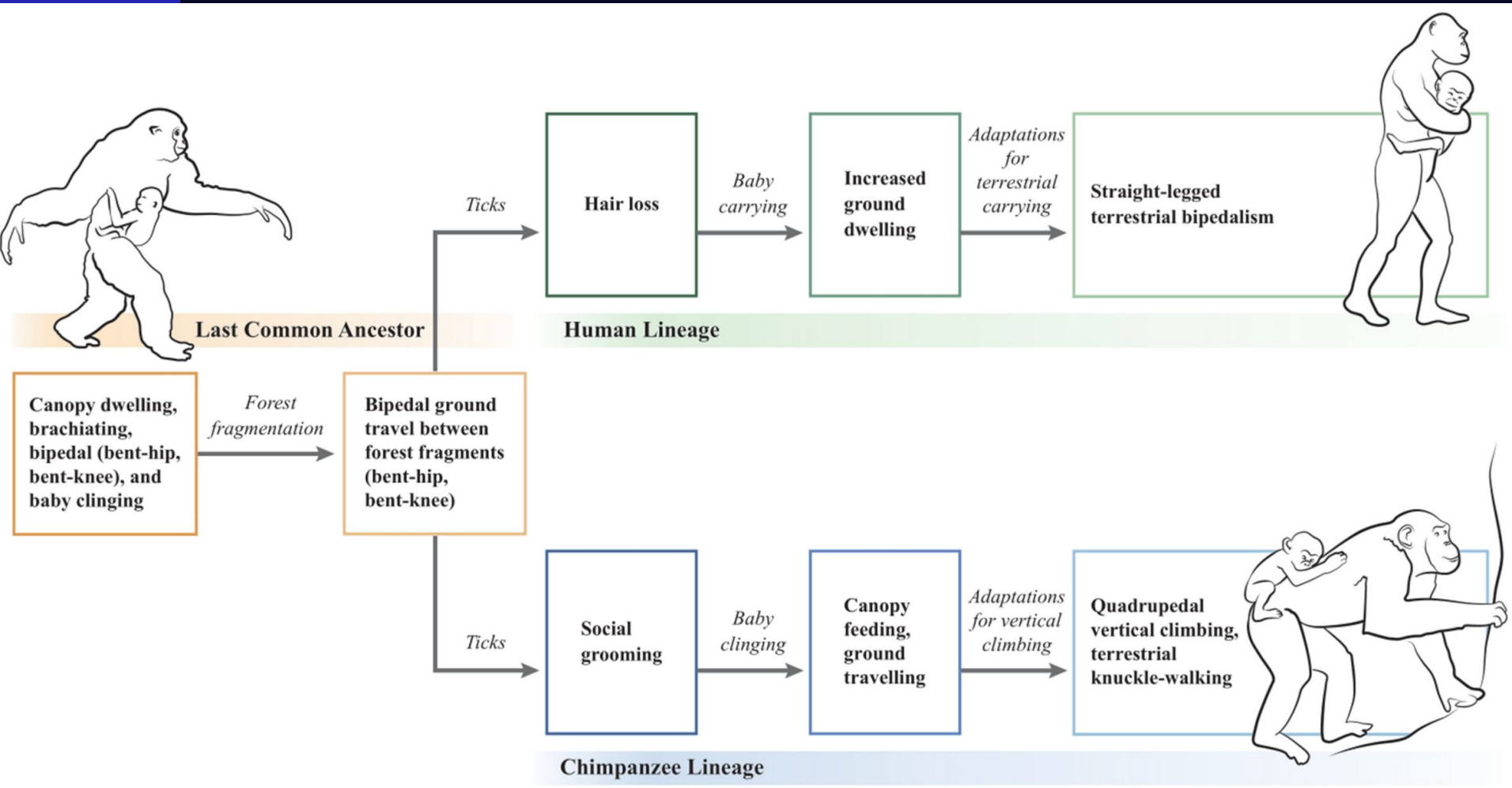
Why evolve to less hair cover?

- Temperature Regulation
  - Changing behavior
    - Hunting in the day—safer
  - Fire—temperature control better
  - Clothing

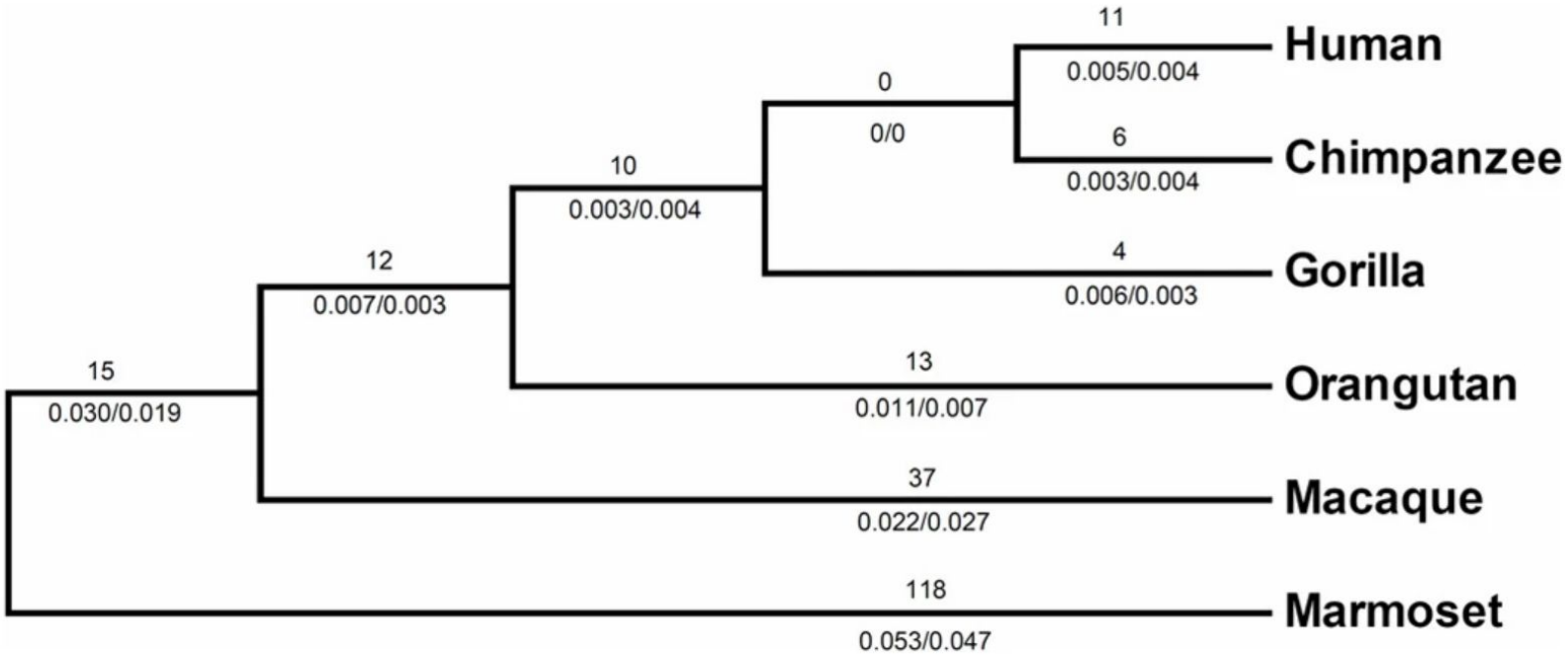


Brown JG. Ticks, Hair loss, and non-clinging babies: a novel tick-based hypothesis for the evolutionary divergence of humans and chimpanzees. *Life* 11(5):, 135, **2021.**

Human Hairless Gene

Figure 2

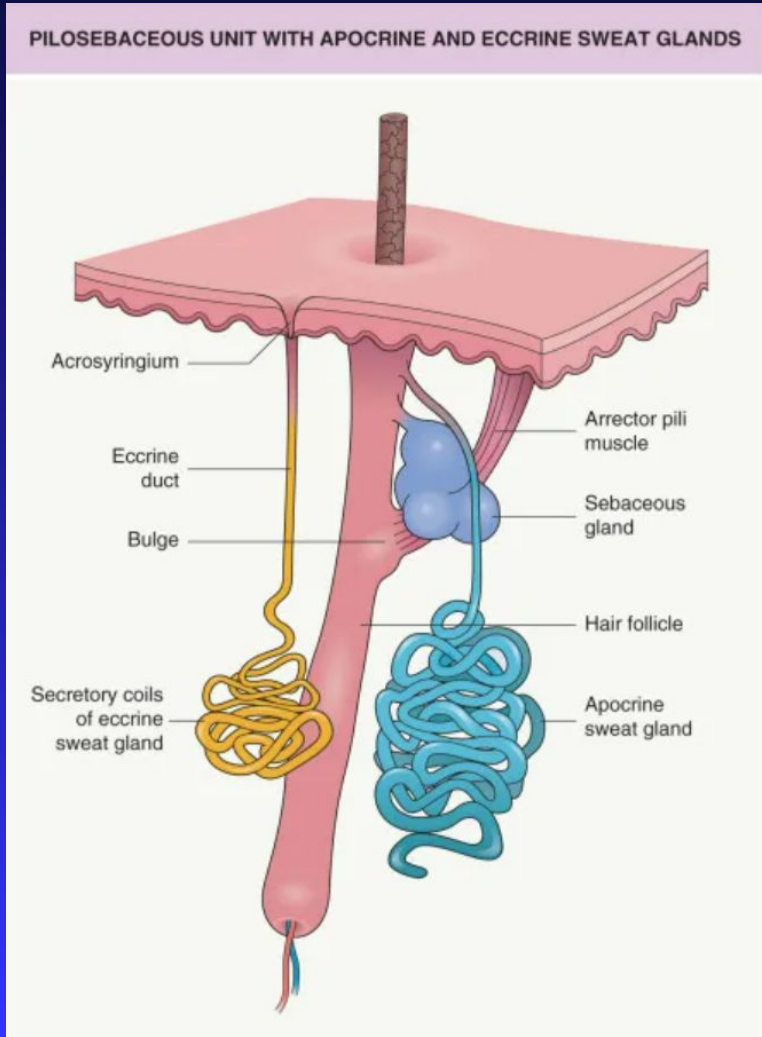
From: Molecular evolution of *HR*, a gene that regulates the postnatal cycle of the hair follicle



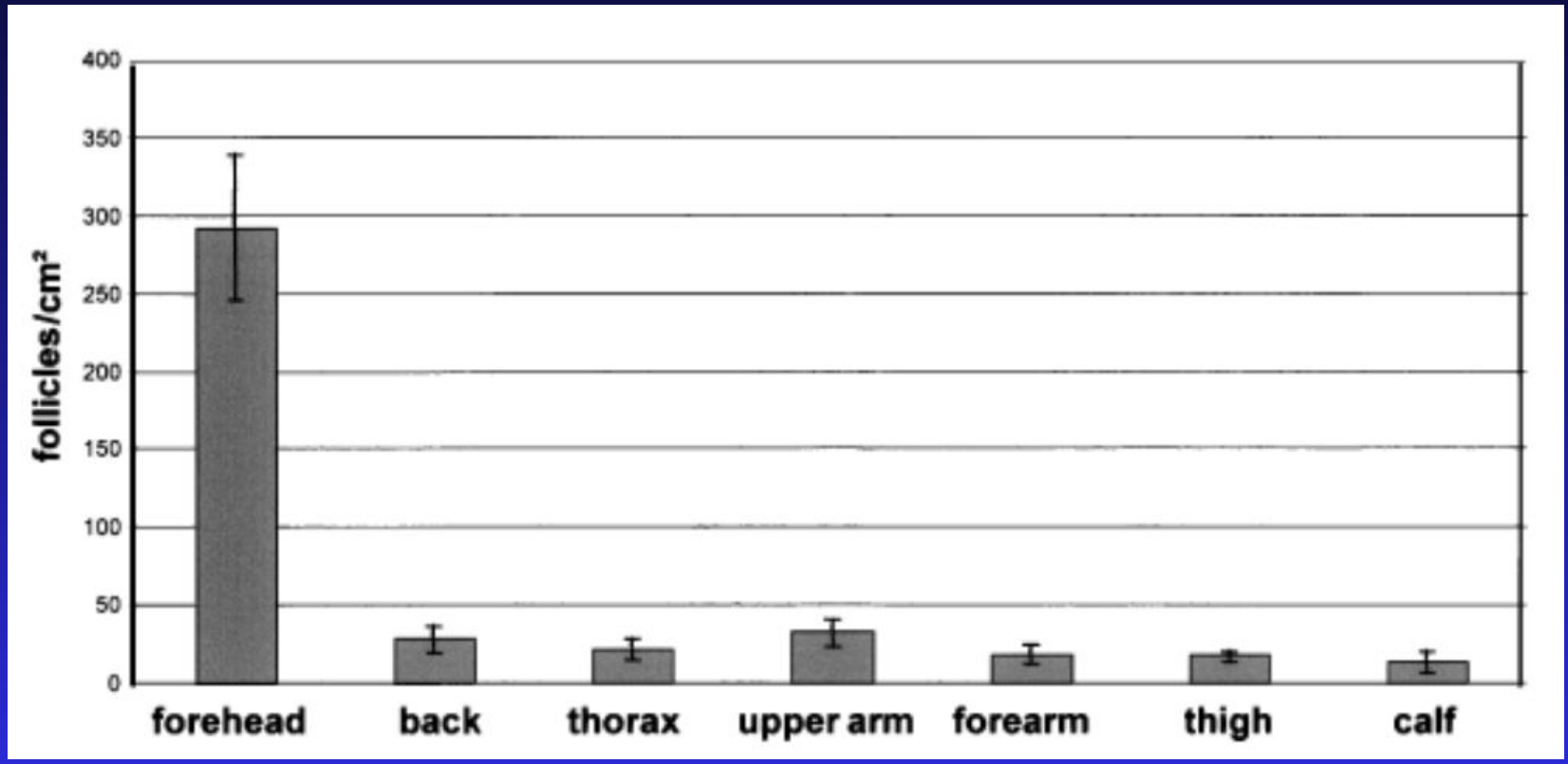
Molecular evolution of *HR* in primates.

Ka and *Ks* values were estimated for each branch of the *HR* tree with the reconstructed sequences at ancestral nodes. Number above the lineage indicates the minimum number of amino acid replacements to explain differences among reconstructed sequences. *Ka/Ks* ratios are shown below branches. Branch lengths are drawn arbitrarily and do not reflect evolutionary time.

2.5x higher density of eccrine glands on forehead



Follicular density varies with anatomic site



Otberg N et al. Variations of Hair Follicle Size and Distribution in DifferentBody Sites. J Invest Dermatol 122:14-19, 2004.

Hairlessness = Better cooling

- Decreased hair cover
- Increased eccrine sweat gland density
  - 10x higher than chimpanzee and macaque
  - 2.5x higher density on forehead

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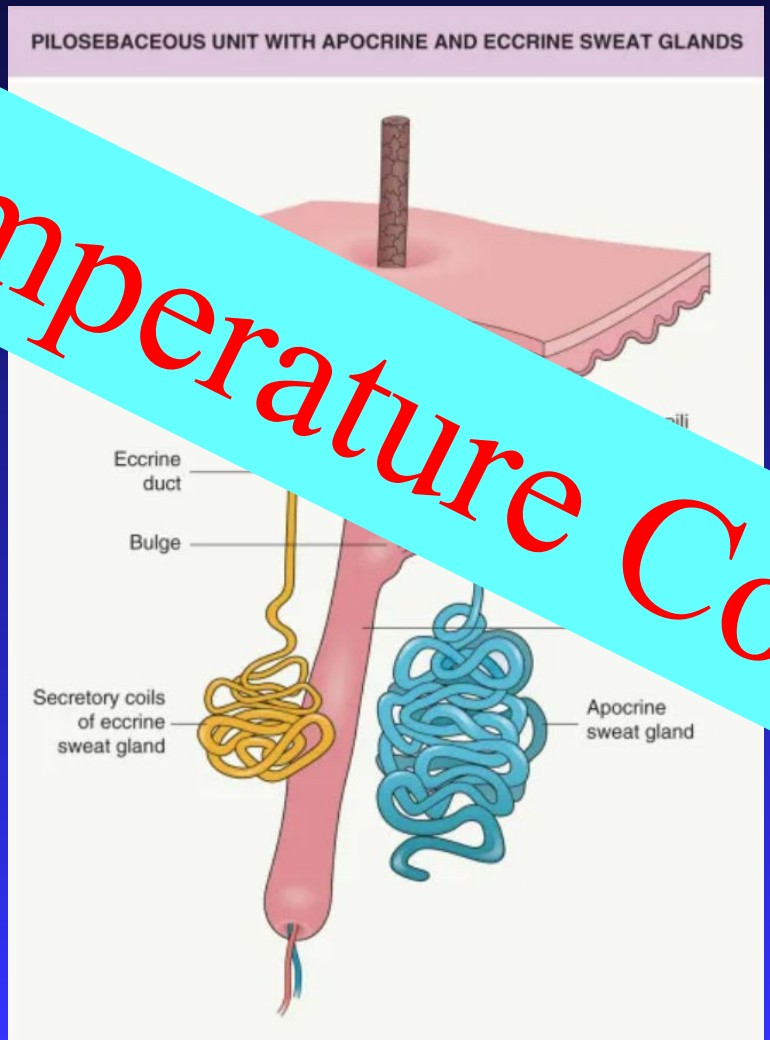
2.5x higher density of eccrine glands on forehead



Temperature Control

diseases

- Size of hai

Autosomal recessive inheritance of atrichia congenita

J. M. CANTÚ, J. SÁNCHEZ-CORONA, A. GONZÁLEZ-MENDOZA, R. MARTÍNEZ Y MARTÍNEZ AND D. GARCÍA-CRUZ

Divisiones de Genética y Hematología y de Patología Experimental, Subjefatura de Investigación Científica, Unidad de Investigaciôn Biomédica, Centro Médico de Occidente, Instituto Mexicano del Seguro Social, Guadalajara, Jalisco, Mexico

Two families, each with two sibs presenting atrichia congenita, were studied. Histopathological of scalp biopsies from affected areas revealed absence of hair follicles. The findings were interpreted as corroborative of a previously postulated autosomal recessive inheritance.

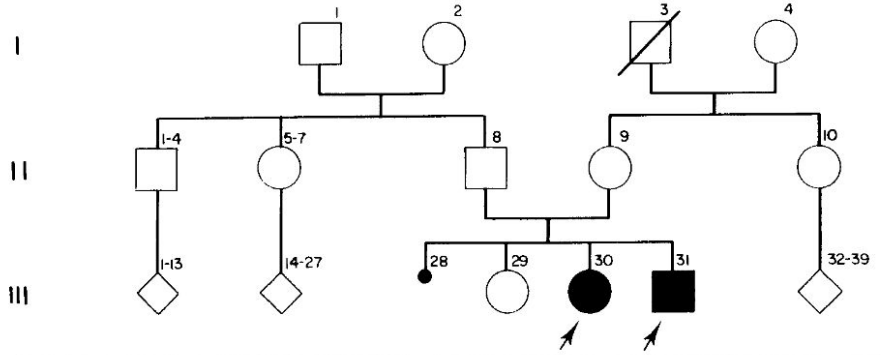


Fig. 1. Family A. Pedigree and facial appearance of the propositi. The girl (left) was more severely affected.

Cantu JM et al. 17(3):209-12, 1980

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http://www.dermweb.com/hairnailsmucousmembranes/sideviewbaldmanpage.htm

Unintended consequence of evolution?

Advances in Anthropology, 2015, 5, 274-281
Published Online November 2015 in SciRes. http://www.scirp.org/journal/aa
http://dx.doi.org/10.4236/aa.2015.54021

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Evolution of Long Head Hair in Humans

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Conclusion

- What we see in the microscope:
  - Size—decrease for hairlessness
  - Density—increase for perspiration
  - Cell cycle—changes for hair length (function)
- Evolution: Temperature control, infestation control, and behavioral change
- Hypothesis: Some hair loss diseases are unintended consequences of evolution

Thanks!

Mahalo!

¡ Gracias!

www.barcelonahair.org