Eye color

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Eye color is a polygenic phenotypic character determined by two distinct factors: the pigmentation of the eye's iris[1][2] and the frequency-dependence of the scattering of light by the turbid medium in the stroma of the iris.[3]

In humans, the pigmentation of the iris varies from light brown to black, depending on the concentration of melanin in the iris pigment epithelium (located on the back of the iris), the melanin content within the iris stroma (located at the front of the iris), and the cellular density of the stroma.[4] The appearance of blue, green, as well as hazel eyes results from the Rayleigh scattering of light in the stroma, a phenomenon similar to that which accounts for the blueness of the sky. Neither blue nor green pigments are ever present in the human iris or ocular fluid.[3][5] Eye color is thus an instance of structural color and varies depending on the lighting conditions, especially for lighter-colored eyes.

The brightly colored eyes of many bird species result from the presence of other pigments, such as pteridines, purines, and carotenoids.[6] Humans and other animals have many phenotypic variations in eye color.[7] The genetics of eye color are complicated, and color is determined by multiple genes. So far, as many as 15 genes have been associated with eye color inheritance. Some of the eye-color genes include *OCA2* and *HERC2*.[8] The once-held view that blue eye color is a simple recessive trait has been shown to be incorrect. The genetics of eye color are so complex that almost any parent-child combination of eye colors can occur.[9][10] However, OCA2 gene polymorphism, close to proximal 5′ regulatory region, explains most human eye-color variation.[11]

Contents [show]

ADVERTISEMENT

Genetic determination Edit

See also: Human genetic clustering

Eye color is an inherited trait influenced by more than one gene.[12][13] These genes are sought using associations to small changes in the genes themselves and in neighboring genes. These changes are known as single-nucleotide polymorphisms or SNPs. The actual number of genes that contribute to eye color is currently unknown, but there are a few likely candidates. A study in Rotterdam (2009) found that it was possible to predict eye color with more than 90% accuracy for brown and blue, using just six SNPs.[14] There is evidence that as much as 16 different genes could be responsible for eye color in humans; however, the main two genes associated with eye color variation are *OCA2* and *HERC2*, and both are localized in Chromosome 15.[8]

The gene *OCA2* (OMIM: 203200), when in a variant form, causes the pink eye color and hypopigmentation common in human albinism. (The name of the gene is derived from the disorder it causes, oculocutaneous albinism type II.) Different SNPs within *OCA2* are strongly associated with blue and green eyes as well as variations in freckling, mole counts, hair and skin tone. The polymorphisms may be in an *OCA2* regulatory sequence, where they may influence the expression of the gene product, which in turn affects pigmentation.[11] A specific mutation within the *HERC2* gene, a gene that regulates *OCA2* expression, is partly responsible for blue eyes.[15] Other genes implicated in eye color variation are: *SLC24A4*[16] and *TYR*.[16]

Blue eyes with a brown spot, green eyes, and gray eyes are caused by an entirely different part of the genome. As Eiberg said: "The SNP rs12913832 [of the *Herc2* gene] is found to be associated with the brown and blue eye color, but this single DNA variation cannot explain all the brown eye color variation from dark brown over hazel to blue eyes with brown spots."

Classification of color Edit

Iris color can provide a large amount of information about a person, and a classification of various colors may be useful in documenting pathological changes or determining how a person may respond to various ocular pharmaceuticals.[17] Various classification systems have ranged from a basic light or dark description to detailed gradings employing photographic standards for comparison.[17] Others have attempted to set objective standards of color comparison.[18]

Eye colors range from the darkest shades of brown to the lightest tints of blue.[12] To meet the need for standardized classification, at once simple yet detailed enough for research purposes, Seddon et al. developed a graded system based on the predominant iris color and the amount of brown or yellow pigment present.[19] There are three pigment colors that determine, depending on their proportion, the outward appearance of the iris, along with structural color. Green irides, for example, have blue and some yellow. Brown irides contain mostly brown. Some eyes have a dark ring around the iris, called a limbal ring.

Eye color in non-human animals is regulated differently. For example, instead of blue as in humans, autosomal recessive eye color in the skink species *Corucia zebrata* is black, and the autosomal dominant color is yellow-green.[20]

As the perception of color depends on viewing conditions (e.g., the amount and kind of illumination, as well as the hue of the surrounding environment), so does the perception of eye color.[21]

Changes in eye color Edit

Most babies who have European ancestry have light-colored eyes before the age of one. As the child develops, melanocytes (cells found within the iris of human eyes, as well as skin and hair follicles) slowly begin to produce melanin. Because melanocyte cells continually produce pigment, in theory eye color can be changed. Most eye changes happen when the infant is around one year old, although it can happen up to three years of age.[22] Observing the iris of an infant from the side using only transmitted light with no reflection from the back of the iris, it is possible to detect the presence or absence of low levels of melanin. An iris that appears blue under this method of observation is more likely to remain blue as the infant ages. An iris that appears golden contains some melanin even at this early age and is likely to turn green or brown as the infant ages.

Changes (lightening or darkening) of eye colors during puberty, early childhood, pregnancy, and sometimes after serious trauma (like heterochromia) do represent cause for plausible argument to state that some eyes can or do change, based on chemical reactions and hormonal changes within the body.

Studies on Caucasian twins, both fraternal and identical, have shown that eye color over time can be subject to change, and major demelanization of the iris may also be genetically determined. Most eye-color changes have been observed or reported in the Caucasian population with hazel and amber eyes.[23]

Eye color chart (Martin Scale) Edit

Carleton Coon created this chart by the *original* Martin Scale. The numbering is reversed of this scale in the (later) Martin-Schultz scale, which is (still) used in physical anthropology.

I. Light eyes

   Eyes light and light mixed are 16–12 in Martin scale.

   Light

      15: Blue, Gray only. 16: Blue exclusive; 16-1a: pure light blue.

   Light-mixed

      14–12 in Martin scale.

   a. Very light-mixed (blue with gray or green or green with gray)
   b. Light-mixed (light or very light-mixed with small admixture of brown pigment)

II. Mixed eyes

   Mixed

      12–6 in Martin scale. Mixture of light eyes (blue, gray or green) with brown pigment when light and brown pigment are the same level.

III. Dark eyes

   Dark-mixed

      6–4 in Martin scale. Brown with small admixture of light pigment.

   Dark

      4–1 in Martin scale. Brown (light brown and dark brown) and very dark brown (almost black).

Amber Edit

File:HumanFemalewithAmberIris.jpg

Amber eyes are of a solid color and have a strong yellowish/golden and russet/coppery tint. This may be due to the deposition of the yellow pigment called lipochrome in the iris (which is also found in green eyes).[24][25] Amber eyes should not be confused with hazel eyes; although hazel eyes may contain specks of amber or gold, they usually tend to comprise many other colors, including green, brown and orange. Also, hazel eyes may appear to shift in color and consist of

flecks and ripples, while amber eyes are of a solid gold hue. Even though amber is considered to be like gold, some people have russet or copper colored amber eyes that many people mistake for hazel, though hazel tends to be duller and contains green with red/gold flecks, as mentioned above. Amber eyes may also contain amounts of very light gold-ish gray.

The eyes of some pigeons contain yellow fluorescing pigments known as pteridines.[26] The bright yellow eyes of the Great Horned Owl are thought to be due to the presence of the pteridine pigment xanthopterin within certain chromatophores (called xanthophores) located in the iris stroma.[27] In humans, yellowish specks or patches are thought to be due to the pigment lipofuscin, also known as lipochrome.[28] Many animals such as canines, domestic cats, owls, eagles, pigeons and fish have amber eyes as a common color, whereas in humans this color occurs less frequently.

Blue Edit

> *"Blue eyes" redirects here. For other uses, see Blue eyes (disambiguation).*

File:Blueye.JPG

There is no blue pigmentation either in the iris or in the ocular fluid. Dissection reveals that the iris pigment epithelium is brownish black due to the presence of melanin.[29] Unlike brown eyes, blue eyes have low concentrations of melanin in the stroma of the iris, which lies in front of the dark epithelium. Longer wavelengths of light tend to be absorbed by the dark underlying epithelium, while shorter wavelengths are reflected and undergo Rayleigh scattering in the turbid medium of the stroma.[4] This is the same frequency-dependence of scattering that accounts for the blue appearance of the sky.[3][5] The result is a "Tyndall blue" structural color that varies with external lighting conditions.

In humans, the inheritance pattern followed by blue eyes is considered similar to that of a recessive trait (in general, eye color inheritance is considered a polygenic trait, meaning that it is controlled by the interactions of several genes, not just one).[13] In 2008, new research suggested that people with blue eyes have a single common ancestor. Scientists tracked down a genetic mutation that leads to blue eyes. "Originally, we all had brown eyes," said Eiberg.[30] Eiberg and colleagues showed in a study published in *Human Genetics* that a mutation in the 86th intron of the *HERC2* gene, which is hypothesized to interact with the *OCA2* gene promoter, reduced expression of *OCA2* with subsequent reduction in melanin production.[31] The authors concluded that the mutation may have arisen in a single individual probably living in the northwestern part of the Black Sea region (around modern Romania) 6,000–10,000 years ago during the Neolithic revolution.[30][31][32] Eiberg stated, "A genetic mutation affecting the OCA2 gene in our chromosomes resulted in the creation of a 'switch,' which literally 'turned off' the ability to produce brown eyes." He added:

> The genetic switch is located in the gene adjacent to OCA2 and rather than completely turning off the gene, the switch limits its action, which reduces the production of melanin in the iris. In effect, the turned-down switch diluted brown eyes to blue. If the OCA2 gene had been completely shut down, our hair, eyes and skin would be melanin-less, a condition known as albinism.[30]

Blue eyes are most common in Ireland, the Baltic Sea area and Northern Europe,[33] and are also found in Eastern, Central, and Southern Europe. Blue eyes can also be found in parts of Central, South, and West Asia,[34][35][36] especially among the Jewish population of Israel. Many modern Israeli Jews are of European Ashkenazi origin, among whom this trait is common (A study taken in 1911 found that 53.7% of Jews in Galicia in Eastern Europe had blue eyes).[37][38]

Y-Chromosome DNA testing performed on ancient Scythian skeletons dating to the Bronze and Iron Ages in the Siberian Krasnoyarsk region found that 10 out of the 11 subjects carried Y-DNA R1a1 (most commonly found today in Eastern Europe and Sikh clans of North India), with blue or green eye color and light hair common, suggesting mostly European origin of that particular population.[39][40][41]

In Estonia, 99% of people have blue eyes, stated Hans Eiberg from the Department of Cellular and Molecular Medicine at the University of Copenhagen.[42] In Denmark 30 years ago, only 8% of the population had brown eyes, though through immigration, today that number is about 11%. In Germany, about 75% have blue eyes.[42]

A 2002 study found that the prevalence of blue eye color among Caucasians in the United States to be 33.8 percent for those born from 1936 through 1951 compared with 57.4 percent for those born from 1899 through 1905.[13] As of 2006, one out of every six people, or 16.6% of the total population, and 22.3% of the white population, has blue eyes. Blue eyes are continuing to become less common among American children.[33] <div class="thumb tnone" style="width: **Expression error: Unrecognised punctuation character "[".**px; margin: 0 auto;">

File:Сиамская кошка.jpg	File:Karasu2a.JPG	File:FrankieakaLogan.jpg
Blue-eyed Siamese cat and Jungle Crow. The Australian Wildlife Experience has the first blue-eyed koala known to be born in captivity in the world.[43]		

Blue eyes are rare in mammals; one example is the quite recently discovered marsupial, the Blue-eyed Spotted Cuscus (*Spilocuscus wilsoni*). The trait is hitherto known only from a single primate other than humans – Sclater's Lemur (*Eulemur flavifrons*) of Madagascar. While some cats and dogs have blue eyes, this is usually due to another mutation that is associated with deafness. But in cats alone, there are four identified gene mutations that produce blue eyes, some of

which are associated with congenital neurological disorders. The mutation found in the Siamese cats is associated with strabismus (crossed eyes). The mutation found in blue-eyed solid white cats (where the coat color is caused by the gene for "epistatic white") is associated with deafness. However, there are phenotypically identical, but genotypically different, blue-eyed white cats (where the coat color is caused by the gene for white spotting) where the coat color is not strongly associated with deafness. In the blue-eyed Ojos Azules breed, there may be other neurological defects. Blue-eyed non-white cats of unknown genotype also occur at random in the cat population.

Brown Edit

"Brown eyes" redirects here. For other uses, see Brown eyes (disambiguation).

File:Lens5.jpg

File:S7307583.jpg

In humans, brown eyes result from a relatively high concentration of melanin in the stroma of the iris, which causes light of both shorter and longer wavelengths to be absorbed.[3]

Dark brown eyes are dominant in humans[44] and in many parts of the world, it is nearly the only iris color present.[45] Dark pigment of brown eyes is most common in East Asia, Southeast Asia, South Asia, West Asia, Oceania, Africa, Americas, etc. as well as parts of Eastern Europe and Southern Europe.[16] The majority of people in the world overall have dark brown eyes. Dark brown is also found in the semitic people seen in a fair percentage among Jewish and Arab populations in the Middle East.

Light or medium-pigmented brown eyes are common in South Europe and parts of Asia (Afghanistan, India, Middle East, and Pakistan). Light-pigmented brown eyes are sometimes referred to as "honey eyes".

Gray Edit

File:Gray Eye With Yellow Ring.jpg

File:Gray eyes.jpg

Like blue eyes, gray eyes have a dark epithelium at the back of the iris and a relatively clear stroma at the front. One possible explanation for the difference in the appearance of gray and blue eyes is that gray eyes have larger deposits of collagen in the stroma, so that the light that is reflected from the epithelium undergoes Mie scattering (which is not strongly frequency-dependent) rather than Rayleigh scattering (in which shorter wavelengths of light are scattered more). This would be analogous to the change in the color of the sky, from the blue given by the Rayleigh scattering of sunlight by small gas molecules when the sky is clear, to the gray caused by Mie scattering off large water droplets when the sky is cloudy.[46] Alternatively, it has been suggested that gray and blue eyes might differ in the concentration of melanin at the front of the stroma.[46]

Gray eyes are most common in Northern and Eastern Europe.[47] Gray eyes can also be found among the Algerian Shawia people[48] of the Aurès Mountains in North West Africa, in the Middle East, and Central and South Asia. Under magnification, gray eyes exhibit small amounts of yellow and brown color in the iris.

A gray iris may indicate the presence of a uveitis. However, other visual signs make a uveitis obvious. Gray and blue eyes are at increased risk of uveal melanoma.[49]

Green Edit

File:Green eye lashes.jpg

Green eyes

As in the case of blue eyes, the color of green eyes does not result simply from the pigmentation of the iris. Rather, its appearance is caused by the combination of an amber or light brown pigmentation of the stroma, given by a low or moderate concentration of melanin, with the blue tone imparted by the Rayleigh scattering of the reflected light.[3]

Green eyes probably result from the interaction of multiple variants within the *OCA2* and other genes. They were present in south Siberia during the Bronze Age.[50] They are most common in Northern and Central Europe.[51][52] They can also be found in Southern Europe,[47] Middle East, and parts of South and Central Asia (Afghanistan, India, and Pakistan). In Iceland, 89% of women and 87% of men have either blue or green eye color.[53] A study of Icelandic and Dutch adults found green eyes to be much more prevalent in women than in men.[54] Among European Americans, green eyes are most common among those of recent Celtic and Germanic ancestry, about 16%.[55]

Hazel Edit

File:Hazel green eyes close up.jpg

File:Hazel Eye close up.jpg

Hazel eyes are due to a combination of Rayleigh scattering and a moderate amount of melanin in the iris' anterior border layer.[4][28] Hazel eyes often appear to shift in color from a brown to a green. Although hazel mostly consists of brown and green, the dominant color in the eye can either be brown/gold or green. This is how many people mistake hazel eyes to be amber and vice versa.[56][57][58][59][60][61][62] This can sometimes produce a multicolored iris, i.e., an eye that is light brown/amber near the pupil and charcoal or dark green on the outer part of the iris (or vice versa) when observed in sunlight.

Definitions of the eye color *hazel* vary: it is sometimes considered to be synonymous with light brown or gold, as in the color of a hazelnut shell.[56][58][61][63]

Hazel eyes are common throughout Caucasoid populations, in particular in regions where blue, green and brown eyed peoples are intermixed.

Red and violet Edit

File:OCA1 Auge.jpg

The eyes of people with severe forms of albinism may appear red under certain lighting conditions owing to the extremely low quantities of melanin,[64] allowing the blood vessels to show through. In addition, flash photography can sometimes cause a "red-eye effect", in which the very bright light from a flash reflects off the retina, which is abundantly vascular, causing the pupil to appear red in the photograph.[65] Although the deep blue eyes of some people such as Elizabeth Taylor can appear violet at certain times, "true" violet-colored eyes occur only due to albinism.[66]

Medical implications Edit

Those with lighter iris color have been found to have a higher prevalence of age-related macular degeneration (ARMD) than those with darker iris color;[60] lighter eye color is also associated with an increased risk of ARMD progression.[67] An increased risk of uveal melanoma has been found in those with blue, green or gray iris color.[49][53] However, a study in 2000 suggests that people with dark brown eyes are at increased risk of developing cataracts and therefore should protect their eyes from direct exposure to sunlight.[68]

Eye color may also be symptomatic of disease. Aside from the iris, yellowing of the whites of the eyes is associated with jaundice and symptomatic of liver disease, including cirrhosis, hepatitis and malaria. Yellowing of the whites of the eyes in people with darker pigmented skin is often due to melanin being present in the whites of the eyes. However, any sudden changes in the color of the whites of the eyes should be addressed by a medical professional. A white, gray, or blue ring around the eye may be arcus senilis.

Wilson's disease Edit

File:Kayser-Fleischer ring.jpg

Wilson's disease involves a mutation of the gene coding for the enzyme ATPase7B, which prevents copper within the liver from entering the Golgi apparatus in cells. Instead, the copper accumulates in the liver and in other tissues, including the iris of the eye. This results in the formation of Kayser–Fleischer rings, which are dark rings that encircle the periphery of the iris.[69]

Anomalous conditions Edit

Aniridia Edit

Main article: Aniridia

Aniridia is a congenital condition characterized by an extremely underdeveloped iris, which appears absent on superficial examination.[70]

Ocular albinism and eye color Edit

Normally, there is a thick layer of melanin on the back of the iris. Even people with the lightest blue eyes, with no melanin on the front of the iris at all, have dark brown coloration on the back of it, to prevent light from scattering around inside the eye. In those with milder forms of albinism, the color of the iris is typically blue but can vary from blue to brown. In severe forms of albinism, there is no pigment on the back of the iris, and light from inside the eye can pass through the iris to the front. In these cases, the only color seen is the red from the hemoglobin of the blood in the capillaries of the iris. Such albinos have pink eyes, as do albino rabbits, mice, or any other animal with a total lack of melanin. Transillumination defects can almost always be observed during an eye examination due to lack of iridial pigmentation.[71] The ocular albino also lacks normal amounts of melanin in the retina as well, which allows more light than normal to reflect off the retina and out of the eye. Because of this, the pupillary reflex is much more pronounced in albino individuals, and this can emphasize the red eye effect in photographs.

Heterochromia Edit

File:HeterochromiaEye.jpg

Main article: Heterochromia iridum

An example of complete

Template:Refimprove section

heterochromia. The subject has one brown eye and one hazel eye.

Heterochromia (also known as a *heterochromia iridis* or *heterochromia iridum*) is an ocular condition in which one iris is a different color from the other iris (complete heterochromia), or where a part of one iris is a different color from the remainder (partial heterochromia or sectoral heterochromia). It is a result of the relative excess or lack of pigment within an iris or part of an iris, which may be inherited or acquired by disease or injury.[72] This uncommon condition usually results due to uneven melanin content. A number of causes are responsible, including genetic, such as chimerism, Horner's syndrome and Waardenburg syndrome.

File:PartialHeterochromia.jpg

A chimera can have two different colored eyes just like any two siblings can—because each cell has different eye color genes. A mosaic can have two different colored eyes if the DNA difference happens to be in an eye-color gene.

There are many other possible reasons for having two different-colored eyes. For example, the film actor Lee Van Cleef was born with one blue eye and one green eye, a trait that reportedly was common in his family, suggesting that it was a genetic trait. This anomaly, which film producers thought would be disturbing to film audiences, was "corrected" by having Van Cleef wear brown contact lenses.[73] David Bowie, on the other hand, has the appearance of different eye colors due to an injury that caused one pupil to be permanently dilated.

Another hypothesis about heterochromia it that it can result from a viral infection *in utero* affecting the development of one eye, possibly through some sort of genetic mutation. Occasionally, heterochromia can be a sign of a serious medical condition.

A common cause in females with heterochromia is X-inactivation, which can result in a number of heterochromatic traits, such as calico cats. Trauma and certain medications, such as some prostaglandin analogues, can also cause increased pigmentation in one eye.[74] On occasion, a difference in eye color is caused by blood staining the iris after injury.

See also Edit

- Hair color
- Human skin color
- Iridology
- List of Mendelian traits in humans
- Xanthophore

References Edit

1. ↑ Wielgus AR, Sarna T (2005). Melanin in human irides of different color and age of donors. *Pigment Cell Res.* **18** (6): 454–64.
2. ↑ Prota G, Hu DN, Vincensi MR, McCormick SA, Napolitano A (1998). Characterization of melanins in human irides and cultured uveal melanocytes from eyes of different colors. *Exp. Eye Res.* **67** (3): 293–9.
3. ↑ 3.0 3.1 3.2 3.3 3.4 Fox, Denis Llewellyn (1979). *Biochromy: Natural Coloration of Living Things*, University of California Press.
4. ↑ 4.0 4.1 4.2 Huiqiong Wang, Stephen Lin, Xiaopei Liu, Sing Bing Kang (2005). Separating Reflections in Human Iris Images for Illumination Estimation. *Tenth IEEE International Conference on Computer Vision* **2**: 1691–1698.
5. ↑ 5.0 5.1 Mason, Clyde W. (1924). Blue Eyes. *Journal of Physical Chemistry* **28** (5): 498–501.
6. ↑ Oliphant LW (1987). Pteridines and purines as major pigments of the avian iris. *Pigment Cell Res.* **1** (2): 129–31.
7. ↑ Morris, PJ. "Phenotypes and Genotypes for human eye colors." Athro Limited website. Retrieved May 10, 2006.
8. ↑ 8.0 8.1 "Genotype–phenotype associations and human eye color", *Journal of Human Genetics* January 2011. (2011). Genotype-phenotype associations and human eye color. *Journal of Human Genetics* **56** (1): 5–7.
9. ↑ No Single Gene For Eye Color, Researchers Prove. Sciencedaily.com (2007-02-22). Retrieved on 2011-12-23.
10. ↑ October 19, 2011. Eye color definition – Medical Dictionary definitions of popular medical terms easily defined on MedTerms. Medterms.com. URL accessed on 2011-10-19.
11. ↑ 11.0 11.1 (2007). A three-single-nucleotide polymorphism haplotype in intron 1 of OCA2 explains most human eye-color variation. *Am. J. Hum. Genet.* **80** (2): 241–52.
12. ↑ 12.0 12.1 Sturm RA, Frudakis TN (2004). Eye colour: portals into pigmentation genes and ancestry. *Trends Genet.* **20** (8): 327–32.
13. ↑ 13.0 13.1 13.2 Grant MD, Lauderdale DS (2002). Cohort effects in a genetically determined trait: eye colour among US whites. *Ann. Hum. Biol.* **29** (6): 657–66.
14. ↑ "DNA test for eye colour could help fight crime", *New Scientist* 14 March 2009. (2009). Eye color and the prediction of complex phenotypes from genotypes. *Current Biology* **19** (5): R192–R193.
15. ↑ (2008). Three genome-wide association studies and a linkage analysis identify HERC2 as a human iris color gene. *Am. J. Hum. Genet.* **82** (2): 411–23.

16. ↑ 16.0 16.1 16.2 (2007). Genetic determinants of hair, eye and skin pigmentation in Europeans. *Nat. Genet.* **39** (12): 1443–52.
17. ↑ 17.0 17.1 German EJ, Hurst MA, Wood D, Gilchrist J (1998). A novel system for the objective classification of iris colour and its correlation with response to 1% tropicamide. *Ophthalmic Physiol Opt* **18** (2): 103–10.
18. ↑ Fan S, Dyer CR, Hubbard L. Quantification and Correction of Iris Color." Technical report 1495, University of Wisconsin–Madison, Dec, 2003.
19. ↑ Seddon, J.M., CR Sahagian, RJ Glynn, RD Sperduto and ES Gragoudas (1 August 1990). Evaluation of an iris color classification system. *Investigative Ophthalmology & Visual Science* **31** (8): 1592–8.
20. ↑ Jones, S.L., Schnirel, B.L. (2006). Subspecies comparison of the Genus: Corucia. *Polyphemos* **4** (1): 1–25.
21. ↑ Color Perception. Edromanguitars.com. Retrieved on 2011-12-23.
22. ↑ Aluzri, Shan Z., All About Eyes., retrieved 1 June 2009.
23. ↑ (1997). Eye Color Changes Past Early Childhood. *Archives of ophthalmology* **115** (5): 659–63.
24. ↑ Howard Hughes Medical Institute: Ask A Scientist. Hhmi.org. Retrieved on 2011-12-23.
25. ↑ Larry Bickford Eye Color. Eyecarecontacts.com. Retrieved on 2011-12-23.
26. ↑ Oliphant LW (1987). Observations on the pigmentation of the pigeon iris. *Pigment Cell Res.* **1** (3): 202–8.
27. ↑ Oliphant LW (1981). Crystalline pteridines in the stromal pigment cells of the iris of the great horned owl. *Cell Tissue Res.* **217** (2): 387–95.
28. ↑ 28.0 28.1 Lefohn A, Budge B, Shirley P, Caruso R, Reinhard E (2003). An Ocularist's Approach to Human Iris Synthesis. *IEEE Comput. Graph. Appl.* **23** (6): 70–5.
29. ↑ Menon IA, Basu PK, Persad S, Avaria M, Felix CC, Kalyanaraman B (1987). Is there any difference in the photobiological properties of melanins isolated from human blue and brown eyes?. *Br J Ophthalmol* **71** (7): 549–52.
30. ↑ 30.0 30.1 30.2 includeonly>Bryner, Jeanna. "Genetic mutation makes those brown eyes blue", *MSNBC*, 2008-01-31. Retrieved on 2009-10-19.
31. ↑ 31.0 31.1 (2008). Blue eye color in humans may be caused by a perfectly associated founder mutation in a regulatory element located within the HERC2 gene inhibiting OCA2 expression. *Hum. Genet.* **123** (2): 177–87.
32. ↑ includeonly>Highfield, Roger. "Blue eyes result of ancient genetic 'mutation'", *The Daily Telegraph*, 2008-01-30. Retrieved on 2011-10-19.
33. ↑ 33.0 33.1 Douglas Belkin. Don't it make my blue eyes brown Americans are seeing a dramatic color change. *The Boston Globe*.
34. ↑ Cavalli-Sforza, L. L., Menozzi, P., & Piazza, A. (1994). the history and geography of human genes.
35. ↑ Distribution of Bodily Characters. Pigmentation, the Pilous System, and Morphology of the Soft Parts
36. ↑ Day, John V. (2002). In Quest of Our Linguistic Ancestors: The Elusive Origins of the Indo-Europeans. *The Occidental Quarterly* **2** (3): 5–20.
37. ↑ http://www.nature.com/news/2010/100603/full/news.2010.277.html
38. ↑ Maurice Fishberg (1911). *Jews, race & environment*, Transaction Publishers. URL accessed 23 December 2011.
39. ↑ Thapar , R. (2004). early india: From the origins to ad 1300. University of California Press. ISBN0520242254
40. ↑ http://www.infoukes.com/history/
41. ↑ Keyser, Christine (2009). Ancient DNA provides new insights into the history of south Siberian Kurgan people. *Human Genetics* **126** (3): 395–410.
42. ↑ 42.0 42.1 Weise, Elizabeth. (2008-02-05) More than meets the blue eye: You may all be related. Usatoday.com. Retrieved on 2011-12-23.
43. ↑ Blue eyed Koala. Adelaidenow.com.au (2008-01-11). Retrieved on 2011-12-23.
44. ↑ Eiberg H, Mohr J (1996). Assignment of genes coding for brown eye colour (BEY2) and brown hair colour (HCL3) on chromosome 15q. *Eur. J. Hum. Genet.* **4** (4): 237–41.
45. ↑ OMIM 227220
46. ↑ 46.0 46.1 Lucy Southworth. Are gray eyes the same as blue in terms of genetics?. *Understanding Genetics: Human Health and the Genome*. Stanford School of Medicine. URL accessed on 2011-10-19.
47. ↑ 47.0 47.1 Herbert Risley, William Crooke, The People of India, (1999)
48. ↑ **(French)** Provincia: bulletin trimestriel de la Société de Statistique ..., Volumes 16–17 By Société de statistique, d'histoire et d'archéologie de Marseille et de Provence p. 273 *l'iris gris est celui des chaouias...*
49. ↑ 49.0 49.1 Stang A, Ahrens W, Anastassiou G, Jöckel KH (2003). Phenotypical characteristics, lifestyle, social class and uveal melanoma. *Ophthalmic Epidemiol* **10** (5): 293–302.
50. ↑ (2009). Ancient DNA provides new insights into the history of south Siberian Kurgan people. *Human Genetics* **126** (3): 395–410.
51. ↑ Blue Eyes Versus Brown Eyes: A Primer on Eye Color. Eyedoctorguide.com. Retrieved on 2011-12-23.
52. ↑ Why Do Europeans Have So Many Hair and Eye Colors?. Cogweb.ucla.edu. Retrieved on 2011-12-23.
53. ↑ 53.0 53.1 Rafnsson V, Hrafnkelsson J, Tulinius H, Sigurgeirsson B, Olafsson JH (2004). Risk factors for malignant melanoma in an Icelandic population sample. *Prev Med* **39** (2): 247–52.
54. ↑ Genetic determinants of hair, eye and skin pigmentation in Europeans. Retrieved on 2012-08-07.
55. ↑ Gene Expression: NLSY blogging: Eye and hair color of Americans.
56. ↑ 56.0 56.1 (2004). A genome scan for eye color in 502 twin families: most variation is due to a QTL on chromosome 15q. *Twin Res* **7** (2): 197–210.
57. ↑ (2003). Iris melanocyte numbers in Asian, African American, and Caucasian irides. *Trans Am Ophthalmol Soc* **101**: 217–21; discussion 221–2.
58. ↑ 58.0 58.1 Mitchell R, Rochtchina E, Lee A, Wang JJ, Mitchell P (2003). Iris color and intraocular pressure: the Blue Mountains Eye Study. *Am. J.*

Ophthalmol. **135** (3): 384–6.

59. ↑ Lindsey JD, Jones HL, Hewitt EG, Angert M, Weinreb RN (2001). Induction of tyrosinase gene transcription in human iris organ cultures exposed to latanoprost. *Arch. Ophthalmol.* **119** (6): 853–60.
60. ↑ 60.0 60.1 Frank RN, Puklin JE, Stock C, Canter LA (2000). Race, iris color, and age-related macular degeneration. *Trans Am Ophthalmol Soc* **98**: 109–15; discussion 115–7.
61. ↑ 61.0 61.1 Regan S, Judge HE, Gragoudas ES, Egan KM (1999). Iris color as a prognostic factor in ocular melanoma. *Arch. Ophthalmol.* **117** (6): 811–4.
62. ↑ Hawkins TA, Stewart WC, McMillan TA, Gwynn DR (1994). Analysis of diode, argon, and Nd: YAG peripheral iridectomy in cadaver eyes. *Doc Ophthalmol* **87** (4): 367–76.
63. ↑ Hammond BR, Fuld K, Snodderly DM (1996). Iris color and macular pigment optical density. *Exp. Eye Res.* **62** (3): 293–7.
64. ↑ NOAH — What is Albinism?. Albinism.org. Retrieved on 2011-12-23.
65. ↑ includeonly>Dave Johnson. "HOW TO: Avoid the red eye effect", 2009-01-16. Retrieved on 2010-01-09.
66. ↑ Palmer, Roxanne. Elizabeth Taylor: Beautiful Mutant. *Slate*. URL accessed on March 26, 2011.
67. ↑ (2003). Iris colour, ethnic origin and progression of age-related macular degeneration. *Clin. Experiment. Ophthalmol.* **31** (6): 465–9.
68. ↑ Cumming RG, Mitchell P, Lim R (2000). Iris color and cataract: The Blue Mountains Eye Study. *American journal of ophthalmology* **130** (2): 237–238.
69. ↑ McDonnell G, Esmonde T (1999). A homesick student. *Postgrad Med J* **75** (884): 375–8.
70. ↑ eMedicine *oph/43*
71. ↑ eMedicine *OPH/260*
72. ↑ Imesch PD, Wallow IH, Albert DM (1997). The color of the human eye: a review of morphologic correlates and of some conditions that affect iridial pigmentation. *Surv Ophthalmol* **41** (Suppl 2): S117–23.
73. ↑ Template:IMDb name
74. ↑ Hejkal TW, Camras CB (1999). Prostaglandin analogs in the treatment of glaucoma. *Seminars in ophthalmology* **14** (3): 114–23.

Further reading Edit

- Baker, H. D., Henderson, R., & O'Keefe, L. P. (1989). An improved retinal densitometer: Design concepts and experimental applications: Visual Neuroscience Vol 3(1) Jul 1989, 71-80.
- Bassett, J. F., & Dabbs, J. M., Jr. (2001). Eye color predicts alcohol use in two archival samples: Personality and Individual Differences Vol 31(4) Sep 2001, 535-539.
- Beer, J., & Beer, J. (1992). Aggression of youth as related to parental divorce and eye color: Perceptual and Motor Skills Vol 75(3, Pt 2) Dec 1992, 1066.
- Coplan, R. J., Coleman, B., & Rubin, K. H. (1998). Shyness and little boy blue: Iris pigmentation, gender, and social wariness in preschoolers: Developmental Psychobiology Vol 32(1) Jan 1998, 37-44.
- Coren, S. (1994). Eye color and pure-tone hearing thresholds: Perceptual and Motor Skills Vol 79(3, Pt 1) Dec 1994, 1373-1374.
- Crowe, M., & O'Connor, D. (2001). Eye color and reaction time to visual stimuli in rugby league players: Perceptual and Motor Skills Vol 93(2) Oct 2001, 455-460.
- Cruz, E. M. V., & Brown, C. L. (2007). The influence of social status on the rate of growth, eye color pattern and insulin-like growth factor-I gene expression in Nile tilapia, Oreochromis niloticus: Hormones and Behavior Vol 51(5) May 2007, 611-619.
- Fallone, A. R., & Baluch, B. (1993). Eye colour: An unconsidered variable in cognitive research? : Perceptual and Motor Skills Vol 77(3, Pt 2) Dec 1993, 1123-1127.
- Frost, P. (2006). European hair and eye color: A case of frequency-dependent sexual selection? : Evolution and Human Behavior Vol 27(2) Mar 2006, 85-103.
- Hammond, B. R., Jr., Nanez, J. E., Fair, C., & Snodderly, D. M. (2000). Iris color and age-related changes in lens optical density: Ophthalmic and Physiological Optics Vol 20(5) Sep 2000, 381-386.
- Jacklin, C. N. (1977). Review of Eye color, sex, and children's behavior: PsycCRITIQUES Vol 22 (12), Dec, 1977.
- Jacobs, G. H., Williams, G. A., & Fenwick, J. A. (2004). Influence of cone pigment coexpression on spectral sensitivity and color vision in the mouse: Vision Research Vol 44(14) Jun 2004, 1615-1622.
- Kobayashi, H., & Kohshima, S. (2001). Evolution of the human eye as a device for communication. New York, NY: Springer-Verlag Publishing.
- Laeng, B., Mathisen, R., & Johnsen, J.-A. (2007). Why do blue-eyed men prefer women with the same eye color? : Behavioral Ecology and Sociobiology Vol 61(3) Jan 2007, 371-384.
- Lawrence, J., Bautista, J., & Hicks, R. A. (1994). Arousability and eye color: A test of Worthy's hypothesis: Perceptual and Motor Skills Vol 78(1) Feb 1994, 143-146.
- Lester, D. (1991). Eye color and personality: Perceptual and Motor Skills Vol 73(3, Pt 2), Spec Issue Dec 1991, 1074.
- Miller, L. K., Rowe, P. J., & Lund, J. (1992). Correlation of eye color on self-paced and reactive motor performance: Perceptual and Motor Skills Vol 75(1) Aug 1992, 91-95.
- Patee, T., Frewen, M., & Beer, J. (1991). Association of eye color and sex with basketball free throws by elementary school children: Perceptual and Motor Skills Vol 73(3, Pt 2), Spec Issue Dec 1991, 1181-1182.

- Posthuma, D., Visscher, P. M., Willemsen, G., Zhu, G., Martin, N. G., Slagboom, P. E., et al. (2006). Replicated Linkage for Eye Color on 15q Using Comparative Ratings of Sibling Pairs: Behavior Genetics Vol 36(1) Jan 2006, 12-28.
- Rohmer, S. C., & Meadows, M. E. (1992). Relation of eye color and gender to Type A scores and vocational preference: Perceptual and Motor Skills Vol 75(3, Pt 2) Dec 1992, 1283-1288.
- Rohmer, S. S. (1992). The relationship of eye color and gender to Type A behavioral characteristics and vocational preference: Dissertation Abstracts International.
- Rowe, P. J., & Evans, P. (1994). Ball color, eye color, and a reactive motor skill: Perceptual and Motor Skills Vol 79(1, Pt 2), Spec Issue Aug 1994, 671-674.
- Rowe, P. J., & Miller, L. K. (1990). Correlation of eye color with performance on two motor skill tasks: Perceptual and Motor Skills Vol 71(2) Oct 1990, 611-614.
- Samuels, C. A., & Block, J. (1995). Eye color and behavioral inhibition: A further study: Journal of Research in Personality Vol 29(1) Mar 1995, 139-144.
- Sandem, A. I., Janczak, A. M., Salte, R., & Braastad, B. O. (2006). The use of diazepam as a pharmacological validation of eye white as an indicator of emotional state in dairy cows: Applied Animal Behaviour Science Vol 96(3-4) Feb 2006, 177-183.
- Sandem, A.-I., Braastad, B. O., & Bakken, M. (2006). Behaviour and percentage eye-white in cows waiting to be fed concentrate--A brief report: Applied Animal Behaviour Science Vol 97(2-4) May 2006, 145-151.
- Suedfeld, P., Paterson, H., Soriano, E., & Zuvic, S. (2002). Lethal stereotypes: Hair and eye color as survival characteristics during the Holocaust: Journal of Applied Social Psychology Vol 32(11) Nov 2002, 2368-2376.
- Takagi, A., Ishihara, S. y., Kondo, T., Sakakibara, H., Toyoshima, H., Kono, K., et al. (1999). Age effects on pupil dilation among Alzheimer's patients: Journal of the American Geriatrics Society Vol 47(2) Feb 1999, 257-258.
- Volpato, G. L., Luchiari, A. C., Duarte, C. R. A., Barreto, R. E., & Ramanzini, G. C. (2003). Eye color as an indicator of social rank in the fish Nile tilapia: Brazilian Journal of Medical and Biological Research Vol 36(12) Dec 2003, 1659-1663.
- Worthy, M. (1991). Eye color and feeding behavior of animals: Perceptual and Motor Skills Vol 73(3, Pt 1) Dec 1991, 1033-1034.

Trivia Edit

File:Fake Shrunken Irises.jpg

- The white colored eye resembles the minimum iris size, but the iris size wasn't affected.

External links Edit

- Genetics of eye color
- Eye Color and Human Diseases
- Eye colour: portals into pigmentation genes and ancestry
- Various links on human eye color

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