



Letter

Red Hair In Genetics

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Introduction

Appearance is the most crucial part of making first impressions. With vision being our most robust sense, what we see immediately drives us to draw conclusions. Hair color is one of these features, the most unique of them being red. Terms like “Fiery redhead” and comments like “Oh, he/she has a red-headed personality.” are common. People with natural red hair have been subjected to these stereotypical remarks for years. Another example is that people with blonde hair are often associated with the term “dumb blonde.” Different aspects of one’s personality can be associated with his or her hair color, but do these terms have any aspects of truth to them? Is there any scientific backing to suggest that there is a real correlation between hair color and the stereotype? Genetically, how can having red hair actually affect one’s health and overall personality?

Redheads in History

A few times throughout the history of the Bible, it implies that a person had red hair. Esau, for example, is described as “red,

covered with hair like a fur coat.”¹ Through his actions, he is seen as a rather impulsive character, compromising his status as the oldest son in a moment of hunger. The second person in the Bible, and arguably one of the greatest Jewish monarchs, David, was thought to be a redhead as well.² He used his passion and his fire to kill in the name of God and to be a leader to his people. Other famous leaders throughout history include Alexander The Great, Queen Elizabeth I, Winston Churchill, and George Washington.³ All of these figureheads were able to use their fierce characteristics, stemming from their hair color, to guide their people. Why does red hair correlate with leadership? What biologically could cause this correlation?

To further investigate these ideas, one may wonder why redheads are even prone to impulsivity? What gives them the qualities to lead based on their hair color? The basis for this stereotype comes from a chemical exchange in the human body. Red-headed people produce more adrenaline than non-redheads while also having the ability to

more readily and quickly access this adrenaline, leading to an intensified fight-or-flight reaction.

Genetics of Red Hair

How does someone obtain the unique characteristic of red hair? Red hair is an autosomal recessive trait. Thus, this gene must be in both parents' chromosomes for a child to express red hair. There are various causes for the different effects associated with having red hair, which all stem from a genetic mutation in the MC1R gene, which encodes for the melanocortin-1 receptor. This gene is pleiotropic, and can be expressed in multiple phenotypic traits. Biochemically, the development of red hair is caused by the synthesis of more pheomelanin pigment, the typical primary pigmentation responsible for the black-brown hair color gradient, than eumelanin pigment. The larger amount of pheomelanin, instead of eumelanin, is responsible for the red hair color.⁴ This, coupled with excessive prenatal exposure to estrogen, facilitates the expression of red hair during fetal development. Additionally, red hair is hypothesized to be an evolutionary adaptation for sufficient

photosynthesis of provitamin D in conditions of low intensity of UV-B radiation, which is common throughout Europe. Statistics prove that one to two percent of the European population has red hair. Researchers discovered red hair to be the most prevalent color to have emerged through evolution. Therefore, corrective evolution did not have sufficient time to have taken place, which would have otherwise neutralized the multitude of adverse side-effects associated with the existing red hair alleles.⁵

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Causes for Red Hair

Red hair can be a result of climate adaptation. Mutations in the gene MC1R also regulate melanogenesis which is responsible for low melanin levels. Eumelanin is a yellow-red pigmentation responsible for red hair, which replaces the black color from pheomelanin in skin, hair, and the iris. Pale skin also results from congenitally low eumelanin in the skin, which explains the often combination of fair skin and red hair. Pheomelanin cannot protect the body from UV radiation and thus promotes mutagenic and cancerogenic influences. Many genes involved in skin

pigmentation also affect the vitamin D 25(OH)D3 concentration in the human body. In a study with controlled sun exposure, vitamin D 25(OH)D3 had a much greater effect on the 73 redheads than on the 130 subjects who had various other hair colors. Sun exposure was found to have a minimal effect on 25(OH)D3 concentrations in redheads yet had a positive effect on the levels of 25(OH)D3 of non-red-heads. The decrease in the eumelanin-pheomelanin ratio in red-headed people apparently was an adaptation synthesis of sufficient amounts of vitamin D in regions with low UVB radiation because redheads were found to have a greater 25(OH)D3 concentration. Many redheads, often born with fair skin, avoid sun exposure. As a result, they maintain their fair skin by preventing sunlight from inducing the formation of vitamin D. The intensity of redness is an adaptation to low-intensity radiation, causing inadequate sunlight-induced photosynthesis of vitamin D in the skin. Redheads obtained the ability to synthesize sufficient 25(OH)D3 even with their minimal levels of sun exposure.⁶

Physiological Impacts of Red Hair

Now that the reason for red hair is understood, the different effects of the

character trait on different genders can be investigated. Research proves that men with red hair are prone to develop colorectal cancer scientifically. Regarding performance in health studies, men with red hair did better in three categories and worse in three categories compared with those men who have black, brown, or blonde hair colors.⁵ Parkinson's, decreased platelet function, and defects in the immune system were all found to be associated with both genders. Many interesting elements correspond specifically to red-headed female women. These women are found to have higher levels of pain sensitivity and are prone to endometriosis. In comparing red-headed females and females with other colored hair, red-headed women did better in three specific categories and worse in ten other categories when equated to one another. Other negative associations for female redheads include colorectal cancer, cervical cancer, uterine cancer, and ovarian cancers. This can be explained by the excess transference of estrogen from the mother to the baby during fetal development.⁵ Estrogen is known to influence the development of these fetal reproductive organs. Subsequently, fertility problems were found to be at greater incidence in those with red hair, coinciding with the higher incidence of endometriosis

that was reported. Red hair, as previously discussed, is associated with having fair skin, causing a higher vulnerability to UV radiation, leading to sunburns, and ultimately potentially skin cancer. Despite this, more reproductive lesions and cancers were reported than sun cancer cases despite this.

Interestingly enough, along with being more prominent in red-headed women, people with richer red hair color were found to report greater incidence. Furthermore, those with richer red hair reported a higher rate of severe disorders, including musculoskeletal disorders, heart and vascular problems, cancer, fertility issues, metabolic illnesses, sexual dysfunction, genitourinary disorders, osteoporosis, obstetric complications, and neurological problems.⁵ These conclusions resulted from studies performed using many red-headed women with different shades of hair color. Red hair was found to be more frequent in women than men. Although many problems are clearly associated with red hair, which results in selection against redheads, there is a counterbalance of positive sexual selections in favor of redhead women, maintaining red hair frequency at a low but stable balance. This

may provide reasoning for the conclusion that red-headed people, regardless of gender, are found to have more children.

Not subjected to redheads, pain is not something that most people like to endure.

However, redheads specifically have greater anxiety levels in regards to pain, especially dental pain.⁷ MC1R, the gene for red hair, is also the gene that regulates pain pathways. The melanocortineric pathway is also involved in anxiety-like behaviors, and the MC4R gene, which is involved in producing both red hair and fair skin, is implicated in anxiety.⁸ Anesthesia is reduced in people with the MC1R variant. This resistance to subcutaneous local anesthesia leads to an increase in anxiety, leading to avoidance of dental care. This anxiety also leads to a greater perception of pain, causing the necessity for larger amounts of anesthesia. This can be explained by the emotional amplification of the somatic experience.⁸ Interestingly, women were also found to be more sensitive to cold pain perception, cold pain tolerance, and heat pain. Those with darker shades or more variants correlated with greater levels of dental anxiety.⁸ Additionally, patients

“MC1R, the gene for red hair, is also the gene that regulates pain pathways.”

with red hair reported significantly greater pain in regards to needle insertion.⁷ Medically, there is no block on the inferior alveolar nerve, which is the injection for anesthesia, thought to be the cause for the greater necessity, but rather it is the emotional amplification due to the increase in anxiety coupled with extreme pain perception which causes the greater need for anesthesia in red-headed peoples.

Conclusion

After discussion of the multitude of associations of traits linked to the red hair gene, the positive and negative outcomes can be evaluated. Red-headed people do not choose their hair color, but it is overall a desirable trait because it is visually appealing. The choice of how to use the inborn qualities given to red-headed people can be observed throughout the red-headed characters in the Bible. One can use the impulsive nature and passion to be a positive leader of people, guiding them towards growth. The bloodthirst can be productive by obtaining a job such as a surgeon, where cutting is ultimately to heal and provide life instead of death. Red hair is an interesting phenomenon that has much-unexpected research accompanying it.

Although hair color is not a choice, and some aspects which are correlated are not in one's control, there are elements of being a redhead that one can use to benefit oneself and help others ultimately. Characteristics associated with being red-headed are not set in stone. Through developing one's personality and traits, these characteristics can be worked on to only be used in effective ways. With the right amount of self-discovery and work, anger can turn into passion.

References

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- ² 1 Samuel 16:12
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