

Skin color is one of the most distinguishable features of human appearance. It is a polygenic trait, controlled by 3 or 4 genes. Each gene by itself makes only a small contribution to the phenotype; the overall appearance is a reflection of the sum total of the effects of each individual gene [1].

Breishit (9:18) gives some interesting insight into the genetics of skin color: “The three sons of Noach who emerged from the *tevyah* were Shem, Chom, and Yefet, and the descendants of these spread over the whole Earth.” As such, the people who survived the *mabul* were inevitably going to be the ancestors of all subsequent human populations. According to a *medrash* in *Breishit Rabbah* (34:7), Chom and his wife were olive-skinned and are thought to be the progenitors of the dark-skinned races. But how does this explain the existence of extremely dark skin [1]?

Suppose a gene pair for skin color contains a dominant allele P that codes for a certain amount of pigmentation and a recessive allele p coding for no pigmentation. In a case in which skin color is determined by 3 pairs of polygenes, a person with the genotype $P_1p_1P_2p_2P_3p_3$ will be darker than someone with the genotype $P_1p_1P_2p_2P_3p_3$. During the process of gametogenesis, these polygenes are randomly allocated to the gametes, or sex cells. Two trihybrids with the genotype $P_1p_1P_2p_2P_3p_3$ could hypothetically have offspring ranging from opposite ends of the skin-color spectrum. That is, from albino ($p_1p_1p_2p_2p_3p_3$) to extremely dark or black skin ($P_1P_1P_2P_2P_3P_3$). Thus, if Chom and his wife were trihybrids, each having a skin color genotype of $P_1p_1P_2p_2P_3p_3$, there is a 1/256 chance that they could have produced offspring with extremely dark skin [1].

A story that dates back only to 2006 illustrates this phenomenon. In this case, a mixed-race (olive-skinned) couple produced a set of twins with very different skin color genes. One twin was black with dark hair and dark eyes, while the other twin was white with blonde hair and blue eyes. As mentioned above, in the process of gametogenesis in the parents, a random mixture of genes are distributed to each sex cell. Gametes from a mixed-race person will in most cases have a combination of both black and white genes. These gametes will fuse to form a zygote, with a

phenotype of a mixed race. Rarely will the egg or sperm have all the genes for one skin color, but it could still happen. If both egg and sperm contained all “white” genes, then the baby will be “white” and if the egg and sperm contain all “black” genes, then the baby will be “black.” This rarity is exactly what happened in the case of this mixed race couple who produced twins with phenotypes at opposite ends of the skin-color spectrum [2].

According to Rabbi Yehoshua ben Korchah, the significance of Queen Esther’s second name, Hadassah, was evident in the greenish yellow tinge of her skin, like that of a myrtle.

Getting back to Chom and his wife, the story about the twins supports the likelihood that Chom and his wife were the progenitors of the black race. At the same time, it also points to the possibility of Chom and his wife having been able to produce offspring with an albino skin as well [1].

Words in Torah also give insight into various diseases that are characterized by unusual discoloration of the skin. One of these infirmities is neonatal jaundice, whose most visible symptom is the yellowing of the skin [3]. Jaundice is the most commonly discussed liver disease in the Talmud. Some medical information on the condition is provided by an anecdote in the Talmud, which demonstrates its practical application in the customary *brit milah* [4]. But before the *halachic* applications of the condition are delved into, it is necessary to offer a brief description of the disease.

Jaundice is caused by too much bile pigment in blood. In neonates, hemolytic or pathological jaundice is characterized by an increased production of bile pigment as a result of red blood cell damage. This type of jaundice may be caused by

antibodies produced by an incompatible blood transfusion. In infants, this may be caused by fetomaternal blood group incompatibility [3]. The antibodies produced by the mother to fight the mismatch will treat her fetus as an intruder, causing the red blood cells in the fetus to agglutinate [5]. Bilirubin is the yellow breakdown product of normal heme catabolism and is excreted in the urine. Relatively high levels of bilirubin, however, may be indicative of such hemolytic disease and is a symptom of pathological jaundice [6]. Physiological jaundice on the other hand, sometimes also found in neonates, is typified by hyperbilirubinemia, a temporary defect in the synthesis of the enzyme that breaks down bile to an excretable form [3].

Modern medicine notes that technically an infant diagnosed with neonatal hyperbilirubinemia is no more at risk to undergo *brit milah* than is an infant without the condition. If medical opinion was the only standard for determining whether or not *brit milah* is to be performed, the ritual would not be delayed for an infant with physiological jaundice [7]. However, a passage in the Talmud (*Shabbat* 134a) may indicate otherwise:

“Abaye also said: Mother told me... If he [infant] is *yarok*, so that he is deficient in blood, we must wait until he is full-blooded and then circumcise him.” Furthermore, R’ Natan was presented with a case of a woman whose first two sons had died from bleeding after circumcision. She brought her third son before R’ Natan, who relayed that “seeing that he was *yarok*, I examined him and saw no covenant blood in him. I said to her, wait until he is full-blooded; she waited and then circumcised him and he lived. They called him Nathan the Babylonian after my name.”

There is some controversy as to exactly what color *yarok* or *yerakon* refers to and whether or not the term used in the case of R’ Natan Habavlee actually referred to neonatal jaundice. However, the Talmud generally uses the words *yarok* and *yerakon* to describe jaundice, characterized by a yellow discoloration of the skin [4].

During the time of the Talmud, there was no clinical test for these diseases [7]. An authority would notice an infant’s yellow complexion and conclude that the infant may be at risk for some disease. This concern alone justified the postponement of the *brit milah* until the symptoms disappeared. However, with today’s diagnostic testing, it has been determined that an infant with physiological jaundice is at no greater risk to undergo *brit milah* than a normal, healthy baby. Do the statements of Abaye’s mother bear the same weight as *halacha*? It seems that her recommendation suggested no basis in *halachic* tradition. In fact, *Rashi* commented that the advice of Abaye’s mother was based on

her experience as a nurse, indicating the medical opinion of the time [7].

On the other hand, the advice of Abaye’s mother prompted a ruling by the *Rambam* (*Hilchot Milah* 1:17) and the *Shulchan Aruch, Yoreh De’ah* (263:1). As such, many rabbinical authorities forbid circumcision of a jaundiced infant despite modern medicine’s view that physiological jaundice is not a threat to the infant; “one cannot accept medical advice that contradicts the words of *Chazal* [7].”

Further analysis of the passage may make one wonder if the Talmud even intended to postpone *brit milah* in all cases of *yarok*. In fact, *Rambam, Hilchot Milah* (1:17) actually ruled that an infant who is “*yarok be-yoter*” or overly-*yarok* may not be circumcised. By implication, an infant with a tint of *yarok*, may be circumcised. The *Avnei Nezer, Choshen Mishpat* (no. 125) cited *Rambam’s* verdict as justification for giving final authority to the physician in evaluating the overall condition of the jaundiced infant [7].

The *tinok hayarok* mentioned in the Talmud may have been referring to *tinok hayarok be-yoter* as more than 60% of all babies born display symptoms of jaundice. It would be irrational to consider that historically 60% of all circumcisions were delayed. Otherwise, a more extensive discussion on the topic would be evident in previous sources. By implication, the standard of *yarok* is likely to be *yarok be-yoter* [7].

Further discussion on the *tinok hayarok* is far beyond that which has been discussed. In the final analysis, a Rav is always to be consulted in the case of a *tinok hayarok* and a doctor should make the diagnosis with the *mohel’s* approval. In cases of physiological jaundice, decisions regarding whether or not to postpone the *brit milah* are rendered on a case-by-case basis. A diagnosis of physiological jaundice is generally based on eliminating the possibility of hemolytic disease and evaluating the overall health of the baby and level of bilirubin. In cases of pathological jaundice the *brit milah* is always postponed until symptoms have disappeared [7].

Thus far, skin color phenomena implied by or openly discussed in Torah have been gleaned from the *Chumash* and *Talmud*. Another such incidence of skin color is evident in the *Megillah* as well. Traditionally, Judaism believes that a person’s name bears some symbolic meaning. According to Rabbi Yehoshua ben Korchah, the significance of Queen Esther’s second name, Hadassah, was evident in the greenish yellow tinge of her skin, like that of a myrtle. Queen Esther is thought to have had an interesting medical condition called chlorosis, also known as “green-sickness”. This condition manifested in young women plagued by iron deficiency anemia and is accompanied by a greenish complexion [8].

As far as what recorded history can impart, physicians have attempted to describe the features of chlorosis since the 17th century, but the actual nature of the disease remained a mystery for a long time. However, in 1895, it was proposed that chlorosis was caused by a nutritional iron deficiency. This seems to be the generally accepted medical opinion today. Cases of chlorosis have increasingly been recorded towards the end of the 19th century, but after World War I the incidence of the disease declined. By the 1930s, cases of human chlorosis were no longer being reported [9].

Some of the earliest references to chlorosis in the medical literature discuss the habit of avoiding meat as being a contributing factor to the disease [10]. It is interesting to note that according to a *midrash*, Queen Esther avoided meat in the palace of Achashverosh so as not to transgress the Jewish dietary laws [11]. By doing so, she denied herself an excellent source of iron [12]. Perhaps there is a relationship between these facts about the nutritional value of meat, Queen Esther's meatless diet in the king's palace, and her "diagnosis" of green-sickness.

Queen Esther's greenish complexion may have been

caused by a reduced hemoglobin percentage, a symptom of chlorosis [13]. Hemoglobin is the iron-containing protein that transports oxygen in red blood cells [14]. Reduced hemoglobin may point to a decrease in the amount of normal blood circulating at the surface of the body [13]. This may explain the greenish yellow pallor of Queen Esther, which apparently did not detract from her beauty.

From the genetics of skin color, to the *tinok hayarok*, to Queen Esther's green complexion, the *Torah* provides some compelling insights into various skin color phenomena. Some of the insights described in this manuscript, particularly regarding Chom and Queen Esther, have their basis in *midrash*, which is well known for its allegorical *aggadot*. While the credence of *Torah* supercedes that of modern science, modern scientific knowledge can reinforce the degree of certainty to which *midrashim* can be explained literally. And with the medical knowledge available today, science can offer explanations for phenomena referenced to in *Chumash*, the *Talmud*, and *midrashic aggadot* that include a vast range of topics not only skin deep.

ACKNOWLEDGEMENTS

I express my deepest thanks to Dr. Babich not only for reviewing this manuscript, but also for generously investing his time toward helping me pursue my goals in the sciences. I would also like to thank Dr. E. Kanarfogel for graciously reviewing the accuracy of this manuscript's *Torah* content. And thank you mom and dad for sending me to Stern College and making it possible for me to pursue my goals. The right words do not even exist to sufficiently thank you for your devotion to your children.

REFERENCES

- [1] Babich, H. (2001). Noach and the *Tavya*: Some Torah, Some biology. *Derech Hateva: a Journal of Torah and Science*. 5: 59-65.
- [2] Black and White Twins. Mail Online. <http://www.dailymail.co.uk/news/article>. (retrieved January 15, 2009).
- [3] Dickey, N.H. (1972). Jaundice or Icterus. *Funk and Wagnall's New Encyclopedia*, Vol. 15. Funk and Wagnall's Inc, United States.
- [4] Westreich, M. (1990). Liver disease in the Talmud. *J. Clin. Gastroenterol.*, 12:57-62.
- [5] Rh Factor in Pregnancy. *Pregnancy and Childbirth*. <http://pregnancy.about.com/cs/rhfactor>. (retrieved January 16, 2009).
- [6] Neonatal Jaundice. Wikipedia. http://en.wikipedia.org/wiki/Neonatal_jaundice. (retrieved January 16, 2009).
- [7] Flug, J. (2005). Jaundice and circumcision. *Jewish Med. Ethics*, 5:40-48.
- [8] Hoenig, L.J. (2006). Queen Esther: strong as steel but iron deficient. www.FloridaJewishNews.com
- [9] Guggenheim, K.Y. (1995). Chlorosis: The rise and disappearance of a nutritional disease. *J. Nutr.* 125:1822-1825.
- [10] Loundon, I.S.L. (1980). Chlorosis, anemia, and anorexia nervosa. *Brit. Med. J.* 281:1669-1675.
- [11] Queen Esther the Vegetarian. *The Jew and the Carrot*. <http://www.jcarrot.org/queen-esther-the-vegetarian/> (retrieved January 15, 2009).
- [12] Iron Rich Foods for Iron Deficiency Anemia. *Health Castle: Simply Better Health*. <http://www.healthcastle.com/iron.shtml> (retrieved January 15, 2009).
- [13] Greene, C.L. (1917). *Medical Diagnosis for the Student and Practitioner*. P. Blakiston's Son and Co., Philadelphia, P.A.
- [14] Hemoglobin. Wikipedia. <http://en.wikipedia.org/wiki/Hemoglobin> (retrieved January 18, 2009).