

## THE DERMATOLOGIST LOOKS AT THE HAIR PROBLEM\*

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SINCE EVERYONE has hair, either too much or too little, daily attention must be given to this appendage either by combing, brushing, shaving, washing, cutting, or arranging. Innumerable preparations are sold to aid these processes and to help eliminate unwanted hair or to stimulate and grow new hair. The therapeutic claims used to promote the sale of these items are such that it is well to study, for a moment, the basic knowledge we have concerning hair. At once one becomes aware that most of our information is based on legend or theory rather than on actual proved facts. Even the phylogeny of the hair is not entirely settled.

For those who have not been inclined to postulate a primary sensory function for hair, i.e., its derivation from scale borne sense organs of reptiles or tactile spots of mammalian skin, one of the simplest and at the same time most plausible views is that hair, feathers, and scales are morphologically equivalent. There are many developmental features that speak against

such relationships. There are some resemblances between hair and teeth and those who would homologize the two structures point out that certain developmental disturbances in the pilary system are associated with malformations in tooth development. Danforth (1) concludes that for the present, we must content ourselves with regarding mammalian hair as akin to lateral line organs, tactile organs of reptiles, placoidal scales, teeth, claws, dermal scales, and feathers. It is more closely related to some of these structures than to others, but with none of them is it fully homologous. The subject offers an attractive field for future research.

The actual process of hair exchange, commonly called shedding of the hair, continues throughout life. Shedding of the hair in humans differs from that in animals in that it is a constant phenomenon although it may progress more rapidly at certain seasons than at others. The hair loosens from its papilla and rises up to the level of the middle of the follicle. It here becomes attached to the hair bed and is called a bed hair to differ it from the

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papillary hair. Simultaneously, the walls of the lower third of the follicle collapse on each other and the papilla shrinks while the lower end of the separated hair widens out and becomes broom-like. The hair continues to grow while attached to the hair bed and finally its increased size pushes it farther and farther up the follicle until it reaches a point just below the opening of the duct of the sebaceous gland. At this point, it is no longer nourished by a vascular supply so it stops growing, separates itself and falls out. According to Unna (2) the blood supply of the follicle controls nicely the growth and subsequent shedding of the hair. In normal scalps after an interval, the papilla starts to regenerate and a new hair gradually rises in the follicle to push the old hair up ahead of it or less often it grows alongside of the bed hair. It is believed that the same papilla produces hair throughout life and that a new papilla is rarely produced after puberty. It is thought that this regeneration is caused by the supply of blood to the papilla and though we understand the mechanism of the actual shedding, we have no idea what controls the blood supply of the papilla and follicle. Here we lack vital basic information that is of the utmost importance in the maintenance of good hair growth. If it is true that new papillae are rarely formed after puberty, the old ones must be preserved and kept healthy if we are to continue to grow hair.

What do we know about growing hair and what factors influence the rate of hair growth? Surprisingly enough, we have practically no accurate basic knowledge on these fundamental points. Heredity is known to be of importance. However there is no sharp line of demarcation between what is normal and what is abnormal, the same physical trait may have different meanings in two persons. For example, a full beard has a different significance to a white man than to an Indian. While it is recognized further that the tendency to premature baldness appears to be familial and hereditary, no additional light as to why this occurs or how it is brought about is gained from that observation.

Vascular and nervous factors are of basic importance. The regulation of the blood supply to the follicle is no doubt under control of the sympathetic nervous system and this in turn is intimately related with the central nervous system. The effect of emotional factors on hair loss and the graying of hair as seen in alopecia areata and achromotrichia is, of course, well known. A striking example was reported by Barabal and Freeman (3) in the case of a 38-year-old white soldier, who, following a three-mile hike in December, 1943, developed a sudden sharp pain in the left chest and fainted. Examination revealed no organic disease. During that night he was restless and tense and felt as though he were on the verge of a "nervous breakdown." The next

morning he found that his dark brown hair had turned white with the exception of a few strands and within the next few days, there occurred a considerable loss of frontal, marginal, and facial hair. While extreme examples of this type are rare, less pronounced cases are undoubtedly not too infrequent. The question of graying of hair will be referred to again.

The endocrines appear to be involved in hair growth in some manner. The glands which seem most important are the suprarenals, gonads, thyroid, and the pituitary. The latter two may not have any real direct effect, but may react on the suprarenals which in turn influence the hair. The thyroid is said to particularly affect the hair of the scalp, eyebrows, and eyelashes. The ovary and testes influence the development of pubic and axillary hair, the testes, the body hair and beard. The hypophysis and suprarenal through influence on the testes indirectly influence hair generally except the capillus, eyebrows, and eyelashes. According to Hamilton (4) common baldness (alopecia) is a sequela of sexual maturation and is, in most instances, induced by stimulation from male hormone substances. In keeping with this physiological relationship, the incidence of the disease is much higher in males than in females, and extensive forms of the disease are restricted almost entirely to males. Most women with pronounced forms of the disease are those with virilism.

Apparently, age is a factor in the rapidity with which areas of denudation extend. In eunuchs, susceptibility to such loss of hair can increase with age, but baldness does not occur because of inadequacy of testicular secretions. This increased susceptibility accumulates, unspent, like money in the bank, and later treatment of the eunuchs with androgens results in a rapid loss of hair. Available evidence does not bear crucially on the question of whether or not there is, with increasing age, a lowering of the amount of androgenic stimulation required to produce baldness.

The third factor known to be involved is inheritance. No amount of androgenic stimulation produces baldness in persons who lack an inherited tendency to this disease. The realization of this tendency depends, however, upon androgenic stimulation, since, whatever the inheritance, baldness does not ensue without androgenic stimulation.

Local areas of the skin play a dominant role in the atrophic changes that result in baldness. Application of androgens directly to a local area results in piliary changes limited to that region. At the present stage of our information, it must be assumed that androgens are only one of what might be a family of agents (although they are the usual one) which may be capable of inducing atrophic changes in specific areas. The degree of atrophy is controlled by the local area of skin and does not result from external changes in vascularity

or compression of the area by tight bands. Rather, baldness will occur even in skin transplanted from its usual site.

Baldness is one of the so-called degenerative diseases which remain as extremely important medical problems and have not benefited from the achievements of chemotherapeutic control of infectious diseases. It is a condition, the progress of which can be studied. The nature and therapeutic control of the disease can be investigated carefully. Findings from studies of this disease may be presumed to be applicable to a number of so-called degenerative diseases, like prostatic cancer.

**Vitamin deficiencies** in experimental animals certainly play an important role but whether vitamins are of equal importance in humans is not yet so clearly established. This will be discussed in detail under graying of the hair.

From the standpoint of local measures even the effect of shaving or cutting of hair on rate of regrowth has not been satisfactorily settled. While it is believed that shaving or cutting has no effect on the rate of regrowth and does not stimulate the fine downy hairs into becoming terminal hairs, the work is not entirely conclusive and should be repeated. The reverse of this picture is the question of whether the destruction of one hair by electrolysis does not possibly stimulate other hairs of this particular hair group and as a result increase the growth of the other hairs or stimu-

late follicles in a resting condition. There is competent work to show that this is the case but the majority of physicians believe that destroying one hair by electrolysis has no effect on the rate of growth of other hairs in the same group in the same patient. Again the point is not settled.

*The Effect of Temperature.* Heat and cold are both said to influence the rate of hair growth but the effect is probably slight and brought about through the nervous system or through variations in vascularity. There are races of rabbits which tend to produce light or dark hair depending on the temperature in which they are kept.

Radiation effects have been studied and it is thought that the actinic rays—ultra violet—exert only a slight favorable action on the growth of hair but it is felt that this might be due to the hyperemia that may be produced rather than to any effect of the rays themselves. Again the matter is not settled. The x-rays alone are definitely known to stimulate hair regrowth. Large doses of x-rays or radium of course may cause either temporary or permanent hair loss but less excessive doses because of their depth effect are known to stimulate hair regrowth. This can be beautifully demonstrated in cases of alopecia areata where the exposure of a small sharply demarcated portion of a large bald patch to the x-ray results in hair regrowth in this area while the rest of the patch remains bald.

With all the hair tonics, hair ex-

hilarators, hair restorers, and hair dressings on the market, it is startling that we have absolutely no definite proof as to whether any external application made to the skin or hair, has any effect on hair growth. In fact, the most careful experiments that have been done to date, and there are not many recent ones, indicate that nothing that we apply to the skin or hair appears to have any appreciable effect on the rate of hair growth and that any of the apparently beneficial effects noted, may be due to the massage, hyperemia, or increased vascularity brought about in their application. But even the question of whether beneficial effect ensues from massage in humans has not been proved. Animal experiments indicate that it is the massage and not the local applications that are beneficial in increasing rate of hair regrowth. In this field alone, it would seem to me that research should be undertaken to establish once and for all, the role of local application and massage. Furthermore, studies should be done to determine which vehicles are best suited, physiologically and chemically, and what types of stimulants or irritants could best be added to them to benefit the vascularity of the papilla, follicle, and hair in its life cycle.

The exact shape of the hair in different races and individuals is also not entirely settled. In some races, the hairs are oval or ribbon shaped, while in others there is a tendency for the hair to approach a

rectangular form, smooth ellipse, circular form, etc. It is difficult to discover this without having the hairs arranged for examination so they can be rotated under the microscope. Also just what causes naturally curly or wavy hair is not known. Fritsch (5) says that while curly hair behaves in general as a dominant trait, there is no definite sign of Mendelian segregation in future generations. It is possible that the characteristic bend of the follicle immediately above the papilla is the point where the tendency to curl is really imparted. Supposition but not facts!

Even the pigmentation of the hair is not too well understood. Rothman and Flesch (6) reported on the isolation of a red iron pigment from human red hair. The presented data indicated that it may be a complex phenolic iron compound in which the phenolic OH group is attached to a heterocyclic ring containing nitrogen. This pigment was not obtainable from red hair of animals or from any human hair except bright red. The literature on the darkening of hair with age is meager, general, and as far as known to Steggerda (7) never quantitative. Two hundred and twenty males and one hundred and ninety-four females ranging in age from 6 to 18 were measured annually for 10 years in Holland, Michigan.

The study showed that the head hair becomes darker by almost one unit on the Fischer-Saller hair scale with each year of age for the ages 6 to 18. No significant sex differ-

ences were to be noted. Changes of color are brought about by many factors and the natural and sudden graying of the hair are explained by many theories that have not been at all proved. Probably the greatest amount of recently recorded work done on any phase of the hair problem has been done on the effect of vitamins, etc., on the graying of the hair. In a recent summary in the *Nutritional Review* (8), it was noted that the causes of achromotrichia are not well understood. Both dietary deficiencies and hormonal disturbances have been implicated. A deficiency of pantothenic acid is known to result in graying of the hair in rats and other experimental animals and there is evidence that additional factors including para-aminobenzoic acid may at times be involved. On the other hand, the many studies that have been made, give us little reason to believe that human achromotrichia is caused by a dietary deficiency. In man, the process of graying and of aging are frequently associated and there is a popular belief that graying may be accelerated by emotional stress. It is not surprising therefore, that hormonal control of the graying process should have been suspected even though direct experimental evidence has in a large measure been lacking. This confused picture has been somewhat clarified by Ralli, *et al.*, who have shown that even in experimental animals rendered gray by a deficiency in pantothenic acid, adrenalectomy will bring about the restora-

tion of the original color of the hair. It appears that hormone balance, dietary deficiency, and possibly mineral and water balances may influence the production of melanin or its deposition in the hair and skin. The hormonal control must be particularly strong since adrenalectomy overcomes the effect of a pantothenic acid deficient diet. It is not yet clear, however, whether the various factors operate through single or separate mechanisms and the nature of these processes is not well defined.

The tendency to production of hairs of a finer, more silky character in advanced life, is caused by seborrhea according to Sabouraud (8a) and is not a natural phenomenon of normal hair growth as was once supposed. This is explained as being due to a mechanical plugging of the follicles. The matter of premature alopecia, therefore is a very complicated one in which probably many factors come in to play. Studying the fundamentals and going back to the mechanism of the replacement of the hairs which are constantly being shed, therefore, would seem to be the logical approach to the solution of this problem. The question whether the vascular supply controls this mechanism and the factors that might influence or control the vascular supply is therefore of the utmost interest and importance. Wright, *et al.* (8b) studied seborrheic dermatitis and found the administration of vitamin B<sub>6</sub> (pyridoxine) resulted in definite improvement and

occasionally in complete disappearance of this type of eruption when other standard measures of treatment had failed.

Probably the last word has not been said in the matter of shampooing and certainly we are changing radically in our views as to what is the best type of preparation to cleanse and wash the hair. The sulfonated oils which get us away from the alkaline soaps, are undoubtedly an improvement in some respects but they unquestionably have certain disadvantages, chiefly the fact that they do not lather well and that they are extremely drying to the hair in most cases.

It is not my purpose to go into the dangers attendant to hair waving or hair straightening except to point out that bad results have been reported from the cold wave and also to draw attention to the fact that hair waving usually causes changes in color of the hair but especially if other preparations are being used in the hair and scalp at the same time. It is probable that the number of cases of alopecia areata we see following the waving of the hair, may be purely coincidental. It might be a distinct advantage to examine the hair and scalp under a wood light before waving, as a protective measure to the patient as it would give an excellent idea as to the condition of the hair and its suitability for waving. I do not have in mind ruling out the possibility of a fungus infection, which would be unlikely in an adult, but it would give the operator fairly

definite data as to whether the individual had been using other chemicals on the hair that had not been thoroughly washed out. An examination of the hair with the wood light after the wave would give you a good picture of what damage had been done to the hair, and might be a good check on the operator. Mild dermatitis venanata of scalp in fairly sharply localized patches with temporary hair loss due to breaking off of hair at a level close to the skin is not an infrequent sequella. Cotter (9) in 1946 reported that the number of cases in which a toxic reaction has been observed from the "cold wave" process using thioglycolic acid appear to be on the increase. He reported in detail 5 cases from a large group because in these it had been possible to demonstrate their lesions in the laboratory. He showed that severe allergic reactions can result in sensitive persons from thioglycolic acid. Those individuals with anemias and allergic disturbances are most vulnerable. In the majority of cases recovery occurred without permanent damage to the liver when the exposure was promptly terminated. In those cases in which the acid acted as a systemic poison as well as an allergen the first signs of trouble were to be found in the blood count, the elevation of the alkaline phosphatase, the change in the ratio of free to esterified cholesterol, and the appearance of a positive cephalin flocculation test.

The danger of using celluloid combs in water waving are too well

known to deserve more than a mere comment. It is surprising, however, that in this day and age, thallium acetate could have been used as recently as a few years ago on the body to remove unwanted body hairs when the effect of this poison, in causing depilation of the scalp hairs, but not body hairs, was so well known to most everyone.

Chemical hair straighteners began to evolve in 1910 and today do a huge business. Their mode of action is to make a supple out of a rigid shaft. The cystine variety of the hair proteins can be broken at its disulfide bond to produce this fiber relaxation. Thus the kinking, due to thickness gradations and axial twists, may be overcome. According to Lewis (9a) three general types of treatments can be utilized:

- (1) Reducing substances, which ordinarily contain stannous chloride, sodium hyposulfite, sodium polysulfide, and the like.
- (2) Agents which bring large amounts of heat to the individual hairs by their exothermic reaction with water (calcium oxide, for example).
- (3) Caustics, chiefly sodium and barium hydroxide. Three changes occur: hydrolysis, inhibition, and destruction of the disulfide linkage. The result is a malleable protein gel susceptible to mechanical straightening, a softer hair.

The use of these caustics is not without danger. Burns may be of

such severity that the employment of straighteners is inadvisable except with great care or under the supervision of a qualified expert. Of two cases seen by the author, one suffered permanently damaging burns, as though by lye, and the other a permanently depigmented area across his forehead.

Hair was subjected to a careful analysis by Bagchi and Ganguly (10) and was found to contain, in much excess, all the metals which are likely to be present in human tissues. There is marked variability in the amounts of the metallic elements in hair.

MIXED HAIR OF 30 MALE ADULTS—FROM A  
BARBER SHOP

	Per Cent
C.....	44.60
N.....	14.60
H.....	5.40
S.....	3.80
P.....	0.08
Cl.....	2.00
	Mg. per Kilo
Water.....	4.10
Pb.....	47.7
Cu.....	108.0
As.....	2.2
Zn.....	212.0
Fe.....	141.0
Mn.....	38.0
Co.....	18.1
Ni.....	8.2
Ca.....	208.4
Al.....	32.0
Si.....	150.4
Bi.....	—
Ag.....	—
Sb.....	—
Hg.....	—

Aspartic acid (3.5%) has been isolated for the first time from human hair by Beveridge and Lucas (11). Glutamic acid has been isolated from human hair in higher yields than previously reported.



The quantities of basic amino acids isolated agree essentially with those reported in the literature. Methionine has been found in human hair, and its amount determined as 1.0%.

	Per Cent
Arginine.....	10.7
Histidine.....	0.63
Lysine.....	2.40
Cysteine.....	13.7
Tyrosine.....	2.1
Glutamic acid.....	10.6
Aspartic acid.....	3.5
Methionine.....	1.0

Enkeratins, e.g., wool and hair, are distinguished from pseudokeratins according to Clay, *et al.* (12), in that their basic amino acids (histidine, lysine, and arginine) are found in a relatively constant molecular ratio of 1:4:12. The cystine and cysteine (both non-basic amino acids), nitrogen and sulfur content of 120 samples of human hair was determined. The relation of age, sex, and pigmentation to the composition of hair was studied. No consistent relation between age and composition was found. There was more cystine and cysteine in male hair than in female hair. Dark hair contained more cystine than did light hair. These differences were statistically significant. No significant variations in the nitrogen and sulfur content were observed. Hair contains larger amounts of lead and in cases of abnormal exposure it may retain as much as 508 mg. per kilo. Bagchi, *et al.* (13), reported that black hair of women gives the largest amount while gray hair of men and women gives the minimum, and brown or golden brown or other shades oc-

cupy an intermediate position. Lead may be a likely factor in producing the characteristic pigments of hair in different nationalities.

Relatively large quantities of lead were found in the urine and feces of some Hindu men and women and, since correspondingly high quantities were then found in the hair, it is considered that lead is absorbed into the general circulation and eliminated through the hair.

In many instances a mild form of alopecia was associated with high lead content in the hair, and it is suggested that chronic lead intoxication may prevent access of nourishment to the follicles, with the result that the hair falls out.

According to Butcher when skin producing black hair is interchanged with skin producing white hair in the piebald rat, white hair frequently grows on the skin which formerly had black hair. Likewise if skin producing black hair is incised and sutured back in place, it often produces white hair.

The present conception of pigment formation seems to be that pigment results from the combination of a chemical substance, or propigment, carried by the blood with an enzyme in the cells of the hair bulb. In these rats the propigment was present, since the rest of the hair of the animal remained black and black hairs often appeared among the white ones on the grafts. The white hair was not due to the lack of innervation, as was shown by denervating areas. The enzymatic potentialities of the cells

of the hair bed must, therefore have been affected by the lack of vascularity and nutrition immediately following the operation, since injection studies show that the vascular supply of the graft soon becomes similar to the supply of the surrounding area.

Once the pigment-forming ability is lost by the cells, there is no restitutive capacity to respond to the application of irritants to the skin. Application of irritants to the skin has failed to induce the cells of the hair beds to form pigment again.

Growth or production of the hair by the hair bed is also affected by vascularization. Increased blood supply accelerates hair growth. Growth is not affected permanently by poor blood supply, as shown in these experiments, while the pigment-forming capacities of the cells are affected permanently.

When the skin was incised, all blood supply was eliminated. Nutrition was supplied to the graft by tissue fluid from below the graft and from around its periphery. This tissue fluid sufficed to supply the cells of the hair bulb with nutrition necessary for the survival of their growth potentialities. The tissue fluid, however, did not provide the cells with the substances necessary for the survival of their enzymatic potentialities. Thus, the requirements for growth are less than for pigment formation.

#### SUMMARY AND CONCLUSIONS

I have attempted to touch briefly on all of the fundamental points

that are of vital interest and importance particularly concerning scalp hair. It was my intention to draw your attention to our woeful lack of fundamental information on matters of daily concern to all of us. I trust that I may have succeeded in enlisting your co-operation in attempting to solve:

(1) What basic factors are involved in keeping alive the vital hair papilla and follicle?

(2) Do only internal mechanisms control the life span of the papilla and follicle or can they be influenced by local measures of any type, such as tonics, stimulants, massage, hyperemia, etc.?

(3) If local treatment is of value, what form is best, a liquid or an ointment, and what type base whether liquid or ointment, is most acceptable to the scalp and hair?

(4) What controls hair pigment?

(5) By further study of hair shape, composition, etc., could not some better and perhaps safer methods for curling or straightening the hair be found?

(6) What is dandruff and what role does it play in the causation of premature alopecia—if any?

#### BIBLIOGRAPHY

1. Danforth, C. H., "Hair with Special Reference to Hypertrichosis," *Monograph A.M.A.* (1925).
2. Unna, quoted from McCarthy, L., "Diagnosis and Treatment of Diseases of the Hair," C. V. Mosby Co., St. Louis (1940).
3. Barabal, H. S., and Freeman, N., "Sudden Graying of Hair, Alopecia and Diabetes Mellitus of Psychogenic Origin," *Psychiat. J.*, **20**, 31-38 (Jan., 1946).
4. Hamilton, J. B., "Relationship Between Common Baldness and Male Sex Hor-

- mones," *Tr. N. Y. Acad. Sc.*, **8**, 101-102 (Jan. 1946).
5. Fritsch, Gustav, "Die Menschliche Haupthaaranlage," Gerog Reimer, Berlin (1915).
  6. Rothman, S., and Flesch, P., "Isolation of an Iron Pigment from Human Red Hair," *Proc. Soc. Exper. Biol. & Med.*, **53**, 134-135 (June, 1943).
  7. Steggerda, M., "Change in Hair Color with Age," *J. Hered.*, **32**, 402-403.
  8. *Nutritional Review*, "Pantothenic Acid, the Adrenal Cortex and Gray Hair," **4**, 84-85 (March 1946).
  - 8a. Sabouraud, "Maladies du Cuir Chevelu," Massou et Cie, Paris, 1902, 1910, 1928, 1929, 1932. "Path. of Hair Follicles and of Hair," *Bull. Soc. Franc. de Dermat. et Syph.*, **42**, 868 (1935).
  - 8b. Wright, C. S., Sarnitz, M. H., and Brown, N., "Vitamin B6 (Pyridoxine) in Dermatology," *Arch. Derm. Syph.*, **47**, 651-653 (May, 1943).
  9. Cotter, L. H., "Thioglycolic Acid Poisoning in Connection with the Cold Wave Process," *J.A.M.A.* (June 15, 1946).
  - 9a. Lewis, F., "Danger in the Use of Chemical Hair Straighteners," *Ibid.*, **112**, 36-37 (Jan., 1939).
  10. Bagchi, K. N., and Ganguly, H. D., "Mineral Constituents of Human Hair," *Amer. Biochem. & Exper. Med.*, **1**, 83-86 (1941).
  11. Beveridge, J. M. R., and Lucas, C. C., "The Analysis of Hair Keratin," *Biochem. J.*, **38**, 88-95 (1944).
  12. Clay, R. C., Cook, K., and Routh, J. I., "Studies in the Composition of Human Hair," *J. Amer. Chem. Soc.*, **62**, 2709-2710 (Oct., 1940).
  13. Bagchi, K. N., Ganguly, H. D., and Sirdar, J. N., "Lead-Content of Human Hair," *Indian J. M. Research*, **27**, 777-791 (1940).