professor of eugenics in the child-welfare research station of the State University of Iowa.

DR. RALPH F. SHANER, for several years connected with the department of anatomy of the Harvard Medical School, has entered on his work as assistant professor of anatomy in the University of Alberta.

DR. D. BURNS, Grieve lecturer on physiological chemistry in the University of Glasgow, has been appointed professor of physiology in the University of Durham College of Medicine, Newcastle-upon-Tyne, in succession to the late Professor J. A. Menzies.

DISCUSSION AND CORRESPONDENCE

THE CAUSES OF WHITENESS IN HAIR AND FEATHERS

MY attention has recently been called to a statement by W.D. Bancroft[1] to the effect that white hair and feathers owe their color to the entrance of air into their structure. Similar statements have appeared elsewhere at various times, and this conception appears to be widespread.

No one, to my knowledge, has ever presented any real evidence that either hair or feathers have any more air in them when white, than when colored. Furthermore it is quite unnecessary for them to have more air. I have never been able to see any difference in the structure of white hair and feathers as compared with colored hair and feathers, except for the presence or absence of pigment.

In 1904, I made the statement, in an address, that hair and feathers are white for the same reason that powdered ice or glass and other transparent substances in a fine state of division appear white.[2]

Hair consists of numerous cornified epithelial cells more or less *incompletely* fused together. In the case of human hair, most of the structure is cortical. These cells furnish a vast number of external and internal reflecting surfaces, as can be seen easily by placing a white hair on the microscope stage with no mounting fluid. When pigment is present, the incident light is more or less extensively absorbed, according to the amount of pigment, before reaching the deeper cells. The amount of undispersed light reflected, of course depends on the number of internal reflecting surfaces not screened by pigment. There is always some reflection of undispersed light by the hair cuticle, no matter how much pigment is present.

The white of feathers is produced mostly by the barbules which are of microscopic size and consist of single columns of cells.

Hair and feathers have many times the surface, external and internal, provided by small bodies of similar mass but less intricate structure. According to a well-known law, the surface of a cube varies relatively to the volume inversely as the diameter. Thus a cuboidal cell one tenth of a millimeter in diameter has ten times as much surface, relatively, as a body one millimeter in diameter. Furthermore, the amount of reflecting surface is increased by the irregular contour of the hair and feather elements. The total area of the vast number of facets in a single, unpigmented hair or feather which are in a position to reflect light to the eye is relatively very great.

White in hair and feather structures is due to failure or absence of pigment formation in the follicle before cornification takes place. I know of no critical evidence that either hair or feather structure can become white in any other way. The process is therefore slow, and the time required for a change to white is determined by the rate of growth.

Similar views are expressed in an article by Stieda[3] where a discussion of the origin of the notion that hair may suddenly become white is discussed in detail.

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[1] Applied Colloid Chemistry, 1921, p. 198.

[2] See abstract in *Biol. Bull.*, 1904, Vol. VI., No. 6, p. 311, for remarks about white feathers. See also *Anat. Rec.*, 1918, No. 1, p. 52, for discussion of white hair.

[3] *Verh. der Gesellsch. Deutscher Naturforsch. und Aerzte.*, 1910, Bd. 81, S. 222–224; also *Anat. Hefte*, 1910, Bd. 40, H. 2.