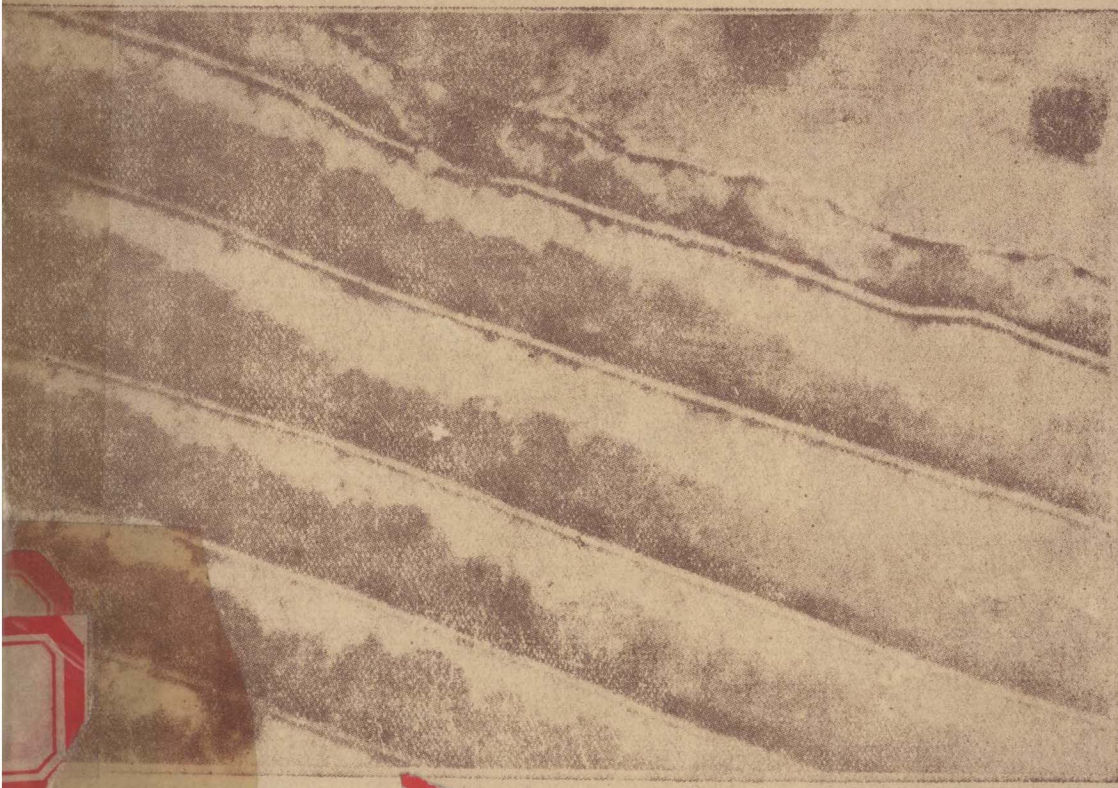
The Physiology and Pathophysiology of the Skin

Volume 4 edited by A. Jarrett



The Physiology and Pathophysiology of the Skin

Volume 4
The Hair Follicle

Edited by
A. JARRETT.
Department of Dermatology,
University College Hospital
Medical School,
London, England

1977

ACADEMIC PRESS
London · New York · San Francisco
A Subsidiary of Harcourt Brace Jovanovich, Publishers

ACADEMIC PRESS INC. (LONDON) LTD
24–28 Oval Road,
London NW1

U.S. Edition published by
ACADEMIC PRESS INC.
111 Fifth Avenue,
New York, New York 10003

Library of Congress Catalog Card Number: 72-7711

ISBN: 0-12-38060 4-6

PRINTED IN GREAT BRITAIN BY
THE WHITEFRIARS PRESS LTD., LONDON AND TONBRIDGE

Contributors

VOLUME 1 The Epidermis

A. JARRETT, M.B., D.Sc., F.I.Biol., F.R.C.Path., F.R.C.P.Ed.

Director, Department of Dermatology, University College Hospital Medical School, London; Reader in Dermatological Histology, University of London; Hon. Consultant, University College Hospital, London, England.

VOLUME 2 The Nerves and Blood Vessels

D. C. SINCLAIR, M.A., M.D., D.Sc., F.R.C.S.Ed.

Regius Professor of Anatomy, University of Aberdeen, Aberdeen, Scotland; Late Professor of Anatomy, University of Western Australia.

T. J. RYAN, B.M., M.R.C.P.

Consultant Dermatologist, United Oxford Hospitals, Oxford; Late Senior Lecturer in Dermatology, St. John's Hospital for Diseases of the Skin; Editor of the Proceedings of the British Microcirculation Society.

VOLUME 3 The Dermis and the Dendrocytes

A. JARRETT, M.B., D.Sc., F.I.Biol., F.R.C.Path., F.R.C.P.Ed.

P. A. RILEY, M.B., Ph.D.

Senior Lecturer in Biochemical Pathology, University College Hospital Medical School, London.

T. J. RYAN, B.M., M.R.C.P.

R. I. C. SPEARMAN, B.Sc., Ph.D., F.I.Biol.

Senior Lecturer, Department of Dermatology, University College Hospital Medical School, London.

VOLUME 4 The Hair Follicle

A. JARRETT, M.B., D.Sc., F.I.Biol., F.R.C.Path., F.R.C.P.Ed.

ELIZABETH JOHNSON, B.Sc., Ph.D.

Lecturer in Zoology, University of Reading, London Road, Reading, England.

R. I. C. SPEARMAN, B.Sc., Ph.D., F.I.Biol.

Preface

The preface written for the three previous volumes applies equally well to this volume on the Hair Follicle. The vast amount of information available concerning mammalian hair follicles and their function is unfortunately limited to specialized aspects of hair growth and coloration, and is restricted to a few species. For example, biologists and geneticists have studied the inheritance of coat colour in the house mouse in great detail, and an immense amount of work has been undertaken on the physico-chemical nature of wool, and also on the production of this commodity because of its great commercial value. This makes the selection of material to be included in a work of this type difficult. Information has been selected that is hopefully of value both to the general biologist interested in hair and to those involved in wool research. The needs of the dermatologist have been rather more difficult to satisfy because man has been neglected in the study of normal hair growth. This is doubtless due to the difficulty of obtaining sufficient suitable material from the scalp for a full investigation of the many and varying functions of the human hair follicle. Nevertheless, recently some advances have been made in relation to disorders of the human follicle: for example, the recognition that acrodermatitis enteropathica is a zinc deficiency disease, and the value of the enzymology of plucked hairs to study the carrier state in sex-linked inborn disorders of metabolism. Most of the disorders of human hair growth are inherited defects but it is far too early to hope that genetic manipulation will be able to help this group of diseases: research in this field has to be carefully monitored for environmental and ethical reasons.

There are some areas of overlap in the subject material covered by the two main contributors but this has been approached from different aspects by the two writers. However, Chapter 37 by Dr Johnson carries, in the main, the same information as Chapter 38 written by Dr Spearman: the former could be considered as an introduction to the following chapter which has more detailed information of interest to the biologist. Chapter 37 may be sufficient on its own for the needs of the clinical dermatologist. It is hoped that the information in this

volume will give an adequate background to the clinician on which he can base new knowledge as it becomes available and which may be of direct value to him in the treatment of his patients.

A. JARRETT *March 1977*

Acknowledgements

Again the authors are indebted to their colleagues at home and abroad who have discussed their work, provided illustrations and given permission to use published material. It is sincerely hoped that all these have been acknowledged in the text and legends.

Mrs Jane Duncan of Academic Press has coped ably with the production of this volume. We are also greatly indebted to the Editor's secretary, Mrs Henchoz, for her patient and accurate typing and re-typing of much of the script, and to Miss Sheila Wakefield who kindly undertook the typescript for the chapters by Elizabeth Johnson.

The coloured illustrations have been made possible by virtue of a grant from the Imperial Chemical Industries: this was kindly organized by Dr C. Marsden, Head of I.C.I. Medical Department.

A. JARRETT *March 1977*
E. JOHNSON
R. I. C. SPEARMAN

Contents of Volume 1
The Epidermis

Contents of Volume 2
The Nerves and Blood Vessels

Contents of Volume 3
The Dermis and the Dendrocytes

Contents

37 Cycles and Patterns of Hair Growth

ELIZABETH JOHNSON

Department of Zoology
University of Reading, Whiteknights,
England

I. INTRODUCTION

Mammals are unique in their covering of hair, and as in the case of bird feathers, without such keratinous coverings for the conservation of heat it is unlikely that homeothermy could have evolved in higher animals. Certainly with the exception of man, hair is an important thermoregulatory device, and adaptive changes in the length or density of the pelage related to seasonal variation are common features. Effective insulation can only be achieved if the hair is kept dry, and waterproofing is provided by the oily secretions from the sebaceous glands, associated with every hair follicle.

The hair of wild animals is coloured for camouflage;[1] for example in the cat family the pattern and colour of the coat is related to habit and environment. Thus the lion which lives mainly on sandy plains has a uniformly buff coat, and the vertical tawny-orange and black stripes of the tiger blend with the grass stems and reeds of the swamps and grassy plains of its habitat. The arboreal jaguar has a spotted coat which merges with the forest foliage.

1. Cott, H. B. (1940). 'Adaptive Coloration in Animals'. Methuen and Co. Ltd., London.

There may also be seasonal adaptive colour changes from the brown-to-grey summer coat to a white winter coat in a number of northern and Arctic species such as the weasel,[1] the varying hare[2] and the stoat.[3] A similar adaptive function is the assumption of a dappled summer coat by European fallow deer which provides effective camouflage amongst the trees in summer.

There are a few examples of hair being used as a signal rather than for concealment. Such signals are usually sexual, and include the mane of the lion and mandrill, and the beard of man.

Because each hair follicle has nerve fibres around its base, hair is very important in receiving tactile stimuli, and this is true of all hair as well as the extra-sensitive specialized vibrissae (see Vol. 2, p. 415).

Man is peculiar in having a very restricted distribution of hair. It is generally agreed that naked man probably arose as a mutant, and in common with other naked mutants man possesses hair follicles all over the body surface. Indeed, human skin has more follicles per unit area than the chimpanzee,[4] but over most of the body surface they only produce minute vellus hairs which function solely as tactile organs. The terminal hair that remains in man seems to serve either protective or sexual functions. Hair of the scalp not only provides physical protection from trauma, but also protection from ultra-violet and infra-red radiation. The eyebrows protect the delicate area around the eyes as well as serving to divert sweat. The pubic and axillary hair are partly protective in preventing direct contact between skin surfaces, but also, in less deodorized societies, served a sexual function in promoting the dispersal of apocrine secretions. Finally, the hair of the beard, chest and abdomen are truly secondary sexual characteristics, although it is entirely absent from these regions in some races.

II. BODY PATTERNS OF HAIR GROWTH IN MAN

Hair follicles in man are formed between the second and fifth month of foetal life and the number is the same in both sexes, and all races. The absolute number of follicles is also similar in different regions of the body but the density per unit area varies enormously due to differential

1. Wright, P. L. (1942). A correlation between spring molt and spring changes in the sexual cycle of the weasel. *J. exp. Zool.* **91,** 103
2. Lyman, C. P. (1943). Control of coat color in the varying hare, *Lepus americanus*. *Bull. Mus. comp. Zool. Harv.* **93,** 393.
3. Rothschild, M. (1942). Change of pelage in the stoat. *Nature, Lond.* **149,** 78.
4. Schultz, A. M. (1931). The density of hair in primates. *Human Biol.* **3,** 303.

growth of the body surface.[1] For example, the follicle density is four to six times greater on the cheek and forehead than on the trunk and extremities.

The degree of hairiness of an invididual depends upon the development of coarse, terminal hairs (see p. 1244). In some regions, such as the pubis, there is an abrupt transition from the fine postnatal vellus hair to coarse terminal hair. In other areas, such as the scalp, there is a more gradual transition with an intermediate type of hair during early

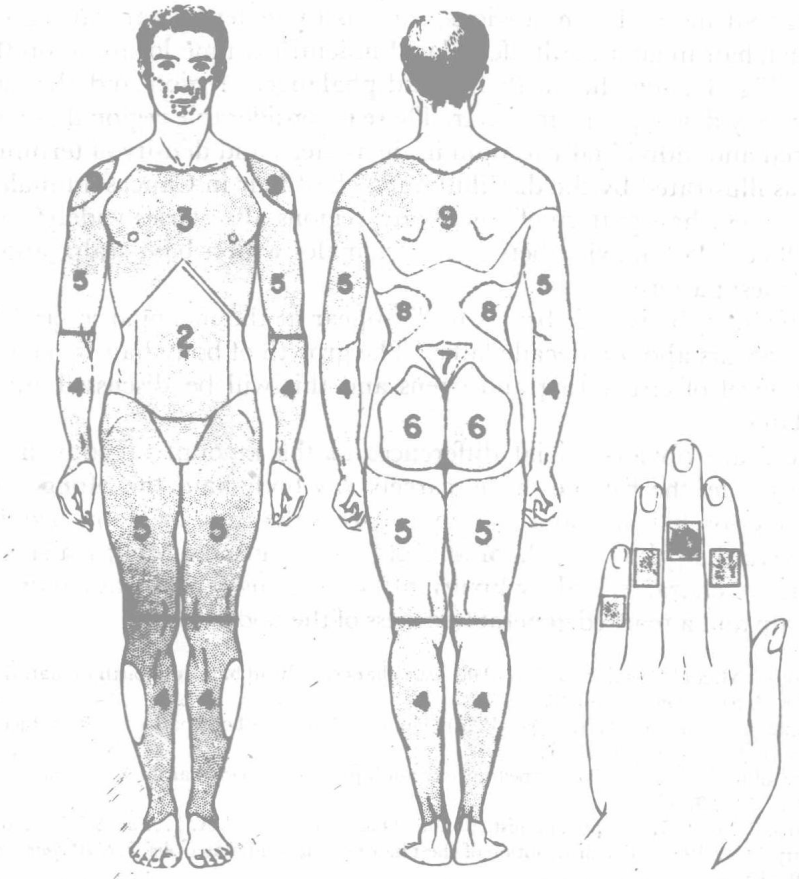


Fig. 1. Body regions in man which may develop terminal hair: 1. beard; 2. hypogastric; 3. thoracic; 4. lower arm and leg; 5. upper arm and leg; 6. gluteal; 7. lumbo sacral; 8. lower back; 9. upper back; 10. mid-phalangeal. From Garn, S. M. (1951). *Annl. N.Y. Acad. Sci.* **53,** 502.

1. Szabo, G. (1958). The regional frequency and distribution of hair follicles in human skin. *In* 'The Biology of Hair Growth'. (Eds Montagna, W. and Ellis R. A.), pp. 33–39. Academic Press, New York and London.