

MICROSCOPIC ANATOMY OF THE DOG



A PHOTOGRAPHIC ATLAS

The widespread use of the Beagle dog as an experimental animal has created a need for a reference which focuses directly on the histologic characteristics of the dog as well as those characteristics which this species shares with other animals and man. The investigator will find that the plates of healthy, purebred Beagles of known ancestry, provides excellent reference material on the normal histology of the dog.

In addition to the photomicrographs, text material in each chapter points out characteristic features of the dog and introduces pertinent differences and similarities to other animals and man. To orient the reader to the gross anatomical relationships, diagrammatic line drawings of each system are included. These are marked with the plane of section and the area from which the photomicrographs were made. A comprehensive bibliography is included.

CHARLES C THOMAS • PUBLISHER
Springfield • Illinois

WILLIAM S. ADAM
A.B., M.S., Ph.D.

*Formerly Instructor
Department of Small Animal
Surgery and Medicine
College of Veterinary Medicine
Michigan State University
East Lansing, Michigan*

M. LOIS CALHOUN
B.S., M.S., D.V.M., Ph.D.

*Professor, Department of Anatomy
College of Veterinary Medicine
Michigan State University
East Lansing, Michigan*

ESTHER M. SMITH
B.S., M.S., Ph.D.

*Professor, Department of Anatomy
College of Veterinary Medicine
Michigan State University
East Lansing, Michigan*

AL W. STINSON
B.S., D.V.M., M.S.

*Associate Professor
Department of Anatomy
College of Veterinary Medicine
Michigan State University
East Lansing, Michigan*

MICROSCOPIC ANATOMY OF THE DOG
A Photographic Atlas

MICROSCOPIC ANATOMY OF THE DOG

A Photographic Atlas

By

WILLIAM S. ADAM, A.B., M.S., Ph.D.

*Formerly Instructor
Department of Small Animal Surgery and Medicine
College of Veterinary Medicine
Michigan State University
East Lansing, Michigan*

M. LOIS CALHOUN, B.S., M.S., D.V.M., Ph.D.

*Professor, Department of Anatomy
College of Veterinary Medicine
Michigan State University
East Lansing, Michigan*

ESTHER M. SMITH, B.S., M.S., Ph.D.

*Professor, Department of Anatomy
College of Veterinary Medicine
Michigan State University
East Lansing, Michigan
and*

AL W. STINSON, B.S., D.V.M., M.S.

*Associate Professor, Department of Anatomy
College of Veterinary Medicine
Michigan State University
East Lansing, Michigan*



CHARLES C THOMAS • PUBLISHER
Springfield • Illinois • U.S.A.

Published and Distributed Throughout the World by
CHARLES C THOMAS • PUBLISHER
BANNERSTONE HOUSE
301-327 East Lawrence Avenue, Springfield, Illinois, U.S.A.
NATCHEZ PLANTATION HOUSE
735 North Atlantic Boulevard, Fort Lauderdale, Florida, U.S.A.

This book is protected by copyright. No
part of it may be reproduced in any manner
without written permission from the publisher.

© 1970, by CHARLES C THOMAS • PUBLISHER
Library of Congress Catalog Card Number: 75-91844

*With THOMAS BOOKS careful attention is given to all details of
manufacturing and design. It is the Publisher's desire to present books
that are satisfactory as to their physical qualities and artistic possibilities
and appropriate for their particular use. THOMAS BOOKS will be true
to those laws of quality that assure a good name and good will.*

Printed in the United States of America
EE-16

Preface

The widespread use of the beagle dog as an experimental animal has created a need for a reference which focuses directly on the histologic characteristics of the dog as well as those which this species shares with other animals and man. Therefore, this atlas is intended to be a reference for the experimental investigator, students in human and veterinary medicine, and those in other health-related fields.

Twenty, six-month-old, purebred beagle dogs from known ancestry were used in this study. While most of the dogs were physically mature at this age, it must be emphasized that there were some differences in the maturation level among the animals studied. Nonetheless, the photomicrographs in this atlas reflect fairly uniform morphologic characteristics of young animals.

Several methods of tissue procurement and fixation were employed in an effort to obtain optimum sections. Some of the dogs were anesthetized prior to the insertion of venous and arterial cannulae. The animals were exsanguinated and then perfused via the cannulae at a constant pressure of 80 mm of Hg with either 10% buffered formalin or a mercury-formol-saline solution. While the perfusion method of fixation allows harvest of a maximum amount of tissues from one animal without postmortem change, it does prevent the collapse of the vascular channels, and many sections exhibit very striking vascular architectural patterns. For this reason, several animals were euthanatized with sodium pentathol and the fresh tissues were dissected out and placed in any one of several fixatives. The majority of the sections were stained with hematoxylin and eosin; however, other stains were used in order to emphasize certain structural details.

The introductory remarks preceding each chapter are designed to point out characteristic features of the dog as well as introduce pertinent comparative histology. It is hoped these comments will make the reader of this text more aware of the differences as well as the similarities in the microscopic anatomy of various species of animals. Perhaps this information, even though meager, may stimulate investigators to search for other dissimilarities and document the comparisons.

In selecting the slides for photography, an effort was made to include the most important areas of each system and to emphasize those structures and organs which are peculiar to the dog. Low-power photomicrographs are used throughout the atlas to help orient the reader to the whole section. These are followed by increasingly higher magnifications in order to demonstrate structural and cellular detail.

Diagrammatic line drawings are included in each chapter and provide

NOTE: This study is supported in part by Contract No. PH 43-65-100 within the Special Virus-Leukemia Program of the National Cancer Institute, NIH, USPHS.

the reader with the location and plane of section from which the photomicrographs were made. The level number found at the end of each figure title corresponds to that same number on the accompanying drawing.

The usefulness of this atlas is further enhanced by including a rather extensive bibliography. The references have been selected carefully to avoid duplicating those included in the *Bibliography of the Dog*, by Marcus Mason (The Iowa State Press, 1959).

The culmination of an effort such as this involves the contribution of many individuals. It is therefore with sincere gratitude that the authors acknowledge the assistance and cooperation of several persons in particular: Mr. Tom Alguire, Miss Linda Bertal, Dr. Gabel Conner, Mrs. Rosemarie Daniels, Mr. Robert Ewing, Mrs. Barbara Hamlin, Mr. Ken Holmes, Mr. Andrew Poole, Dr. Esther Roege, Mr. Roger Sanders, Mr. Payne Thomas, and Mrs. Margaret Thorp, librarian.

Contents

	<i>Page</i>
<i>Preface</i> ..	v
<i>Chapter</i>	
1. INTEGUMENTARY SYSTEM ..	3
2. CARDIOVASCULAR SYSTEM ..	30
3. LYMPHATIC ORGANS ..	59
4. RESPIRATORY SYSTEM ...	85
5. DIGESTIVE SYSTEM ...	102
6. URINARY SYSTEM	159
7. FEMALE REPRODUCTIVE SYSTEM	178
8. MALE REPRODUCTIVE SYSTEM ..	202
9. ENDOCRINE SYSTEM	219
10. NERVOUS SYSTEM	236
<i>Bibliography</i>	252
<i>Index</i>	287

INTEGUMENTARY SYSTEM

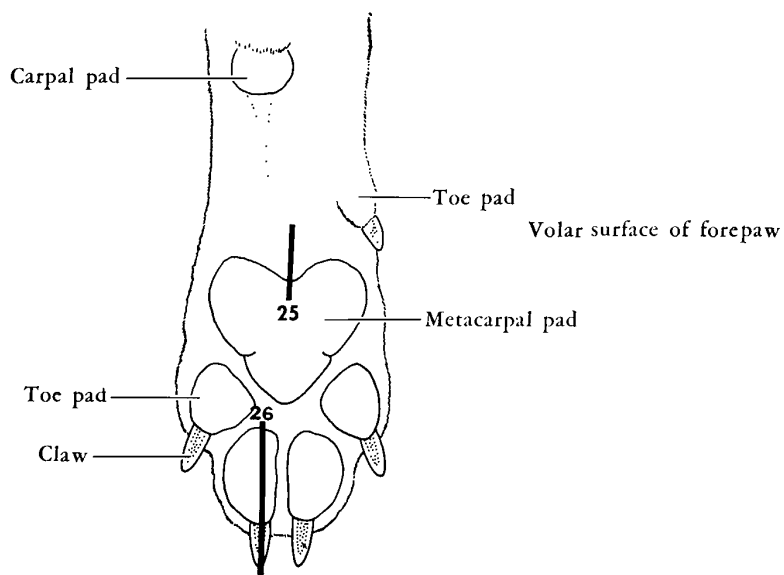
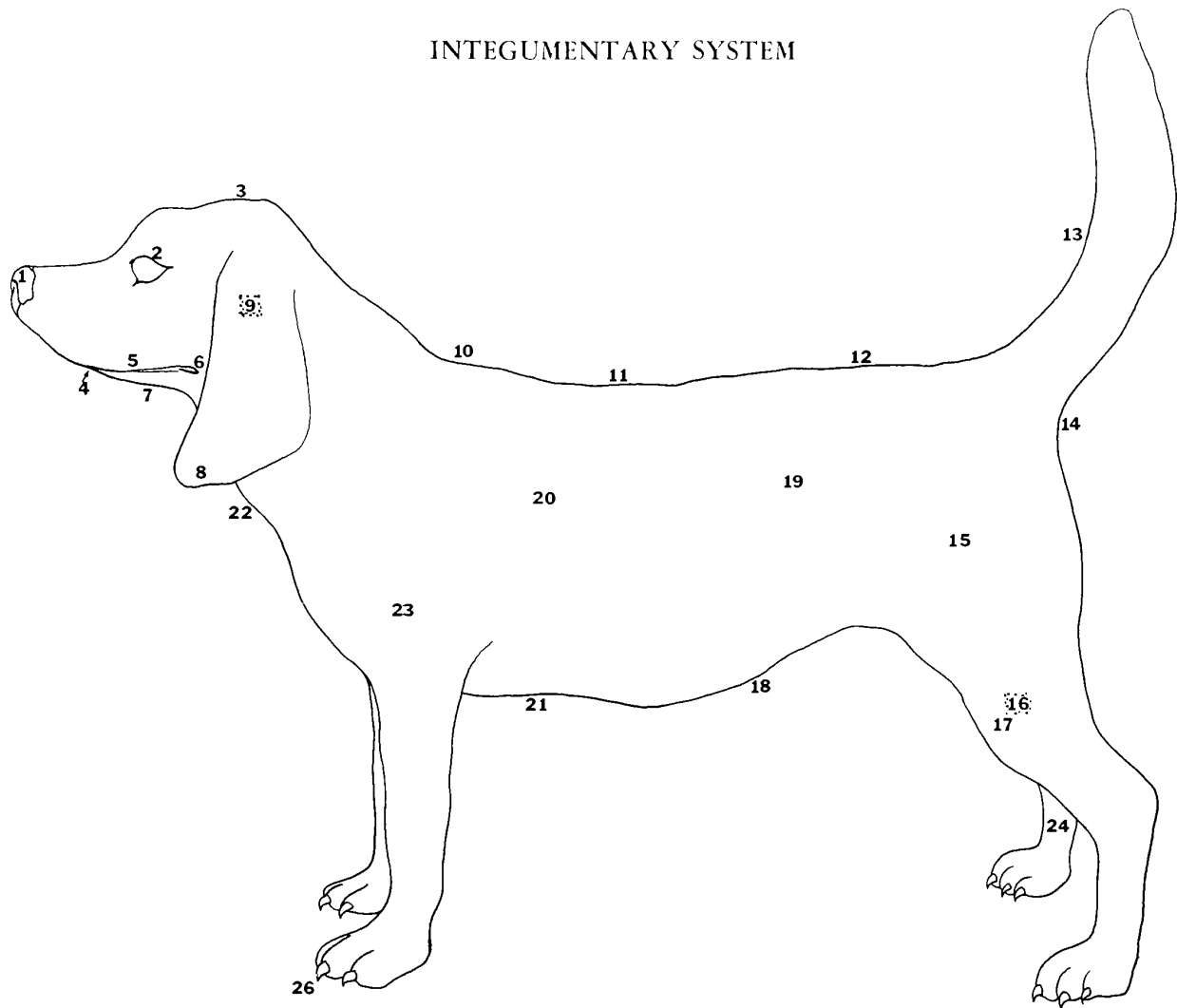


Plate I

MICROSCOPIC ANATOMY OF THE DOG
A Photographic Atlas

Chapter 1

Integumentary System

In general, the microscopic structure of the skin of the dog resembles that of other domestic animals and man. The comparative thickness of the skin of various body areas is illustrated in Plate 2 (Figs. 1-12). It is thickest on the dorsum of the head and neck and decreases in thickness caudally, laterally, and ventrally. Integumentary papillae first reported in dogs by Lovell and Getty (1959) were observed in the beagle dog.

Because of the protective hair coat the epidermis is thin except over the hairless areas. The stratum lucidum is most prominent in the digital pad but insignificant or absent elsewhere. Epidermal pegs are present only in the foot pads, planum nasale and lip. The stratum corneum is thick on the foot pads and thin on the nose.

Hair follicles generally occur in groups of three, the main or guard hair being larger than the smaller associated hairs. The roots are separate but just below the sebaceous glands, the hairs enter a common follicle and emerge in a cluster.

The tactile or sinus hair is typically the carnivore type, which differs from that of other domestic animals by having a proximal trabeculae-free portion in the annular blood sinus located between the inner and outer layers of the dermal sheath. A sinus pad projects into this space.

In the dog as in other domestic animals, but in contrast to the human species, the tubular skin glands of the body are apocrine in type and open into the hair follicle. Merocrine glands opening directly onto the surface are found in the foot pads. A special glandular structure, the anal sac, found in carnivores, contains only apocrine glands in the dog. Sebaceous circumanal glands are related to both the anal mucosa and anal skin. The so-called caudal or tail gland, located on the dorsum of the tail a short distance from the sacrum, is not as prominent in the dog as in the cat. According to Lovell and Getty, 1968, the hair follicles in this area contain only one hair and both the sebaceous caudal glands and apocrine glands are large. Apparently these glands are not very well developed in the six-month-old beagle dog. Other prominent sebaceous glands are located in such mucocutaneous junctions as the lip, prepuce and labium vulva.

A characteristic pattern of plaque-like elevations and grooves on the hairless planum nasale corresponds to the finger prints of man and is used in dog identifications. In contrast to the smooth foot pad of the cat, the surface of the canine foot pad has heavily keratinized conical papillae. Previous reports to the contrary, a few nasolabial glands were observed in two animals.

We were most fortunate to get such an excellent sagittal section of the claw. Its relationship to the phalanges, tendons and foot pad are well illustrated.

Plate 2

Comparison of General Body Skin Areas

The figures in this plate are arranged along the horizontal axis to illustrate areas from the cranial to the caudal region of the body. Likewise, they are arranged along the vertical axis to illustrate areas from the dorsal to the ventral region of the body. The sections are all longitudinal. (H&E X29)

<i>Figure Number</i>	<i>Level</i>
1. Head (dorsal)	3
2. Neck (dorsal)	10
3. Thoraco-lumbar region (dorsal)	11
4. Sacral region (dorsal)	12
5. Neck (ventral)	22
6. Thorax (lateral)	20
7. Abdomen (lateral)	19
8. Thigh (lateral)	15
9. Forelimb (lateral)	23
10. Thorax (ventral)	21
11. Abdomen (ventral)	18
12. Hindlimb (lateral)	17

Plate 2

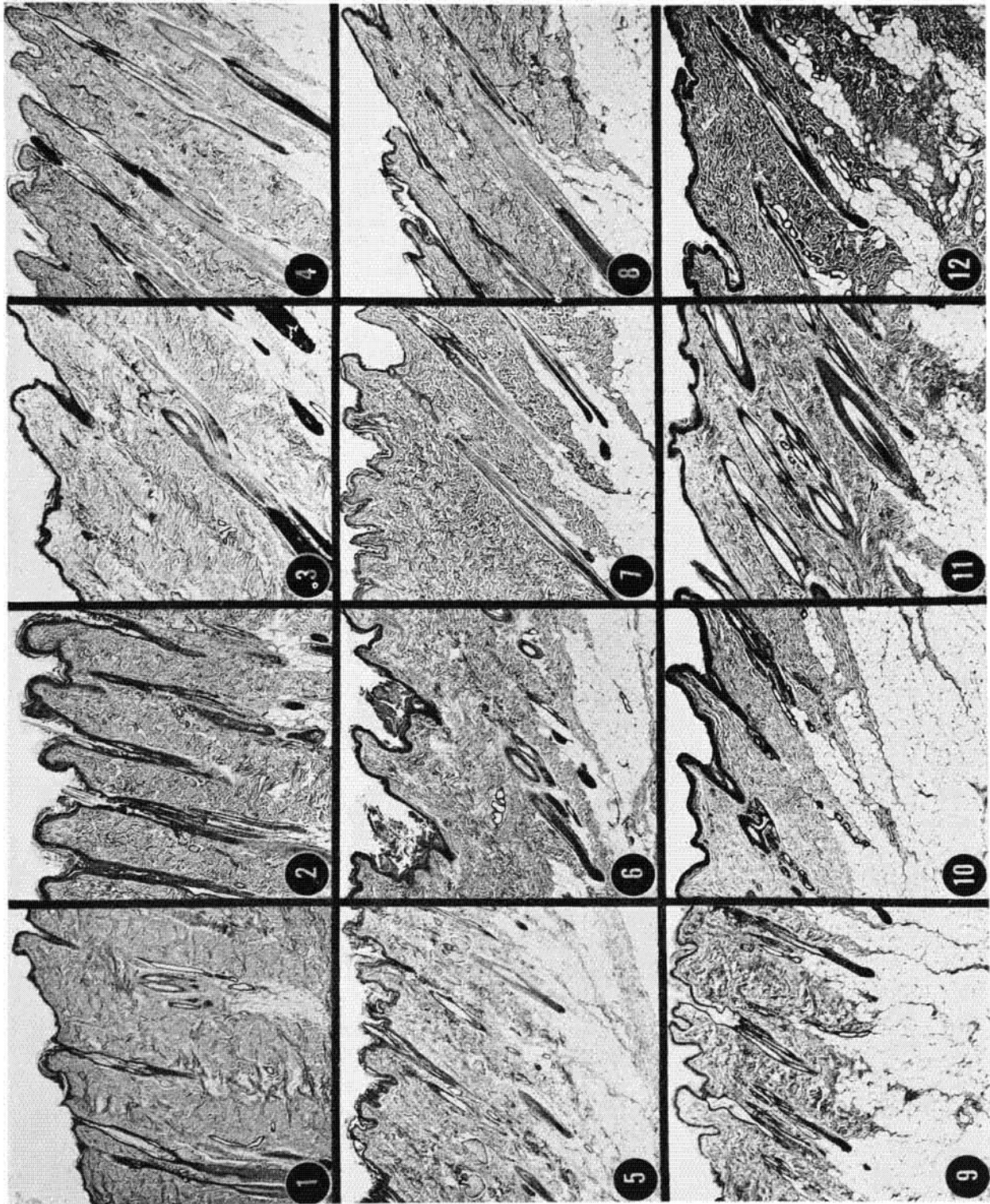


Plate 3

FIGURE 1. Typical hairy skin area. Longitudinal section, Level 11. (H&E X28)

- a. Opening of a hair follicle
- b. Epidermis
- c. Papillary layer of the dermis
- d. Reticular layer of the dermis
- e. Arrector pili muscles
- f. Sebaceous glands
- g. Sweat glands
- h. Sweat duct
- i. Roots of hair follicles
- j. Adipose tissue in subcutis

FIGURE 2. Typical hairy skin area. Cross section, Level 11. (H&E X45)
Cross sections of the hair groups appear at various levels. Notice that one or more large hairs are joined by several smaller hairs and emerge from a single opening at the surface.

- a. Hair groups just above the epidermis
- b. Hair follicles just below the epidermis
- c. Typical cluster of three large hairs with adjacent lanugo hairs. Also refer to Plate 12, Figure 4.
- d. Sebaceous glands
- e. Arrector pili muscles
- f. Sweat gland ducts
- g. Adipose tissue

FIGURE 3. Integumentary papilla. Level 21. (H&E X160)

- a. Papilla
- b. Hair follicle
- c. Cluster of small hair follicles, sweat ducts and sebaceous glands

FIGURE 4. Epidermal pad of a tylotrich follicle, Level 24. (H&E X390)

- a. Stratum corneum
- b. Stratum lucidum
- c. Stratum granulosum
- d. Stratum germinativum
- e. Tactile cells of Merkel (Mann, 1968)

Plate 3

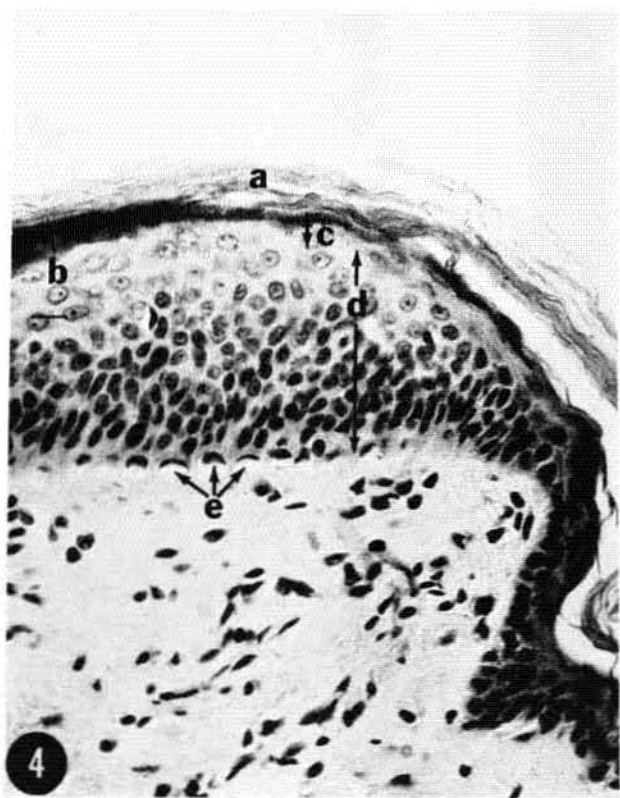
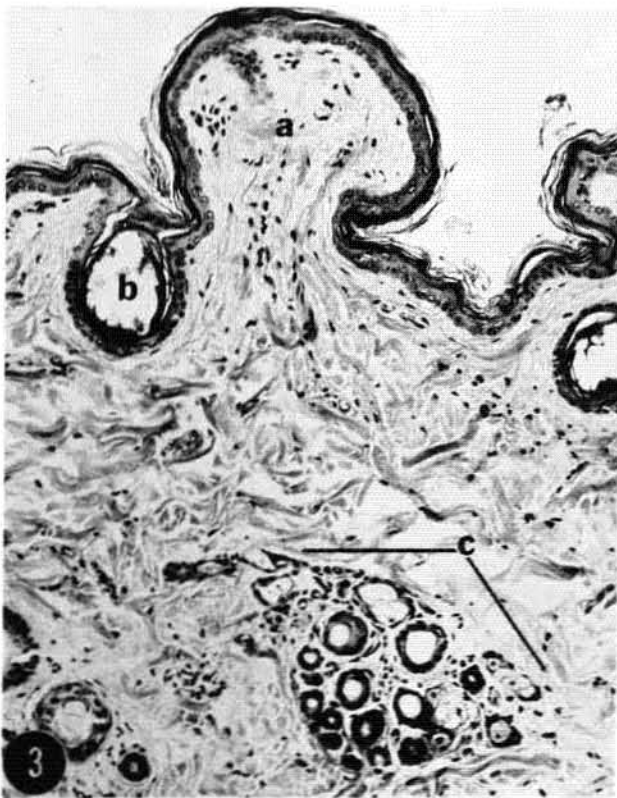
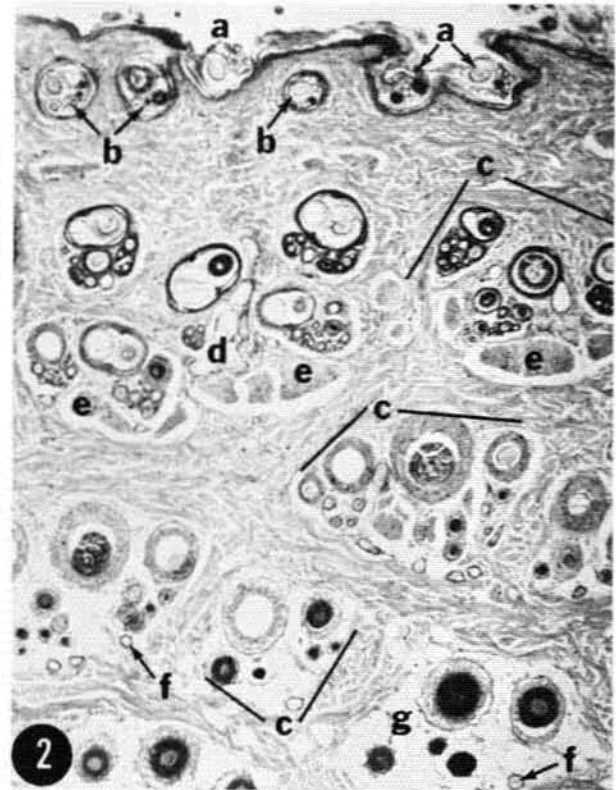
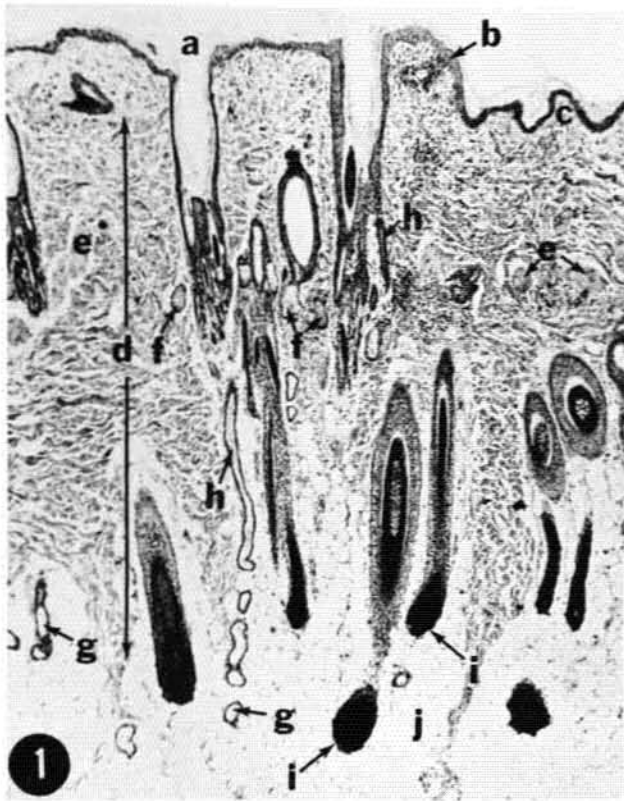


Plate 4

FIGURE 1. Thick section of skin revealing the coiling of the sweat glands.

Longitudinal section, Level 25. (H&E X29)

- a. Coiled sweat glands
- b. Sweat duct
- c. Hair follicles

FIGURE 2. Dermis of the prepuce. (H&E X49)

- a. Sebaceous glands
- b. Hair follicle
- c. Coiled sweat glands
- d. Adipose tissue

FIGURE 3. Coiled active sweat glands of the prepuce. (H&E X145)

- a. Sweat glands
- b. Myoepithelial cells
- c. Adipose tissue

FIGURE 4. Sweat duct and related structures. Level 11. (H&E X340)

- a. Sebaceous gland
- b. Arrector pili muscle
- c. Sweat duct
- d. External root sheath of a hair follicle

Plate 4

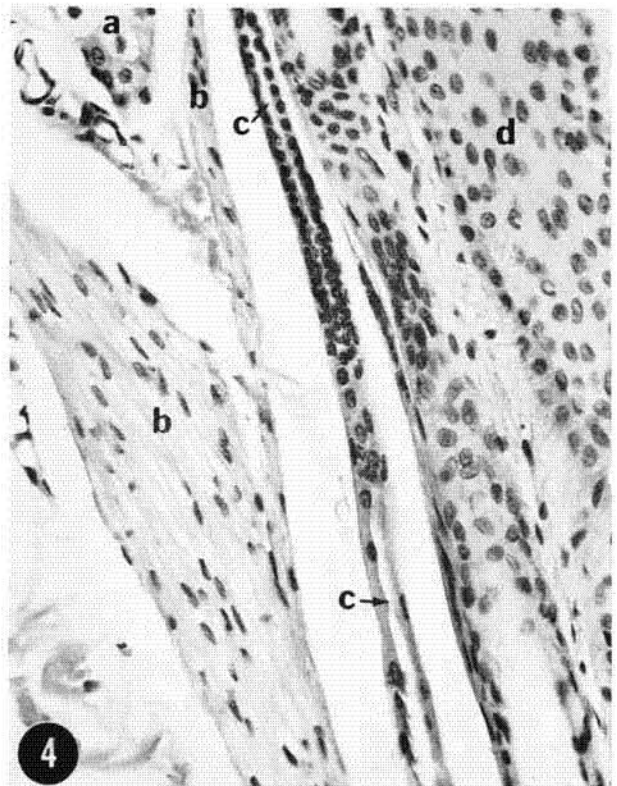
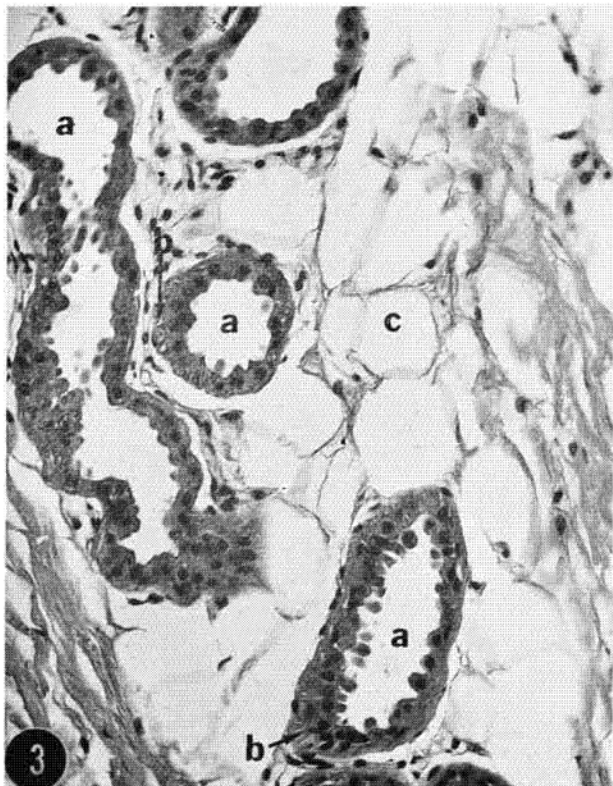
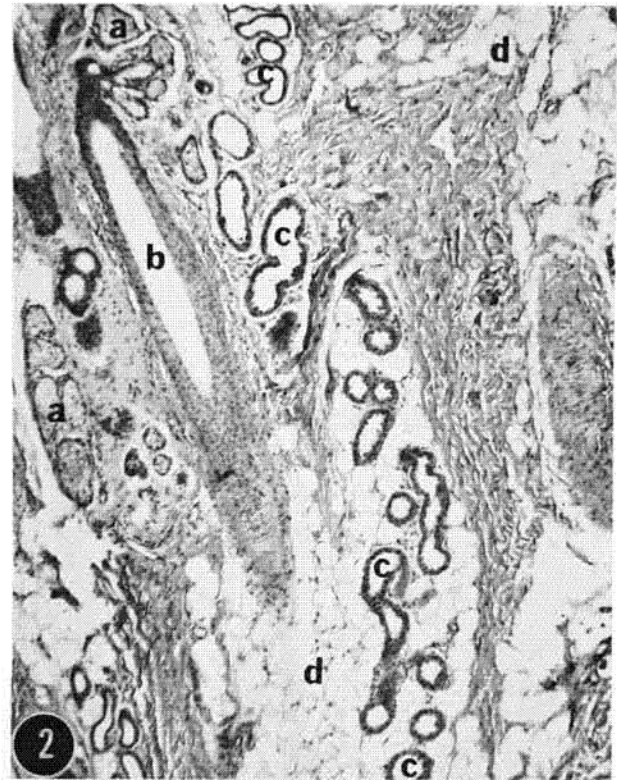


Plate 5

FIGURE 1. Typical sebaceous glands. Cross section, Level 5. (H&E X240)

- a. Lumen of the hair follicle
- b. Opening of a sebaceous gland duct into a hair follicle
- c. Disintegrating alveolar cells (holocrine secretion)
- d. Large cells filled with fat droplets
- e. Small peripheral cells with fat droplets
- f. Blood and lymphatic vessels

FIGURE 2. Labial glands. Vertical section, Level 4. (H&E X105)

- a. Hair follicle
- b. Labial gland lobules (sebaceous)
- c. Sweat glands
- d. Dermis

FIGURE 3. Preputial sebaceous gland with branching lobules (a). Oblique section. (H&E X120)

FIGURE 4. Caudal gland. Longitudinal section, Level 13. (H&E X120)

- a. Hair follicle
- b. Sweat duct opening into the hair follicle
- c. Sebaceous gland duct
- d. Lobules of the sebaceous caudal gland
- e. Arrector pili muscle
- f. Dermis
- g. Sweat gland
- h. Adipose tissue

Plate 5

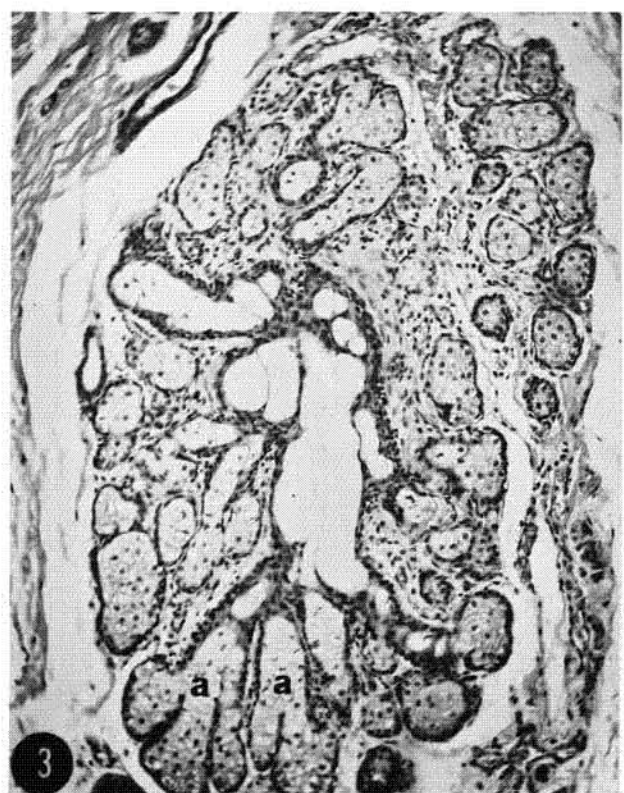
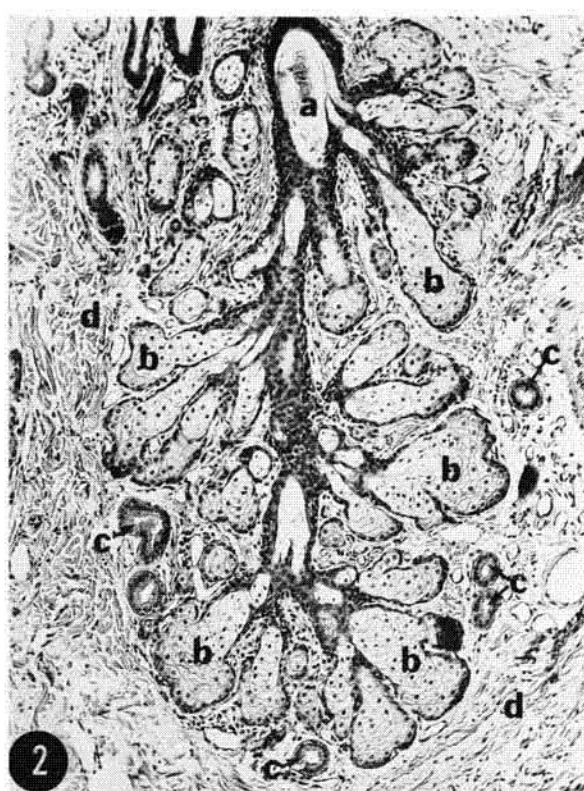


Plate 6

FIGURE 1. Anal sac. Longitudinal section, Level 14. (H&E X5)

- a. Anal sac lumen
- b. Anal sac duct
- c. Anal sac glands
- d. Lymphatic tissue
- e. Circumanal glands

FIGURE 2. Anal sac duct. Longitudinal section, Level 14. (H&E X29)

- a. Skeletal muscle
- b. Sebaceous glands
- c. Stratified squamous epithelium
- d. Cellular debris in the duct lumen

FIGURE 3. Wall of the anal sac. Level 14: (H&E X110)

- a. Stratum corneum
- b. Vein
- c. Duct of the anal sac gland in the stratified squamous epithelium
- d. Anal sac glands

FIGURE 4. Circumanal gland. Longitudinal section, Level 14. (H&E X670)

- a. Proliferative polyhedral basal cells
- b. Nonsebaceous gland cells (Parks, 1950)
- c. Intercellular canaliculi

Plate 6

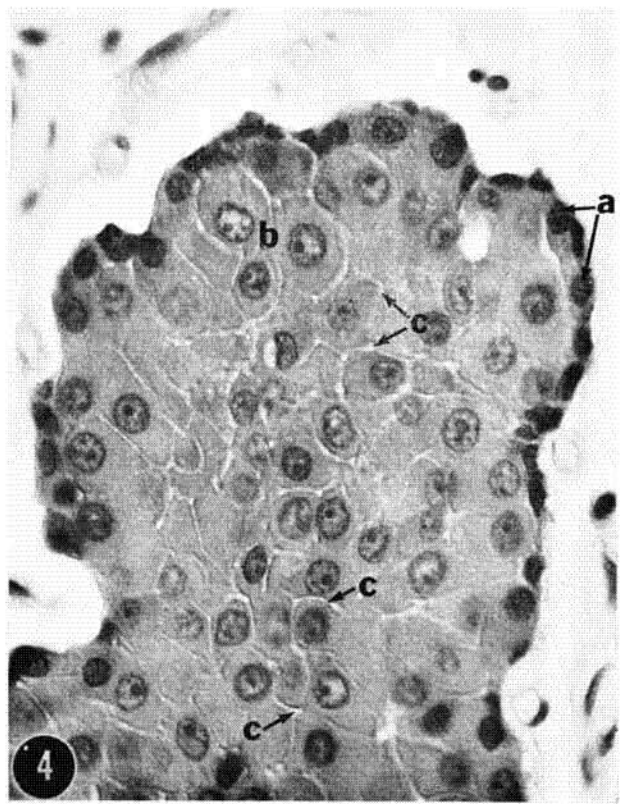
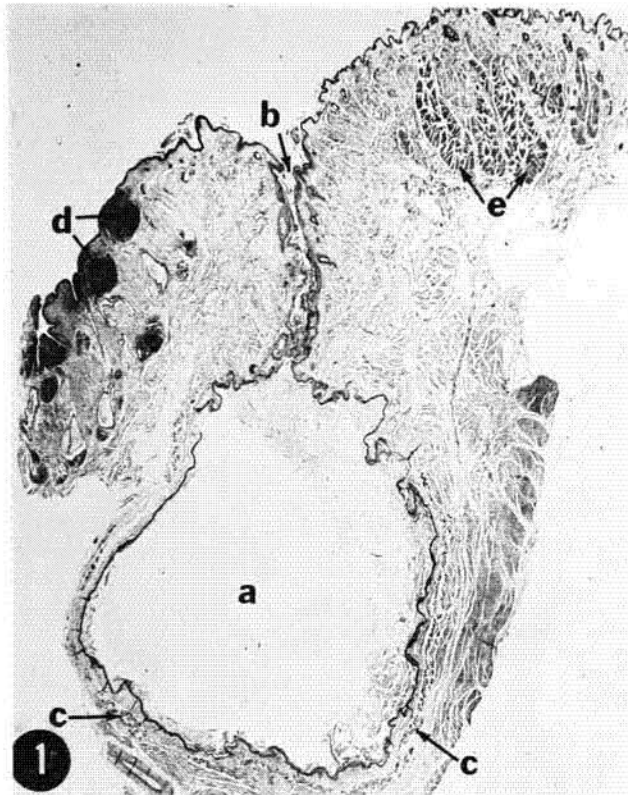


Plate 7**FIGURE 1.** Hair follicle. Cross section. (H&E X610)

- a. Medulla
- b. Cortex
- c. Cuticle of the hair
- d. Cuticle of the internal root sheath
- e. Huxley's layer of the internal root sheath
- f. Henle's layer of the internal root sheath
- g. External root sheath
- h. Vitreous membrane
- i. Connective tissue sheath

FIGURE 2. Hair follicle. Longitudinal section. (H&E X610)

- a. Medulla
- b. Cortex
- c. Cuticle of the hair
- d. Cuticle of the internal root sheath
- e. Henle's layer of the internal root sheath
- f. External root sheath
- g. Vitreous membrane
- h. Connective tissue sheath

FIGURE 3. Bulb of a hair follicle. Longitudinal section. (H&E X340)

- a. Dermal papilla
- b. Pigmented cortex
- c. Cuticle of the hair
- d. Huxley's layer of the internal root sheath
- e. Henle's layer of the internal root sheath
- f. Beginning of the external root sheath
- g. Connective tissue sheath
- h. Capillary
- i. Subcutaneous fat

FIGURE 4. Hair follicle with follicular folds. Longitudinal section. (H&E X850)

- a. Hair
- b. Follicular folds (foldings of the inner root sheath)
- c. Duct of a sebaceous gland