Diseases of Swine

FIFTH EDITION

Edited by

A. D. LEMAN

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The Iowa State University Press, Ames, Iowa, U.S.A.

First, second, and third editions, © 1958, 1964, and 1970 by Howard W. Dunne and The Iowa State University Press; fourth edition, © 1975 by Howard W. Dunne, Allen D. Leman, and The Iowa State University Press

Fifth edition, 1981

Library of Congress Cataloging in Publication Data
Main entry under title:

Diseases of swine.

First-4th ed. edited by H. W. Dunne.
Includes bibliographies and index.
1. Swine—Diseases. I. Dunne, Howard W.
Diseases of swine. II. Leman, Allen D., 1944-
SF971.D8 1980 636.4'0896 80-22940
ISBN 0-8138-0440-X

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Contents

Preface

THE GOALS of the 5th edition of *Diseases of Swine* are to maintain the scholarly excellence of the previous editions; increase the usefulness of the book to its prime users—veterinary students and veterinary practitioners; publish information that is relevant to swine diseases and swine medicine throughout the world; reduce the time delay between chapter submission and printing of the book; and produce a book as inexpensively as possible.

These goals are an amalgamation of the editors' wishes and the many comments from authors, an analysis of the buyers of previous editions, and the suggestions of the editors' students. With these goals in mind, an editorial committee was established, representing veterinary scientists throughout the world. They set up a new format and selected many new authors. The book begins with chapters on each of the important systems. These discuss normal function and provide an introduction to the major disease processes of the system. Also covered here are diseases deemed inappropriate for an individual chapter. Veterinary practitioners and students are encouraged to use this book by starting in the systems chapters, which should aid the reader in differential diagnosis of diseases and direct him or her to the more specific chapters that follow.

Next, the reader will find the chapters on specific diseases, selectively condensed and revised. Additionally, new chapters have been added to reflect the steady advance of scientific knowledge.

There is a major new section on veterinary practice. We predict that it will be one of the most popular parts of the book.

Last and perhaps most important is the index. Entries in the index are arranged to direct the reader to the appropriate chapter where the term is discussed and, more importantly, to other pages throughout the book where the term is used.

The committee wishes to thank the professional editors at Iowa State University Press for their dedication and cooperation. Without them this book could never be.

Finally, the authors deserve special thanks. They represent a selected worldwide group of productive veterinary scientists. Despite their already overbusy schedules, they agreed to write chapters for which there is often very little reward. Their cooperation and response were essential in reducing the usual delay between chapter submission and printing.

After spending the time and effort in coordinating the publication of the 5th edition, our admiration for the late Howard Dunne continues to grow. His clear and pervasive concept of excellence is now even more evident. We marvel at what he accomplished in the four previous editions; it has made the editorial duties on the 5th edition much easier.

Comments about the book or suggestions for changes in future editions are invited.

EDITORIAL COMMITTEE

SECTION

1

Anatomy, Physiology, and Systemic Pathology

1

Anatomy

H. N. Engel • L. E. St. Clair

THE PIG, *Sus scrofa,* belongs to the superorder Ungulata with the other hoofed mammals. The four digits place it in the order of even-toed hoofed animals, Artiodactyla.

SKELETON

Teeth (Figs. 1.1, 1.2, 1.3, 1.4). In the permanent dentition are 3 incisors, 1 canine, 4 premolars, and 3 molars on each side of the jaw above and below. The total is 44. In the temporary dentition are 3 incisors, 1 canine, and 3 premolars on each side above and below, making a total of 28. Each permanent incisor and canine tooth replaces the corresponding deciduous tooth. The deciduous premolars (deciduous molars) are replaced by the caudal 3 premolars. No teeth precede the permanent molars.

The lower and especially the upper incisor areas are shaped so that the medial teeth lie in a plane decidedly rostral to the lateral teeth. The upper central incisor is oval in cross section and angles sharply downward and medially. The intermediate incisor bends medially and lies slightly caudal to the central incisor. A space separates the intermediate incisor from the small corner incisor.

The lower incisors are close together (especially 1 and 2). They are relatively straight and rodlike and project rostrally. The intermediate tooth is slightly larger than the central and much larger than the corner incisor.

There is an interval between the canine tooth and the corner incisor, especially in the upper jaw. The canine tooth (tusk) is large, particularly in the boar, and projects outside the mouth. The pulp cavity remains open, allowing the tooth to elongate and project more and more from the alveolus. The crown of the upper canine is conical and curves upward and slightly backward as it lengthens. The lower canine is long, pointed, and three-sided. It curves outward and backward in front of the upper one so that friction between the two keeps them sharp.

The cheek teeth increase in size from rostral to caudal. They are bunodont in type since their multiple cusps are moundlike. The crowns are short, forming a neck near the roots. The table surfaces of the molars consist of complex crushing mounds, while those of the premolars are simple cutting areas. The first premolar in each jaw is small and simple. The one in the mandible lies just caudal to the canine tooth, whereas the upper one is separated from the canine tooth by a space. This space in the lower jaw is between the first and second premolars. The first premolar, especially in the lower jaw, is absent occasionally. In the upper jaw the first and second premolars possess 2 roots, the third 3, and the fourth 5. The molars have 6 roots. In the lower jaw the first premolar has 1 root, the second and third 2, and the fourth 3. Four roots are possessed by the first and second molars and 5 by the third.

The upper deciduous premolars (deciduous molars) have 2, 3, and 4 roots respectively. The lower deciduous premolars have 2 roots, except the last one, which has 5. The deciduous teeth tend to resemble the permanent teeth that replace them. The last lower one, however, is different in that it possesses three pairs of cusp units.

The lateral incisors and the canines are present at birth. The deciduous premolars (deciduous molars) and central incisors erupt during the 1st month. The intermediate deciduous incisors appear after 2 months. The first premolars and first permanent molars appear at 5 months. The permanent corner incisors and the canines erupt at about 9 months. The permanent central incisors and second molars erupt at about 12 months. By 15 months the last three premolars have appeared. The last molars have erupted by 18 months.

In general, the placement of enamel, dentine, and cementum is like that of an ordinary simple tooth. The permanent canine, however, has

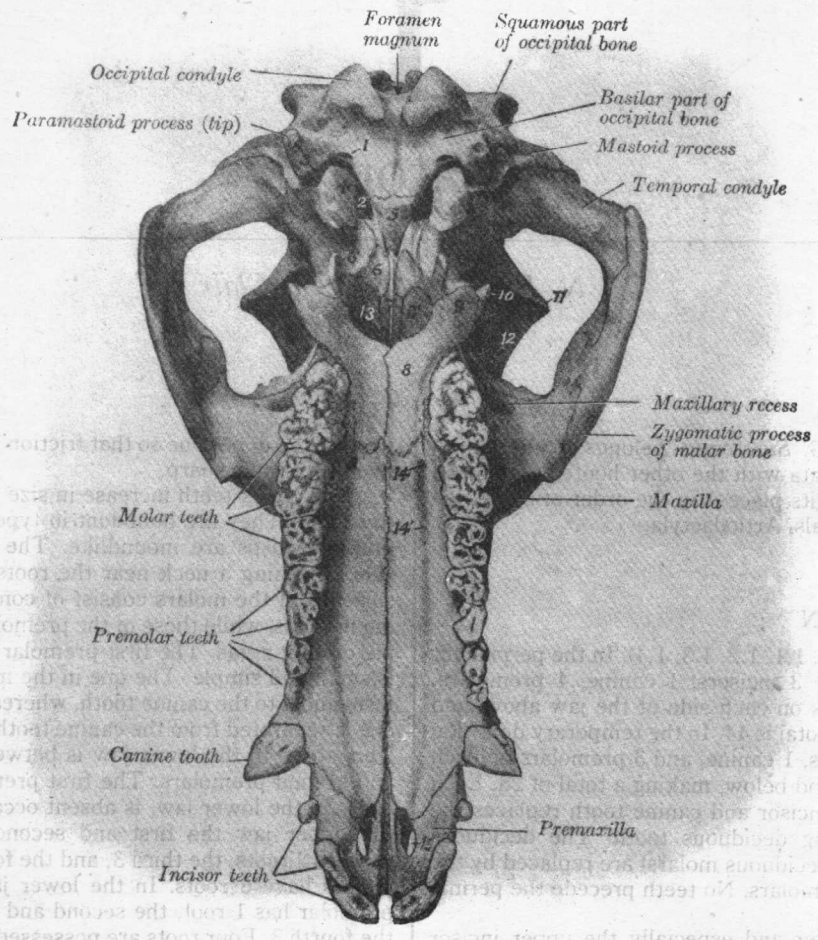

FIG. 1.1—Skull of the pig, ventral view, without the mandible and hyoid. (Sisson and Grossman 1953. Courtesy W. B. Saunders.)

1. Hypoglossal foramen
2. Foramen lacerum (rostral part)
3. Foramen lacerum (caudal part)
4. Bulla tympanica
5. Body of sphenoid
6. Pterygoid bone
6′. Hamulus of pterygoid bone
7. Vomer
8. Horizontal part of palatine bone
8′. Perpendicular part of palatine bone
9. Pterygoid process of palatine bone
10. Pterygoid process of sphenoid bone
11. Supraorbital process
12. Orbital opening of supraorbital canal
13. Choanae or caudal nares
14,14′. Rostral palatine foramen and groove
15. Palatine fissure

enamel on the convex surface and cementum on the concave surface. The labial surface of the crown of the incisors has an extensive covering of enamel, but the lingual surface has enamel on the margin only. Cementum covers the portions devoid of enamel.

The occlusal surfaces of the cheek teeth form a straight line when viewed from the side. The upper premolars are slightly lateral to the lower ones in position. The distance between the cheek teeth of the right and left sides is less caudally than rostrally. The upper and lower corner incisors usually do not contact each other.

Axial Bones (Fig. 1.2). The vertebral formula is C 7, T 14–15, L 6–7, S 4, Ca 20–23. The cervical region is short. The dorsal spines of the cervical vertebrae are tall, as are those of the thoracic area. The arch in the cervical and thoracic regions is perforated by a lateral vertebral foramen. The lumbar transverse processes do not articulate with each other or with the sacrum.

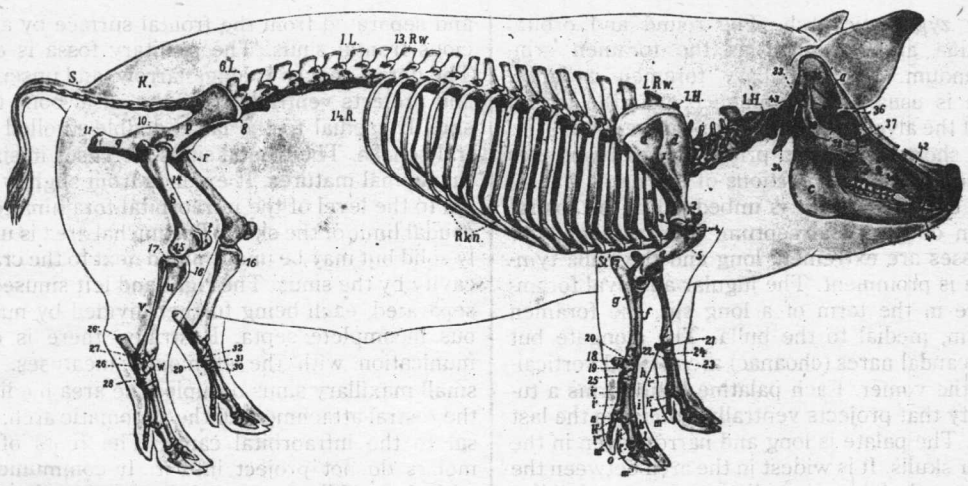

FIG. 1.2—Skeleton of the pig, lateral view. (Ellenberger 1909.)

a. Cranium
b. Maxilla
c. Mandible
1H.–7H. Cervical vertebrae
1R.w. First thoracic vertebra
13R.w. Thirteenth thoracic vertebra (next to last)
1L. First lumbar vertebra
6L. Sixth lumbar vertebra (next to last usually)
K. Sacrum
S. Caudal vertebrae
1R. First rib
14R. Last rib
R.kn. Costal cartilages
St. Sternum
d. Supraspinous fossa
d′. Infraspinous fossa
1. Spine of scapula
2. Neck of scapula
e. Humerus
3. Head of humerus
4. Tuberosities of humerus
5. Deltoid tuberosity
6. Lateral epicondyle of humerus
f. Radius
g. Ulna
7. Olecranon
h. Carpus
8. Tuber coxae
9. Tuber sacrale
10. Ischiatic spine
q. Ischium
11. Tuber ischii
r. Pubis
12. Acetabulum
S. Femur
13. Trochanter major
14. Trochanter minor
15. Lateral epicondyle
t. Patella
u. Tibia
16. Crest of tibia
17. Lateral condyle of tibia
v. Fibula
w. Tarsus
18–25. Carpal bones
i,i″. Metacarpus
k,k″. Proximal phalanges
l,l″. Middle phalanges
m,m″. Distal phalanges
n,o. Sesamoids
p. Ilium
26–32. Tarsal bones
26′. Tuber calcaneus
33. Occipital bone
34. Parachondylar process
35. Parietal bone
36. Frontal bone
37. Lacrimal bone
38. Zygomatic bone (zygomatic process)
39. Temporal bone
40. Infraorbital foramen
40′. Zygomatic process of maxilla
41. Incisive bone
42. Nasal bone
43. External acoustic meatus
44. Body of mandible

The vertebrae composing the sacrum do not fuse to the extent that their identity is lost. Their dorsal spines are almost absent. There are spaces between the arches of the vertebrae except in the cranial two-thirds of the thorax. Those in the cervical region are relatively large, as is the lumbosacral space. The first caudal vertebra often fuses with the sacrum.

The ribs are strongly curved, making a long, barrel-shaped thorax. Seven are sternal and seven or eight asternal. The fifteenth rib, when present, is often floating in type.

The sternum is flat, especially caudally, and consists of six sternebrae. The first segment projects forward and is flattened laterally.

Skull (Figs. 1.1, 1.2, 1.3, 1.4). The skull is massive. The long and narrow nasal and frontal areas that are straight in young animals become dished later. This is especially true in the more brachycephalic breeds. The nuchal crest is very prominent and the temporal fossa is entirely lateral. The external acoustic process is dorsal in position in respect to the caudolateral areas and projects dorsolaterally.

The supraorbital process does not contact the

heavy zygomatic arch. The round and orbital foramina are combined as the foramen orbitorotundum. The maxillary foramen is large. There is usually a prominence over the lateral side of the alveolus of the upper canine tooth.

A short three-sided prism, the os rostri, lies between the rostral portions of the nasal and incisive bones. In life it is imbedded in the rostral portion of the nasal septum. The paracondylar processes are extremely long and the bulla tympanica is prominent. The jugular and oval foramina are in the form of a long slit, the foramen lacerum, medial to the bulla. The elongate but small caudal nares (choanae) are divided vertically by the vomer. Each palatine bone forms a tuberosity that projects ventrally, caudal to the last molar. The palate is long and narrow even in the shorter skulls. It is widest in the area between the canine teeth. There is a distinct fossa, caudal to the central incisors, associated with the incisive foramina. The cranial cavity is relatively small and separated from the frontal surface by a spacious frontal sinus. The pituitary fossa is deep. The dorsal concha is long, narrow, and unscrolled and projects ventrally from the nasal bone to lie slightly medial to the large double-scrolled ventral concha. The frontal sinus increases in size as the animal matures. It extends from slightly caudal to the level of the infraorbital foramina to the caudal limit of the skull. The nuchal area is usually solid but may be undermined next to the cranial cavity by the sinus. The right and left sinuses are separated, each being further divided by numerous incomplete septa. Rostrally, there is communication with the ethmoidal meatuses. The small maxillary sinus occupies the area medial to the rostral attachment of the zygomatic arch, dorsal to the infraorbital canal. The roots of the molars do not project into it. It communicates with the middle meatus of the nasal cavity. The body and wings of the sphenoid bone are excavated to form the relatively large sphenoidal

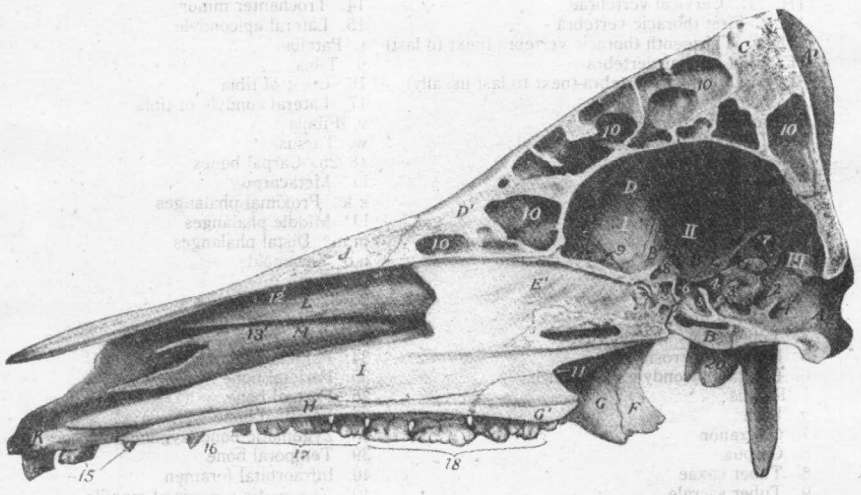

FIG. 1.3—Sagittal section of the skull of the pig, without the mandible. (Sisson and Grossman 1953. Courtesy W. B. Saunders.)

A,A′. Basilar and squamous parts of occipital bone
B. Body of sphenoid bone
B′. Temporal wing of sphenoid bone
B″. Orbital wing of sphenoid bone
C. Parietal bone
D,D′. Internal and external plates of frontal bone
E,E′. Cribriform and perpendicular plates of ethmoid bone
F. Pterygoid bone
G,G′. Perpendicular and horizontal parts of palatine bone
H. Palatine process of maxilla
I. Vomer
J. Nasal bone
K. Incisive bone
L. Dorsal concha
M. Ventral concha
I,II,III. Fossae cranii
1. Hypoglossal foramen
2. Foramen lacerum (caudal part)
3. Meatus acousticus internus
4. Foramen lacerum (rostral part)
5. Hypophyseal or pituitary fossa
6. Foramen orbitorotundum
7. Lateral crest between cerebral and cerebellar parts of cranial cavity
8. Optic foramen
9. Ethmoidal foramen
10. Frontal sinus
11. Choanae or caudal nares
12,13,14. Dorsal, middle, and ventral nasal meatuses
15. Incisor teeth
16. Canine tooth
17. Premolar teeth
18. Molar teeth
19. Paracondylar process
20. Bulla tympanica

sinus. It communicates rostrally with the ventral ethmoidal meatus. The right and left sinuses tend to be separated in the midline. The perpendicular part of the palatine bone may also form a part of the sinus.

The mandible is strong and massive. The body is pointed rostrally, concave dorsally, and convex ventrally. The right and left portions are fused. The horizontal bodies are thick and contain several mental foramina. The mandibular canal is large. The condyle is convex in all directions and is situated caudal to a short coronoid process.

The hyoid bone consists of a flat body, the basihyoid, which continues directly caudally as the wide, curved thyrohyoids. The epihyoids and stylohyoids are slender. The tympanohyoids are thin and cartilaginous. The ceratohyoids are very short.

Limbs. The bones of the limbs are relatively massive. The scapula is very wide at its vertebral border. Its prominent spine possesses a large tuberosity but only a rudimentary acromion. The major tuberosity of the humerus is very large and projects beyond the single bicipital groove, which becomes almost a foramen in older animals. The large ulna is not fused with the radius and continues to the carpus. There are eight carpal bones, four in each row. Four metacarpal bones are present. Each of the four digits contains three phalanges. The two abaxial digits are shorter and smaller than the axial ones. A pair of proximal palmar sesamoid bones rests on the distal portion of each metacarpal bone. A distal palmar sesamoid bone is present at the distal interphalangeal articulation of each axial digit.

The ilia are parallel to each other and tip forward, producing a very sloping pelvic inlet. The ischiatic spines are prominent and increase the concavity of the pelvic floor. The symphysis is rather thick and not firmly fused. The floor of the pelvis slopes more caudally, the symphysis is thinner, and the tuber ischia are more everted in the female. The rim of the acetabulum is thick and notched caudally. The major trochanter of the femur is single. The supracondyloid fossa and the third trochanter are absent. The patella is thick craniocaudally. The tibia is similar to that of other domestic animals. The fibula is large and extends to the tarsus, which consists of seven bones. The articular surfaces are placed so that movement occurs not only between the talus and the tibia but also between the talus and those adjacent to it. The metatarsals and phalanges are like those of the manus except that they tend to be slightly longer. There is an extra sesamoid bone plantar to the proximal portion of the medial axial metatarsal bone.

The epiphyseal lines do not completely disappear from the vertebral bodies and the long bones until 5 years of age.

RESPIRATORY SYSTEM

Nasal Cavity (Fig. 1.3). The snout, or rostrum, is a cylindric projection with a prominent margin. It is practically hairless, is smooth, and fuses with the superior lip. The nostrils are small. The rostral extremity of the nasal septum is ossified as the os rostri. Cartilages tend to form the framework of the nostrils and fill in the nasomaxillary notch.

The nasal cavity is long and narrow except in short-nosed breeds. The long, round caudal choanae are separated from the dorsocaudal part of the cavity by a transverse lamina and from each other by the vomer. The dorsal concha is thin rostrally but gradually increases in diameter caudally. It projects ventrally and medially from the dorsolateral wall of the nasal cavity so that its ventral edge lies medial to the dorsal part of the

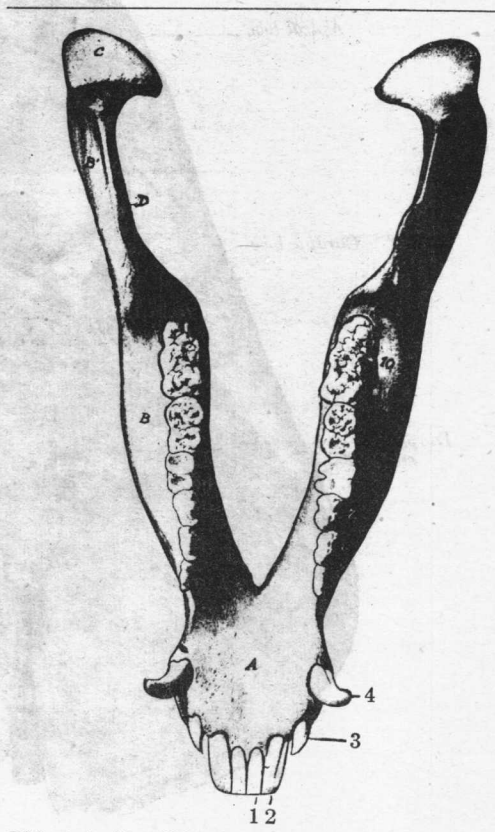

FIG. 1.4—Mandible of the pig, dorsal view. (Sisson and Grossman 1953. Courtesy W. B. Saunders.)

A. Body
B. Body
B'. Ramus
C. Condyle
D. Coronoid process
1,2,3. Incisor teeth
4. Canine tooth
5,6,7. Premolar teeth (first absent)
8,9,10. Molar teeth

ventral concha. The ventral concha is much larger than the dorsal concha and begins rostrally from a fold that projects from the lateral wall of the cavity just caudal to the nostril. The passageway from the nostril is thus somewhat obstructed except dorsally. The scrolls of the ethmoid area do not project forward as a middle concha. The dorsal and middle meatuses are very narrow. The ventral meatus is somewhat larger, especially caudally where the ventral concha becomes wrinkled longitudinally. A small opening in the caudolateral part of the middle meatus communicates with the maxillary sinus, dorsal to which are several small openings to the frontal sinus, via the ethmoidal meatuses. The opening of the nasolacrimal duct is in the caudolateral part of the ventral meatus.

The rostral or vestibular region is lined with a stratified squamous epithelium. This changes gradually into a stratified columnar and then a ciliated pseudostratified columnar epithelium with goblet cells in the main or respiratory area. The olfactory mucosa is brown and thick and contains special sensory cells for olfaction.

Larynx (Fig. 1.9). The larynx is relatively large and does not articulate with the hyoid bones. The epiglottis is very large, broad cranially, and loose-

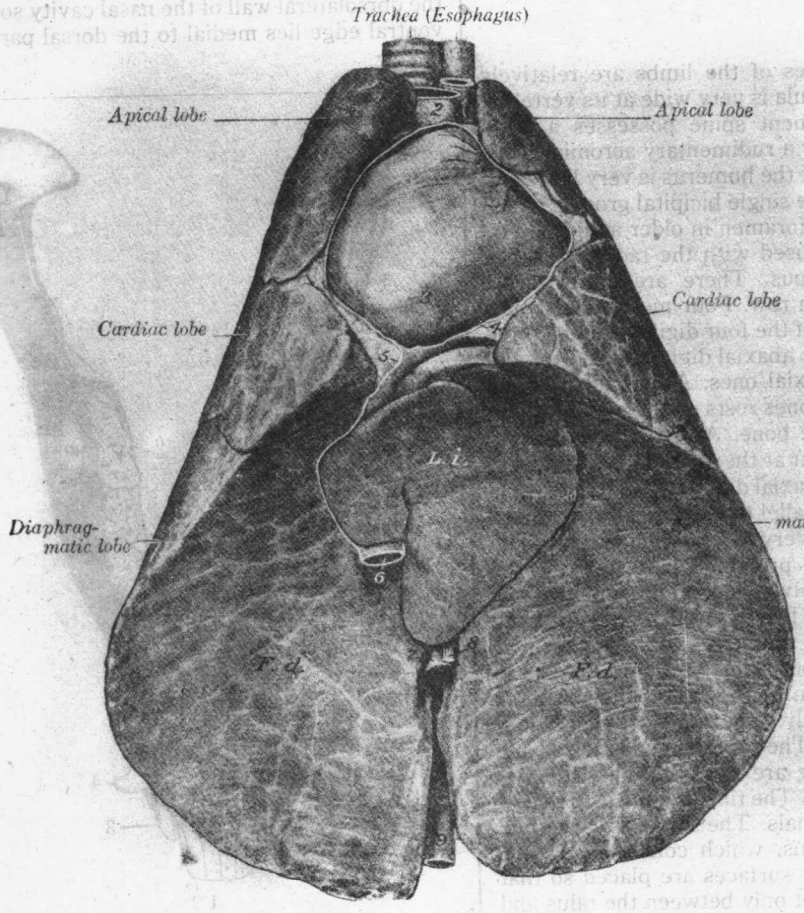

FIG. 1.5—Lungs and heart of the pig, ventral view. (Sisson and Grossman 1953. Courtesy W. B. Saunders.)

L.i. Accessory lobe of right lung
F.d. Diaphragmatic surface of lungs
1. Brachiocephalic trunk.
2. Cranial vena cava
3. Apex of heart
4. Pericardium (cut edge)
5. Plica vena cava
6. Caudal vena cava
7. Esophagus
8. Ventral vagal nerve trunk
9. Aorta