AN ULTRASTRUCTURAL AND HISTOLOGICAL STUDY OF THE EQUINE RESPIRATORY TRACT IN HEALTH AND DISEASE

A thesis submitted to the Faculty of Veterinary Medicine,

University of Glasgow

for the Degree of Doctor of Philosophy

by

Myrtle E.S. Pirie, M.R.C.V.S.

Department of Veterinary Anatomy,

University of Glasgow,

1990.

VOLUME II

ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 – 1346

V O L U M E II

CONTENTS

This Volume contains the Figures referred to in the text of Volume I.

CHAPTER 8 : An ultrastructural and histological study of horses with chronic obstructive pulmonary disease.

Figs. 8.1 - 8.42

CHAPTER 2

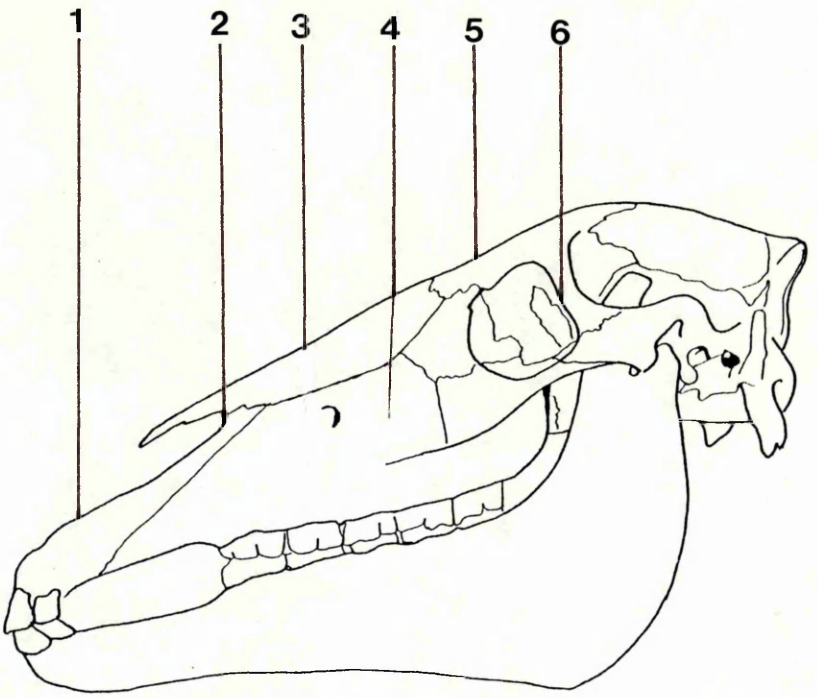
Fig. 2.1 Diagram of a lateral view of a horse skull.

1. Incisive bone
2. Nasoincisive notch
3. Nasal bone
4. Maxilla
5. Frontal bone
6. Edge of the orbit

Fig. 2.2 Ventral surface of a horse skull without the mandible.

1. Palatine bone (horizontal plate)
2. Palatine bone (perpendicular plate)
3. Pterygoid bone
4. Vomer

Choana (Arrow)


1
2
3
4
5
6

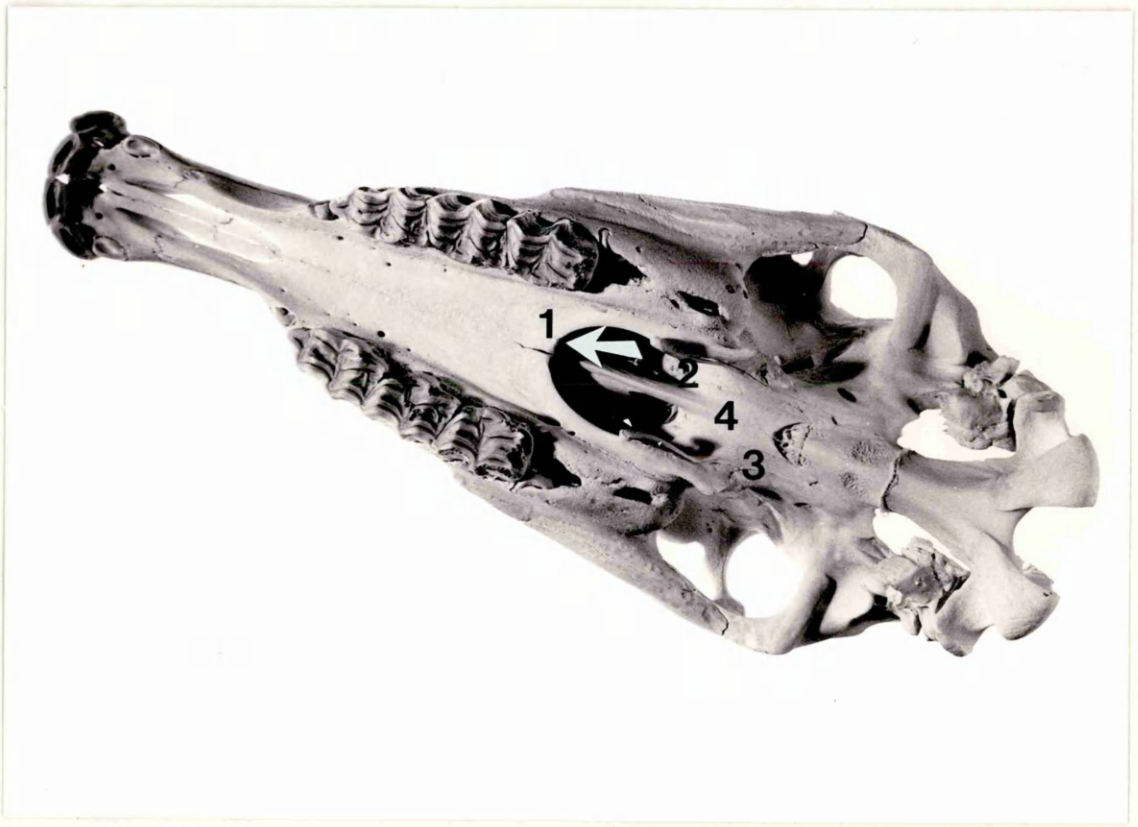

1
2
4
3

Fig. 2.3 The comma-shaped nostril of a horse at rest. (Arrows)

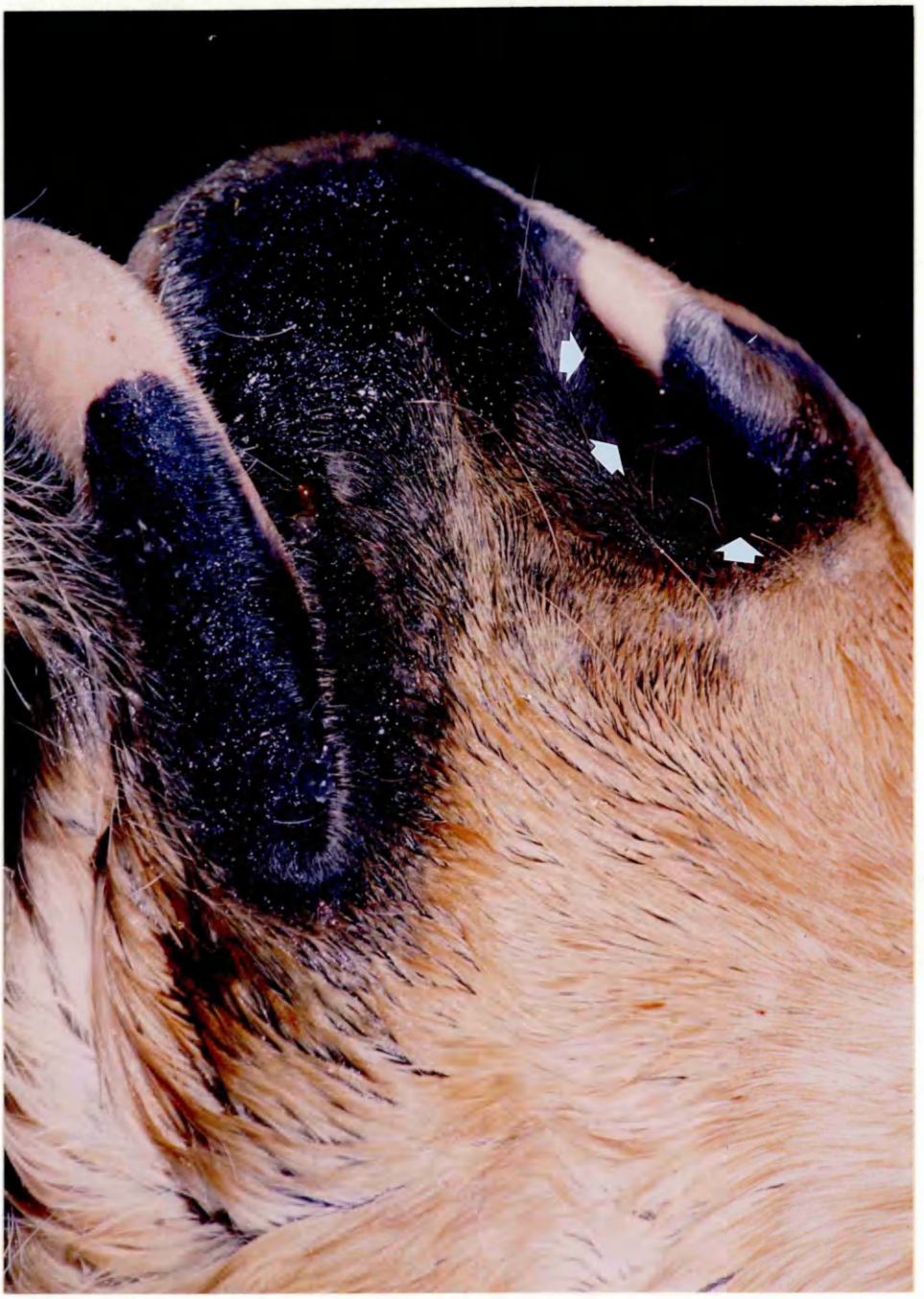


Fig. 2.4 Sagittal section of a horse head with the nasal septum removed.

1. Dorsal nasal concha
2. Ventral nasal concha
3. Ethmoidal conchae
4. Nasopharynx
5. Larynx
6. Guttural pouch

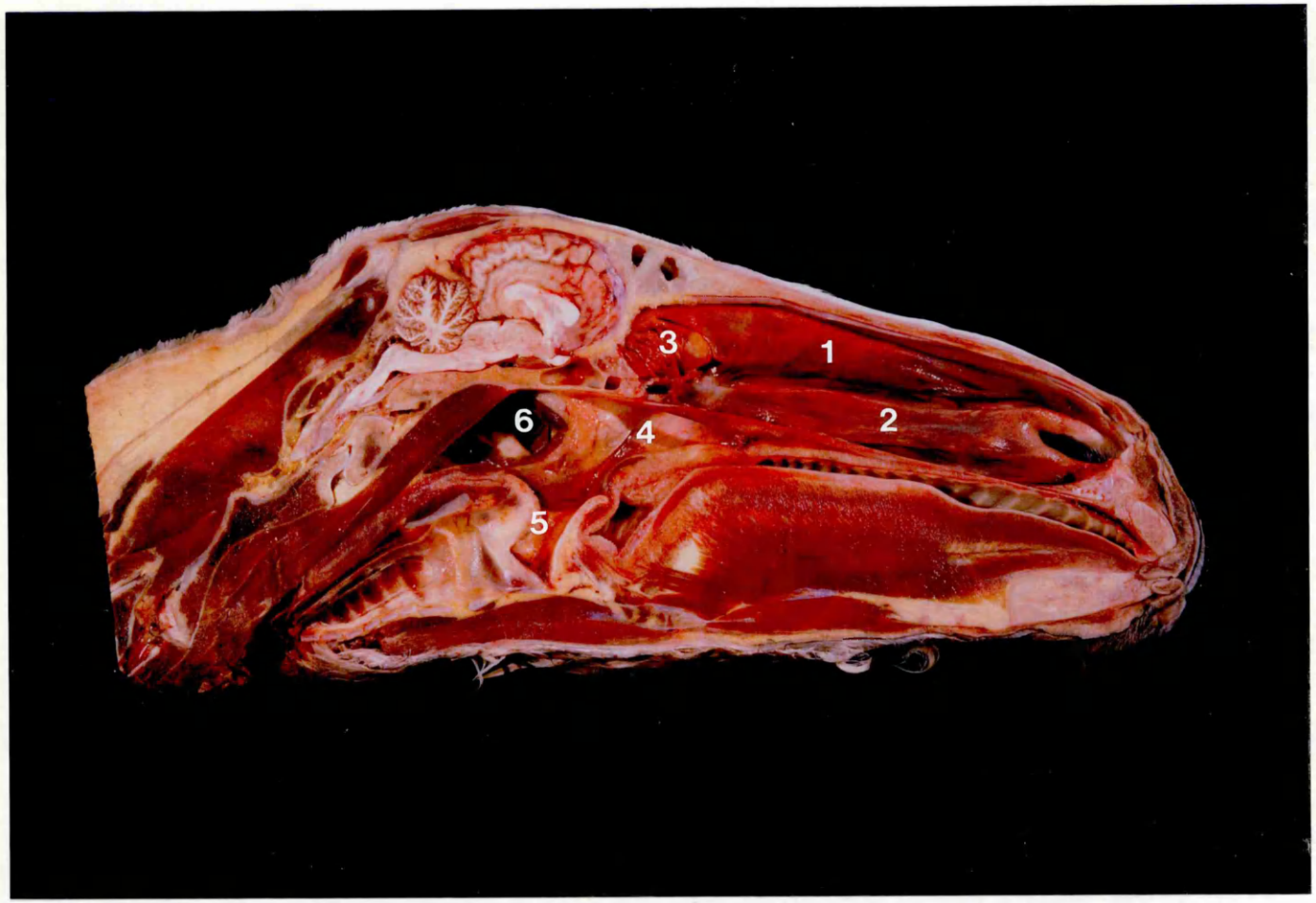

3
1
6
2
4
5

Fig. 2.5 Sagittal section of the rostral region of a horse head with the nasal septum removed.

1. Dorsal nasal concha
2. Ventral nasal concha
3. Basal fold
4. Alar fold

Between 3 and 4 is the horizontal opening from the nasal vestibule into the nasal cavity.

5. Dorsal nasal meatus
6. Middle nasal meatus
7. Ventral nasal meatus

Arrow indicates the position of the rostral end of the vomeronasal duct.


1
5
2
6
4
3
7

Fig. 2.6 (A close up view of the rostral area of Fig. 2.4).

Sagittal section of the rostral nasal cavity of a horse with the nasal septum removed to show the opening from the nasal vestibule into the nasal cavity between the basal fold (1) and the alar fold (2) of the ventral nasal concha.

Note the abrupt junction between the pigmented hairy skin of the vestibule and the nasal mucosa. (Arrows)


1
2

Fig. 2.7 (A close up view of the caudal area of Fig. 2.4).

Sagittal section of a horse head with the nasal septum removed.

1. Dorsal nasal concha
2. Ventral nasal concha
3. Ethmoidal conchae

   Middle nasal concha (Asterisk)
4. Nasopharynx
5. Larynx
6. Guttural pouch
7. Palatine bone (horizontal plate)
8. Vomer

   Choana (Arrow)
9. Soft Palate

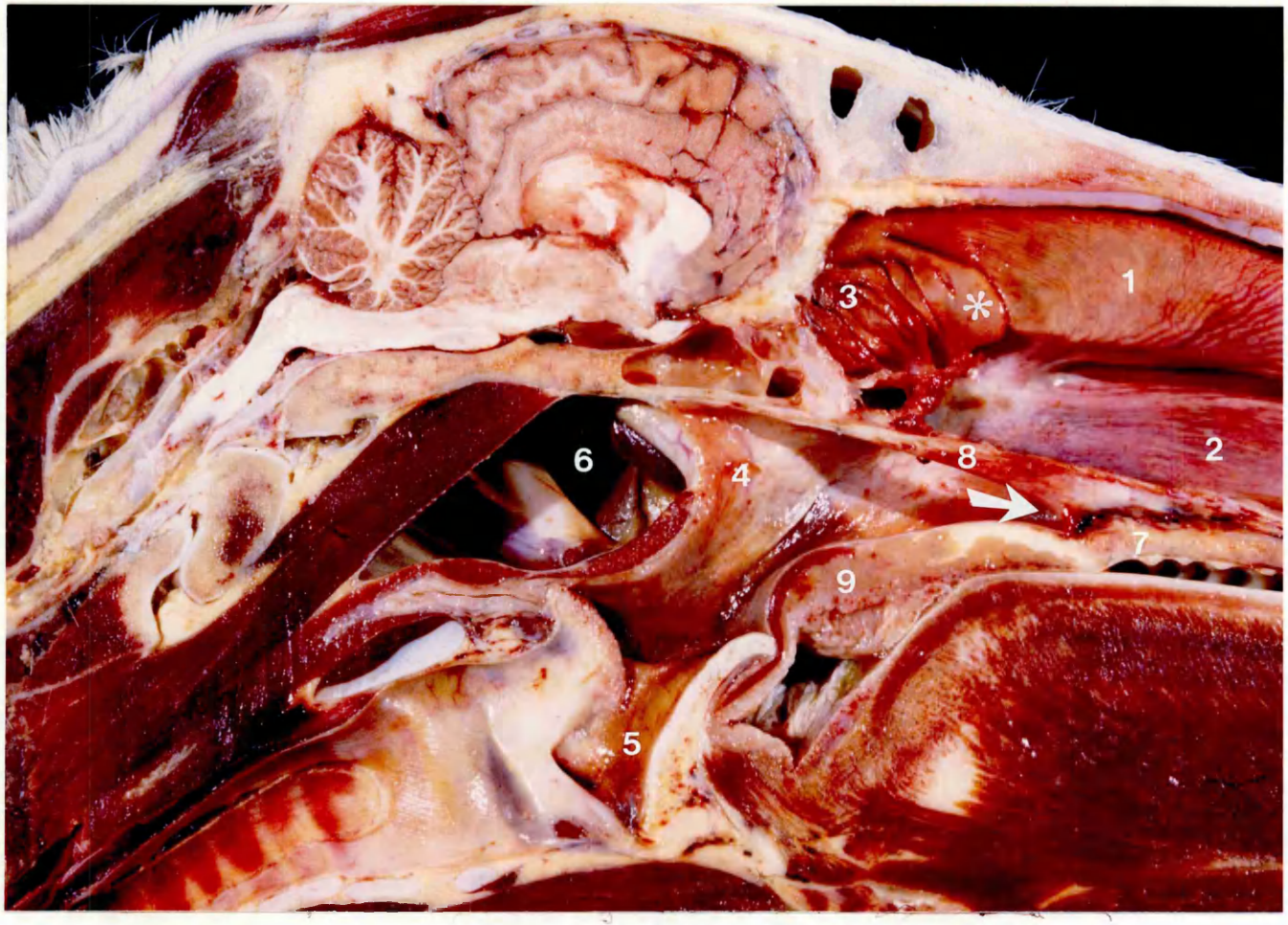

1
2
3
*
4
5
6
7
8
9

Fig. 2.8 Sagittal section of a horse head: the nasal cavity with the nasal septum and the caudo-medial walls of the dorsal and ventral nasal conchae removed.

1. Dorsal nasal concha
2. Ventral nasal concha
3. Middle nasal concha and sinus
4. Conchofrontal sinus (dorsal conchal sinus + frontal sinus)
5. Conchomaxillary sinus (ventral conchal sinus + rostral maxillary sinus)

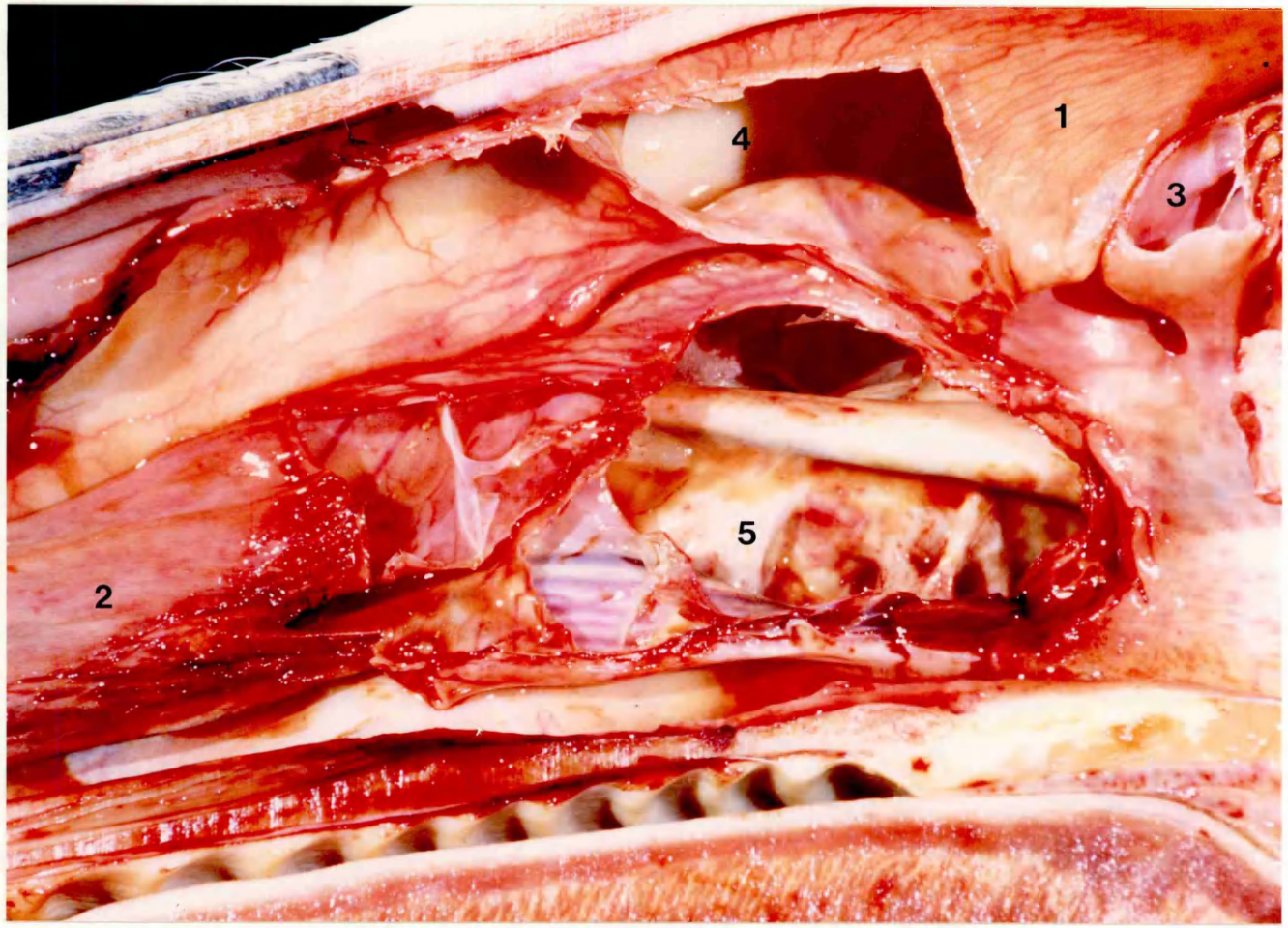

1
2
3
4
5

Fig. 2.9 Sagittal section of the caudal region of a horse head with the nasal septum removed.

1. Dorsal nasal concha
2. Ventral nasal concha
3. Ethmoidal conchae
4. Frontal sinus
5. Middle conchal sinus
6. Sphenopalatine sinus

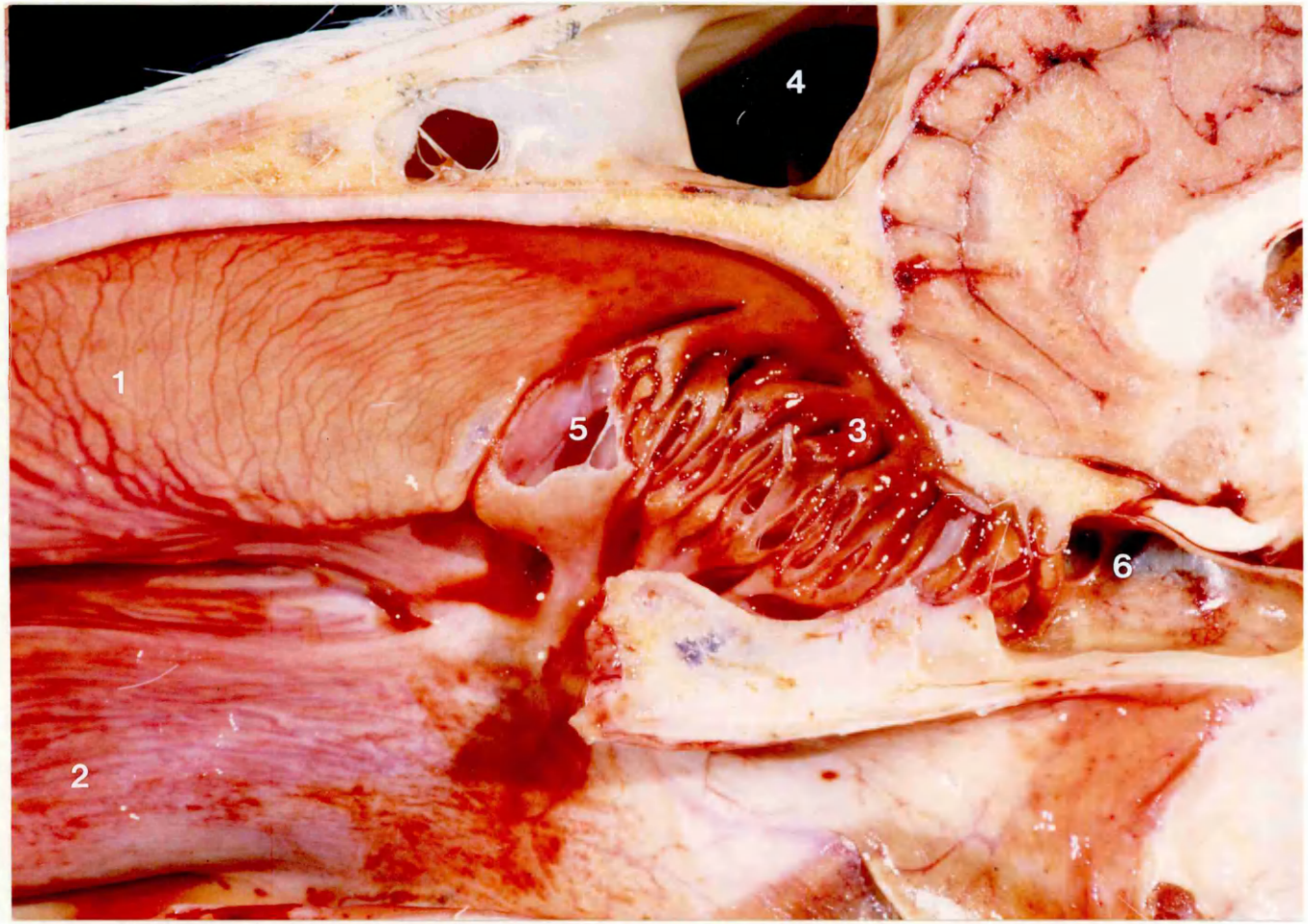

4
1
5
3
6
2

Fig. 2.10 Sagittal section of a horse head with the nasal septum removed: caudal nasal cavity and the nasopharynx.

1. Ethmoidal conchae
2. Sphenopalatine sinus
3. Vomer
4. Soft palate
5. Oropharynx
6. Guttural pouch
   Stylohyoid bone (Asterisk)
   Pharyngeal opening of the auditory tube (Arrow)
7. Epiglottic cartilage
8. Arytenoid cartilage

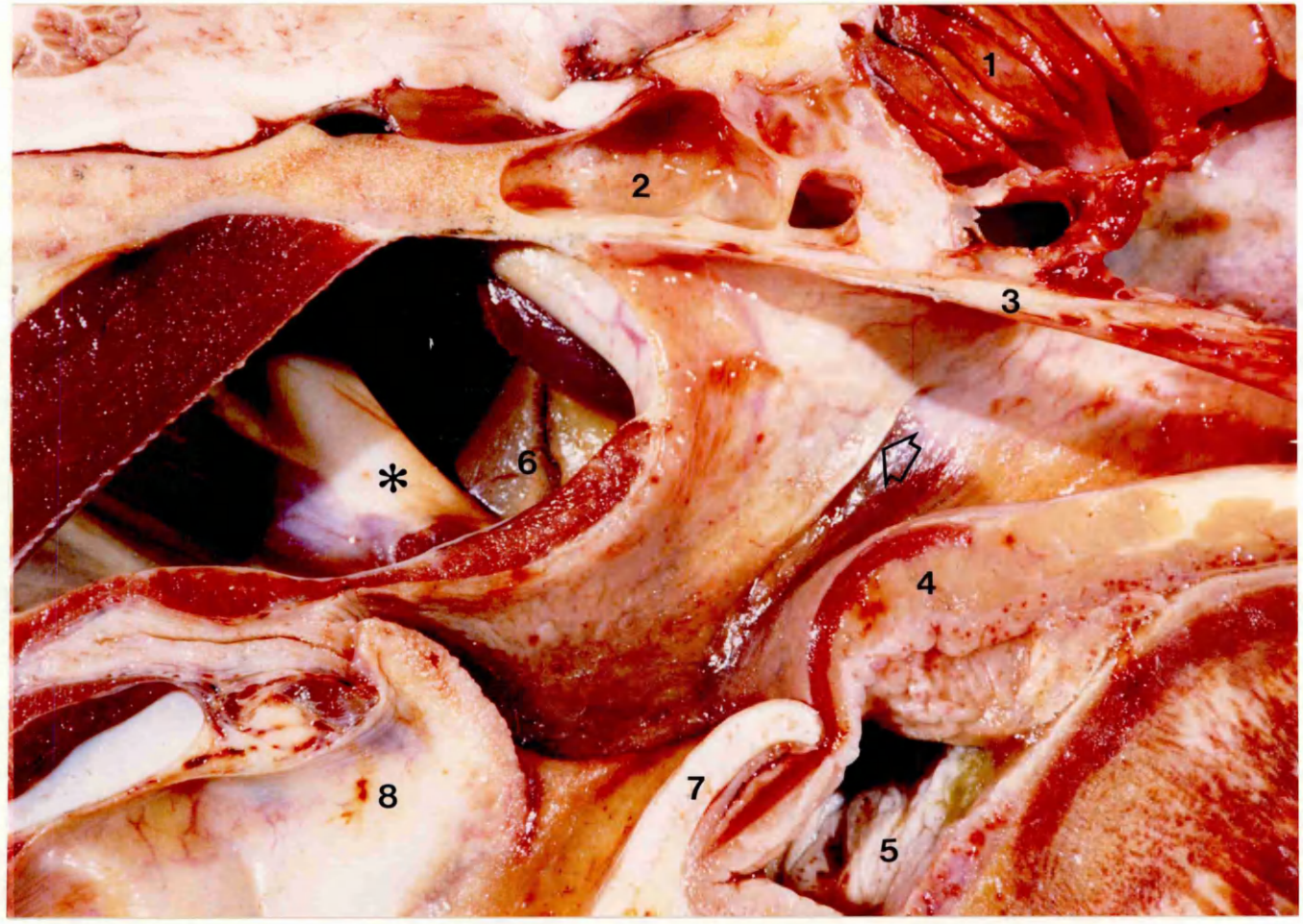

1
2
3
*
6
4
8
7
5

Fig. 2.11 Transverse section of a horse head at the level of the occipital condyles (looking forward).

1. Occipital condyles
2. Foramen magnum
3. Right guttural pouch (medial compartment)
4. Stylohyoid bone
5. Lateral retropharyngeal lymph nodes
6. Mandibular salivary gland
7. Parotid salivary gland
8. Pharynx (Dorsal surface)
9. External carotid artery
   Internal carotid artery with cranial nerves IX - XII (Arrow)

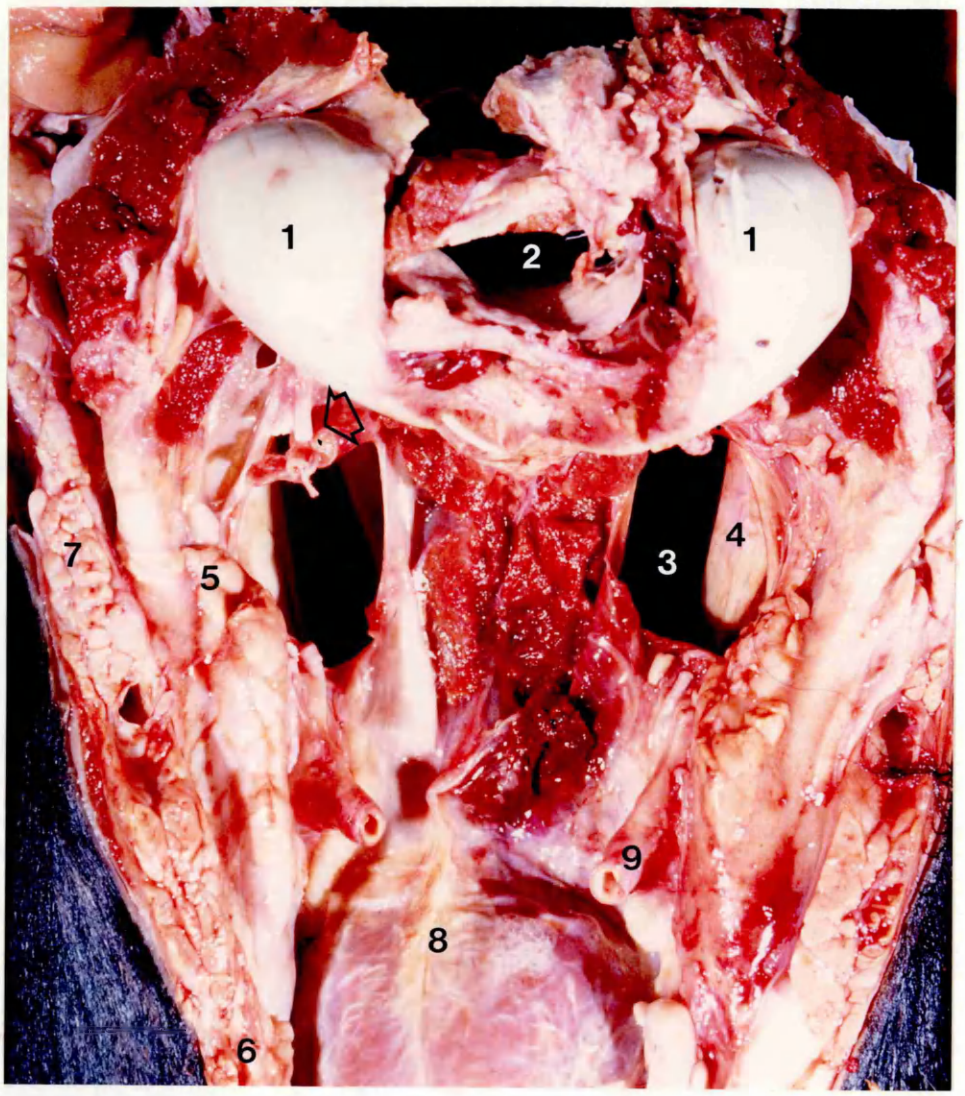

1
2
1
7
5
3
4
9
8
6

Fig. 2.12 Diagram of the laryngeal cartilages of the horse.

1. Epiglottic
2. Cuneiform
3. Thyroid
4. Arytenoid
5. Corniculate process of the arytenoid
6. Cricoid

Trachea (Asterisk)

Fig. 2.13 Sagittal section of a horse larynx.

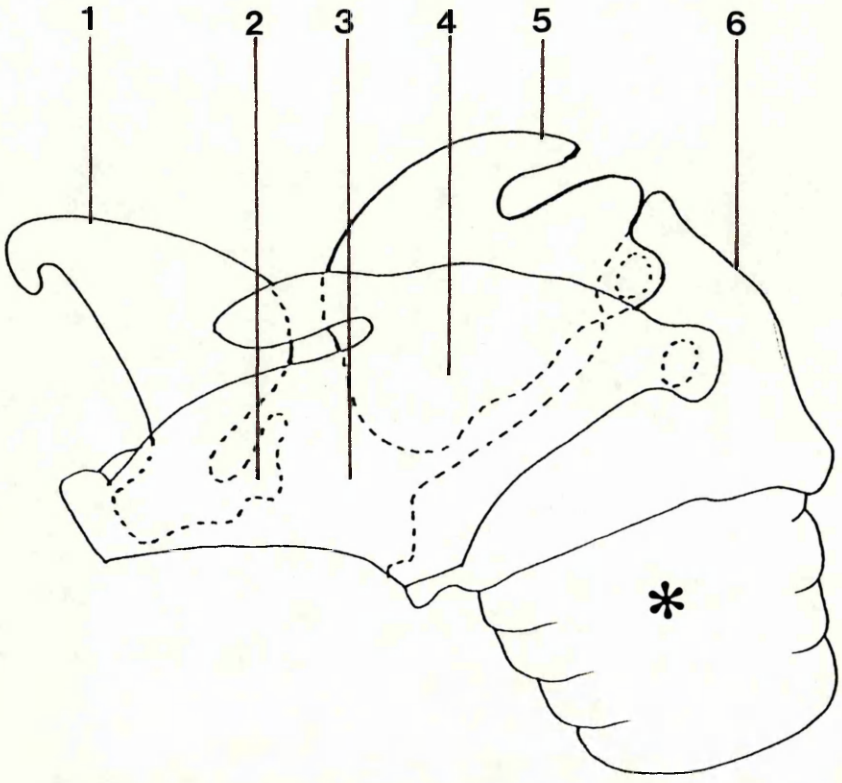
1. Epiglottic cartilage
2. Arytenoid cartilage

Corniculate process (Asterisk)

3. Thyroid cartilage
4. Cricoid cartilage
5. Vestibular fold
6. Vocal fold

Lateral ventricle (Arrow)

7. Aryepiglottic fold
8. Infraglottic cavity
9. First tracheal cartilage


1
2
3
4
5
6
*

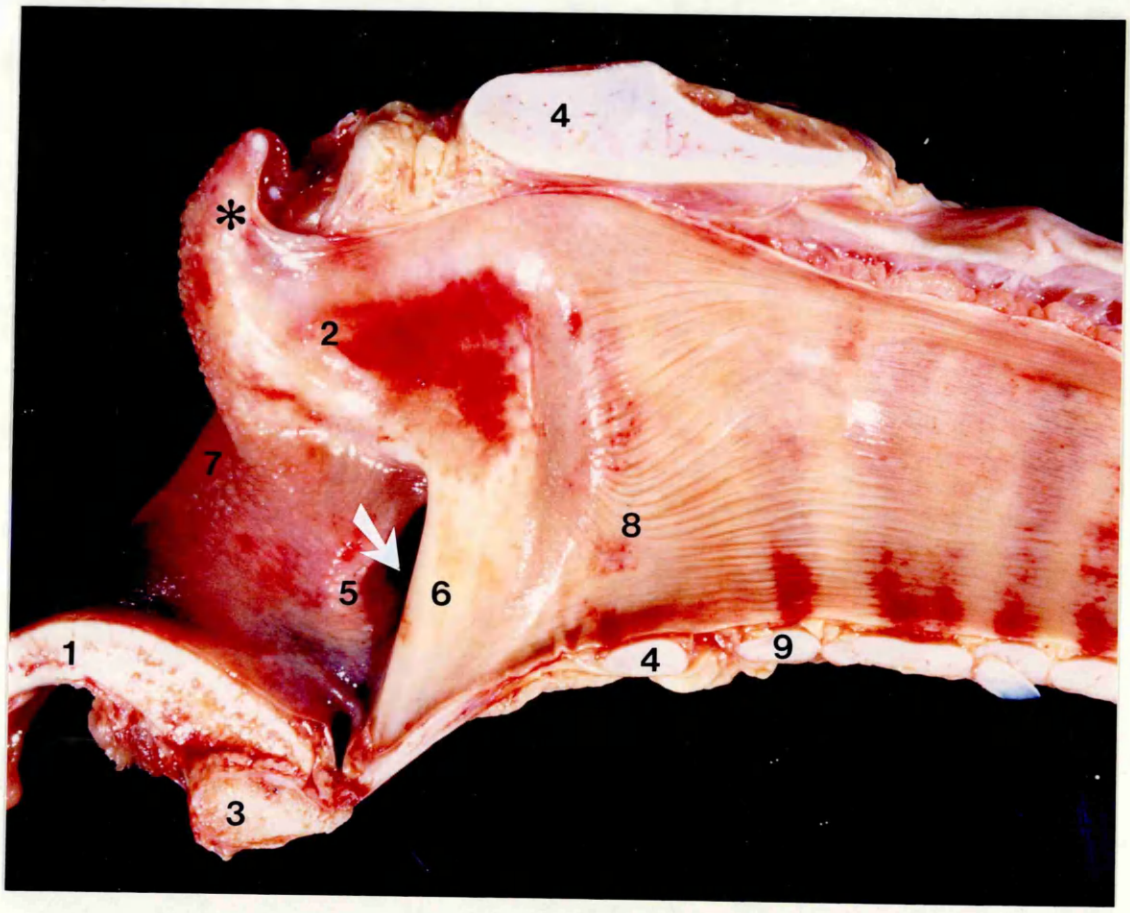

4
*
2
7
8
5
6
1
4
9
3

Fig. 2.14 Dorsal view of horse lungs and trachea.

1. Trachea
2. Left cranial lobe
3. Left caudal lobe

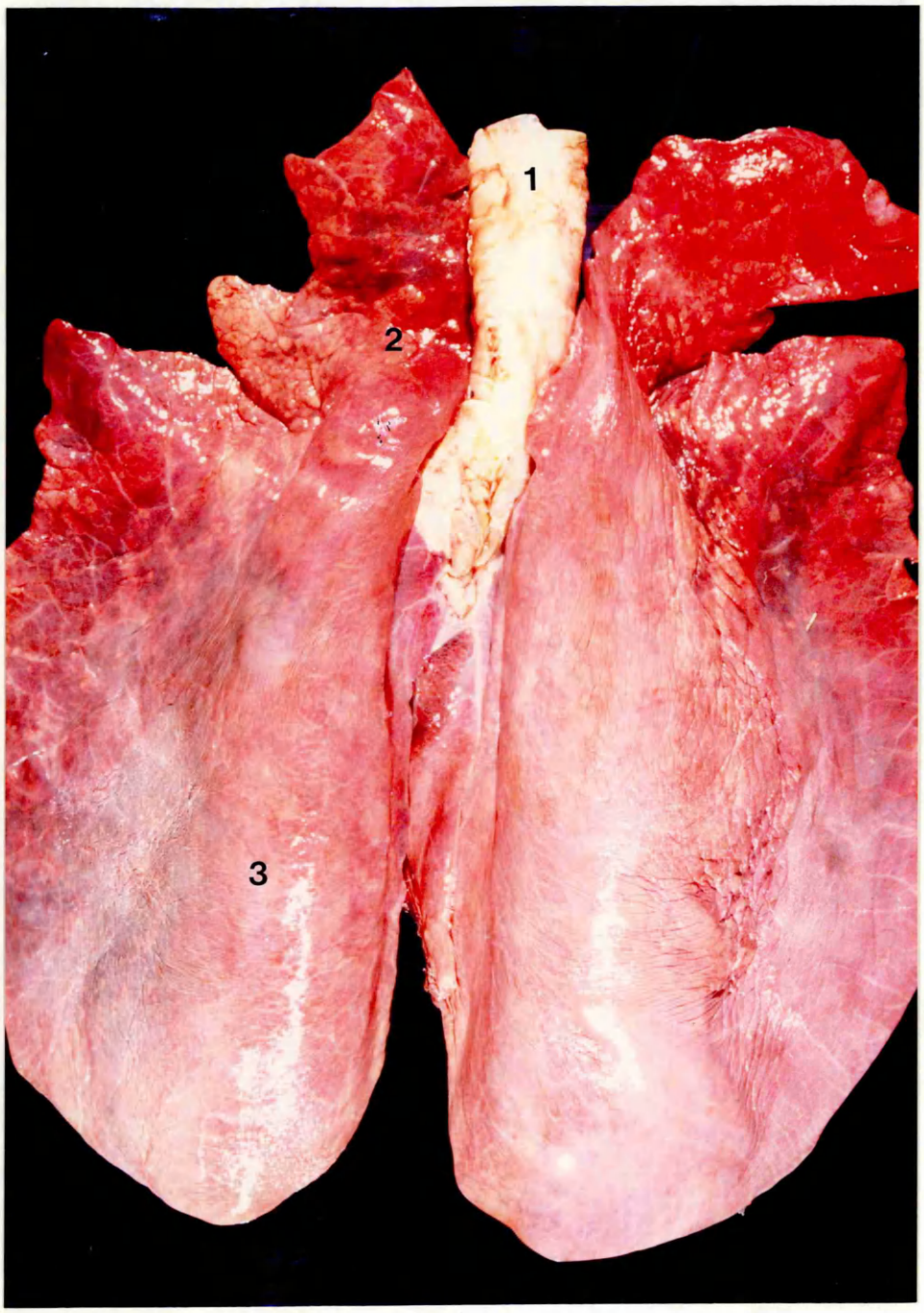

1
2
3

Fig. 2.15 Dorsal view of the right lung of a horse.

1. Trachea
2. Cranial lobe
3. Caudal lobe
4. Accessory lobe

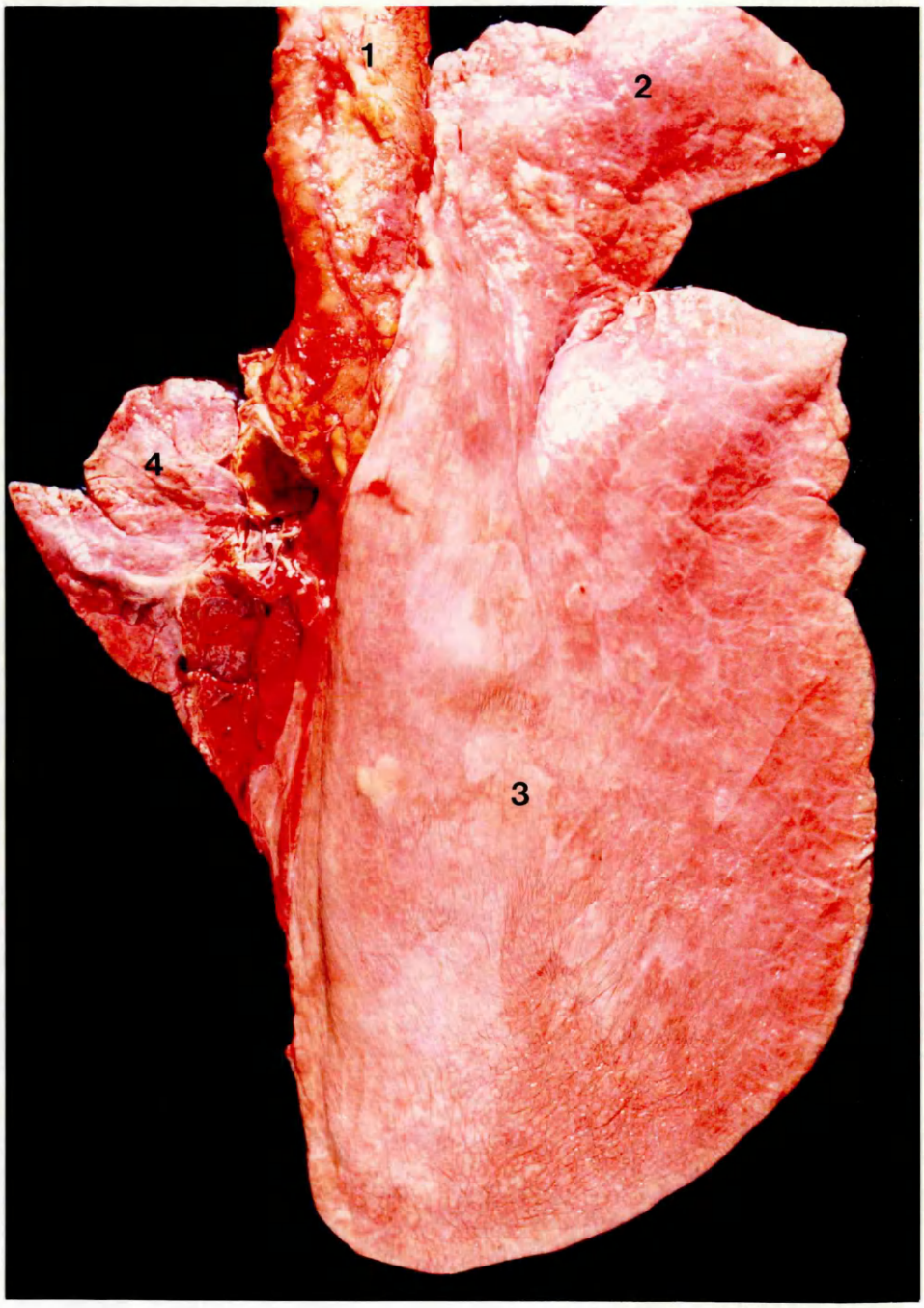
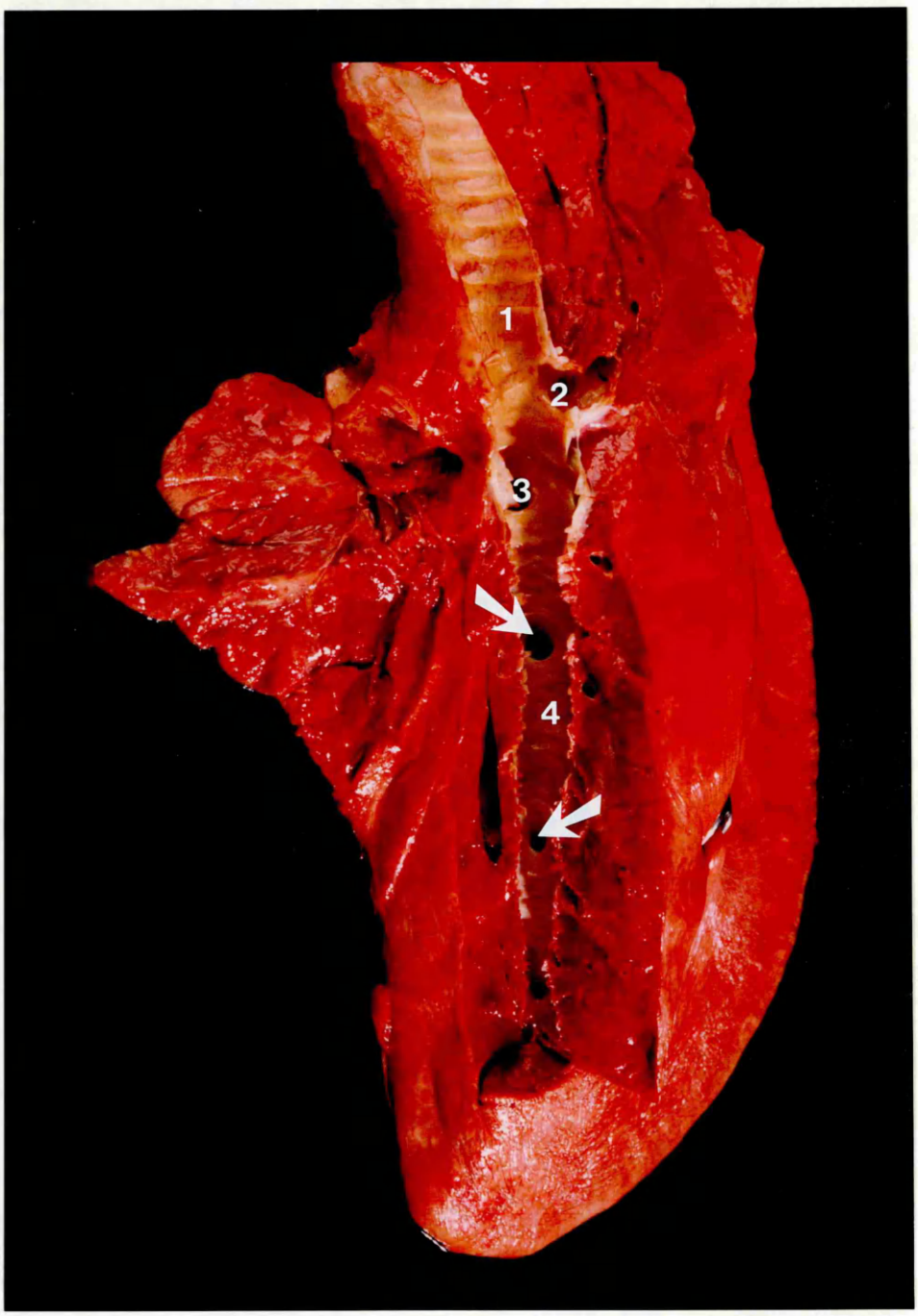

1
2
3
4

Fig. 2.16 Right lung of a horse with the main bronchi opened.

1. Principal bronchus
2. Cranial lobar bronchus
3. Accessory lobar bronchus
4. Caudal lobar bronchus

Segmental bronchi (Arrows)


1
2
3
4

CHAPTER 4

Fig. 4.1 Diagram of a sagittal section of a horse head with intact nasal septum.

1. Region sampled

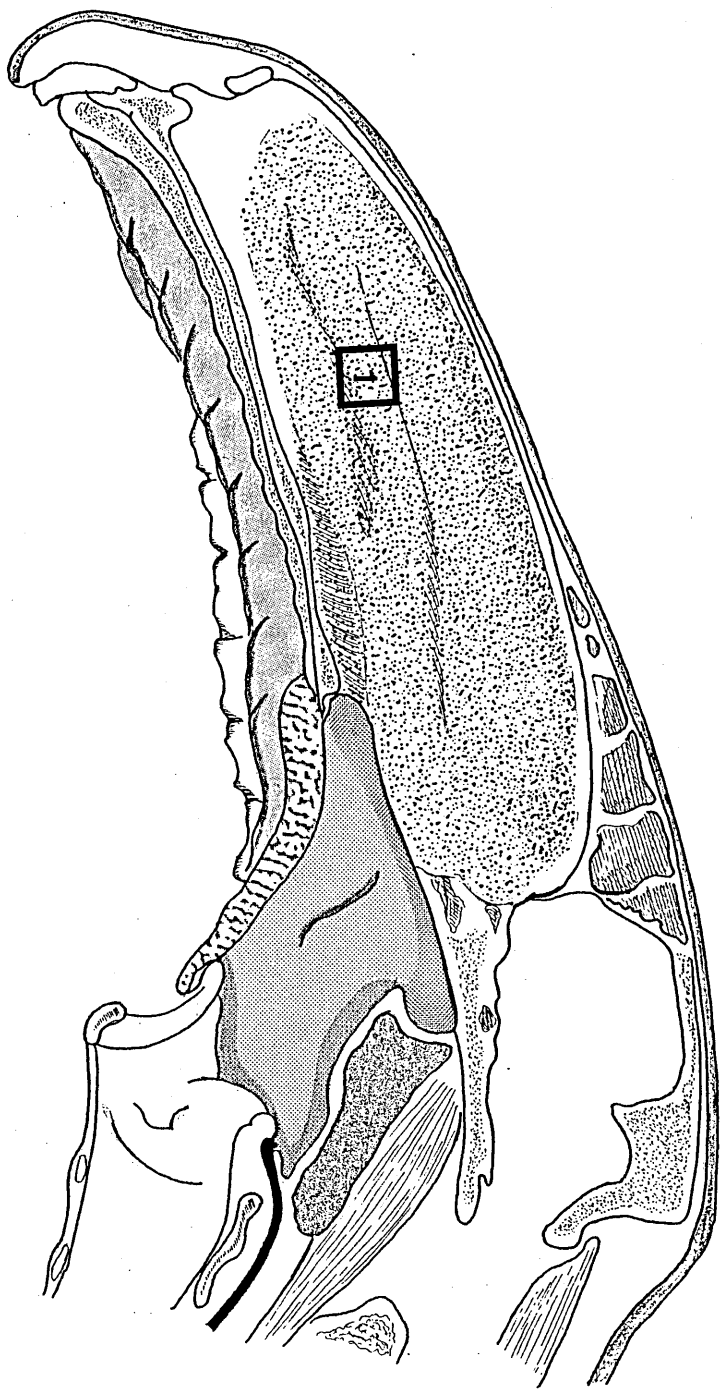


Fig. 4.2 Diagram of a sagittal section of a horse head with the nasal septum removed, showing the areas of the nasal cavity, nasopharynx and larynx sampled.

2. Ventral nasal concha
3. Basal fold of ventral nasal concha
4/5 Dorsal nasal concha and conchofrontal sinus
6. Nasopharynx
7/8 Pharyngeal opening of the auditory tube
9. Guttural pouch
10. Epiglottis
11. Ventral larynx
E. Ethmoidal conchae

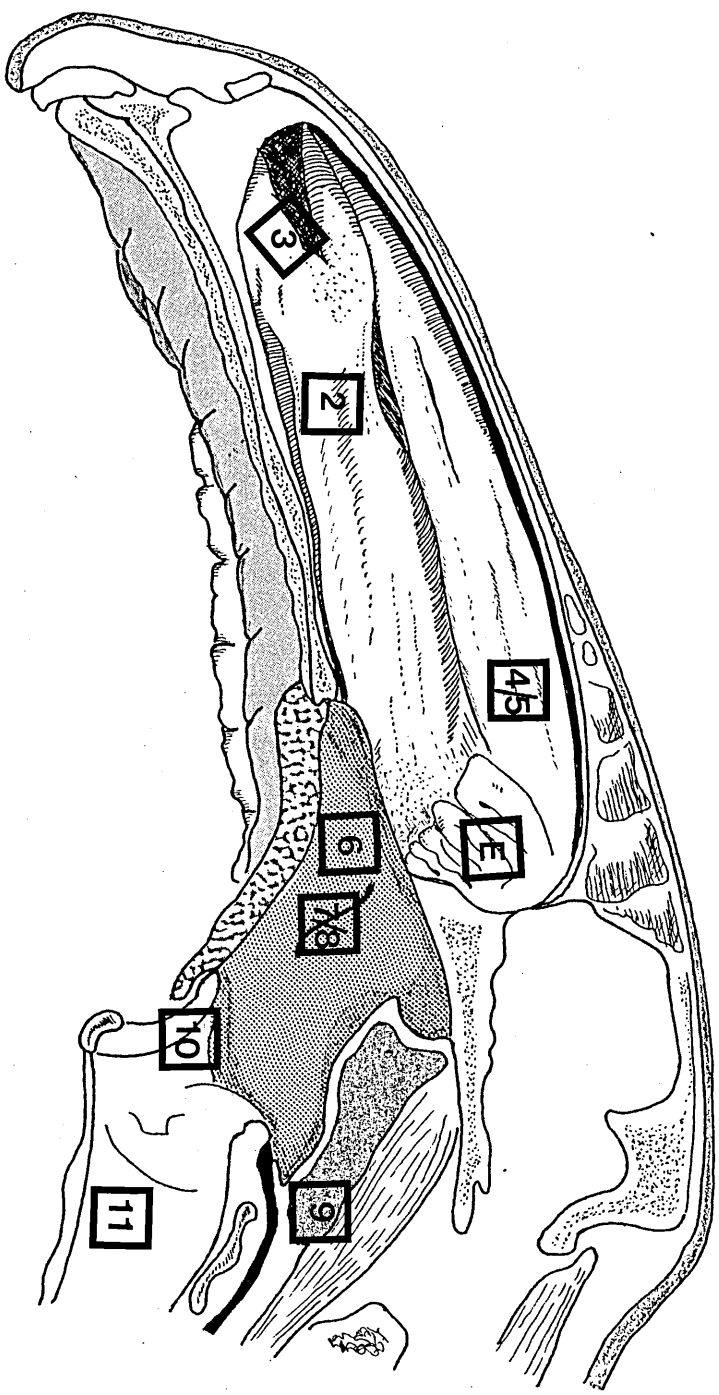
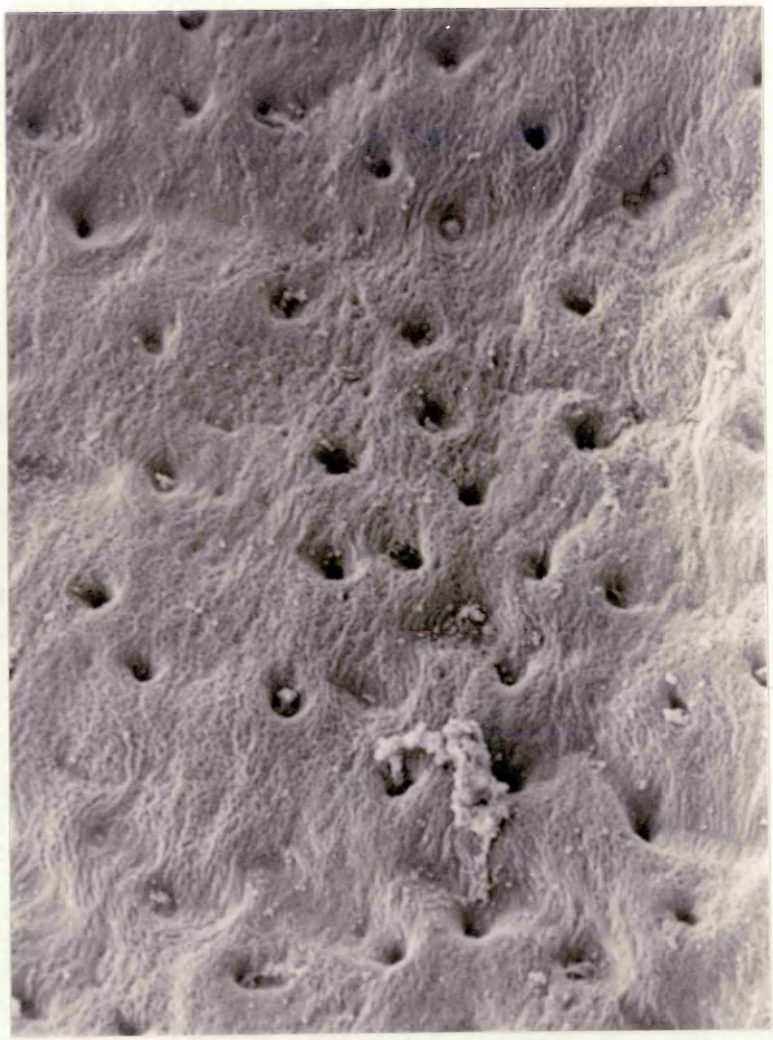

3
2
4E
E
6
8
10
11
9

Fig. 4.3 Nasal septum. A low power view of the surface with numerous duct orifices of the underlying mucosal glands.
SEM x 160

Fig. 4.4 Nasal septum. Surface cells with distinct boundaries give a "cobblestone" appearance to the epithelium. Note the mucus-secreting cells (Arrows).
SEM x 1,280



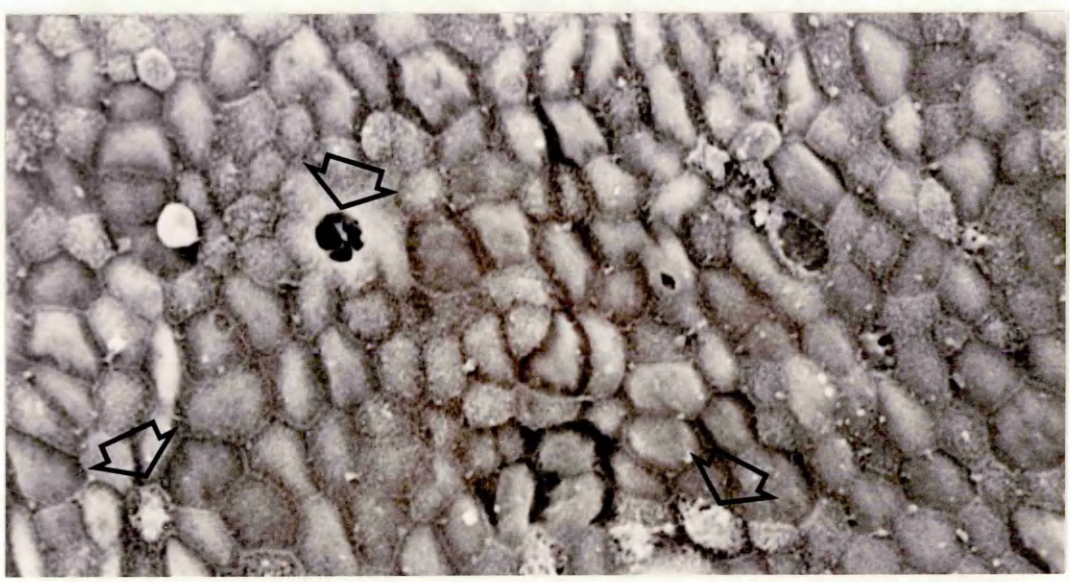
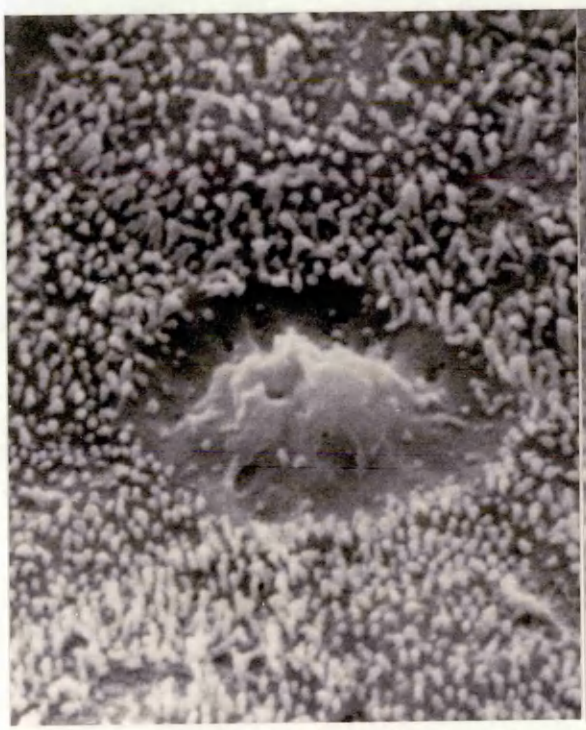


Fig. 4.5 Nasal septum. The "cobblestone" epithelium of microvillous cells with distinct boundaries (Arrows). Note the mucus-secreting cells (M) on the right.
SEM x 2,500 and 5,000

Fig. 4.6 Nasal septum. Two mucus-secreting cells in the initial stages of development. A cell with a dome-shaped central area (left). A second cell shows mucous droplets visible through the surface cell membrane of its bulging central area (right).
SEM x 10,000


m
m



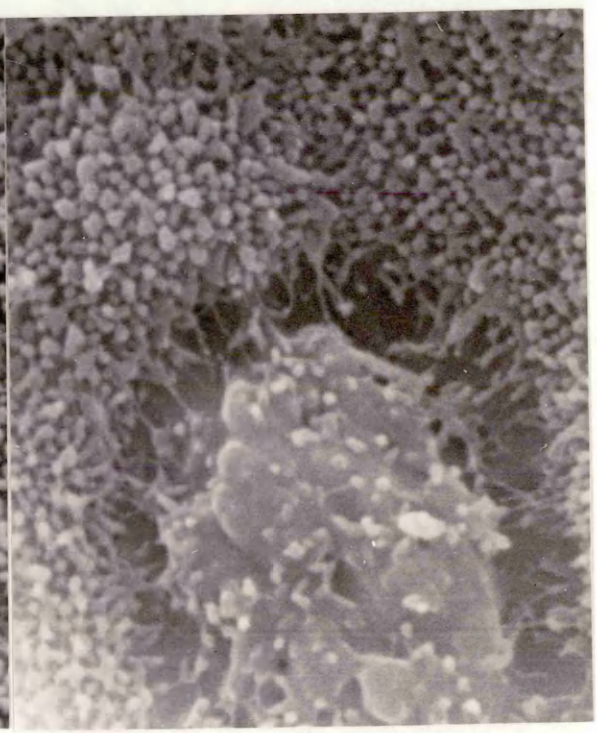


Fig. 4.7 Nasal septum. Mucus streams from the centre of a discharging cell.
Note the sparse surface microvilli of the mucous cell compared with surrounding cells.
SEM x 10,000

Fig. 4.8 Nasal septum. Discharged mucus collects to form a sheet covering the surface.
SEM x 5,000

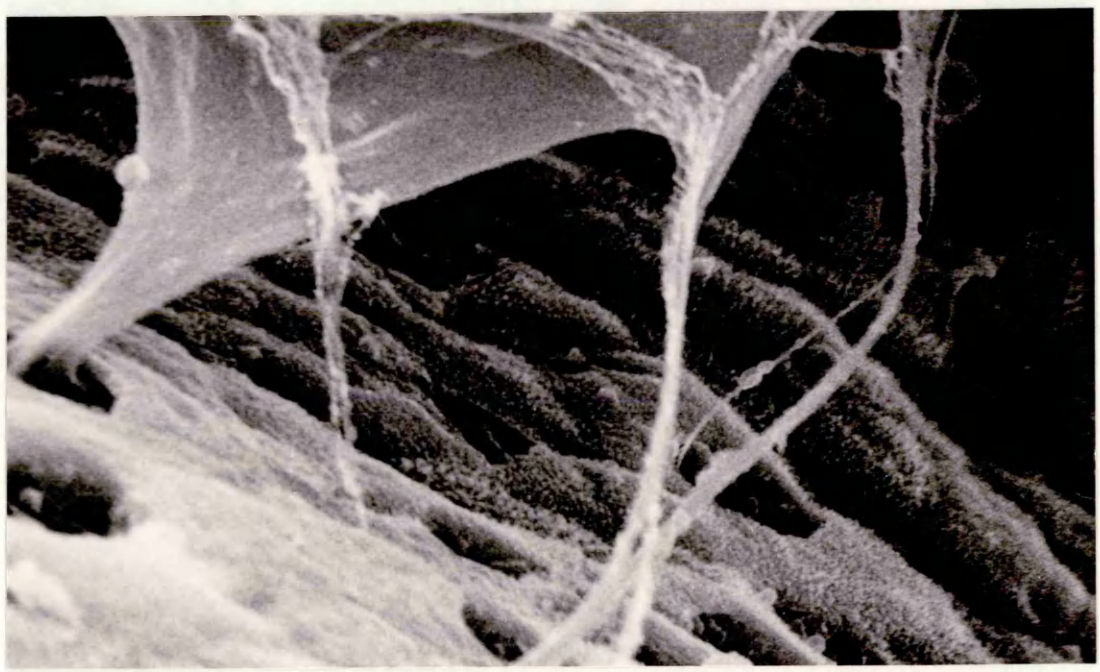
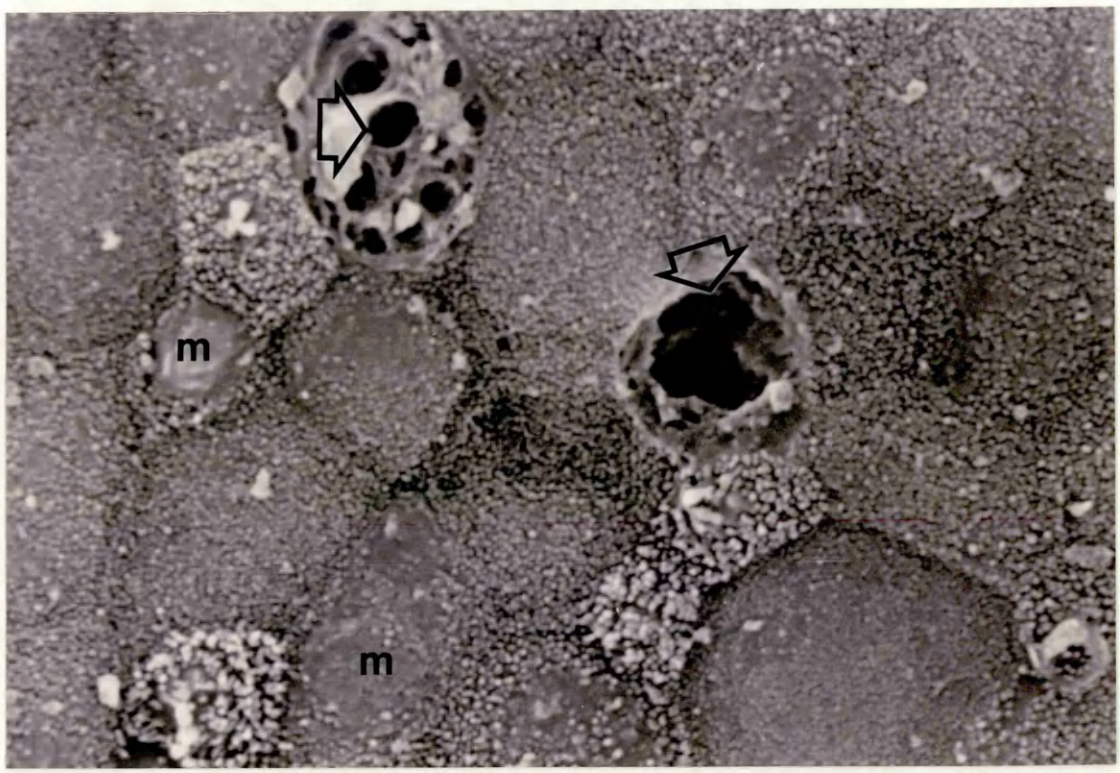


Fig. 4.9 Nasal septum. After discharge of mucus, cells appear empty with surface pores and craters (Arrows). Note also the presence of developing mucous cells (M). SEM x 5,000

Fig. 4.10 Nasal septum. A final stage in the cycle of mucus secretion. A smooth raised edge of the surface cell membrane surrounds a central depressed area with sparse microvilli in cells in the process of regeneration. SEM x 5,000


m
m

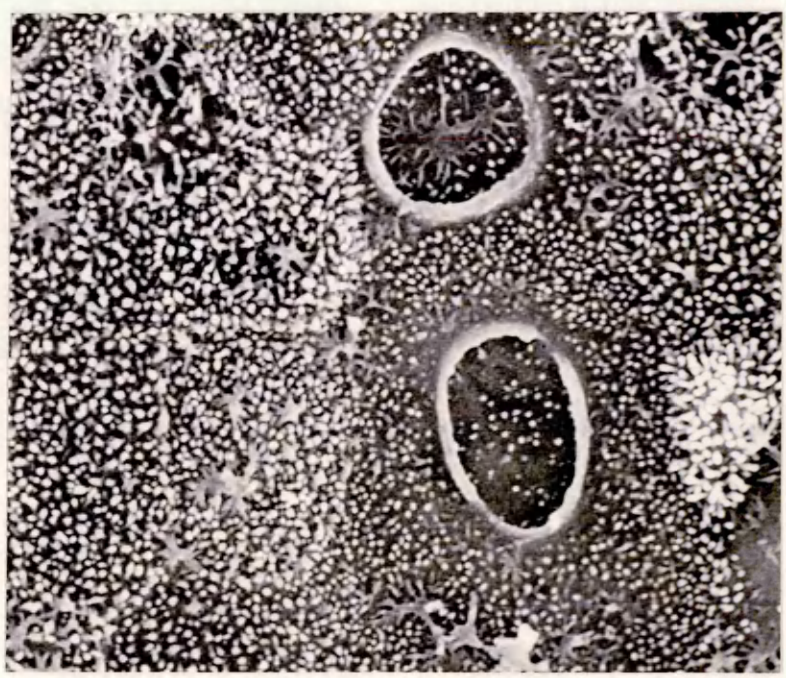
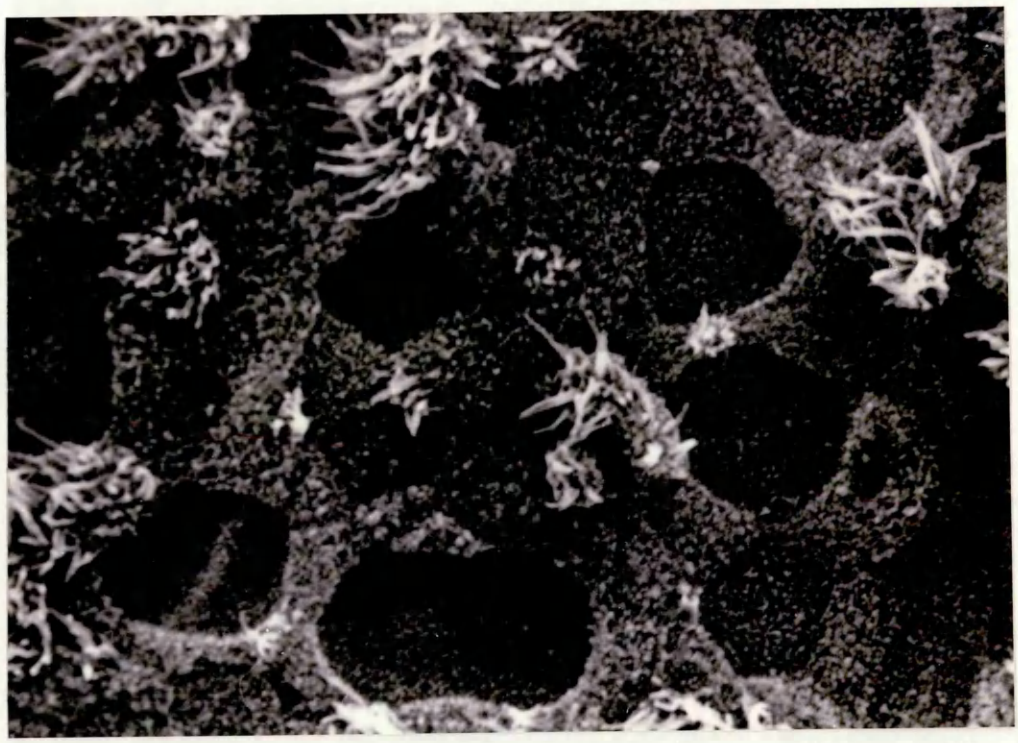


Fig. 4.11 Nasal septum. Sparsely ciliated cells are present among the more numerous microvillous cells.
SEM x 1,500

Fig. 4.12 Ventral nasal concha. Ciliated cells with well developed cilia and microvillous cells.
Note the fine strands of mucus on the surface of the cilia (Arrows)
SEM x 5,000



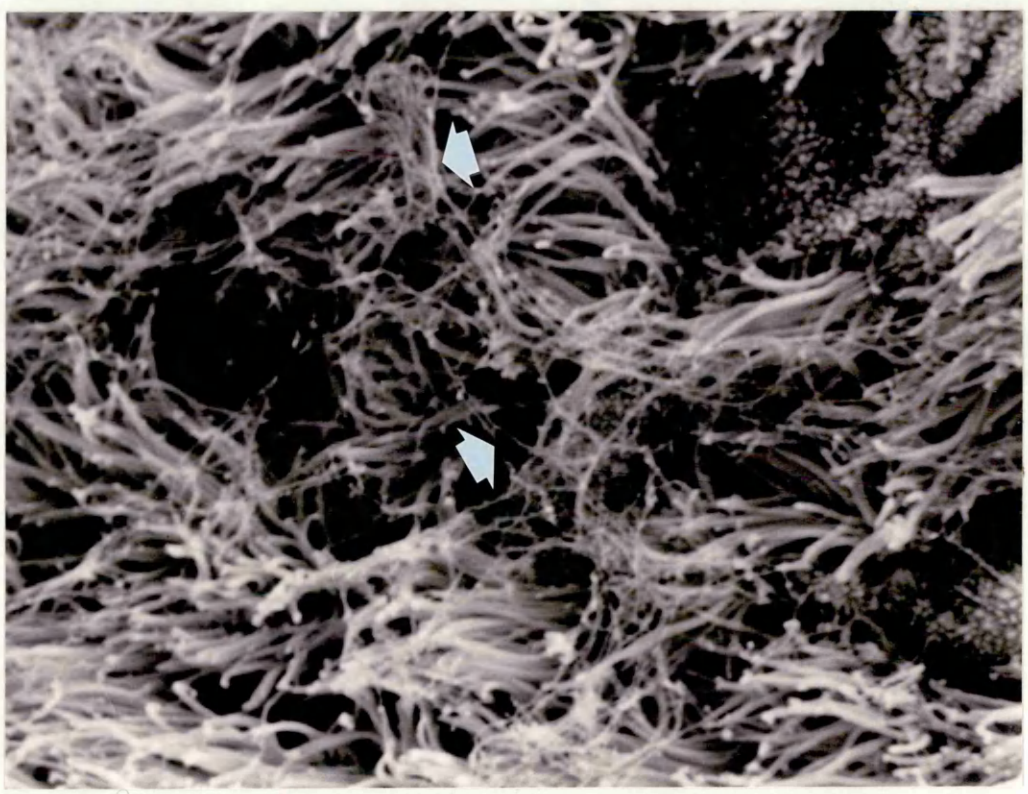


Fig. 4.13 Basal fold of the ventral nasal concha. A low power view to show the three distinct surface areas.

1. Squamous surface cells and projecting hairs (Arrows)
2. Narrow hairless squamous area
3. Deeply folded surface of the nasal mucosa.

SEM x 160

Fig. 4.14 Basal fold of the ventral nasal concha. Squamous cells with surface microplicae.

SEM x 10,000


3
2
1

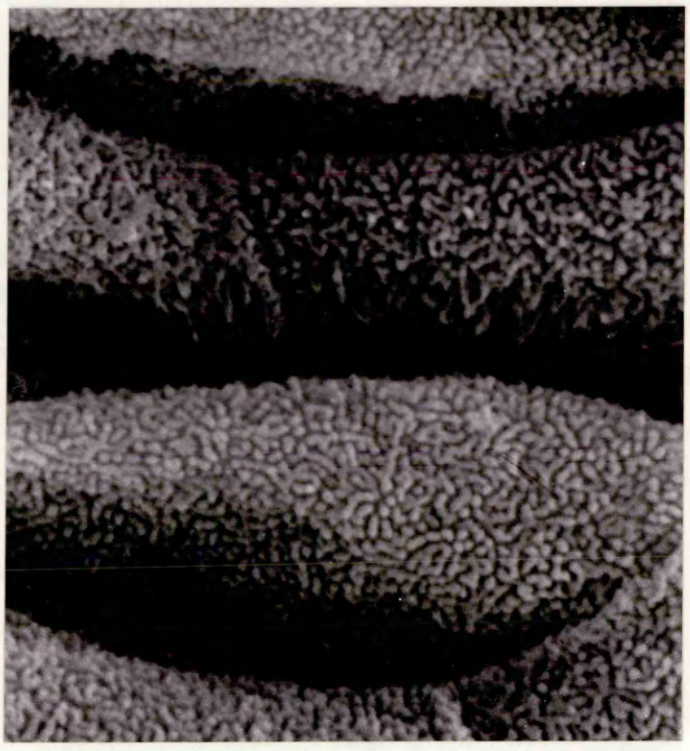


Fig. 4.15 Basal fold of the ventral nasal concha. Squamous surface cells and numerous protruding hairs in the most rostral area. (1 in Fig. 4.13). SEM x 160

Fig. 4.16 Basal fold of the ventral nasal concha. A high power view of the rostral hairy area. Note the surface mucus (M) which has trapped desquamated surface cells, RBCs and other debris. SEM x 1,280

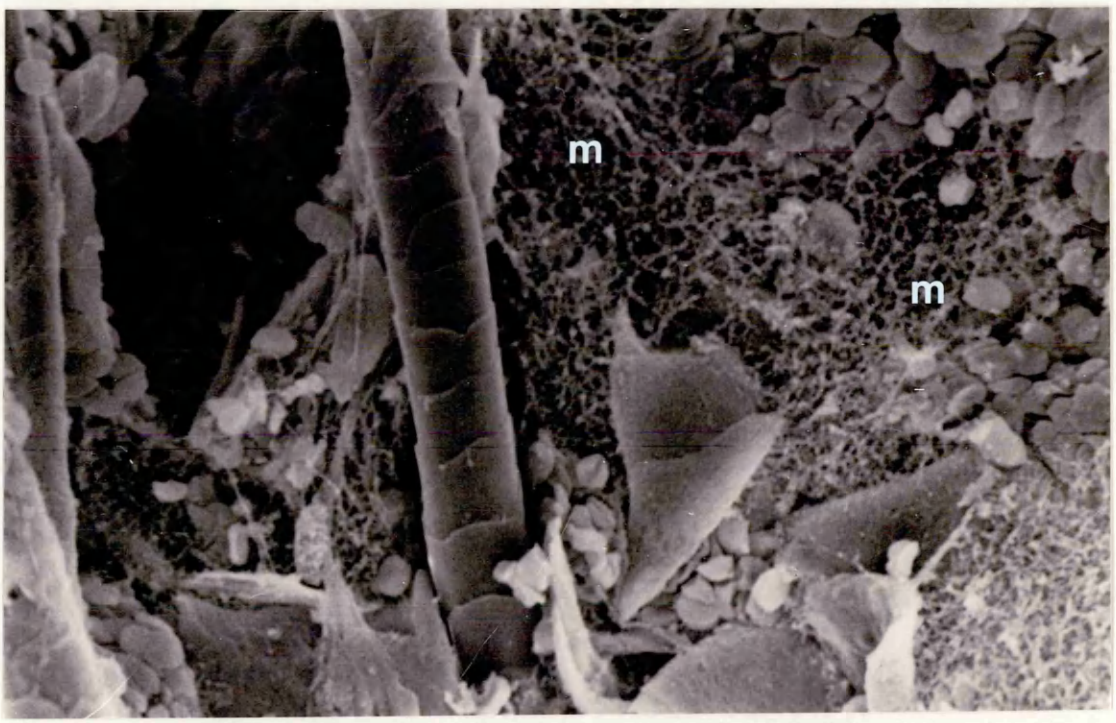

m
m

Fig. 4.17 Basal fold of the ventral nasal concha. Arrows indicate the abrupt junction between the hairless squamous area and the nasal mucosa proper where the bulging surface cells give a "cobblestone" appearance to the epithelium. SEM x 1,280

Fig. 4.18 Dorsal nasal concha. A sheet of mucus partially obscures the surface. Nonciliated cells among the ciliated cells give a characteristic "moth-eaten" appearance to the surface. SEM x 1,280

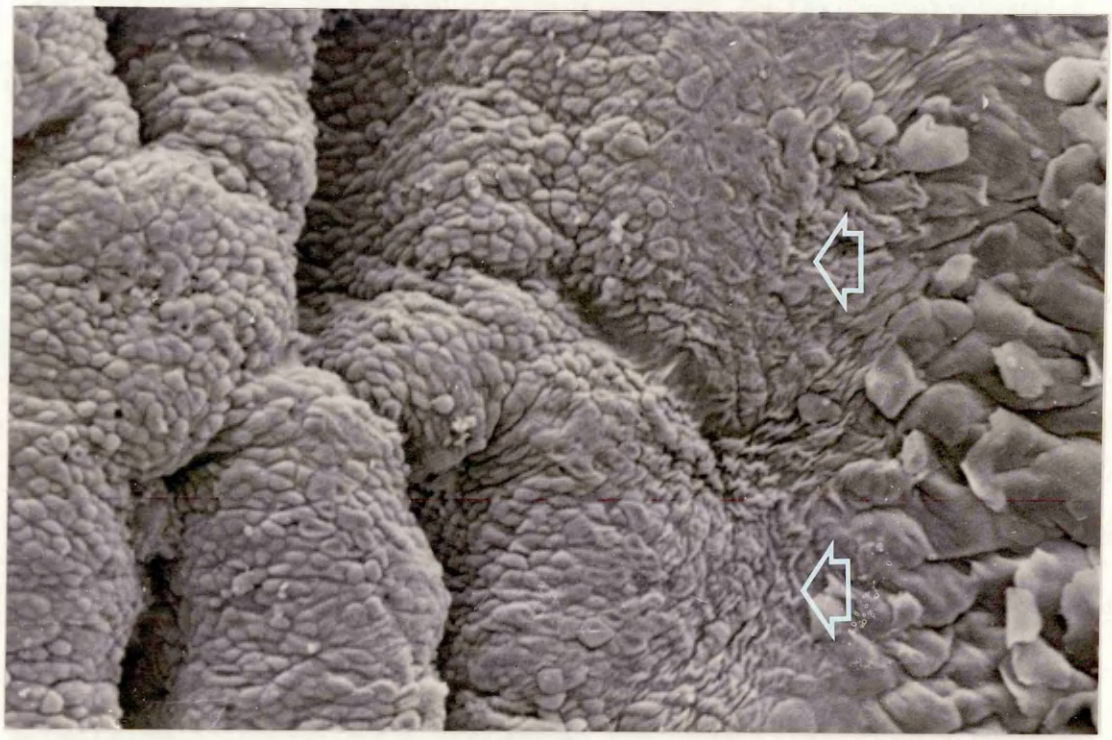


Fig. 4.19 Dorsal nasal concha. The nonciliated cells actively discharging mucus (arrow) on the left, or may be flat with sparse microvilli (right). SEM x 5,000

Fig. 4.20 Conchofrontal sinus. Large patches of nonciliated microvillous cells interrupt the ciliated surface. SEM x 2,500

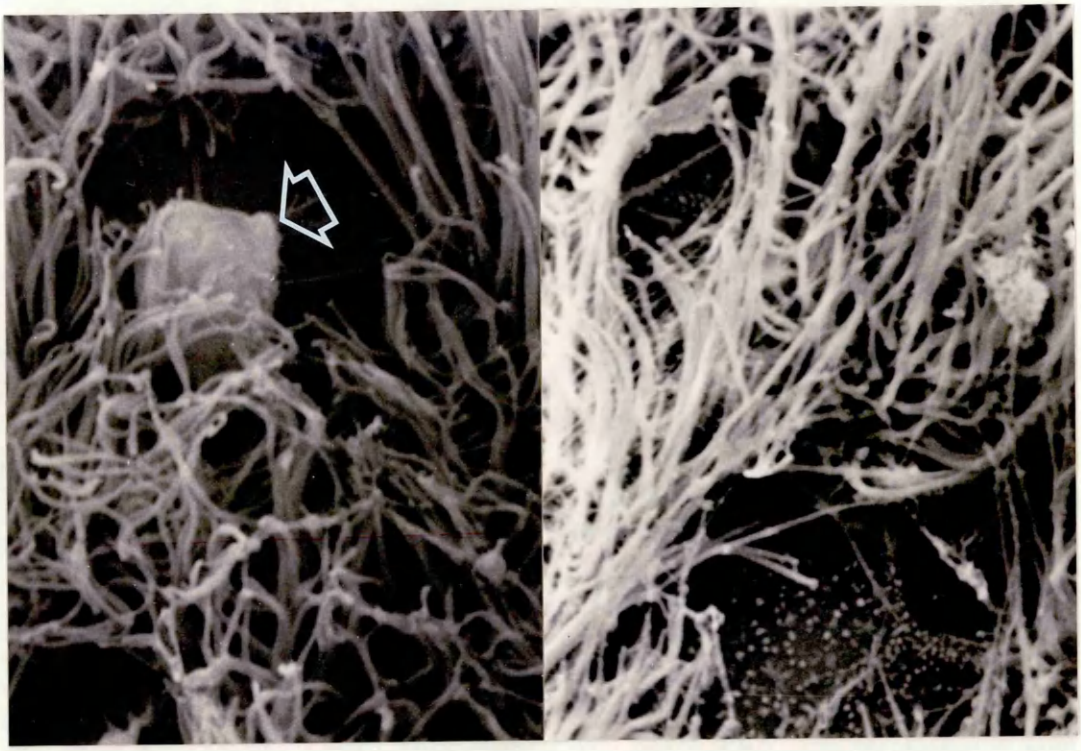
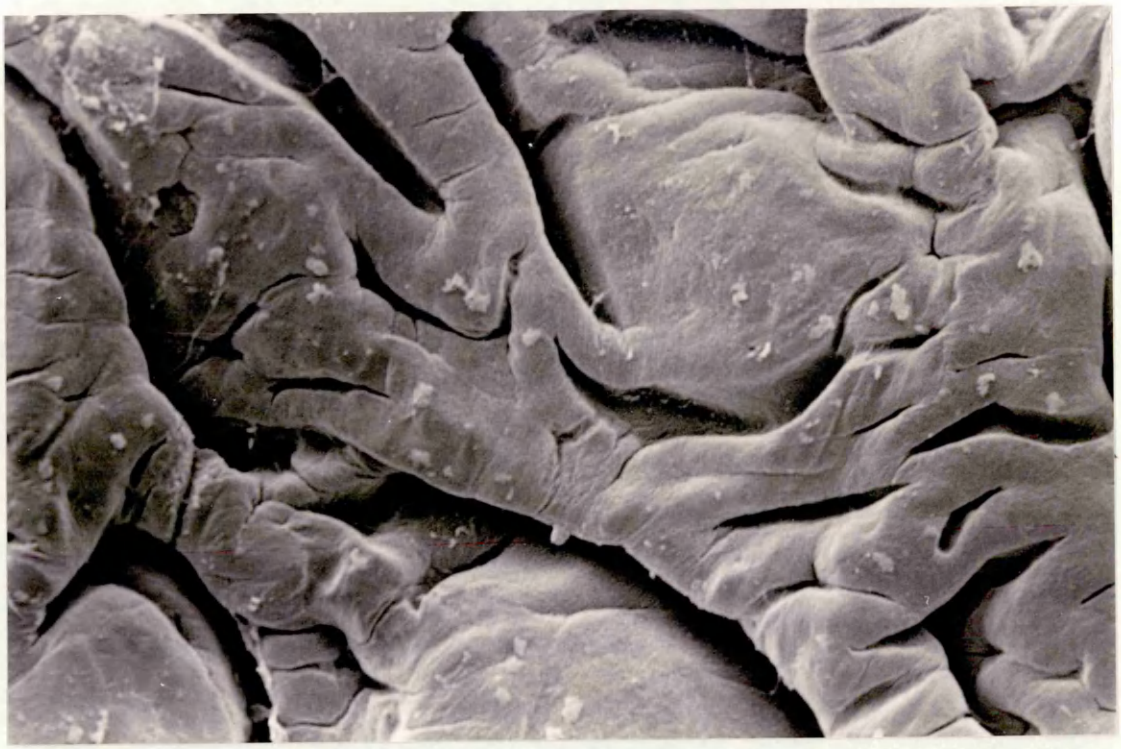


Fig. 4.21 Nasopharynx, showing the deeply folded mucosal surface.
SEM x 80

Fig. 4.22 Nasopharynx, ciliated cells and mucus-secreting cells (Arrows). Note the thick strands of mucus (M) adhering to the surface.
SEM x 5,000



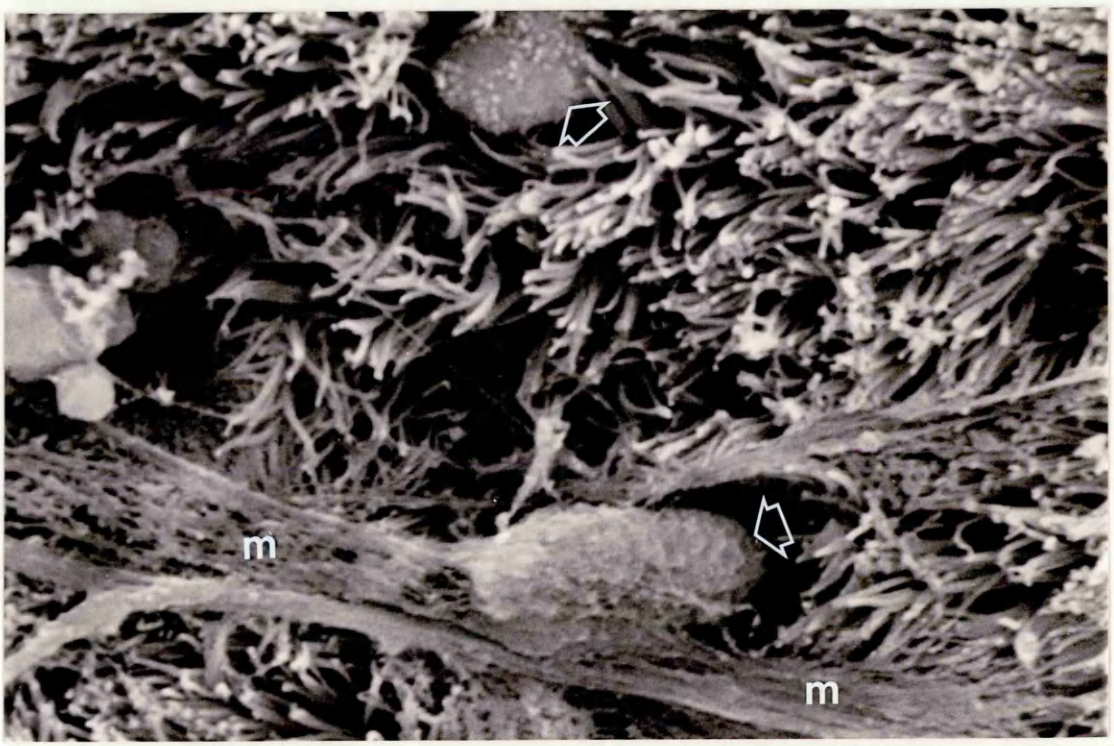
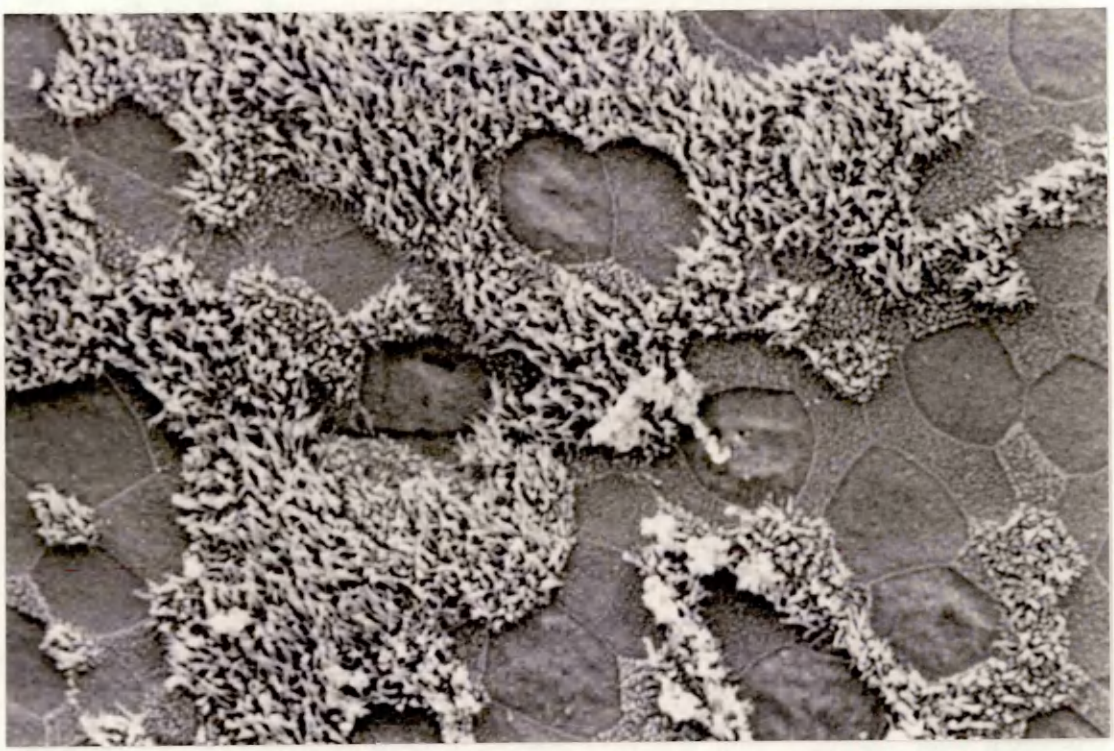

m
m

Fig. 4.23 Nasopharynx. A mixture of ciliated and nonciliated cells. The latter vary in size and shape and are studded with numerous microvillous processes. This surface is similar to that of the nasal septum, illustrated in Fig. 4.11.
SEM x 1,300

Fig. 4.24 Nasopharynx. A large patch of nonciliated microvillous cells with a cell discharging mucus in the centre of the picture.
SEM x 2,500



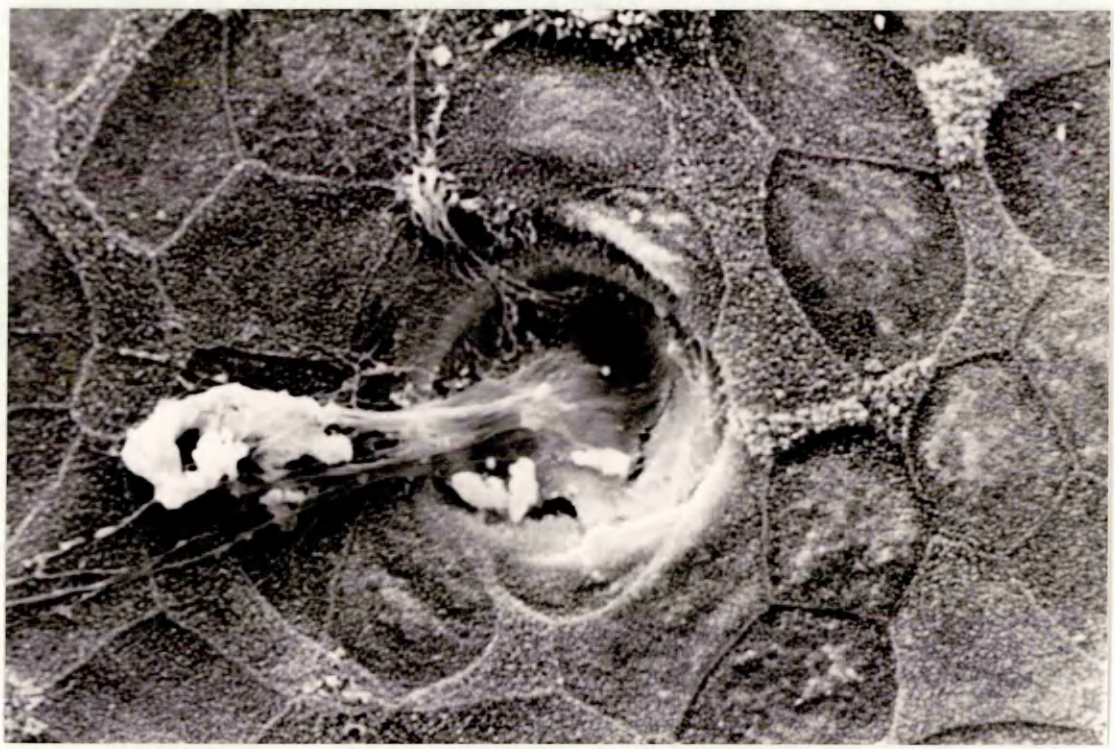
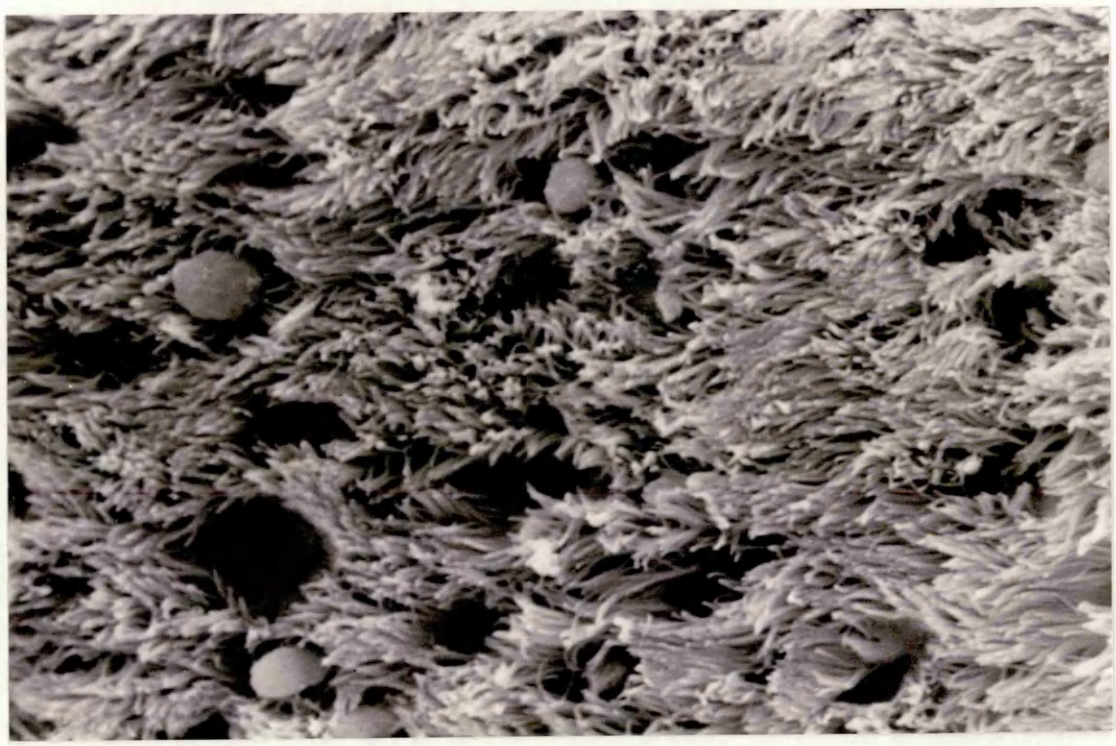


Fig. 4.25 Lateral surface of the pharyngeal opening of the auditory tube. Many discharging mucous cells protrude between the ciliated cells.
SEM x 2,500

Fig. 4.26 Lateral surface of the pharyngeal opening of the auditory tube. Patches of ciliated cells and nonciliated microvillous cells give a surface appearance similar to that of the nasopharynx and nasal septum. (See Fig. 4.23, Fig. 4.11).
SEM x 2,500



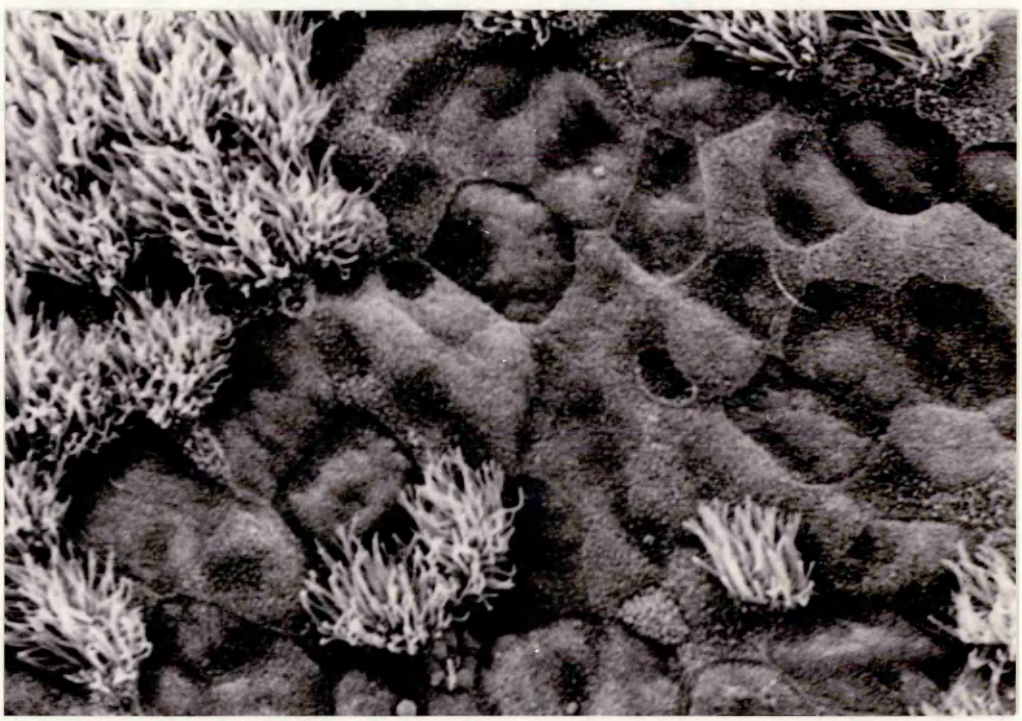
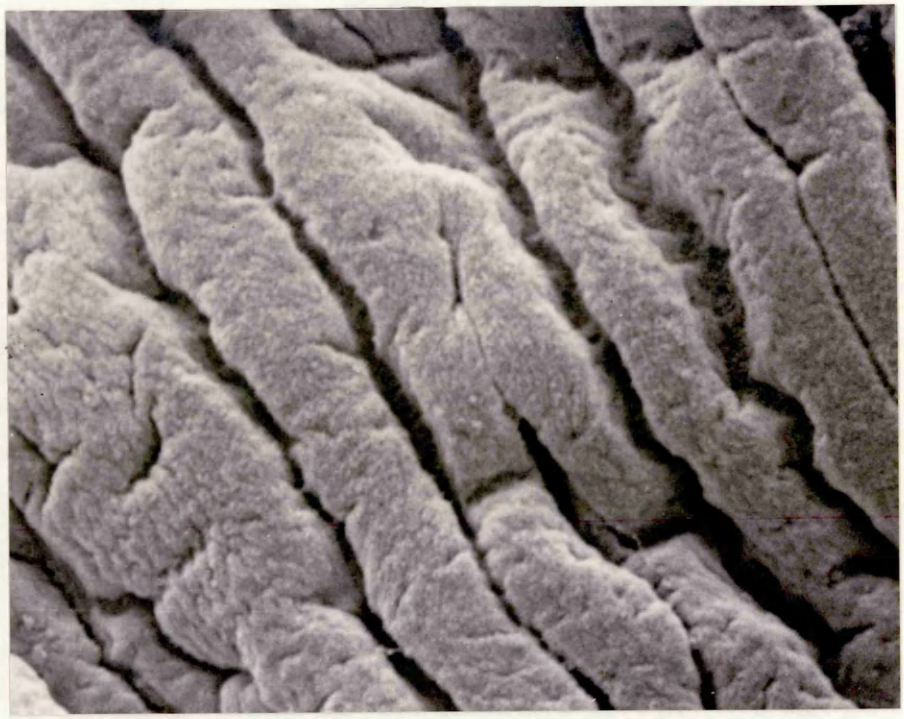


Fig. 4.27 Guttural pouch. A low power view of the folded surface.
SEM x 160

Fig. 4.28 Guttural pouch. Numerous mucus-secreting cells (Arrows) bulge from the surface between ciliated cells.
SEM x 5,000



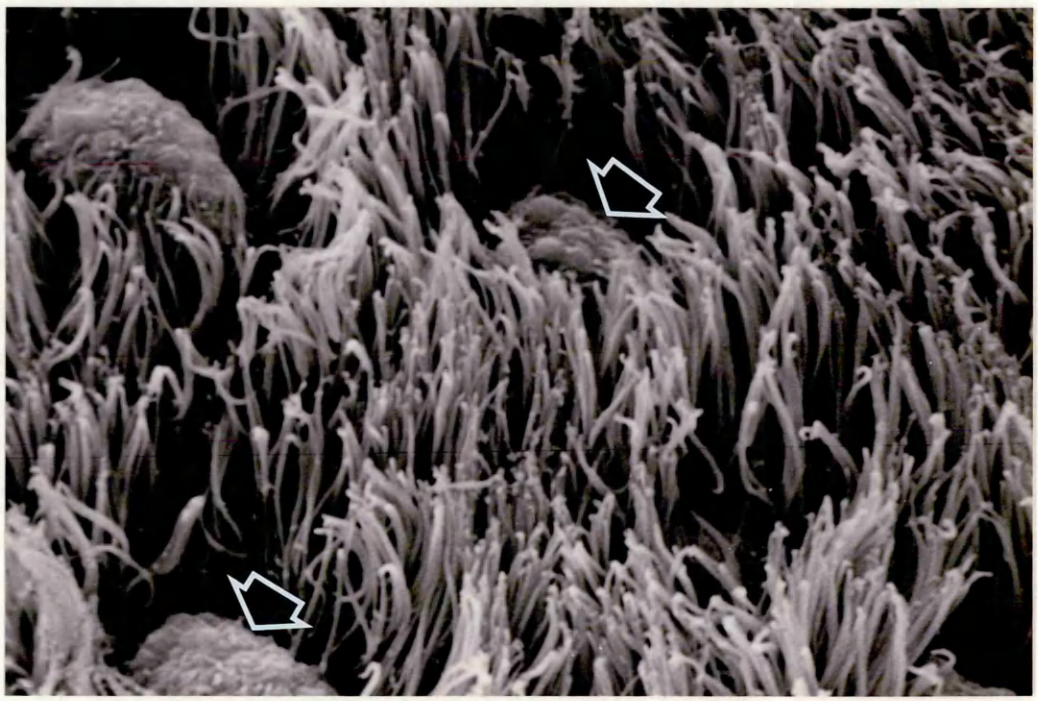
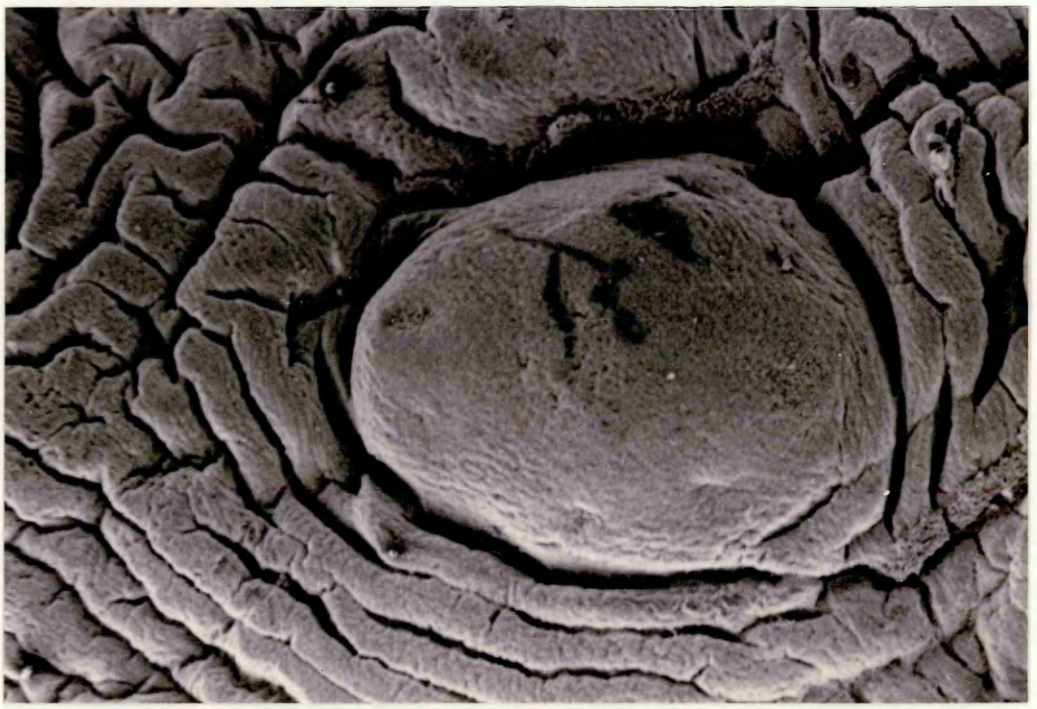


Fig. 4.29 Guttural pouch. The regularly folded mucosal surface is interrupted by a well defined protruberant smooth area.
SEM x 80

Fig. 4.30 Guttural pouch. A high power view of the centre of the smooth area illustrated in Fig. 4.29, showing ciliated cells and microvillous cells.
SEM x 5,000



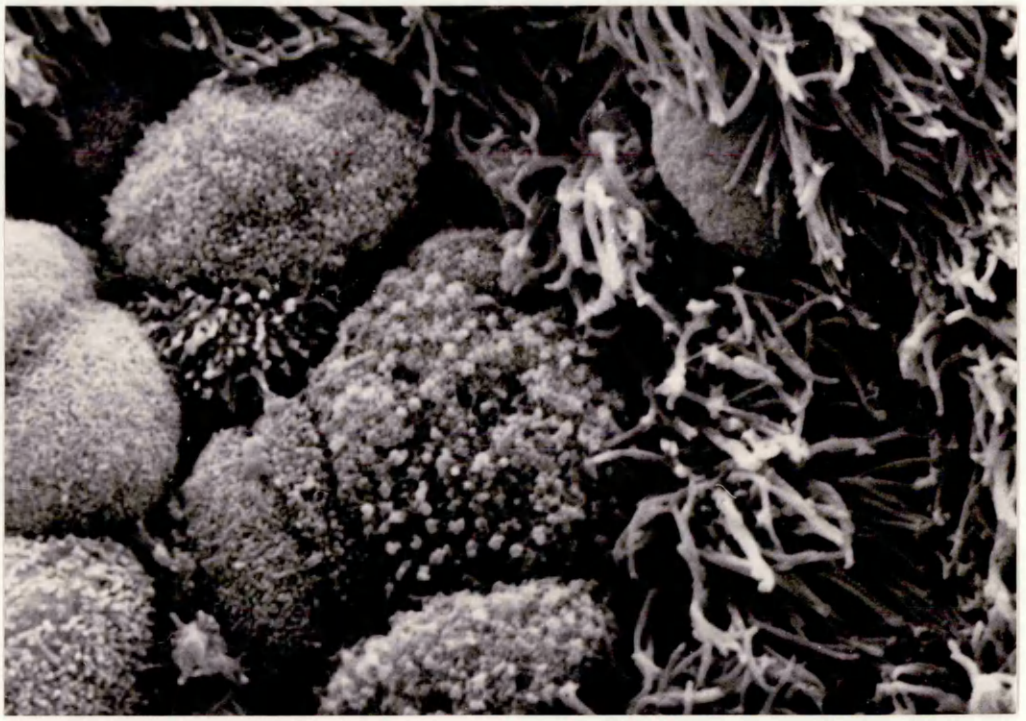
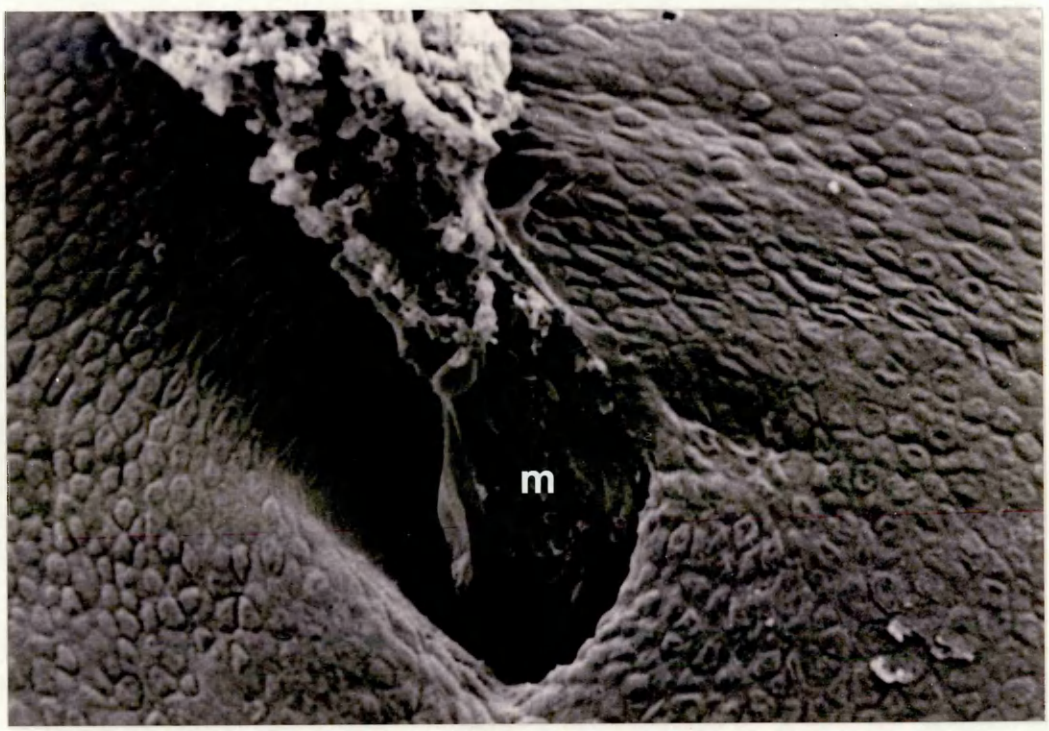


Fig. 4.31 Epiglottis. Small, rounded cells with distinct boundaries give a "cobblestone" appearance to the epithelium very similar to that of rostral nasal cavity surfaces (See Fig. 4.4).
Mucus (M) flows from a gland duct orifice.
SEM x 640

Fig. 4.32 Epiglottis. A high power view of the surface microvillous cells. Note the distinct cell boundaries (Arrows) and a developing mucous cell (M) with sparse microvilli.
SEM x 10,000


m

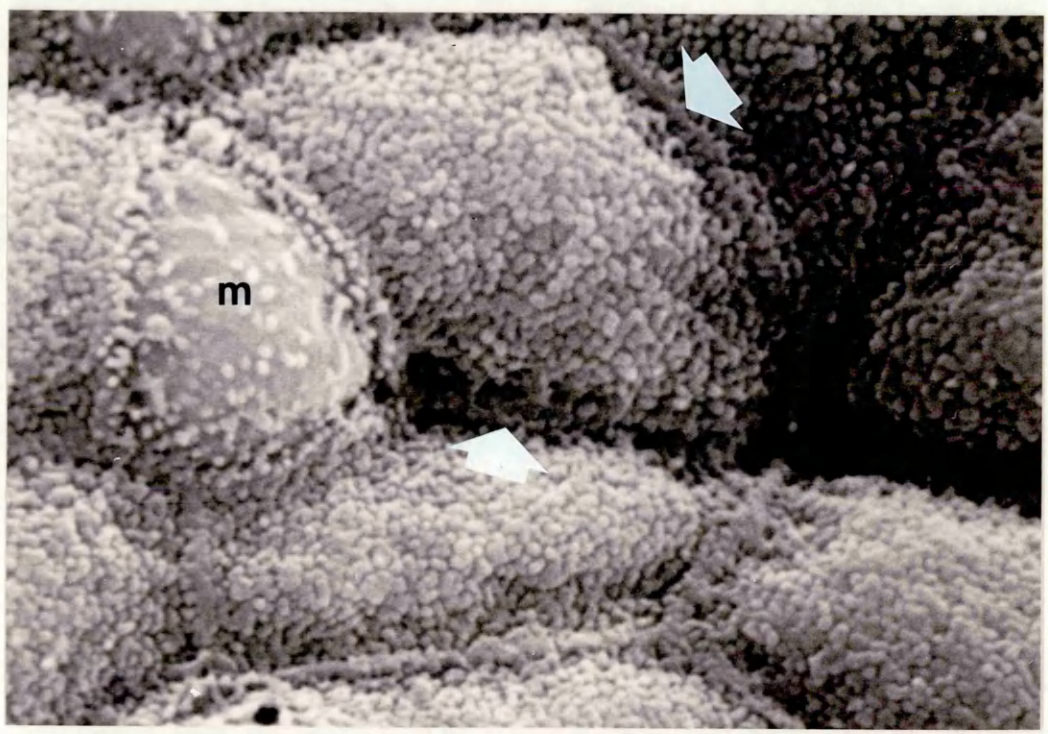
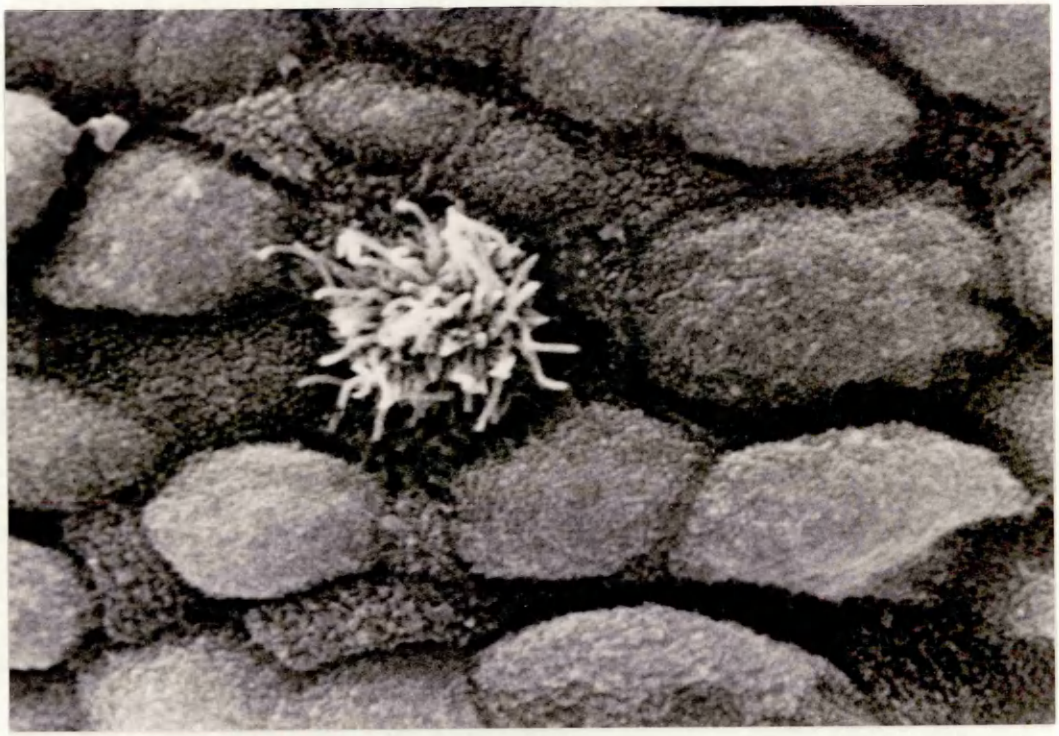

m

Fig. 4.33 Epiglottis. A single ciliated cell among the microvillous cells.
SEM x 5,000

Fig. 4.34 Ventral larynx. The laryngeal surface, caudal to the glottis, was characterized by regular, parallel folds.
SEM x 160



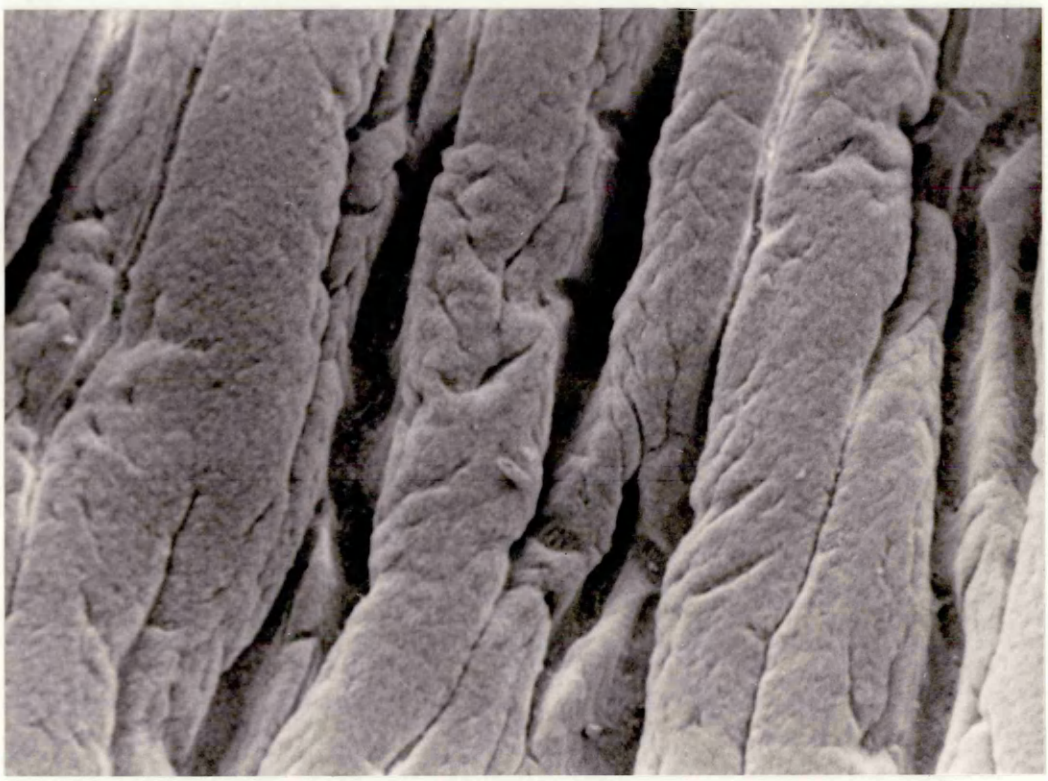
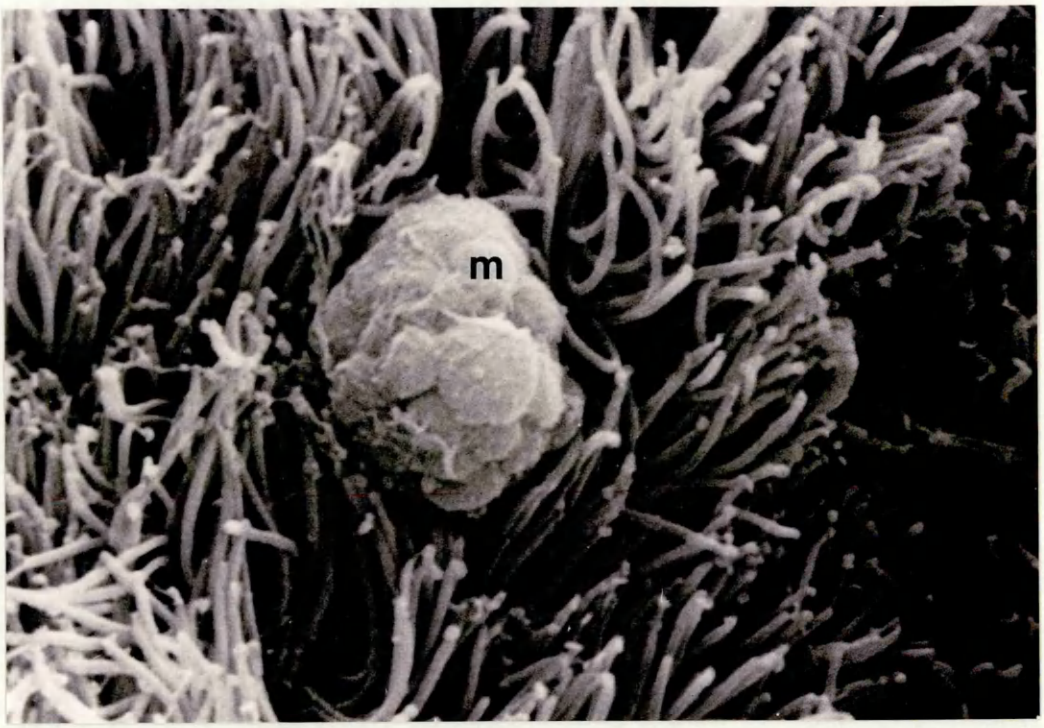


Fig. 4.35 Ventral larynx. Ciliated cells, with well developed cilia, cover the surface. An occasional mucus-secreting cell (M) may be seen.
SEM x 10,000

Fig. 4.36 Ventral larynx. Patches of microvillous cells with a few ciliated cells among them were seen in some horses.
SEM x 5,000


m

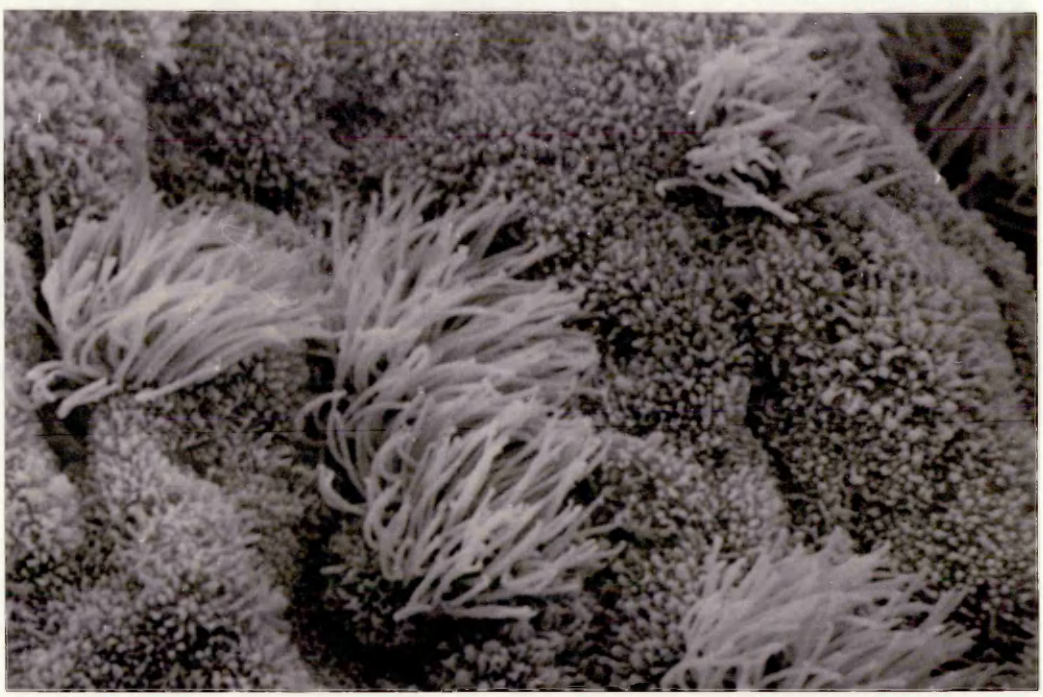
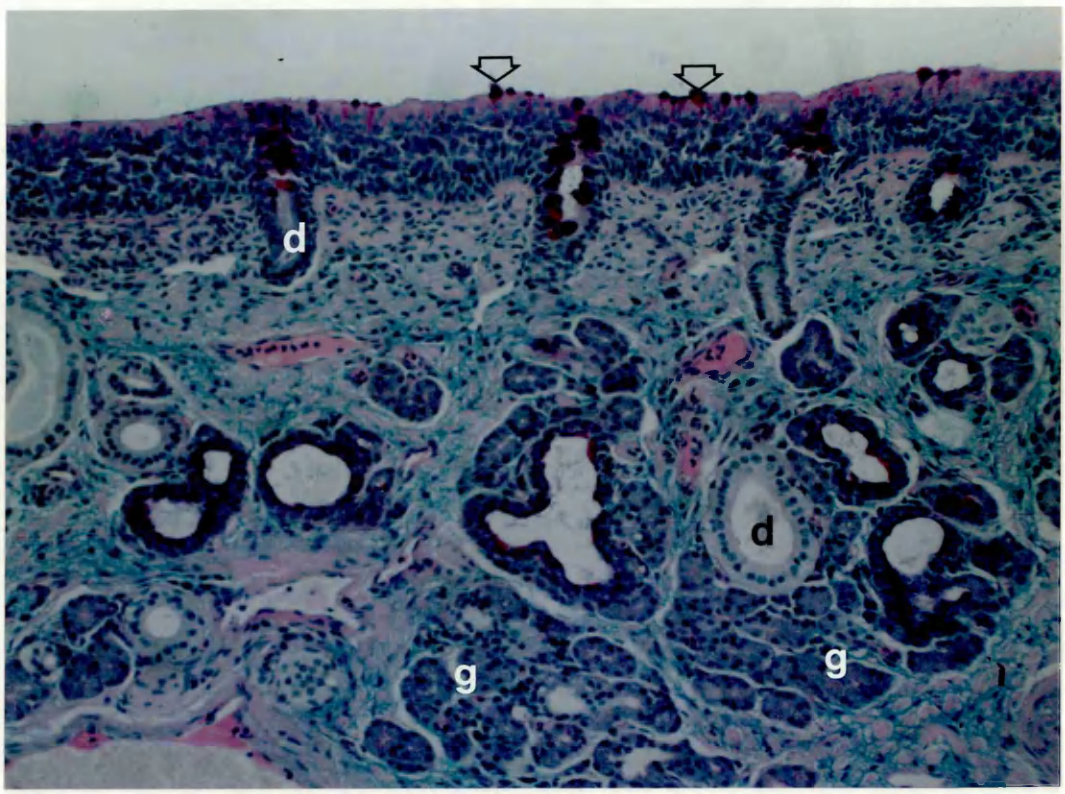


Fig. 4.37 Nasal septum. The epithelium is stratified cuboidal. Some of the surface cells secrete neutral or mixed staining mucus (Arrows). There are numerous serous secreting mucosal glands (G) and their ducts (D). The latter are lined by mucous cells close to the surface.
AB-PAS x 180

Fig. 4.38 Nasal septum. Stratified cuboidal epithelium with a gland duct (D) lined by neutral and mixed staining mucous cells. The outer epithelial cells bulge from the surface and some secrete mucus (Arrows). These features were also noted with SEM (See Figs. 4.4 and 4.5).
AB-PAS x 400


d
d
g
g

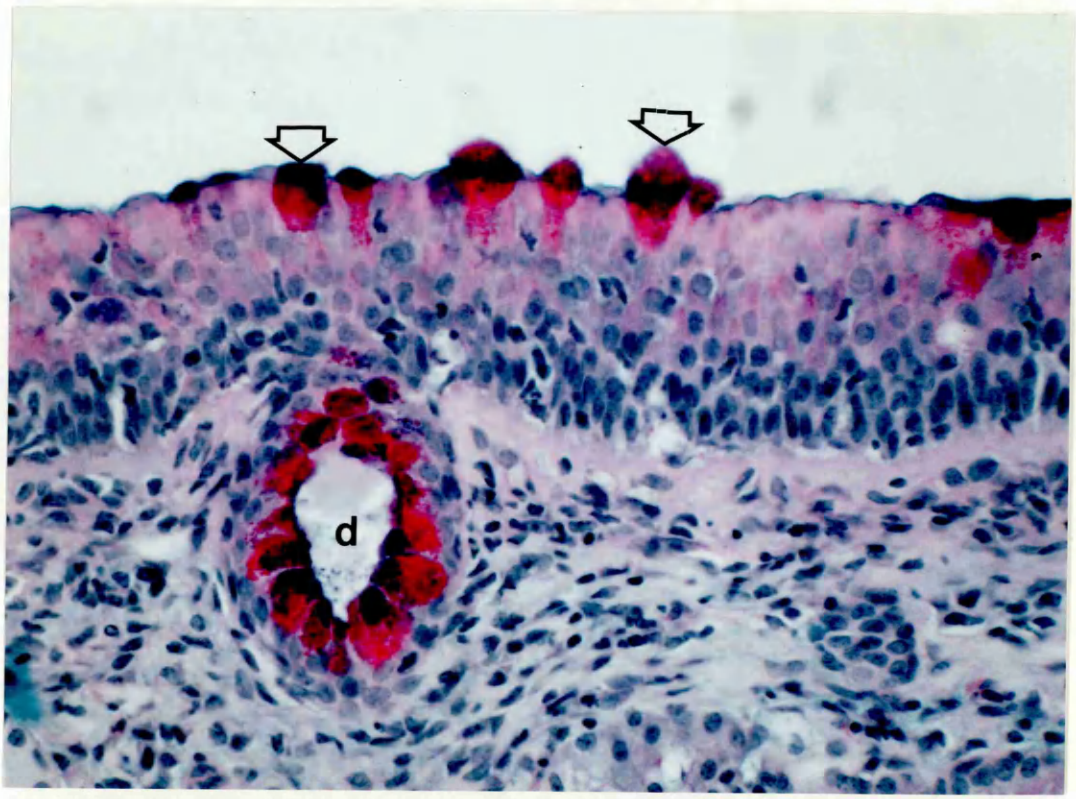
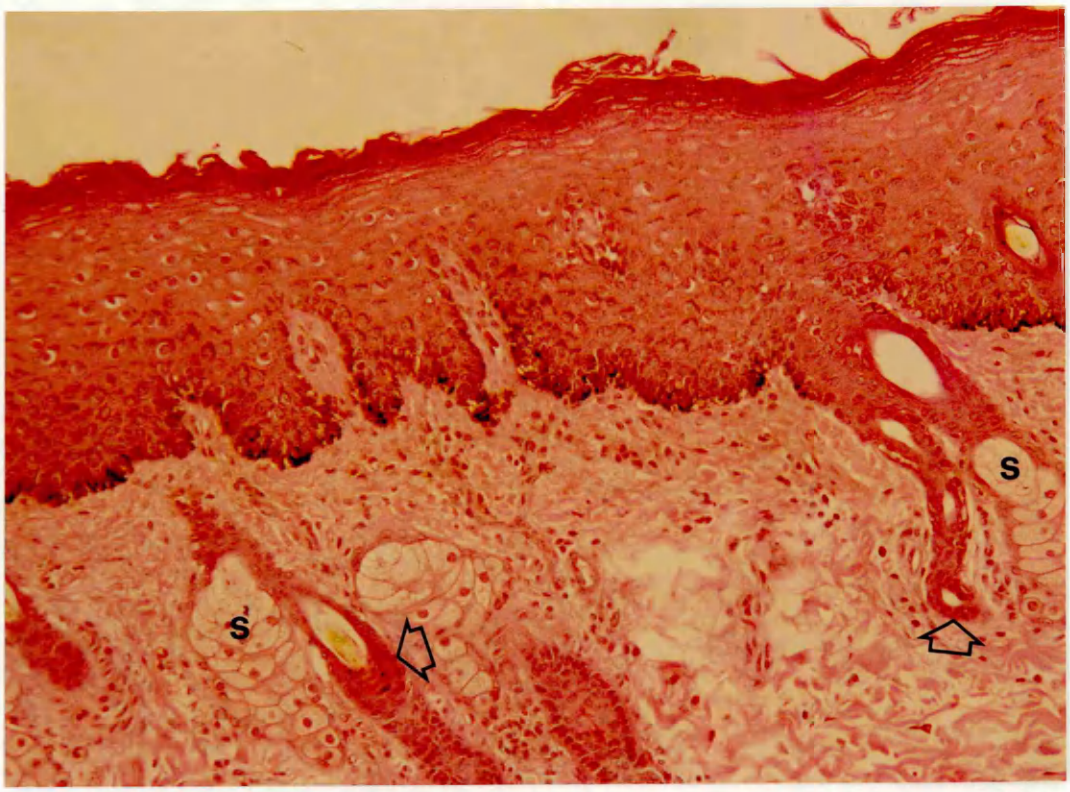

d

Fig. 4.39 Basal fold of the ventral nasal concha. Keratinized stratified squamous epithelium of the nasal vestibule. Note the hair follicles (Arrows) with associated sebaceous (S) glands.
HE x 180

Fig. 4.40 Basal fold of the ventral nasal concha. The junction between the keratinized stratified squamous epithelium (S) of the nasal vestibule and the stratified cuboidal epithelium (C) of the nasal mucosa is abrupt (Arrow). This feature was also obvious with SEM (Fig. 4.17) and in the gross specimen (Fig. 2.6).
HE x 180


S
S

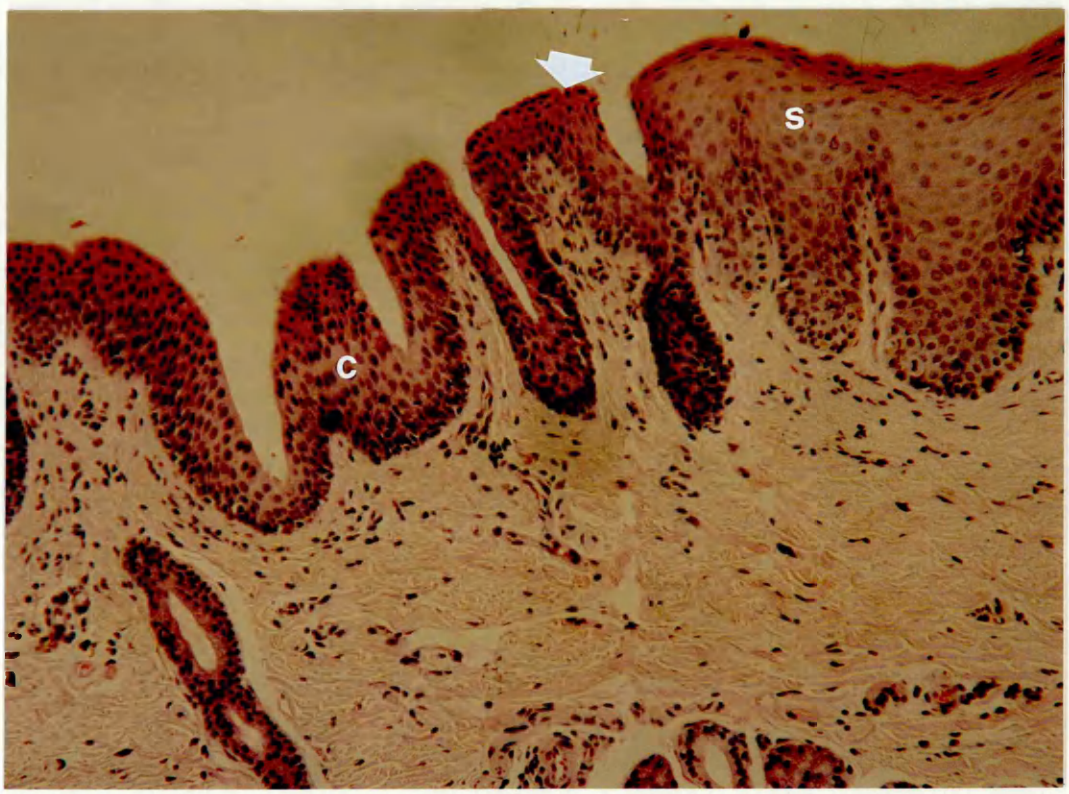
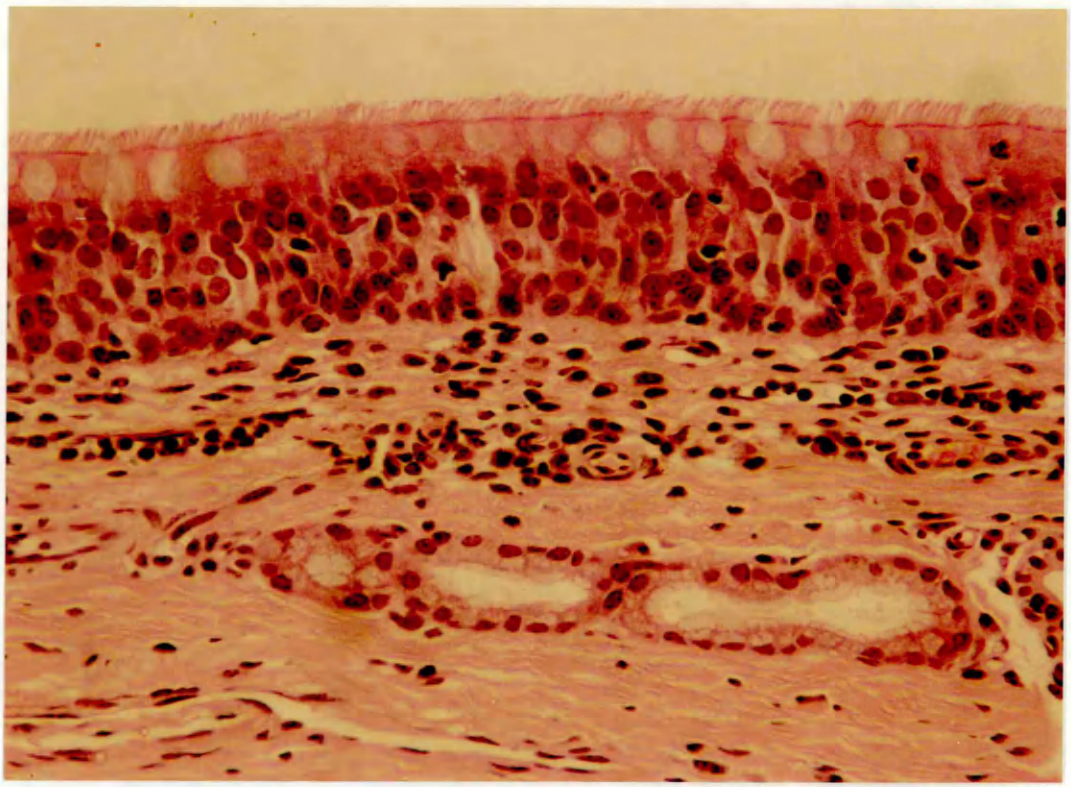

S
C

Fig. 4.41 Dorsal nasal concha. Showing pseudostratified columnar ciliated epithelium with mucous cells (respiratory epithelium) which covered surfaces in the caudal nasal cavity, guttural pouches and ventral larynx and was also present on some nasopharyngeal surfaces.
HE x 250

Fig. 4.42 Dorsal nasal concha. The numerous mucus-secreting cells contain mostly mixed mucosubstances (Arrows).
AB-PAS x 250



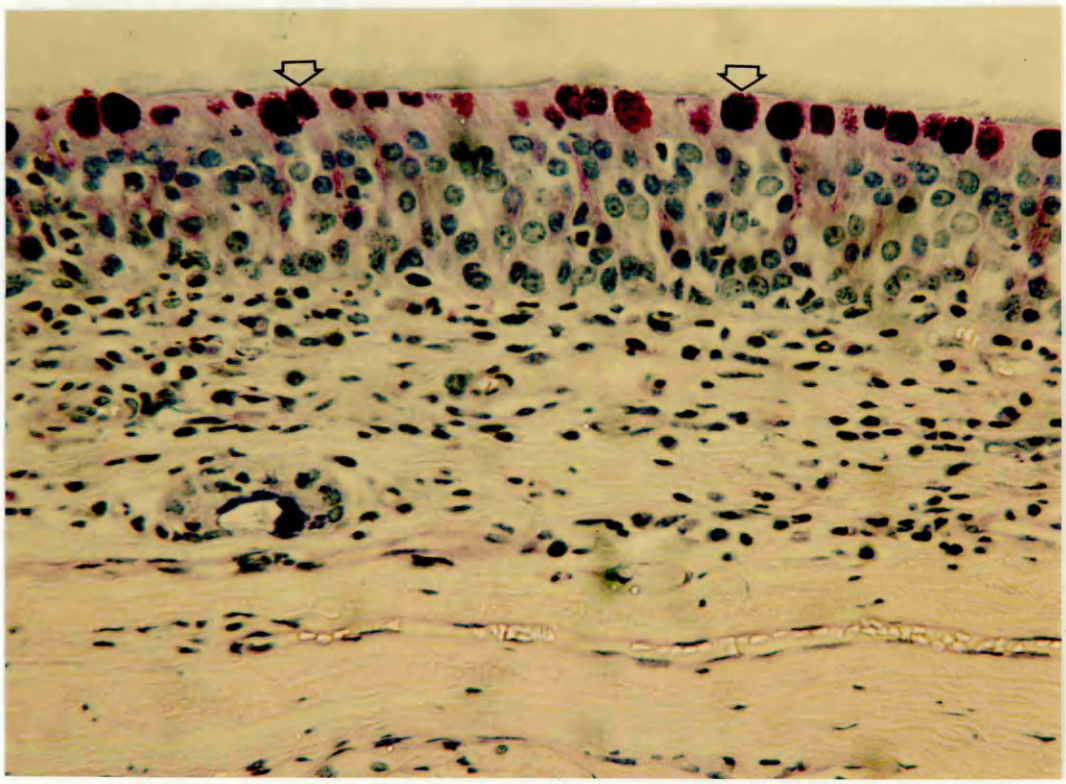


Fig. 4.43 Nasopharynx. Stratified cuboidal type of epithelium with a sub-epithelial aggregation of lymphocytes (Arrows).
HE x 250

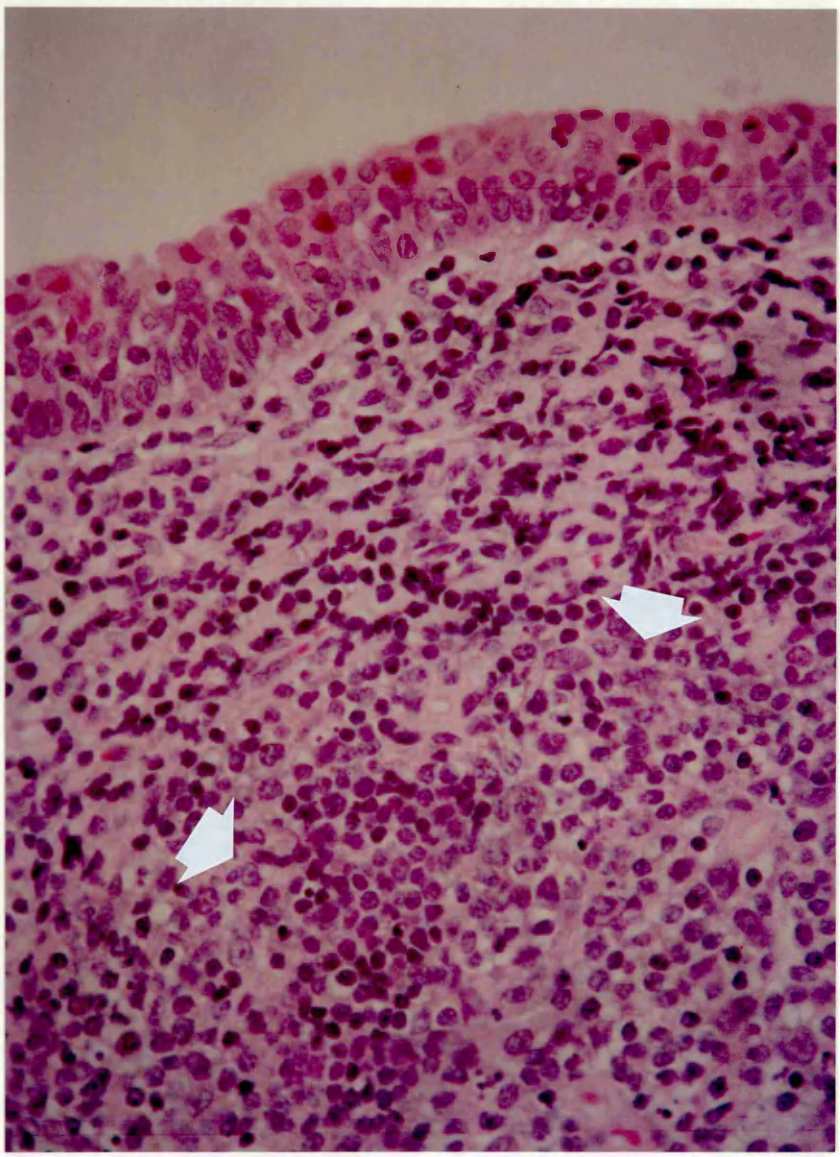
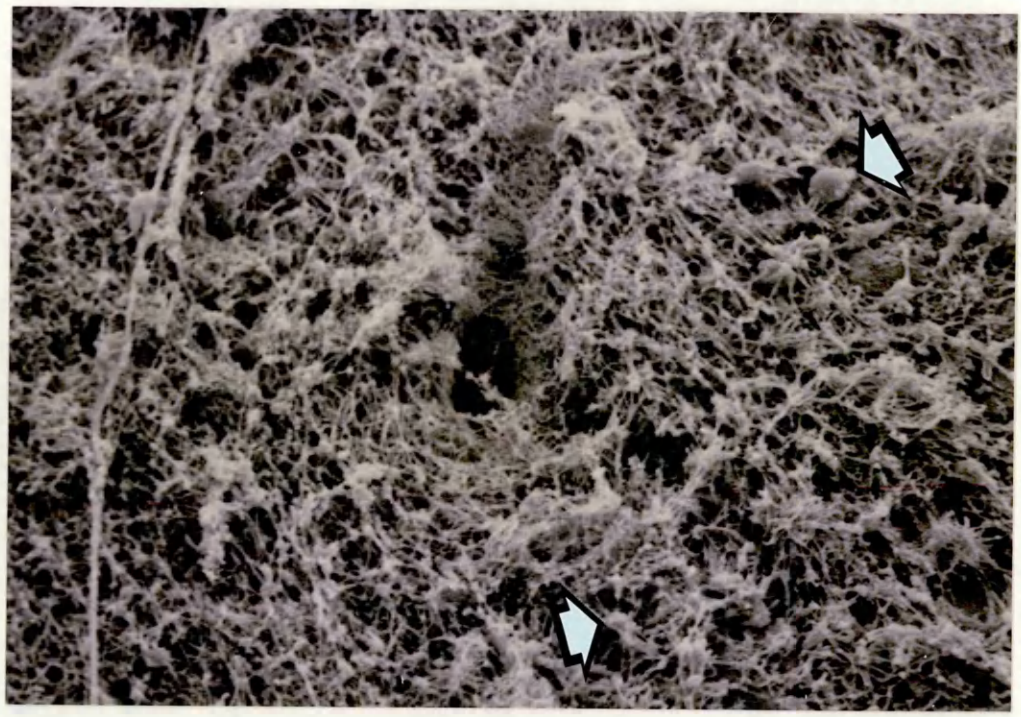


Fig. 4.44 Olfactory epithelium. A tangled mass of cilia clothe the surface. A few olfactory vesicles can be seen (Arrows). SEM x 2,500

Fig. 4.45 Olfactory epithelium. Many gland ducts open on the surface (Arrows). Note the numerous secretory droplets. SEM x 640



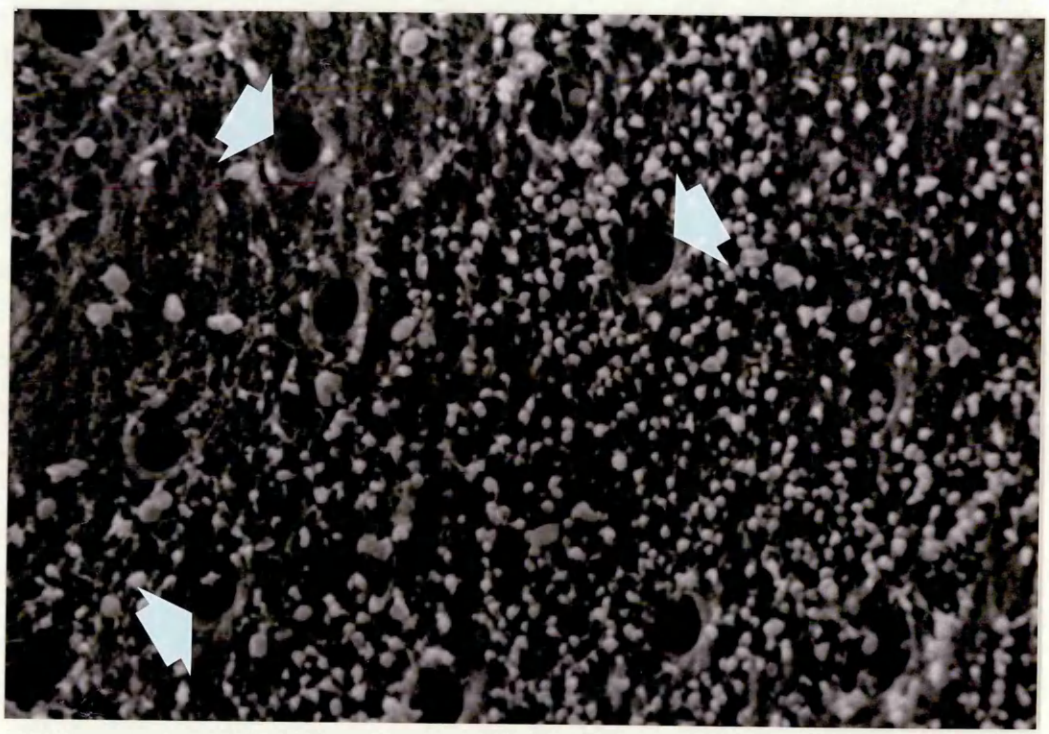
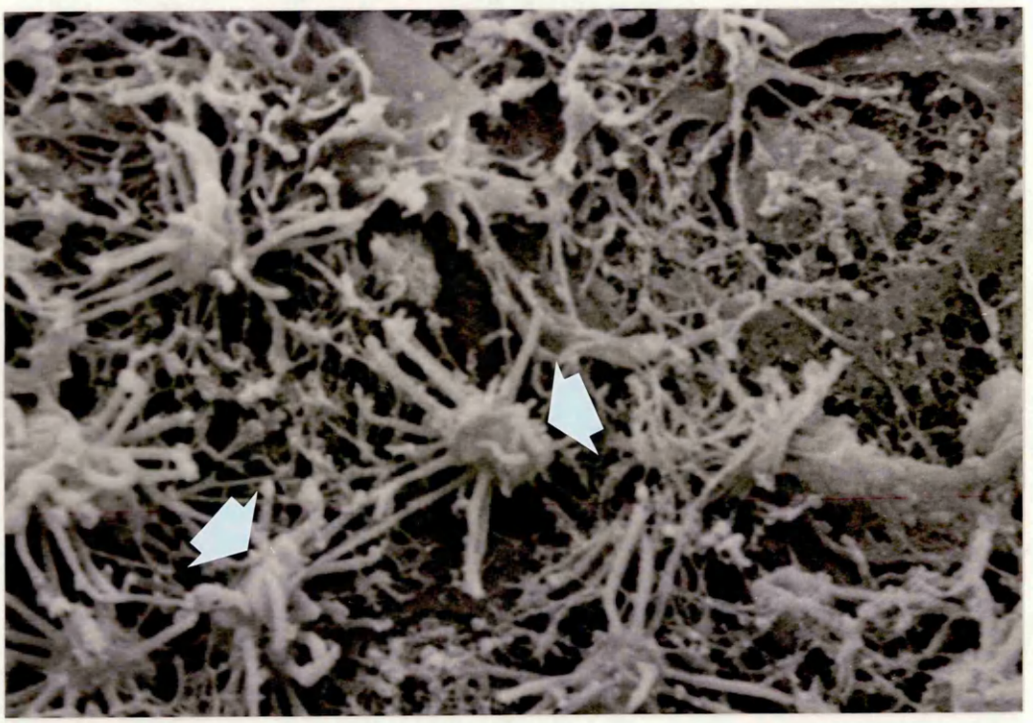
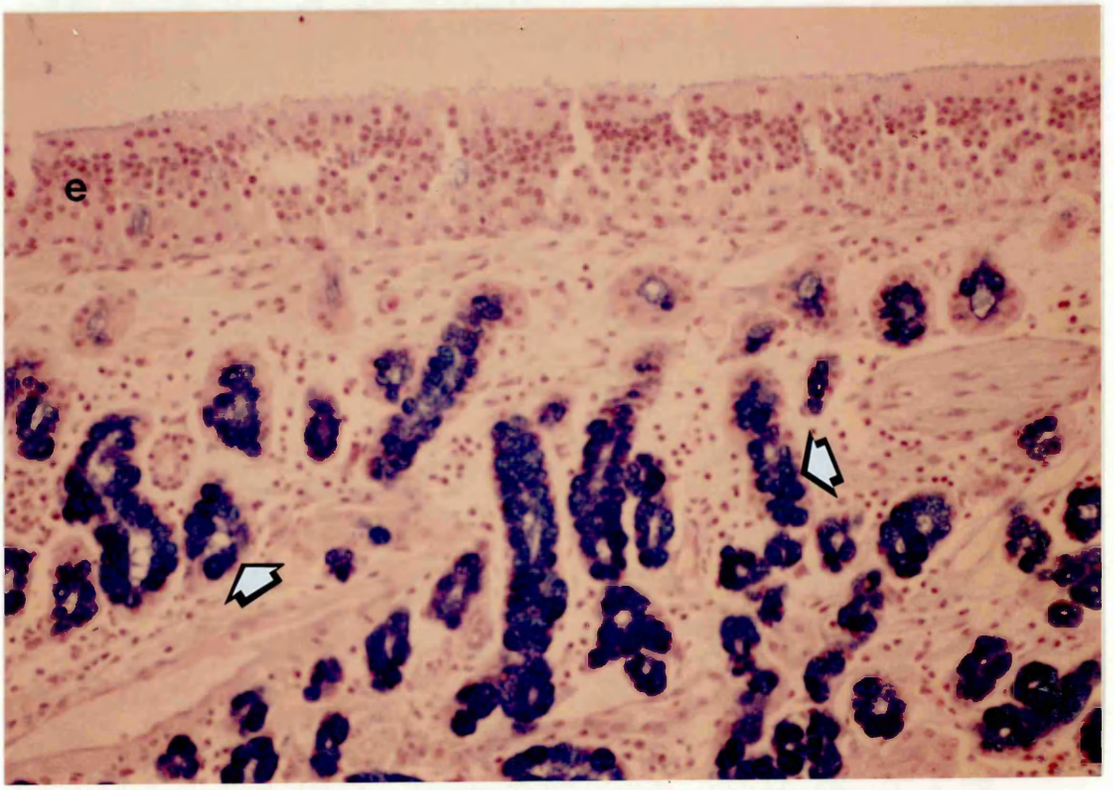


Fig. 4.46 Olfactory epithelium. At higher power the olfactory vesicles (Arrows) are more obvious.
SEM x 10,000

Fig. 4.47 Olfactory mucosa. The thick pseudostratified columnar olfactory epithelium (E) covers the surface. The numerous glands (Arrows) contain alcianophilic granules.
AB-PAS x 180




e

CHAPTER 5

Fig. 5.1 Diagram of a sagittal section of a horse head with the nasal septum almost completely removed to show the levels in the nasal cavity which were sampled.

1. 1cm rostral to the angle between the basal and alar folds of the ventral nasal concha
2. The caudal border of the cartilage supporting the alar fold

3-8 The rostral border of the first to sixth cheek tooth respectively.

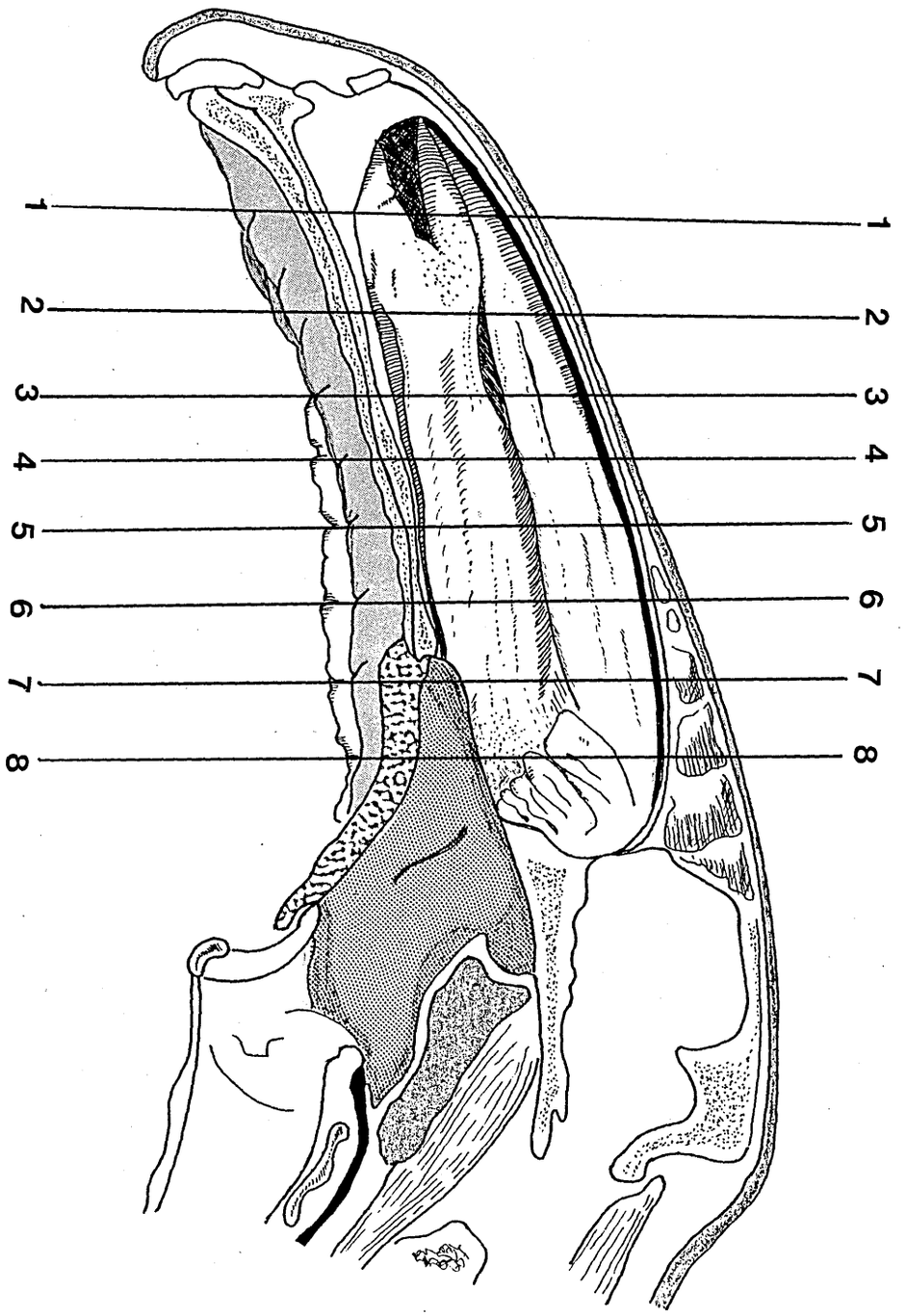

1
2
3
4
5
6
7
8
1
2
3
4
5
6
7
8

Fig. 5.2 Diagram of a sagittal section of a horse head with the nasal septum (Red) almost completely removed.

A. Nasal septum

B. Ventral nasal concha

B1. Basal fold of the ventral nasal concha

B2. Alar fold of the ventral nasal concha

C. Dorsal nasal concha

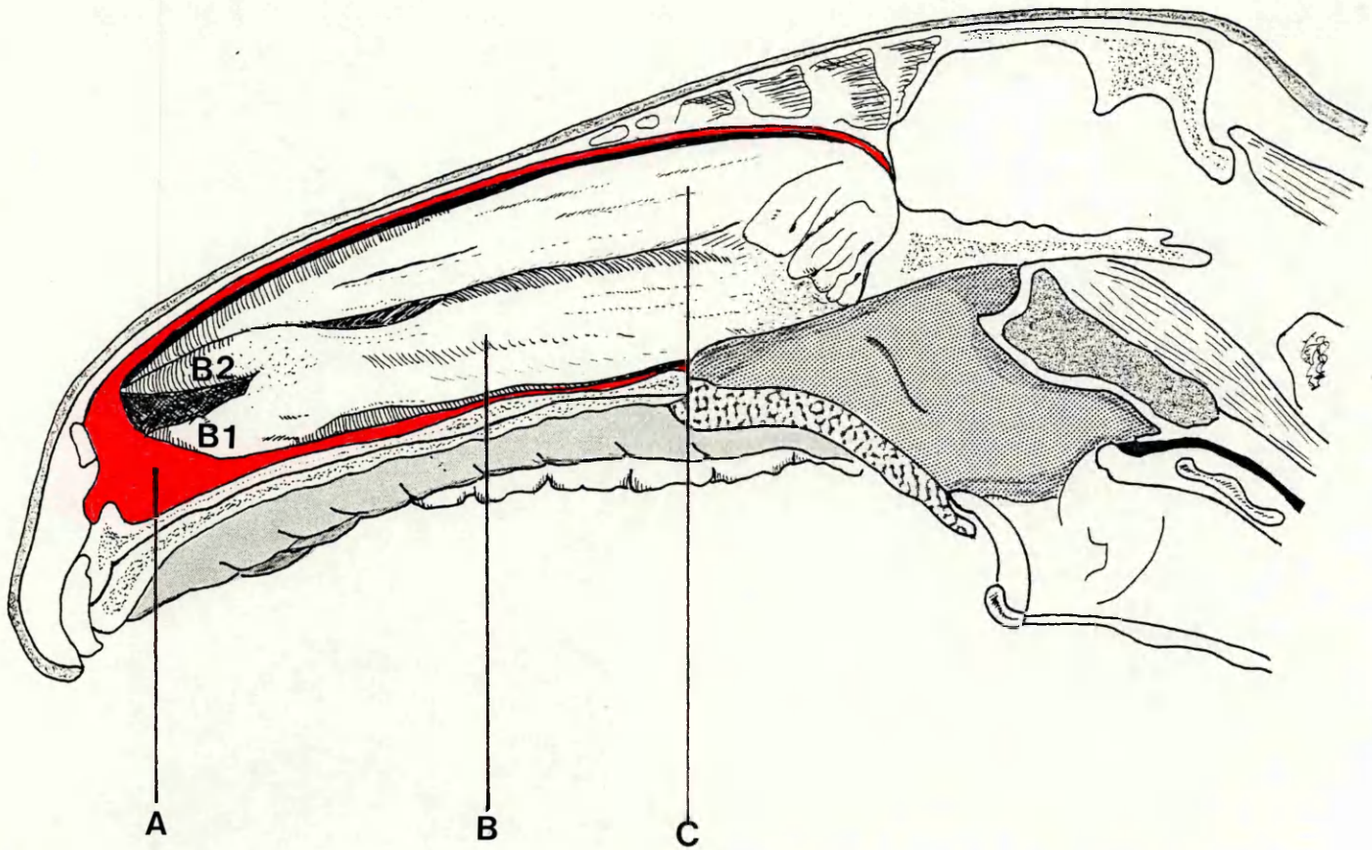

B2
B1
A
B
C

Fig. 5.3 Diagram of a sagittal section of a horse head with the nasal septum intact.
Levels indicated as in Fig. 5.1.
Graduated colour to illustrate the extent of surface ciliation.
White indicates nonciliated surface.
Deep pink indicates almost completely ciliated surface.
Yellow indicates area of olfactory epithelium.

1
2
3
4
5
6
7
8
1
2
3
4
5
6
7
8

Fig. 5.4 Diagram of a sagittal section of a horse head with the nasal septum almost completely removed to show the nasal conchae (see Fig. 5.2).
Levels indicated as in Fig. 5.1.
Graduated colour to illustrate the extent of surface ciliation.
White indicates nonciliated surface.
Red indicates completely ciliated surface.
Yellow indicates area of olfactory epithelium.

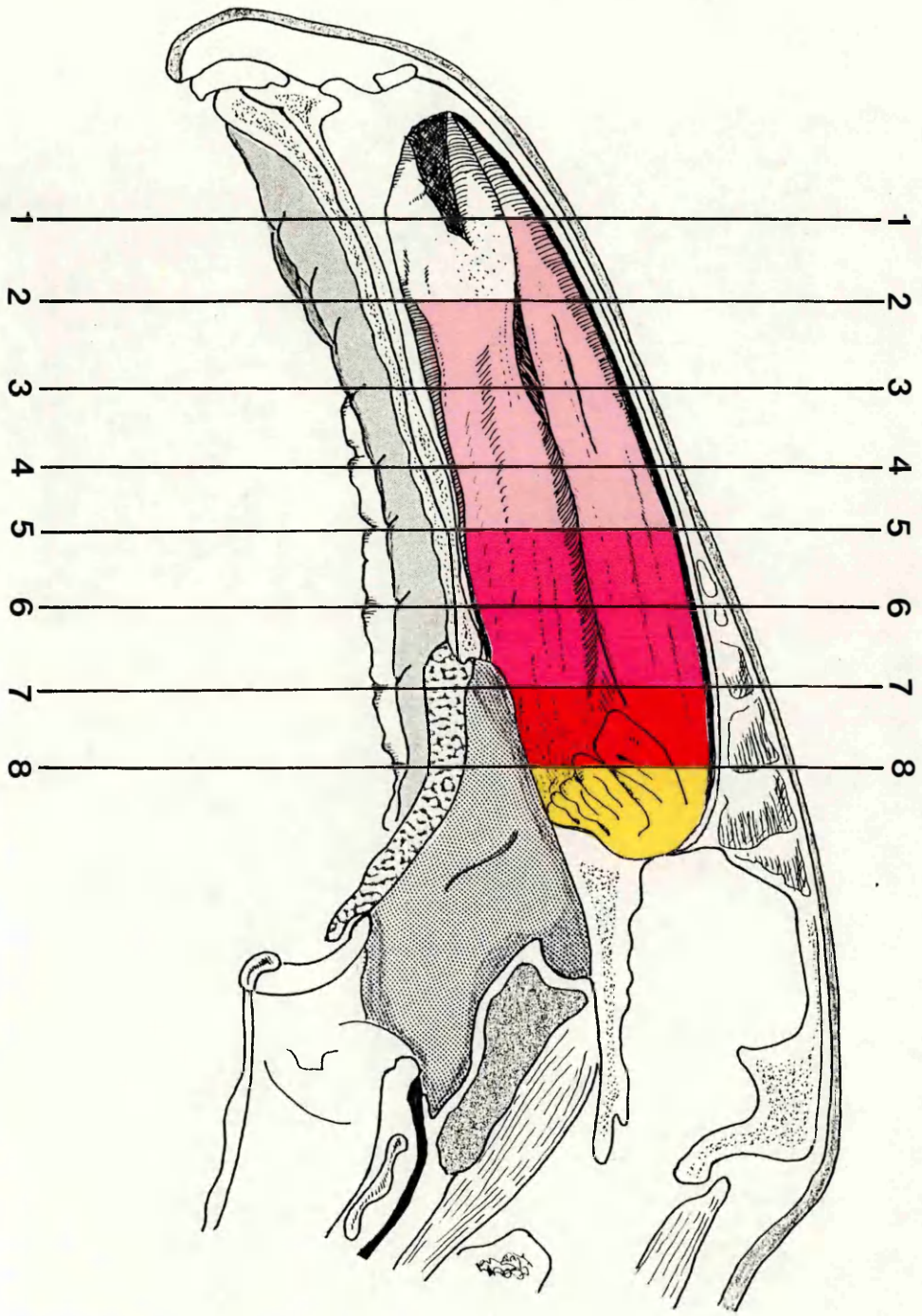
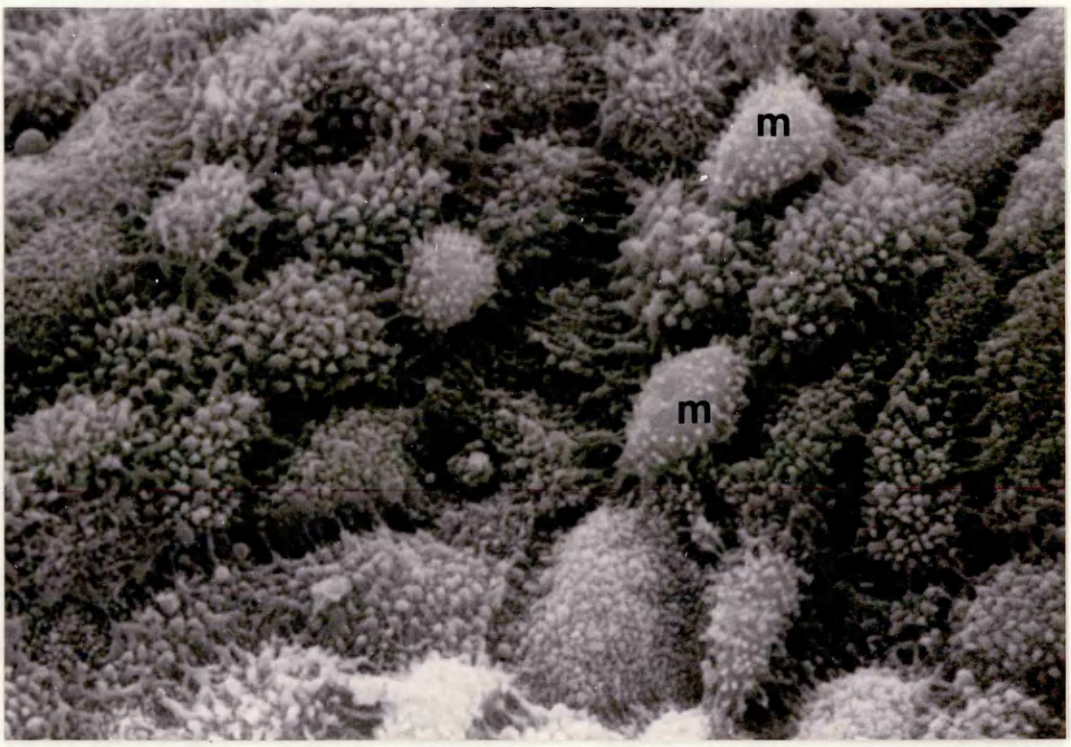

1
2
3
4
5
6
7
8
1
2
3
4
5
6
7
8

Fig. 5.5 Nasal septum. Microvillous cells with distinct cell borders bulge from the surface and give a "cobblestone" appearance to the epithelium. A few mucous cells (M) are present.
SEM x 5,000

Fig. 5.6 Dorsal nasal concha. The surface is covered by microvillous cells. Note the conspicuous gland duct opening (Arrow).
SEM x 2,500


m
m

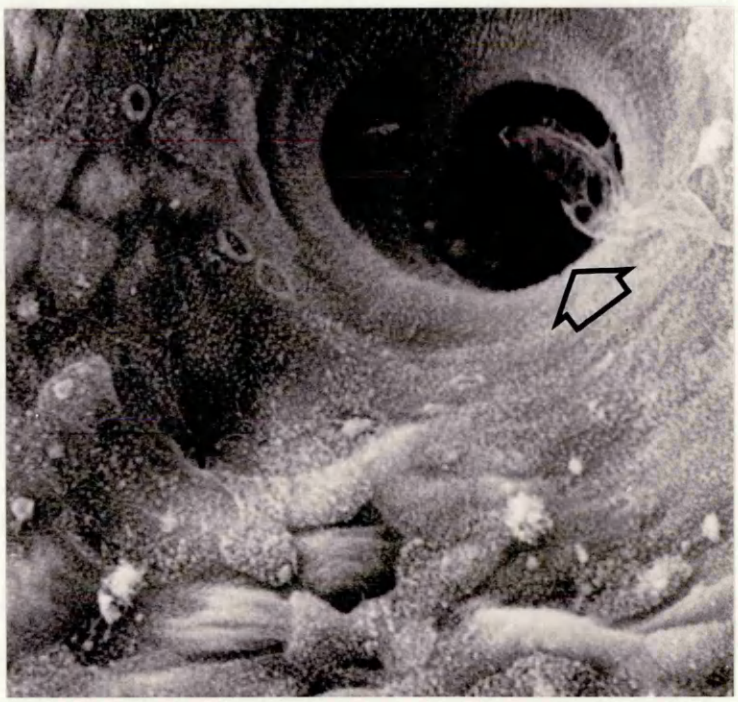
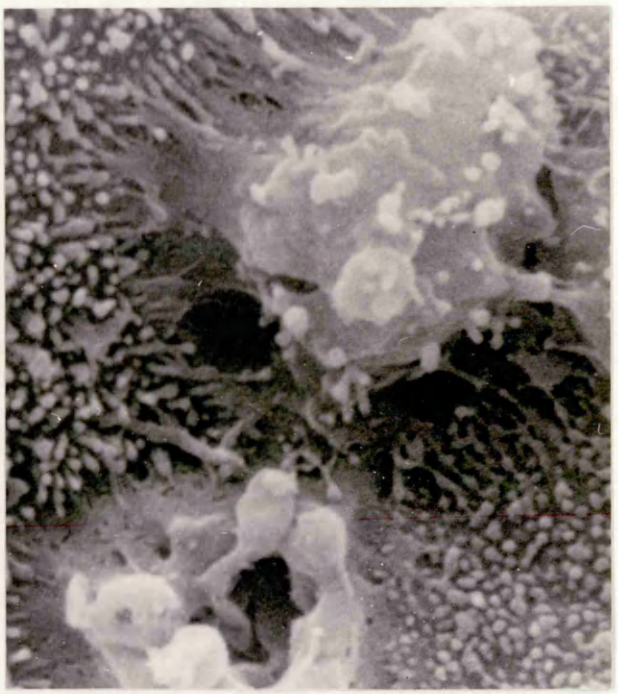
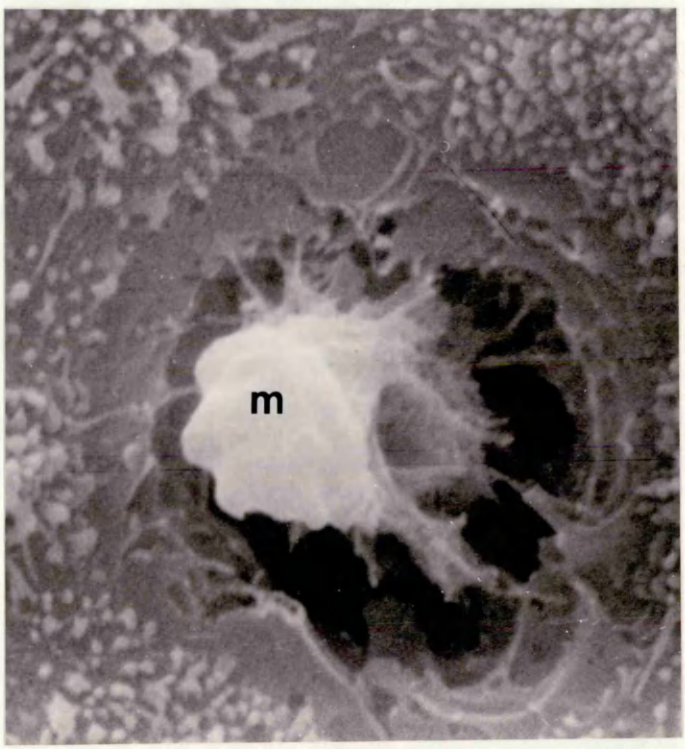


Fig. 5.7 Nasal septum. Mucous cells. On the left a small mucous droplet oozes from the centre of the cell (Arrow). Later in the secretory cycle mucus bulges from the cell (top right) and a second mucous cell below is in the process of discharge. SEM x 10,000

Fig. 5.8 Nasal septum. Mucous cells. Following on from Fig. 5.7, the cell on the left has almost completed secretion. The final mucous droplets (M) are extruded leaving a central crater surrounded by the remnants of the cell membrane. The latter forms a smooth raised edge and the cell subsequently regenerates (Right).




m

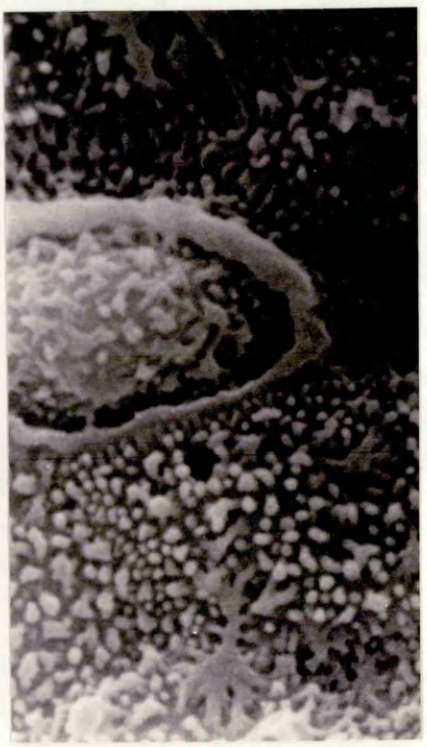
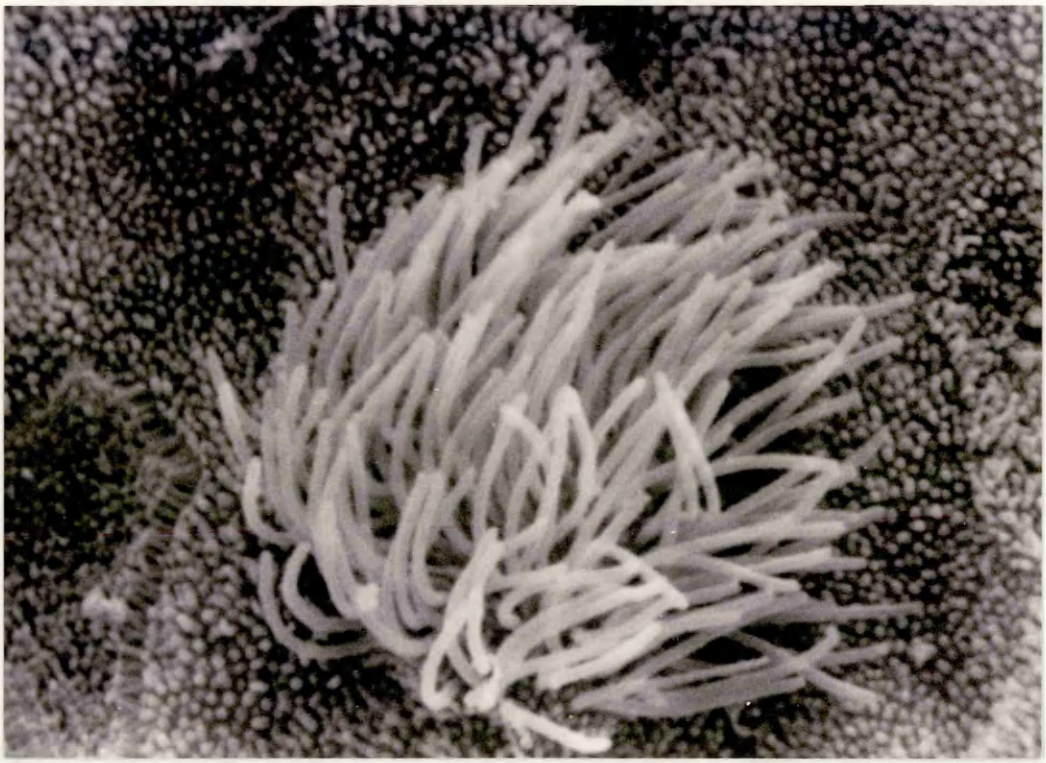


Fig. 5.9 Dorsal nasal concha. A single ciliated cell among microvillous cells.
SEM x 10,000

Fig. 5.10 Nasal septum. An aggregation of lymphocytes (L) lies below the stratified cuboidal epithelium. Note the numerous gland ducts (Arrows).
HE x 180



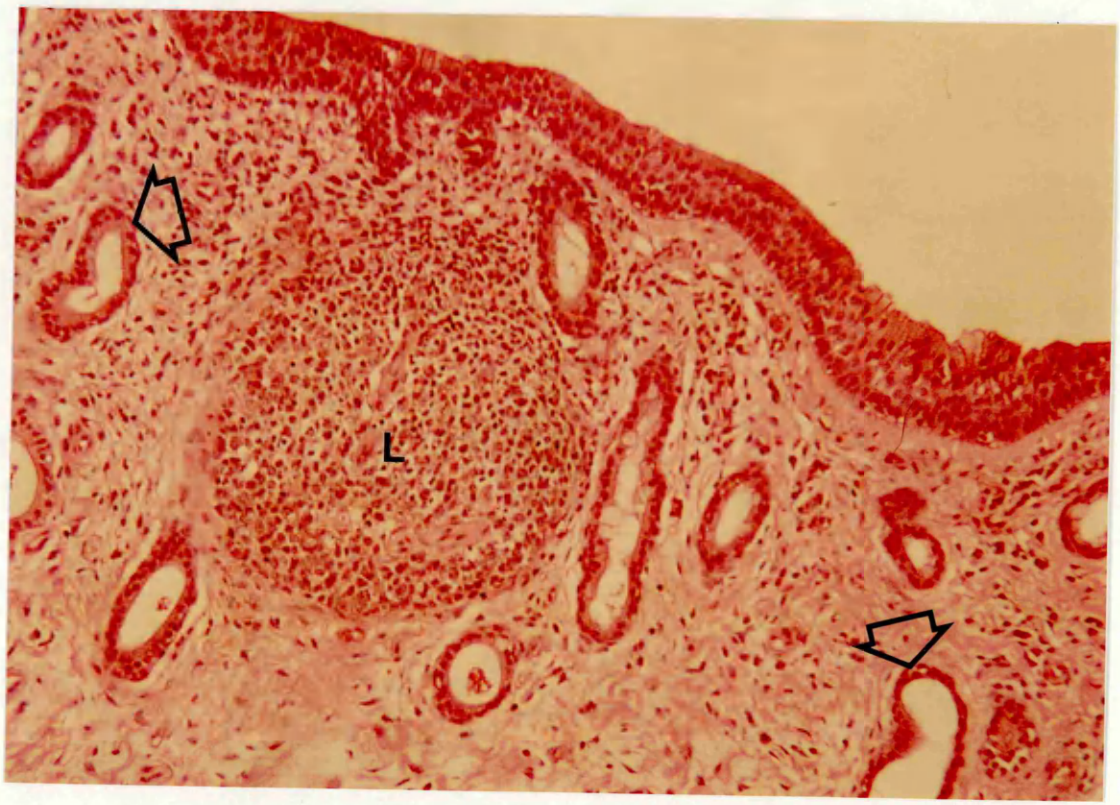
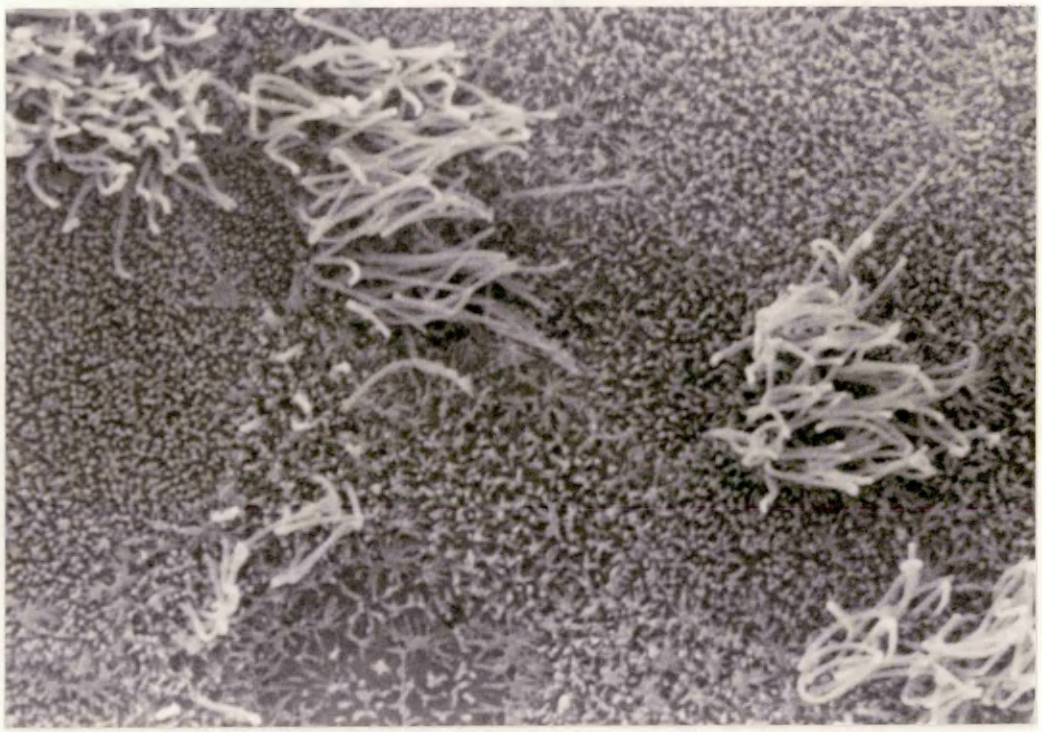

L

Fig. 5.11 Ventral nasal concha. Sparsely ciliated cells among microvillous cells.
SEM x 5,000

Fig. 5.12 Nasal septum. Microvillous cells and many mucous cells in various stages of secretion.
1. Developing
2. Early
3. Active
4. Completed
SEM x 5,000



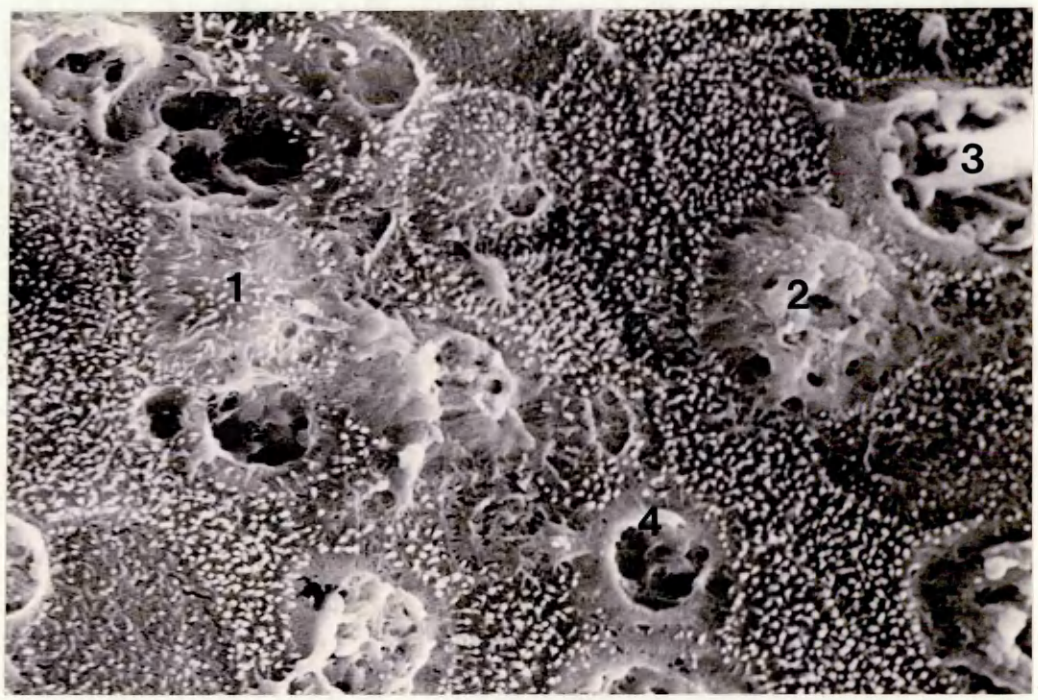
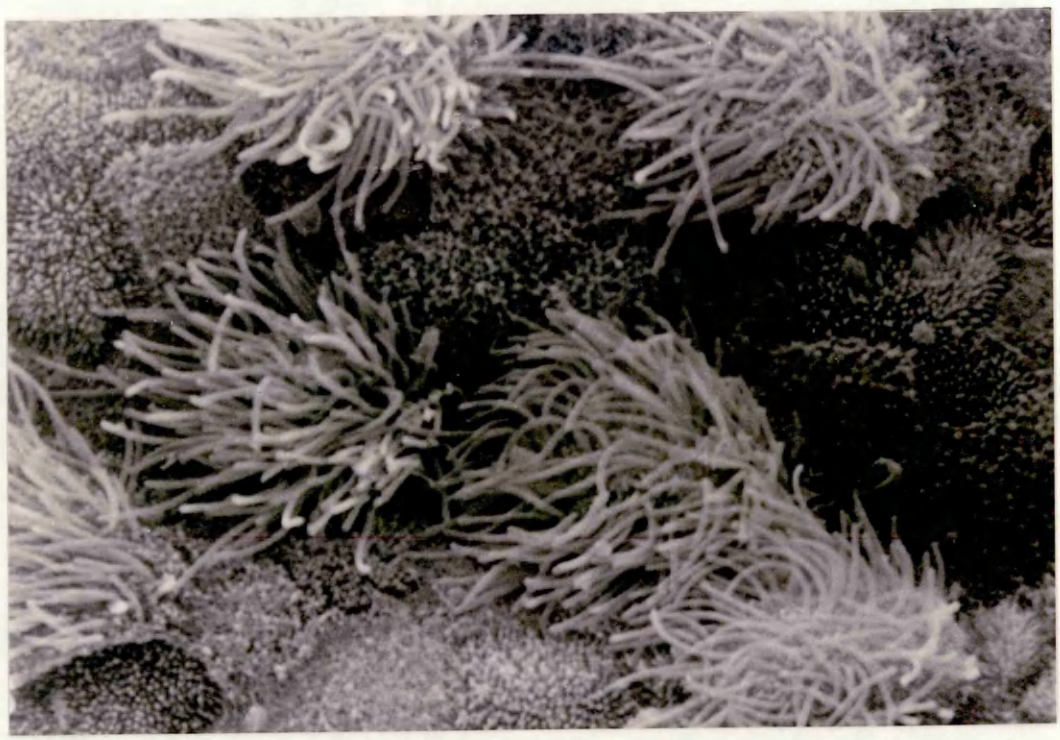

1
2
3
4

Fig. 5.13 Nasal septum. Ciliated cells and microvillous cells. Although still relatively sparse, the cilia are more luxuriant than those in Fig. 5.11.
SEM x 5,000

Fig. 5.14 Ventral nasal concha. Well ciliated surface cells and intervening mucous cells (M).
SEM x 5,000



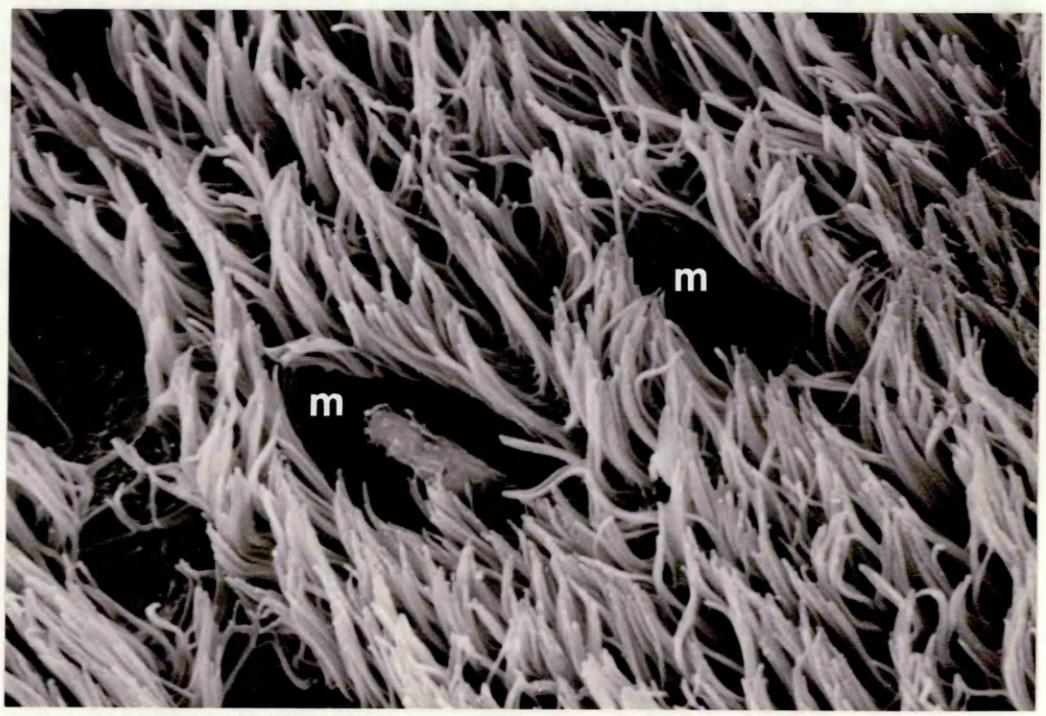
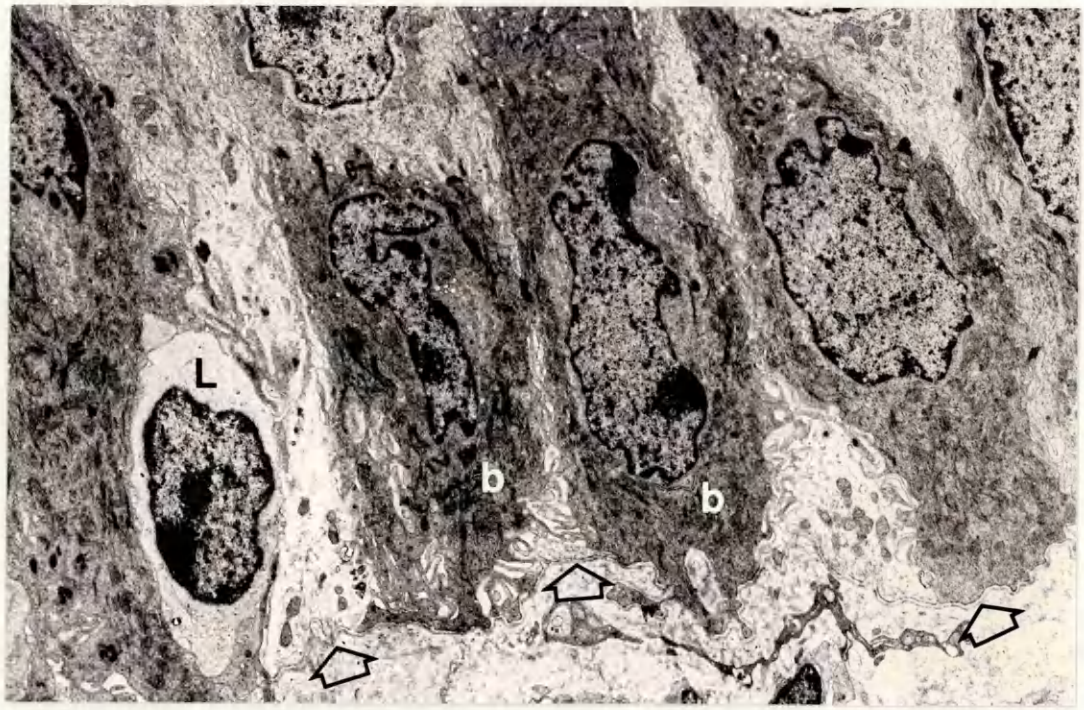

m
m

Fig. 5.15 Nasal septum. Basal cells (B) rest on the thin basal lamina (Arrows). Note a lymphocyte (L) in the process of migrating through the epithelium.
TEM x 5,400

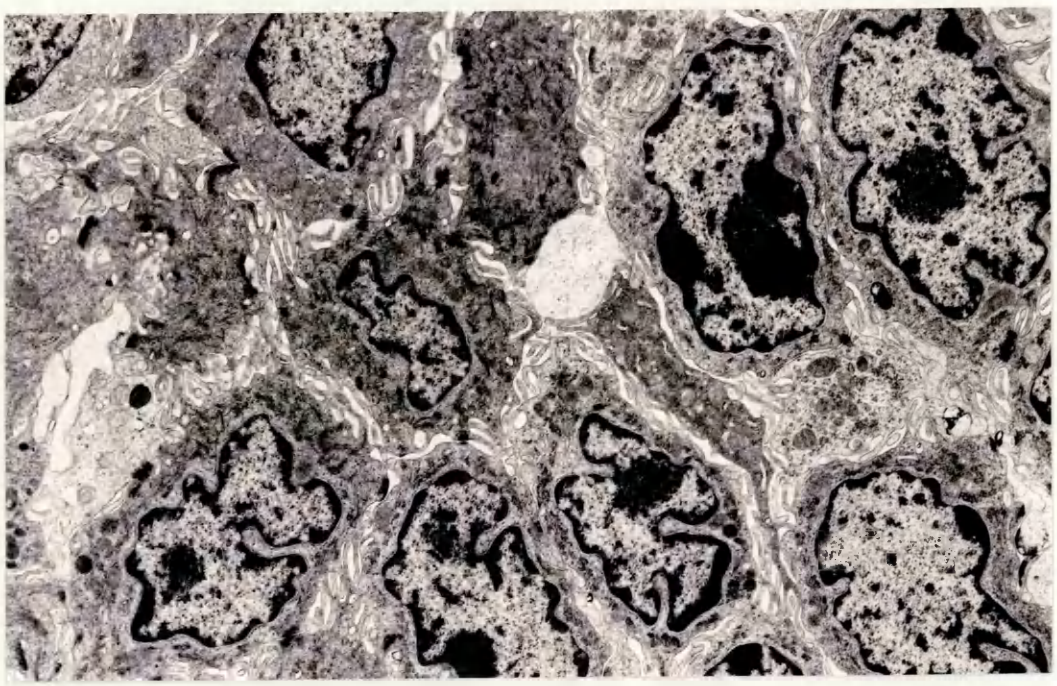
Fig. 5.16 Nasal septum. A basal cell with a deeply indented nucleus (N) and fine lateral cytoplasmic processes (Arrows). Desmosomes join adjacent cells (Small arrows).
TEM x 10,000


L
b
b


N

Fig. 5.17 Nasal septum. Intermediate cells with irregular nuclei form a layer several cells deep. TEM x 5,400

Fig. 5.18 Nasal septum. Polygonal intermediate cells in transverse section. Many cytoplasmic projections extend from the cell borders. Desmosomes (Arrows) join adjacent cells. TEM x 8,000



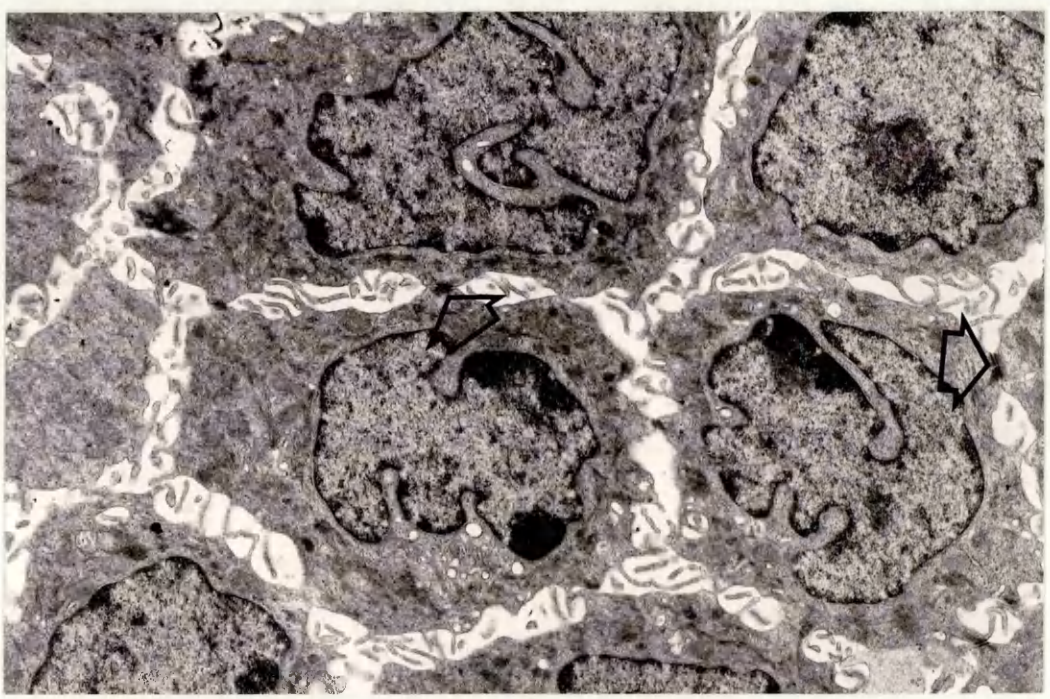
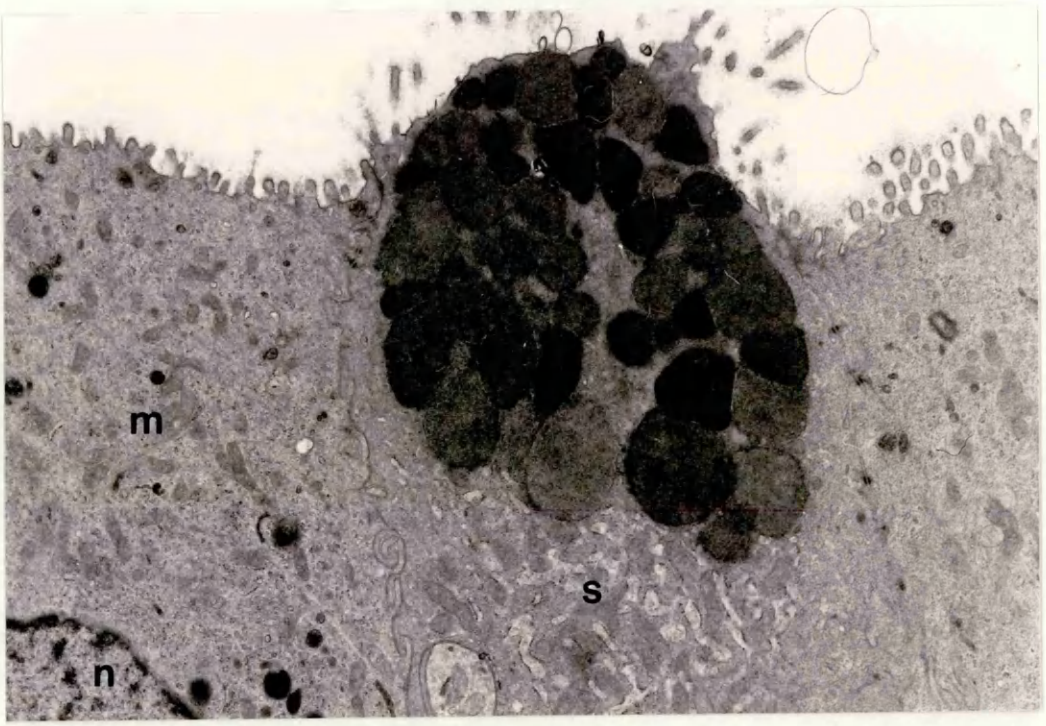


Fig. 5.19 Nasal septum. Surface cells. A microvillous cell (M) with part of its nucleus (N) and an adjacent secretory (mucous) cell (S).
TEM x 10,000

Fig. 5.20 Nasal septum. Microvillous cells bulge from the surface and correspond to similar cells viewed with SEM (see Fig. 5.5). Lateral cytoplasmic processes of adjacent cells interdigitate and are joined in places by desmosomes.
TEM x 10,000


m
s
n

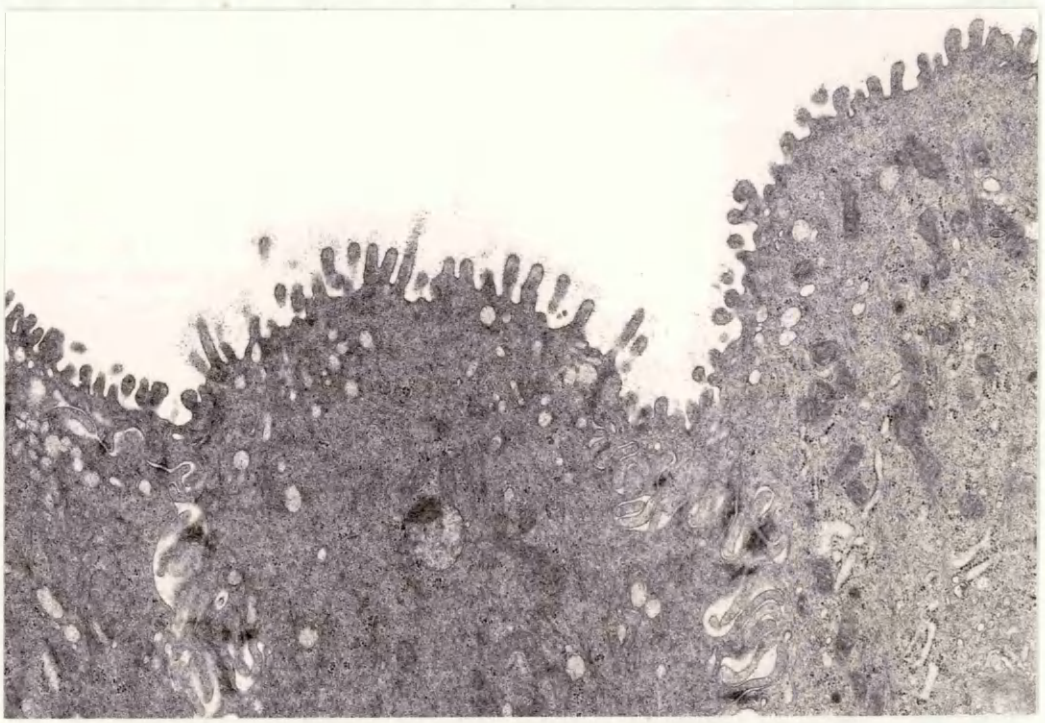
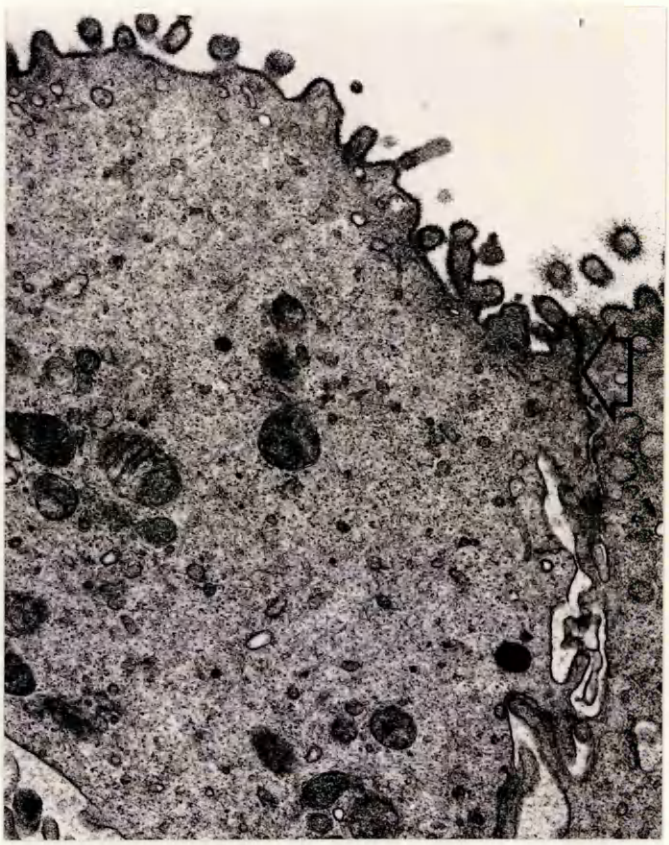


Fig. 5.21 Nasal septum. A tight junction (Arrow) joins adjacent microvillous cells at their lumenal surface.
TEM x 20,000

Fig. 5.22 Nasal septum. A narrow, more electron dense cell sandwiched between two other microvillous cells. The microvilli on the former are longer and more erect than those of adjacent cells.
TEM x 13,400



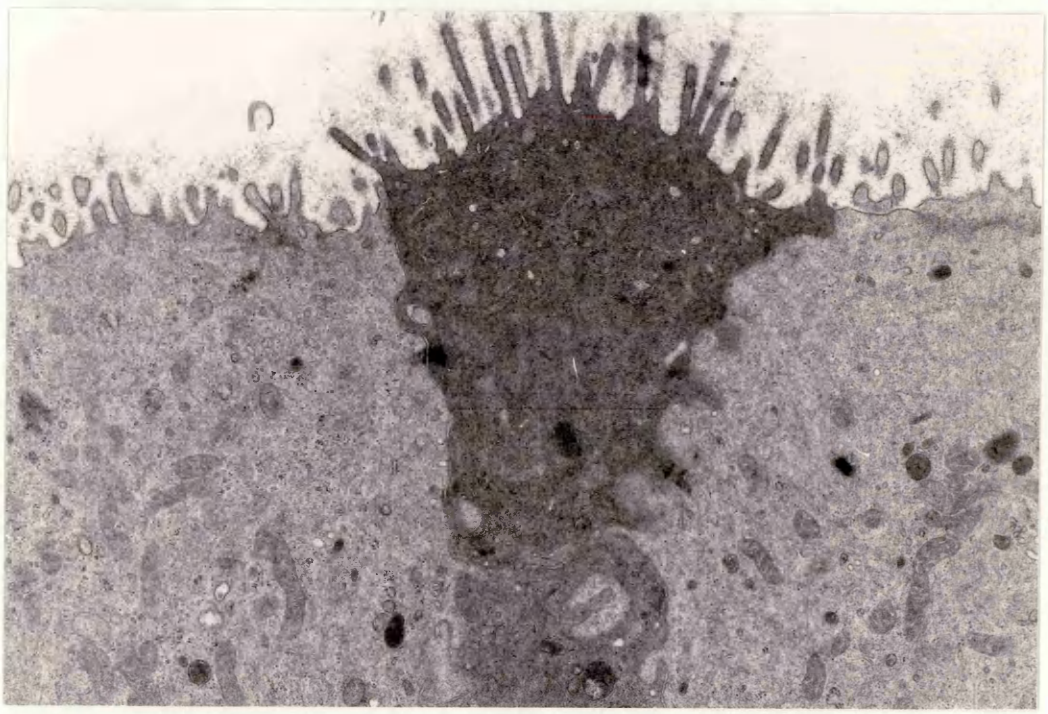


Fig. 5.23 Nasal septum. Mucus-secreting surface cells with a microvillous cell between them. The secretion granules (G) vary in electron density. The granules bulge from the surface in the cell on the left, the few surface microvilli tend to be peripheral (Arrows). Compare with the SEM appearance in Fig. 5.5 and Fig. 5.7
TEM x 8,000

Fig. 5.24 Nasal septum. The surface cell membrane has ruptured (Arrows) and mucous granules are in the process of being discharged.
TEM x 20,000

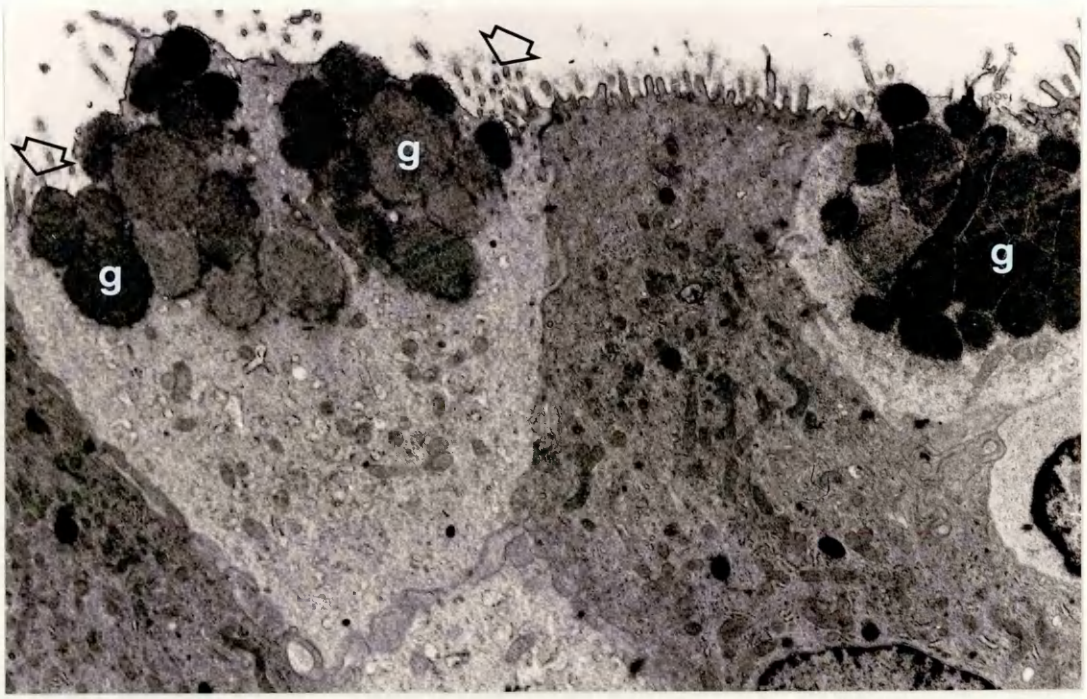
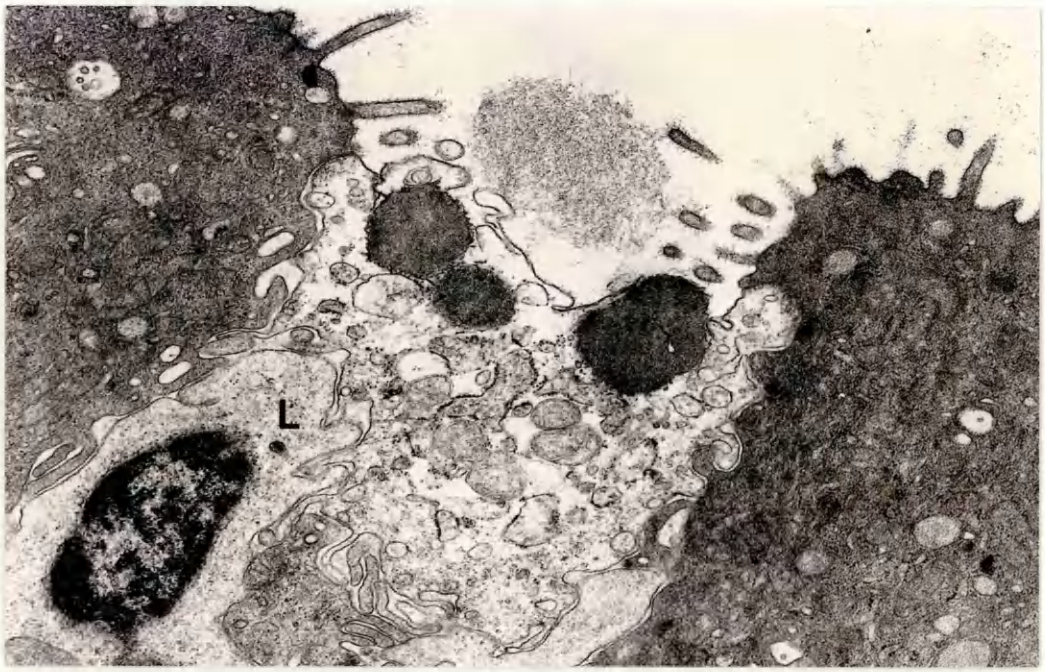

g
g
g

Fig. 5.25 Nasal septum. A mucous cell between two microvillous cells. The former has almost completely discharged its granules and the cell surface is depressed below the level of adjacent cells. Note a lymphocyte (L) migrating between the epithelial cells.
TEM x 16,000

Fig. 5.26 Nasal septum. The remnants of the surface cell membrane (Arrows) are almost all that remains of a discharged mucous cell. The features illustrated in Fig. 5.25 and Fig. 5.26 are comparable with SEM features in Fig. 5.12 (4).
TEM x 13,400


L

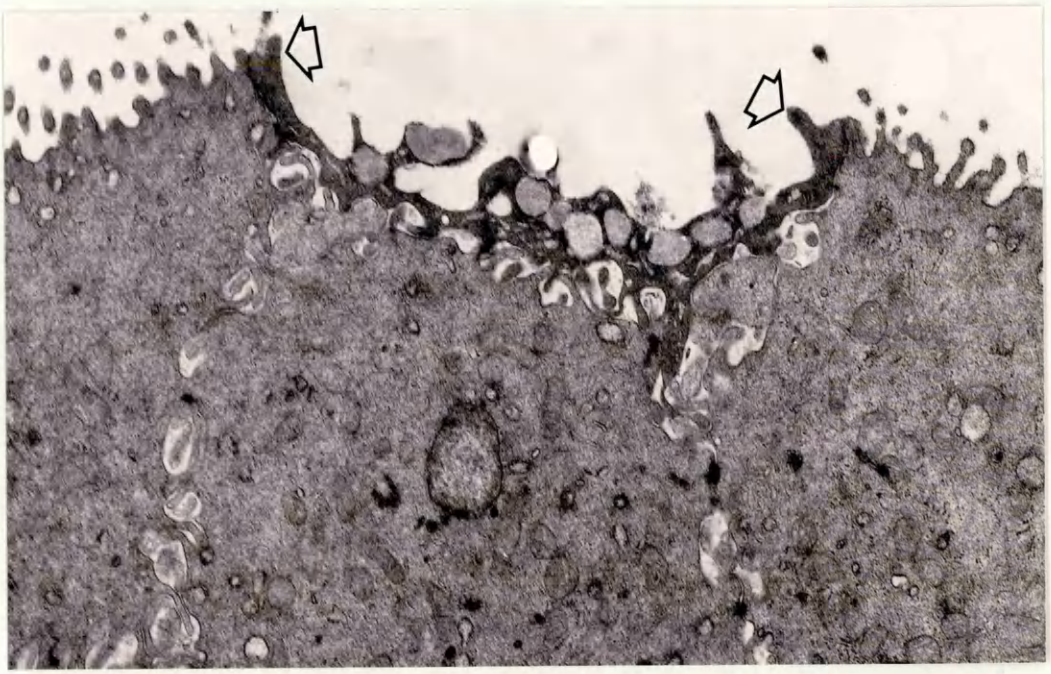
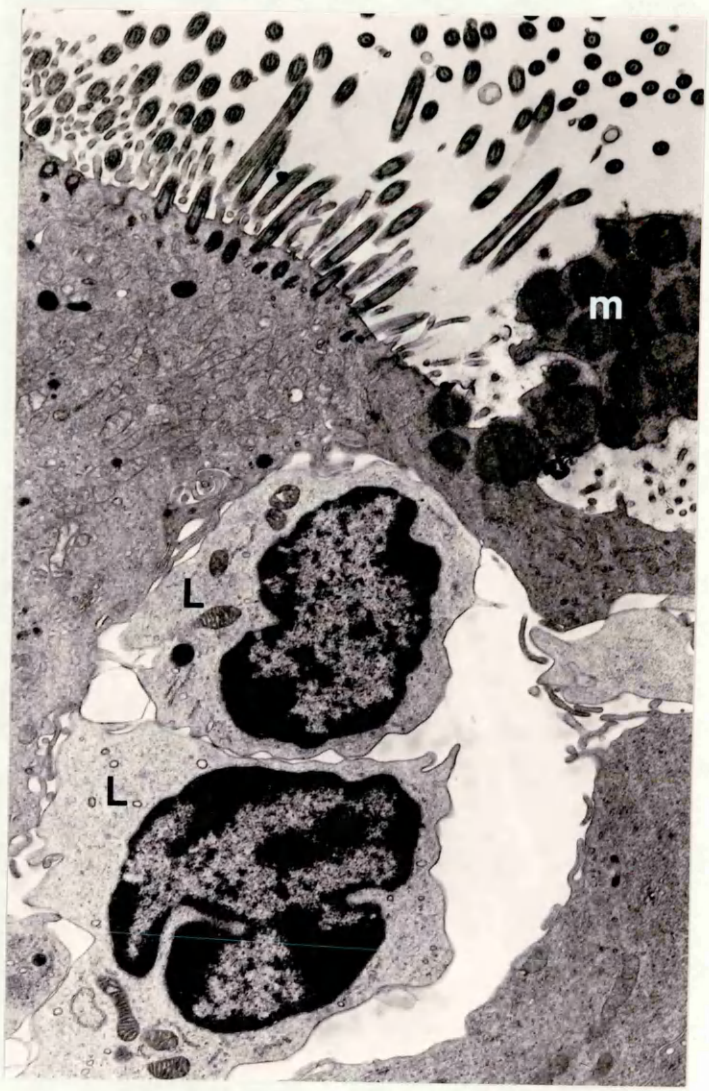


Fig. 5.27 Ventral nasal concha. A ciliated cell with the nucleus (N) situated well below the surface. Lateral cytoplasmic processes interdigitate with those of an adjacent microvillous cell (M). TEM x 8,000


m
n

Fig. 5.28 Dorsal nasal concha. Part of a ciliated cell on the left and an adjacent mucus-secreting cell (M). Note the lymphocytes (L) migrating between the epithelial cells. TEM x 8,000


m
L
L

CHAPTER 6

Fig. 6.1 Diagram of a dorsal view of the trachea and lungs of a horse with the sample sites indicated by black squares for SEM and red squares for light microscopy.

1 and 2. Dorsal and ventral trachea

3. Cranial lobar bronchus

4. Caudal lobar bronchus

5. Small bronchus

6, 7 and 8. Lung slices.

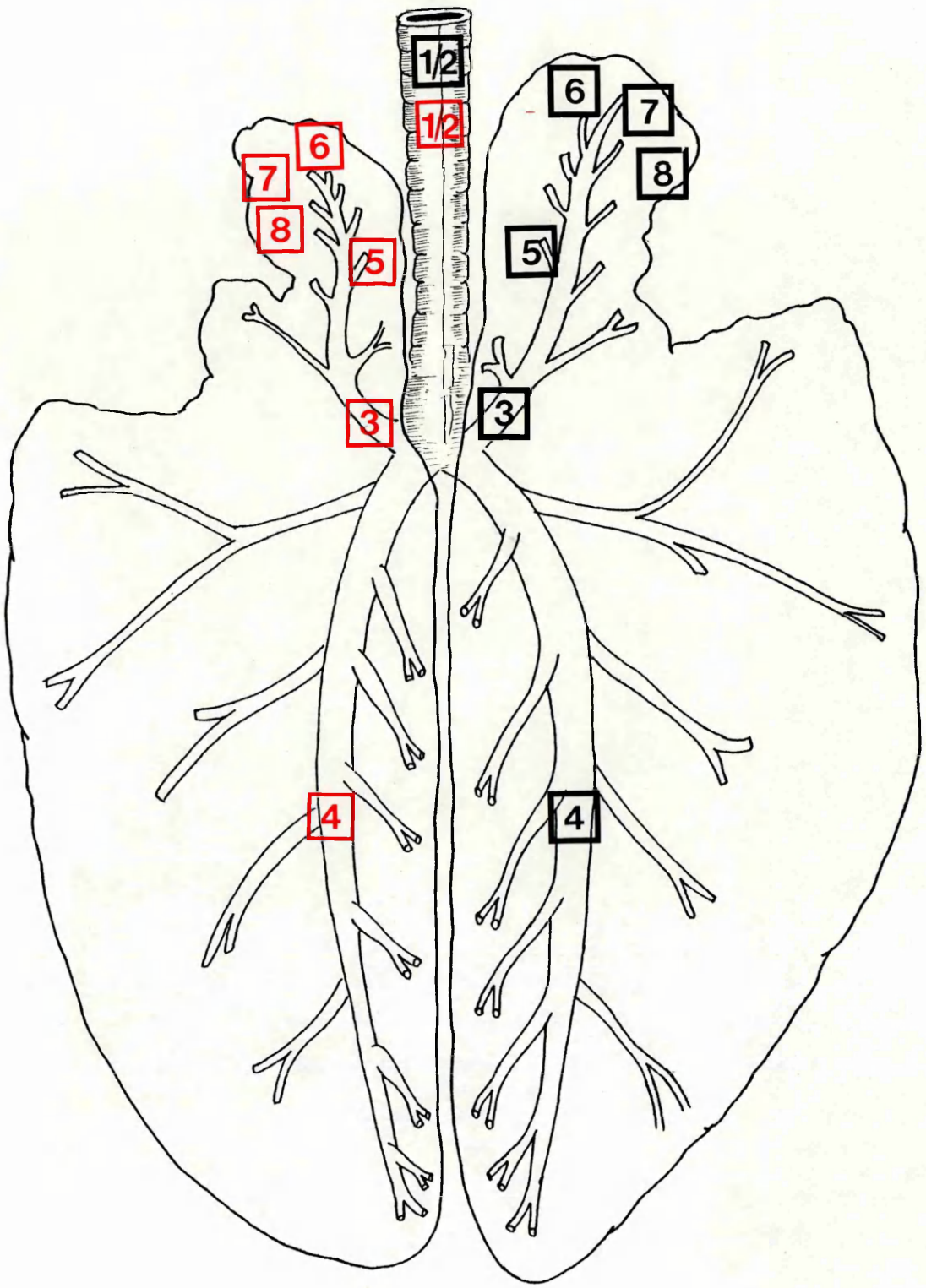
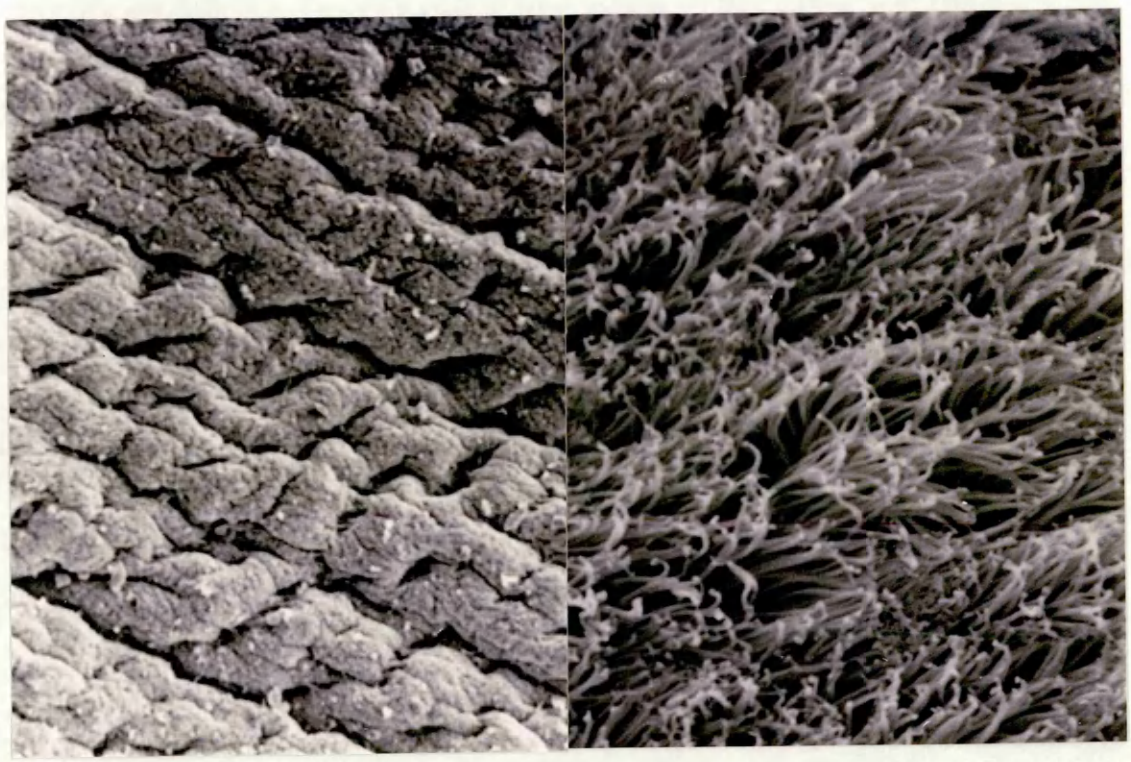

1/2
1/2
6
7
8
5
3
6
7
8
5
3
4
4

Fig. 6.2 Trachea. The regularly folded epithelial surface (left) clothed with a carpet of cilia (right).
SEM x 80 and x 5,000

Fig. 6.3 Trachea. Mucus-secreting cells (Arrows) among the ciliated cells. Note that the former have sparse surface microvilli and mucous droplets are visible through the surface cell membrane.
SEM x 10,000



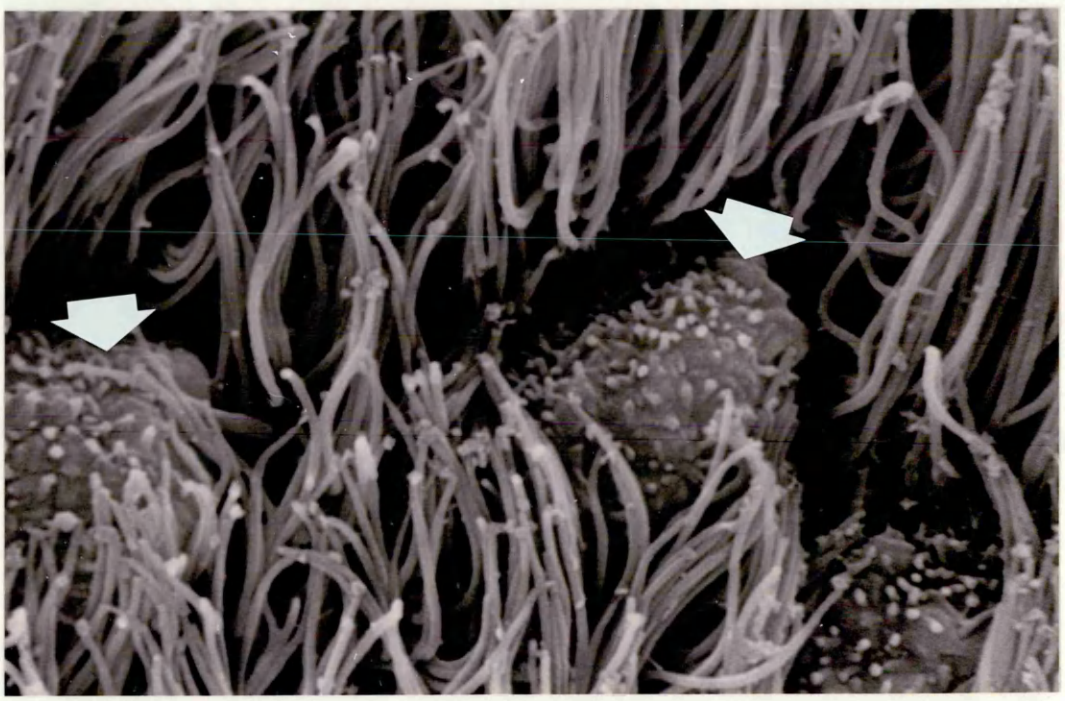
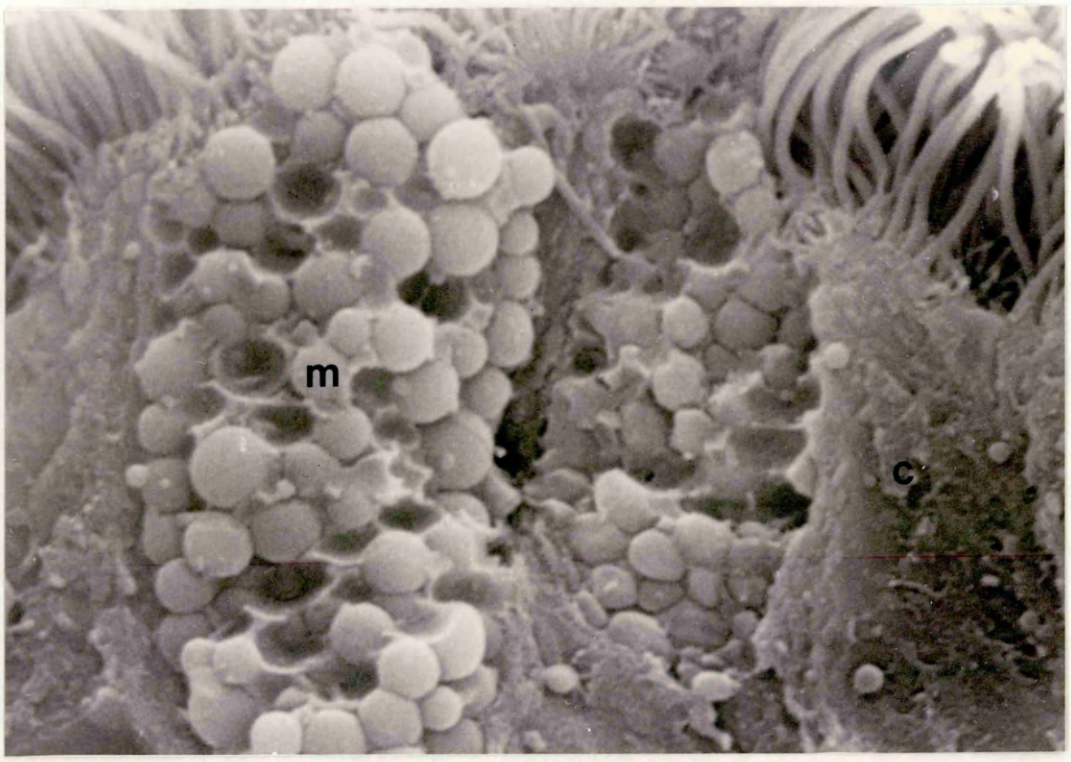


Fig. 6.4 Trachea. Fractured edge of the epithelium showing ciliated cells (C) and mucus-secreting cells (M). The latter are packed with mucous droplets.
SEM x 10,000

Fig. 6.5 Trachea. Ciliated cells surrounding a patch of nonciliated microvillous cells with distinct boundaries.
SEM x 5,000


m
c

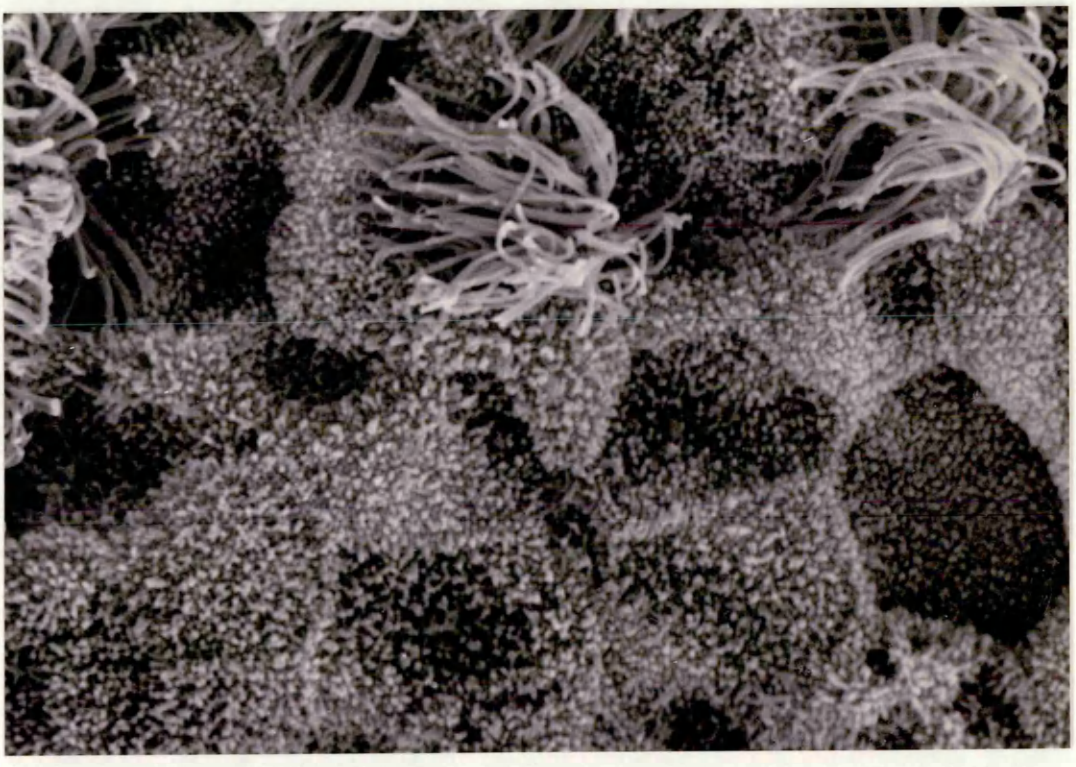
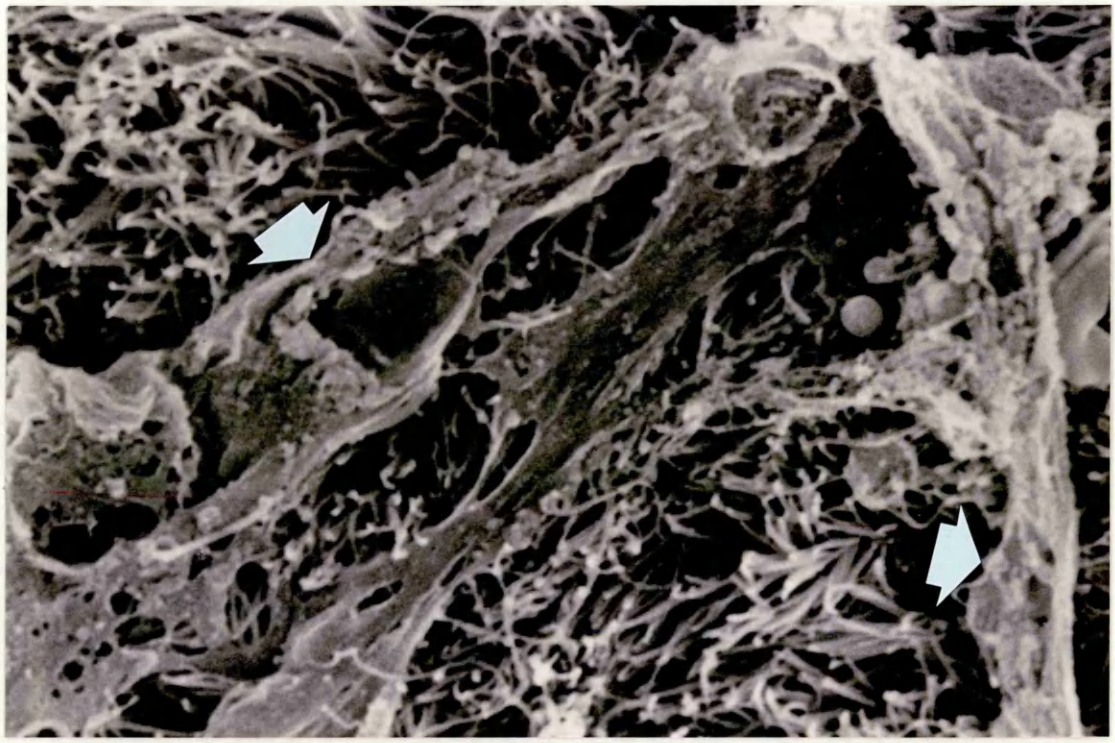


Fig. 6.6 Lobar bronchus. Thick strands of mucus (Arrows) partially obscure the well ciliated surface.
SEM x 5,000

Fig. 6.7 Lobar bronchus. Many mucus-secreting cells (Arrows) bulge from the surface between ciliated cells.
SEM x 5,000



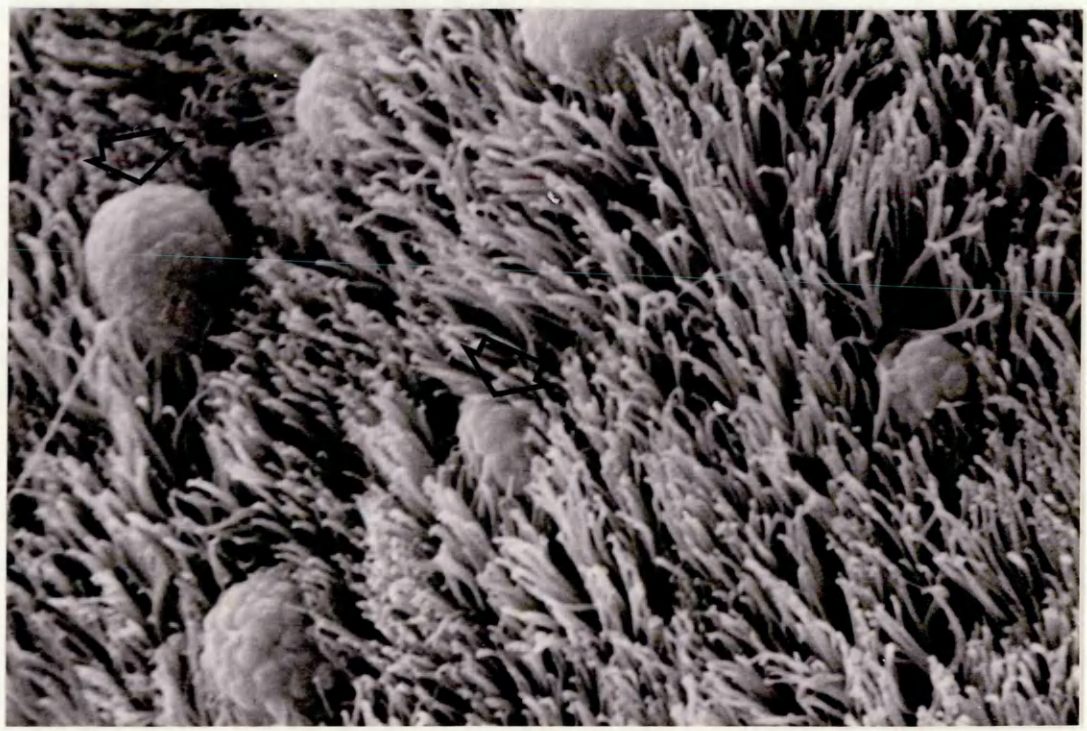


Fig. 6.8 Small bronchus. Nonciliated cells with sparse microvilli lie among the more numerous ciliated cells and give a "moth-eaten" appearance to the surface. This resembles caudal nasal cavity surfaces (See Fig. 4.18).
SEM x 2,500

Fig. 6.9 Small bronchus. A higher power view reveals mucous droplets (Arrows) below the surface cell membrane of many nonciliated cells. Note that their sparse microvilli tend to be peripheral.
SEM x 10,000

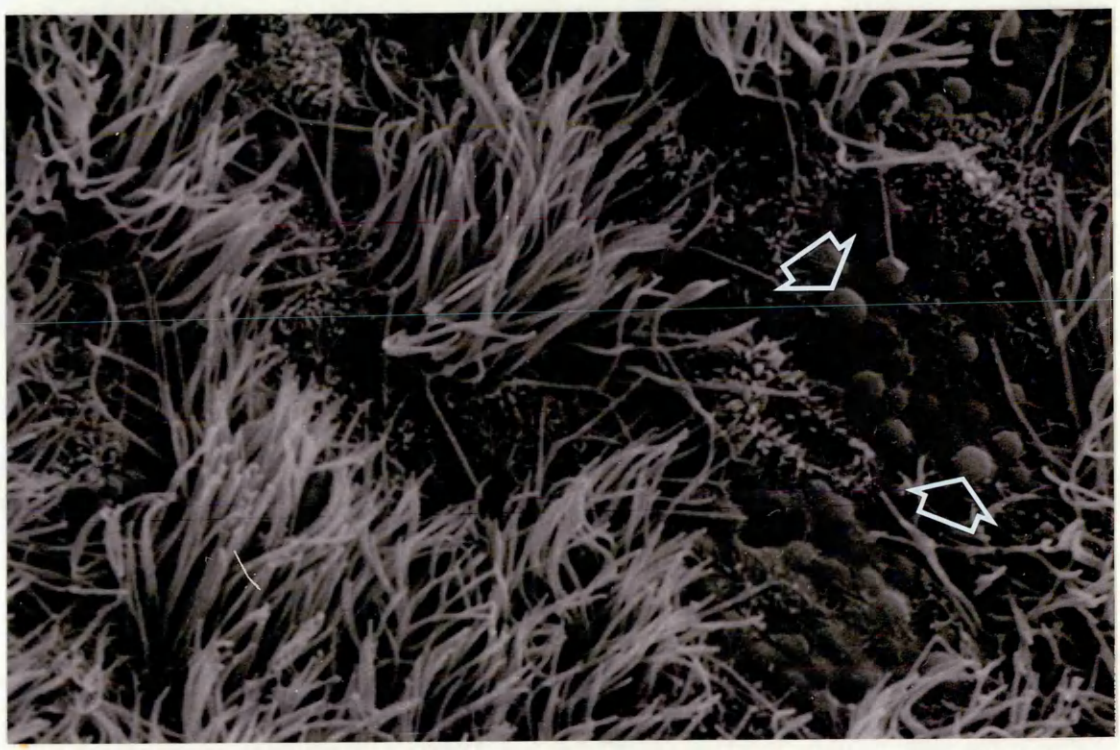


Fig. 6.10 Small bronchus. A flat nonciliated cell (Asterisk) with sparse microvilli. Another cell bulges from the surface and extrudes a droplet of mucus (Arrow). SEM x 10,000

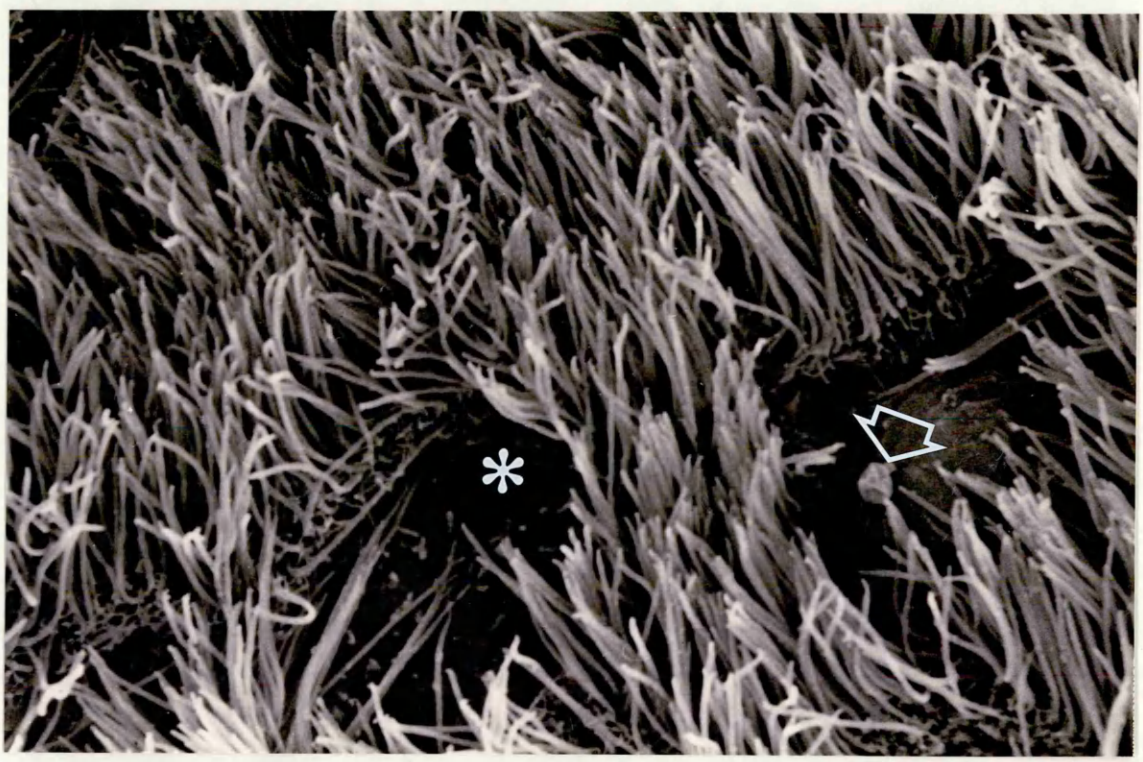
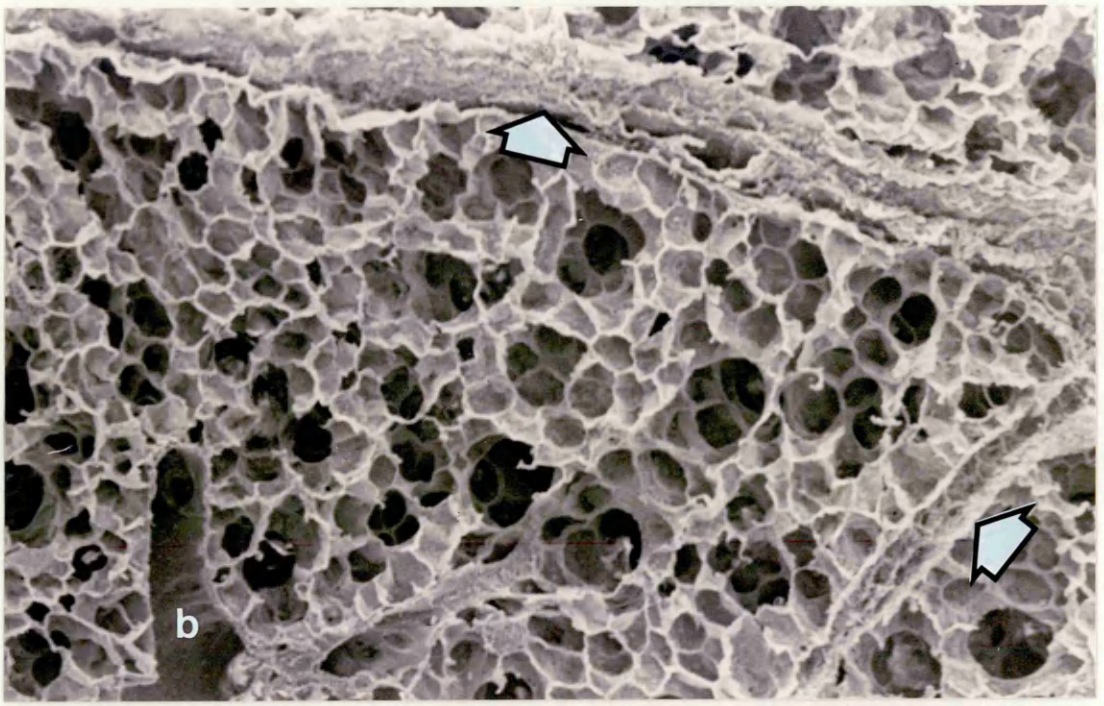


Fig. 6.11 Lung. Interlobular septae (Arrows) divide the lung parenchyma into lobules composed of many alveoli. Note the small bronchiole (B). SEM x 80

Fig. 6.12 Lung. Many alveoli surround a small bronchiole (B) which branches forming a terminal bronchiole (T). This in turn leads into an alveolar duct (D). SEM x 160


b

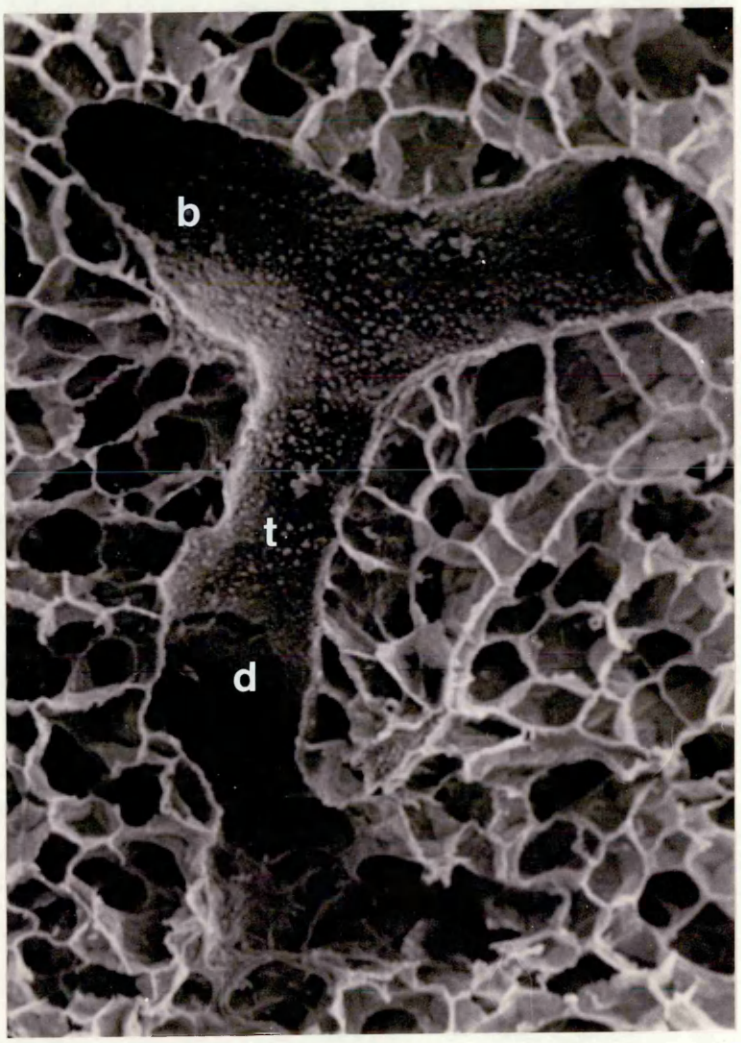

b
t
d

Fig. 6.13 Bronchiole. Ciliated cells and nonciliated bronchiolar epithelial (Clara) cells populate the surface.
SEM x 5,000

Fig. 6.14 Bronchiole. Some Clara cells are distinctly dome-shaped and project from the surface while others are flatter. Note the surface wrinkles and clefts and stubby microvilli.
The ciliated cells are sparsely ciliated and their surface microvilli (Arrows) are clearly visible.
SEM x 10,000

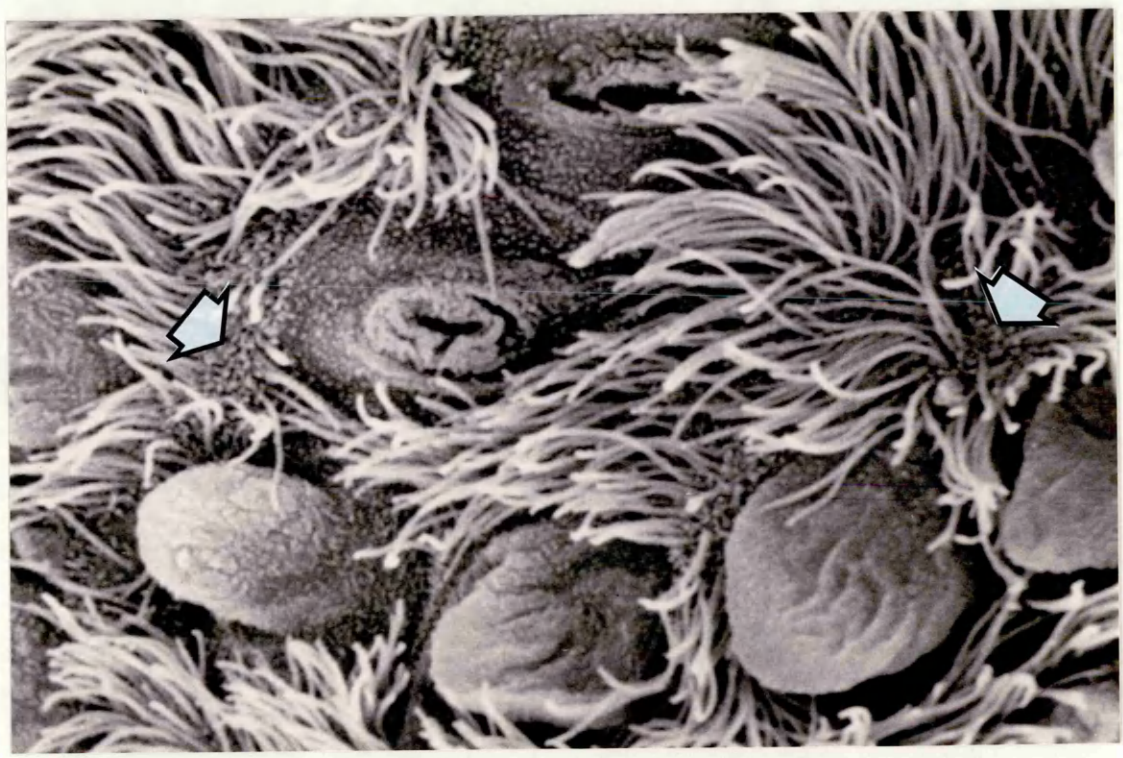
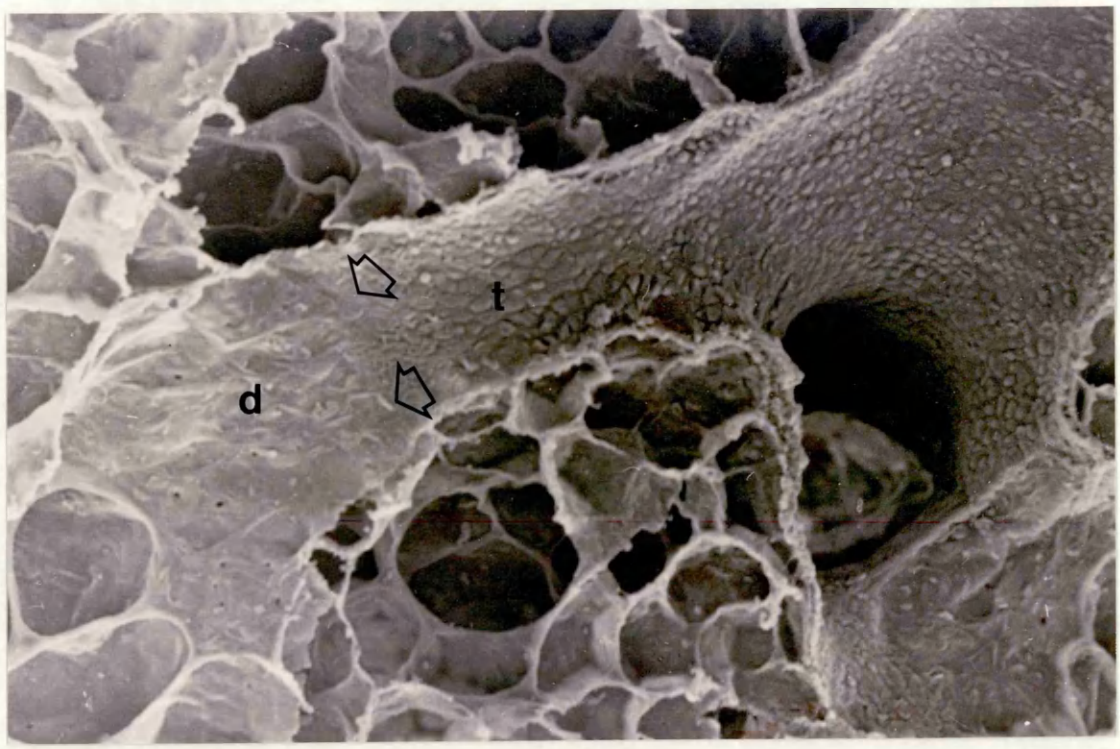


Fig. 6.15 Lung. Arrows indicate the abrupt junction between a terminal bronchiole (T) and an alveolar duct (D).
SEM x 320

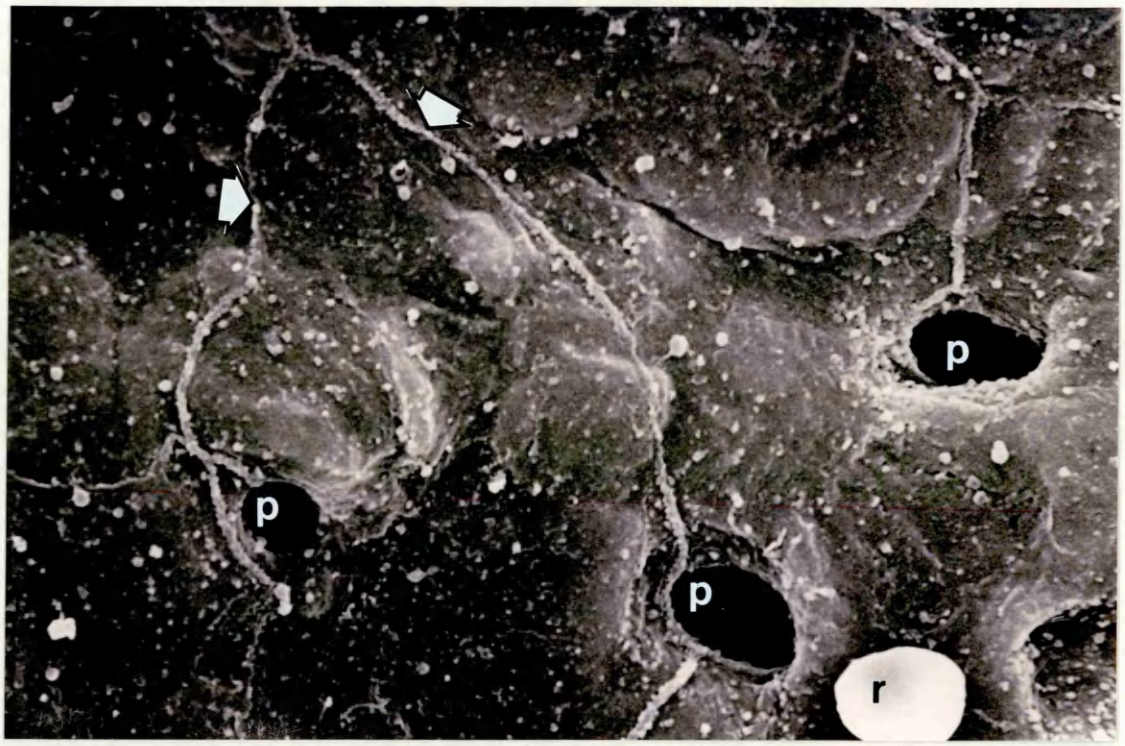
Fig. 6.16 Bronchiole/alveolar duct junction. A Clara cell (Asterisk) and ciliated cells (C) lie adjacent to a Type I pneumocyte (1) of the alveolar membrane.
The ciliated cells have sparse, tangled cilia and the wrinkled surface of the Type I pneumocyte is studded with stubby microvillous processes.
SEM x 10,000


t
d


c
*
c

Fig. 6.17 Alveolar membrane. Type I pneumocytes with distinct cell boundaries (Arrows) cover the surface which is interrupted by 3 alveolar pores (P).
A red blood corpuscle (R) lies on the alveolar surface.
SEM x 5,000

Fig. 6.18 Alveolar membrane. On the left a capillary bulges from the surface close to an alveolar pore. Small microvillous processes are present on the surface of the Type I pneumocytes.
SEM x 10,000


p
p
p
r

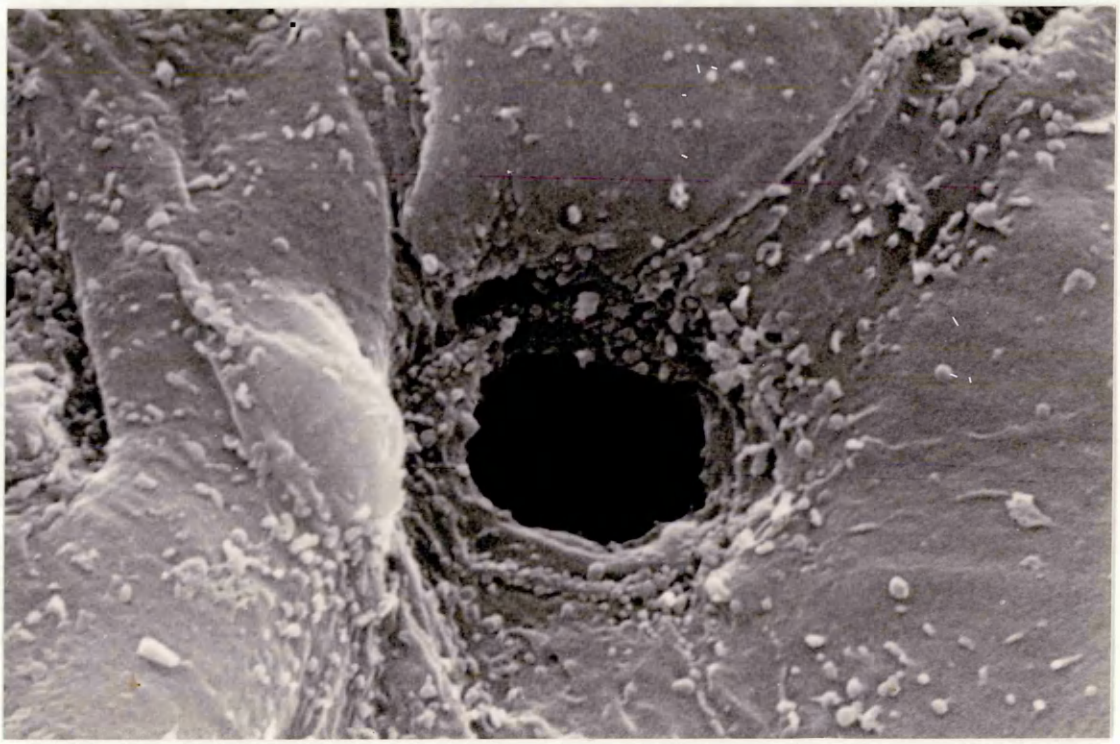
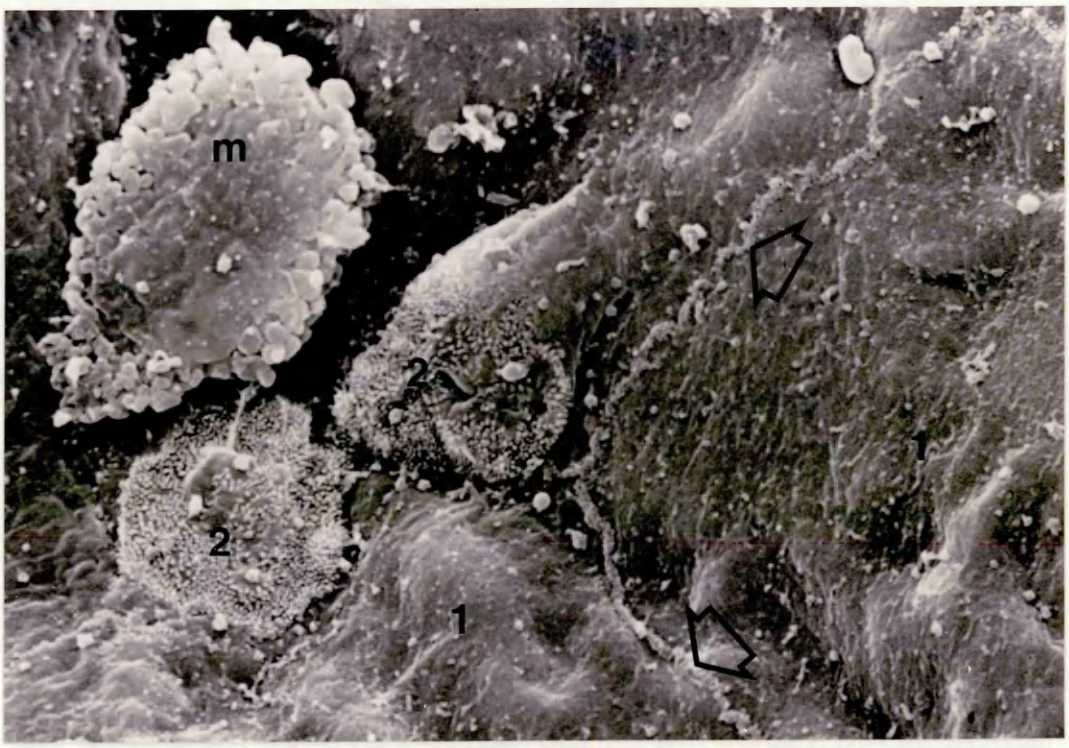


Fig. 6.19 Alveolar membrane. Type I pneumocytes (1) with distinct boundaries (Arrows), 2 Type II pneumocytes (2) and an adjacent alveolar macrophage (M) with uneven surface projections. SEM x 5,000

Fig. 6.20 Alveolar membrane. Type I (1) and Type II (2) pneumocytes. Note the peripheral, short microvilli of the latter, with a smoother central area and small pores (Arrows). An alveolar macrophage (M) is close to the edge of an alveolar pore (P). SEM x 10,000


m
2
2
1
1

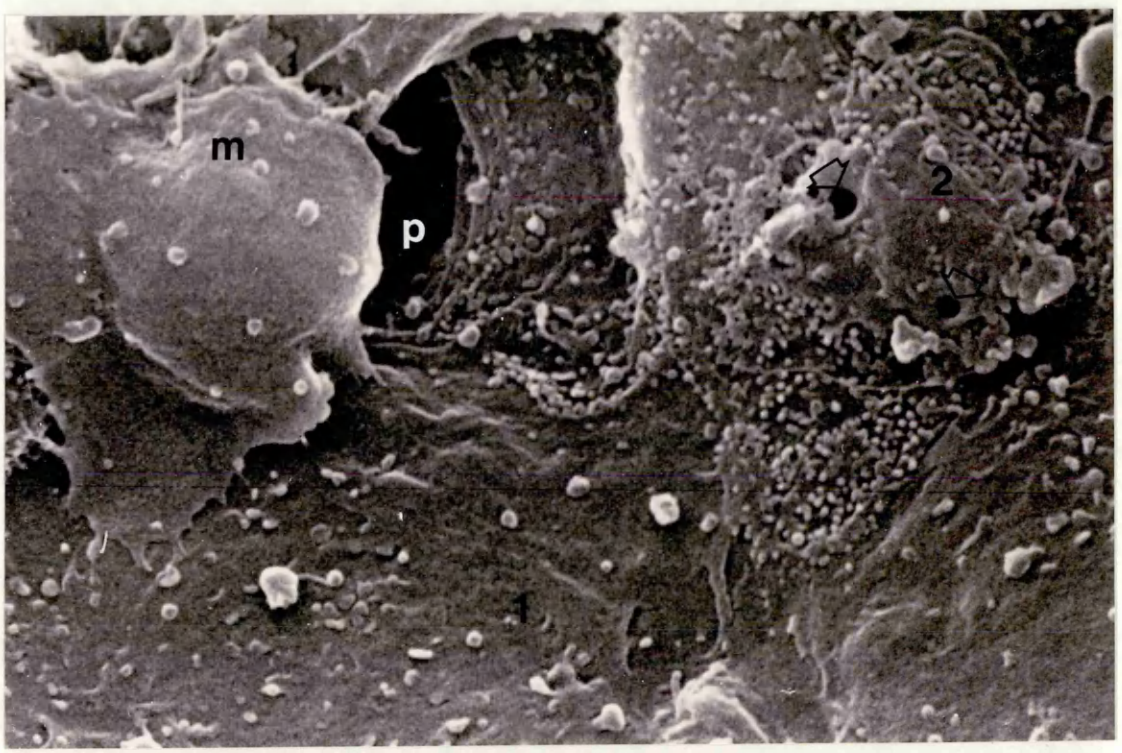
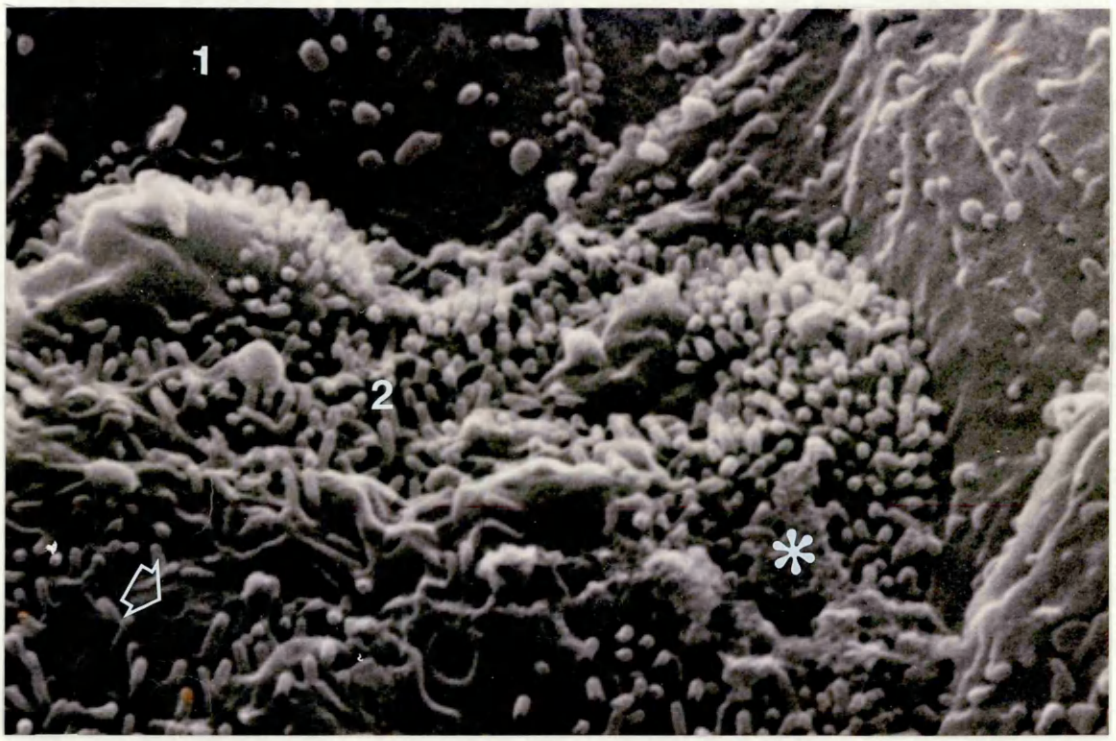

m
p
2
1

Fig. 6.21 Alveolar membrane. Type I pneumocyte (1) with irregular surface and a few stubby microvillous processes. Type II (2) pneumocyte with many more surface microvilli especially at the periphery of the cell. Note the surface pore (Arrow) and a small amount of secretion (Asterisk).
SEM x 20,000

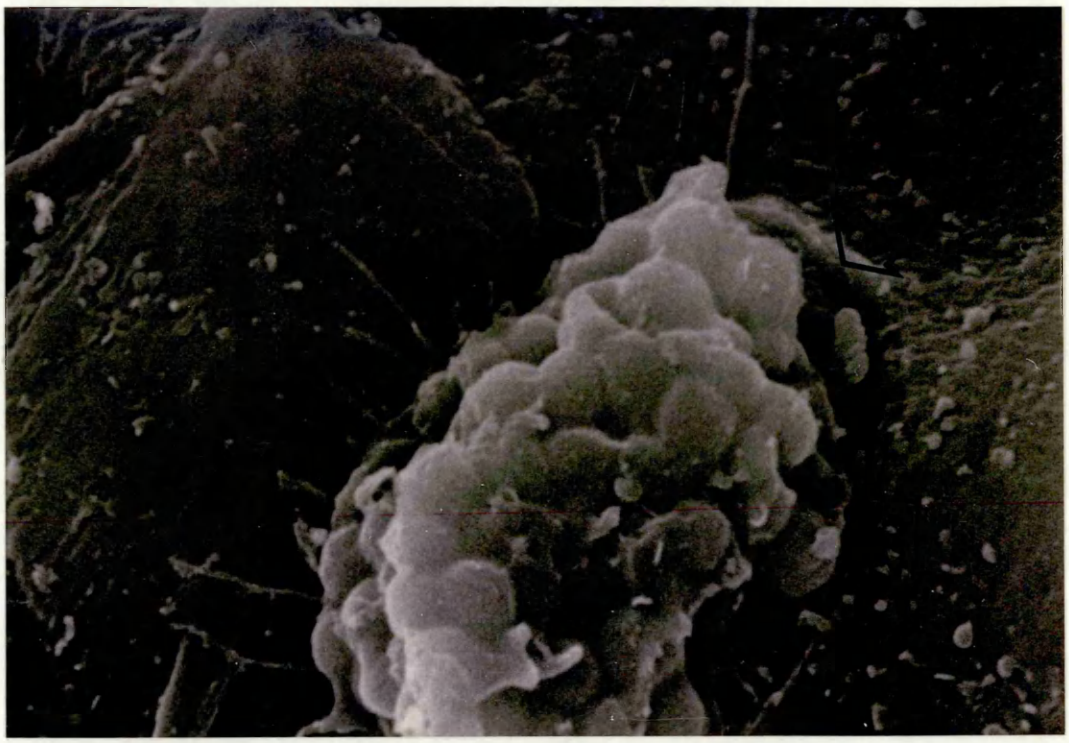
Fig. 6.22 Alveolar membrane. An alveolar macrophage (M) with long cytoplasmic processes (Arrows) is either emerging from or descending into an alveolar pore.
SEM x 10,000


1
2
*


m

Fig. 6.23 Alveolar membrane. An aveolar macrophage with ruffled surface and slender cytoplasmic processes fills an alveolar pore (Edge marked with arrows). SEM x 10,000

Fig. 6.24 Alveolar membrane. An alveolar macrophage with a ruffled edge and many cytoplasmic processes is seen close to an alveolar pore (P). SEM x 10,000



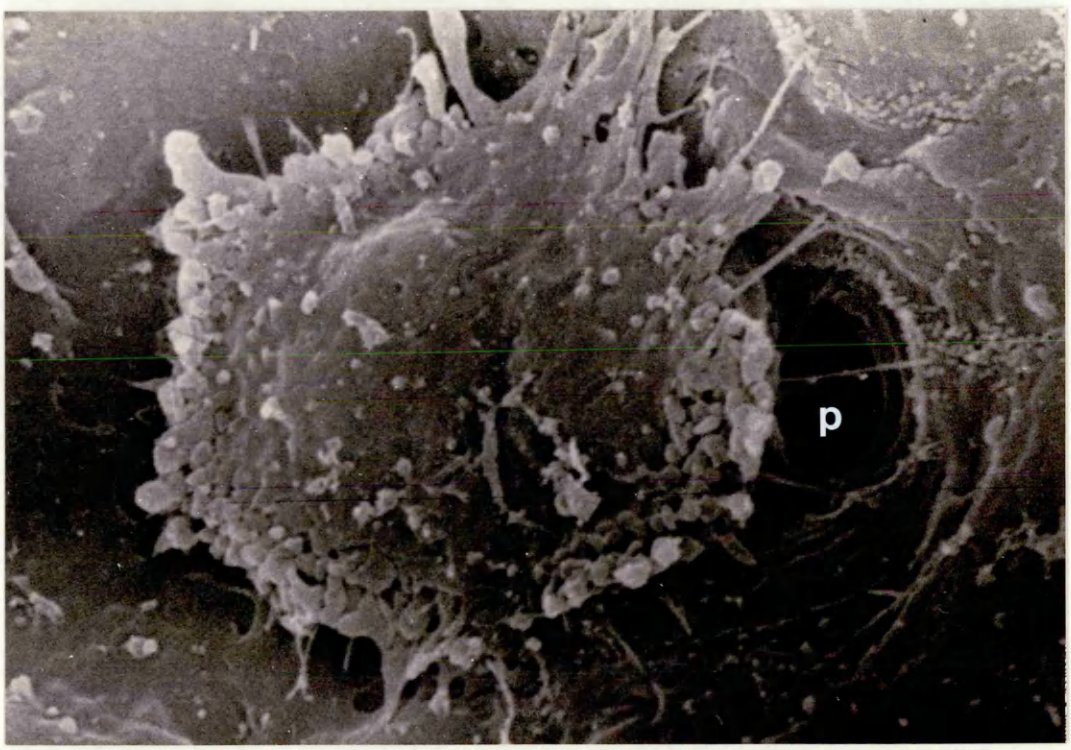
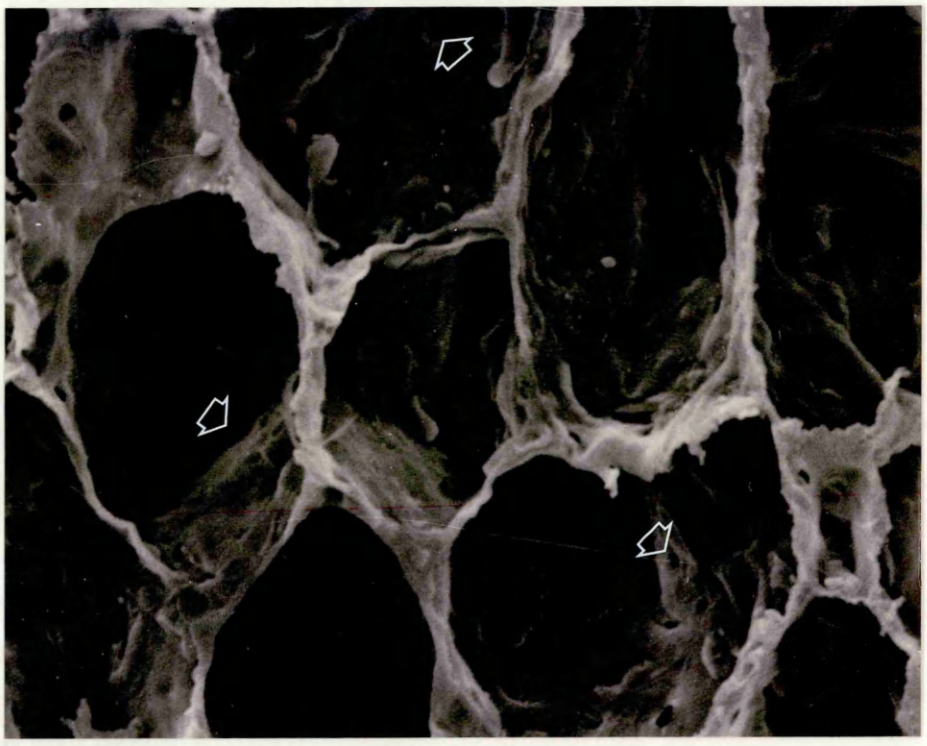

p

Fig. 6.25 Lung. Alveolar pores (Arrows) are few in number in a young, 2 years old horse. SEM x 640

Fig. 6.26 Lung. Numerous alveolar pores (Arrows) in an older animal of 15 years. SEM x 320



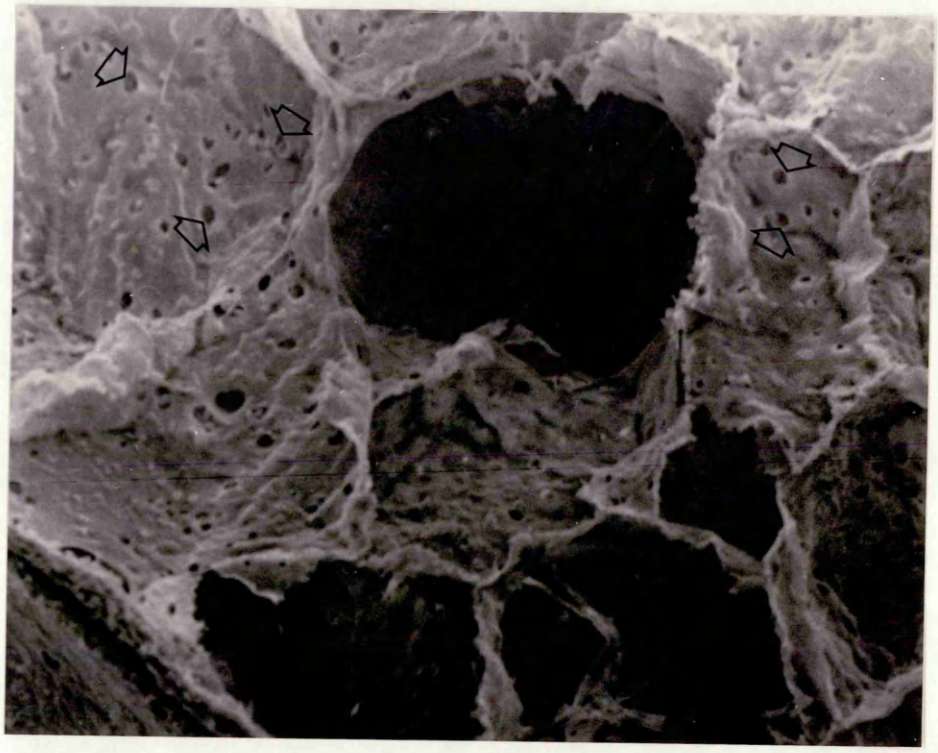


Fig. 6.27 Lung. The wrinkled surface of the pleura (P) covers the lung parenchyma.
SEM x 160

Fig. 6.28 The pleura. Many small microvilli cover the surface of the pleural cells. Cell boundaries are indistinct so individual cells cannot be distinguished.
SEM x 5,000

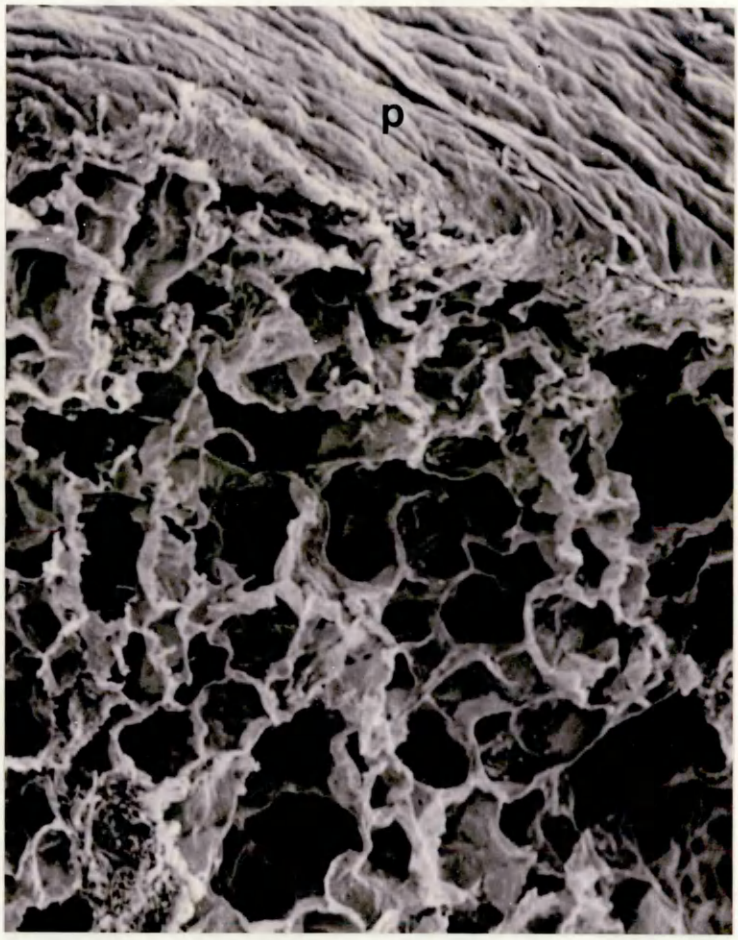
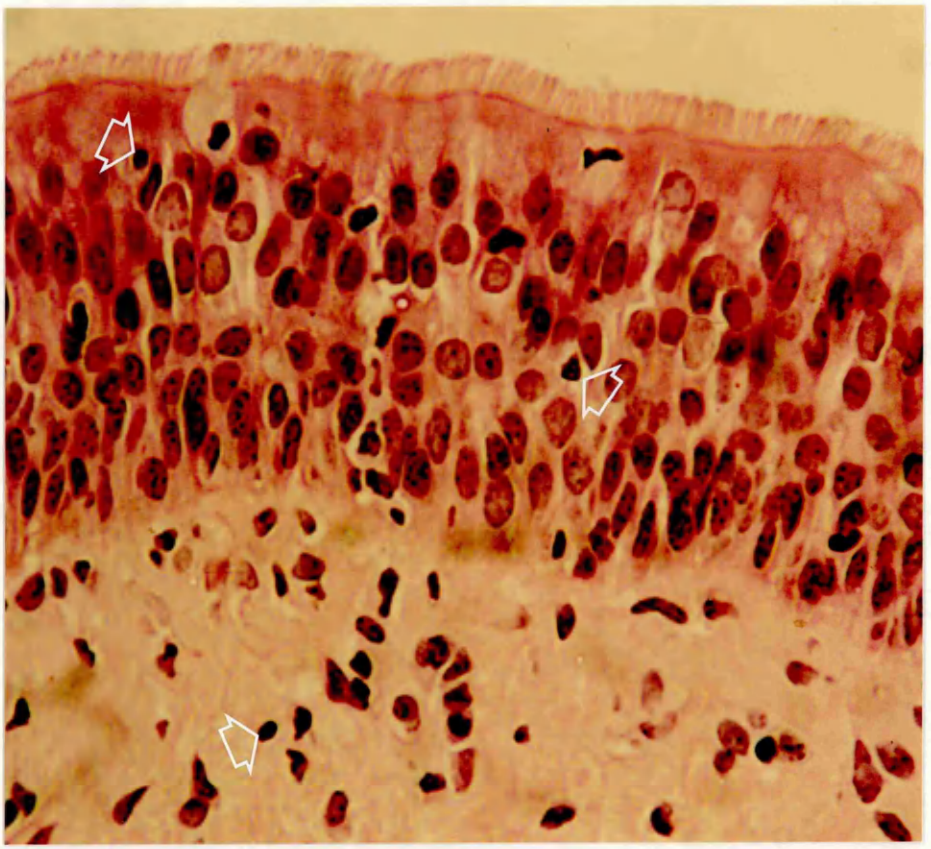

p

Fig. 6.29 Trachea. Thick pseudostratified columnar ciliated epithelium with mucus-secreting cells covers the surface. A few isolated lymphocytes are present in the lamina propria and within the epithelium (Arrows).
HE x 400

Fig. 6,30 Trachea. Some mucus (Arrows) lies on the epithelial surface. The mucus-secreting cells contain mostly mixed mucosubstances.
AB-PAS x 400



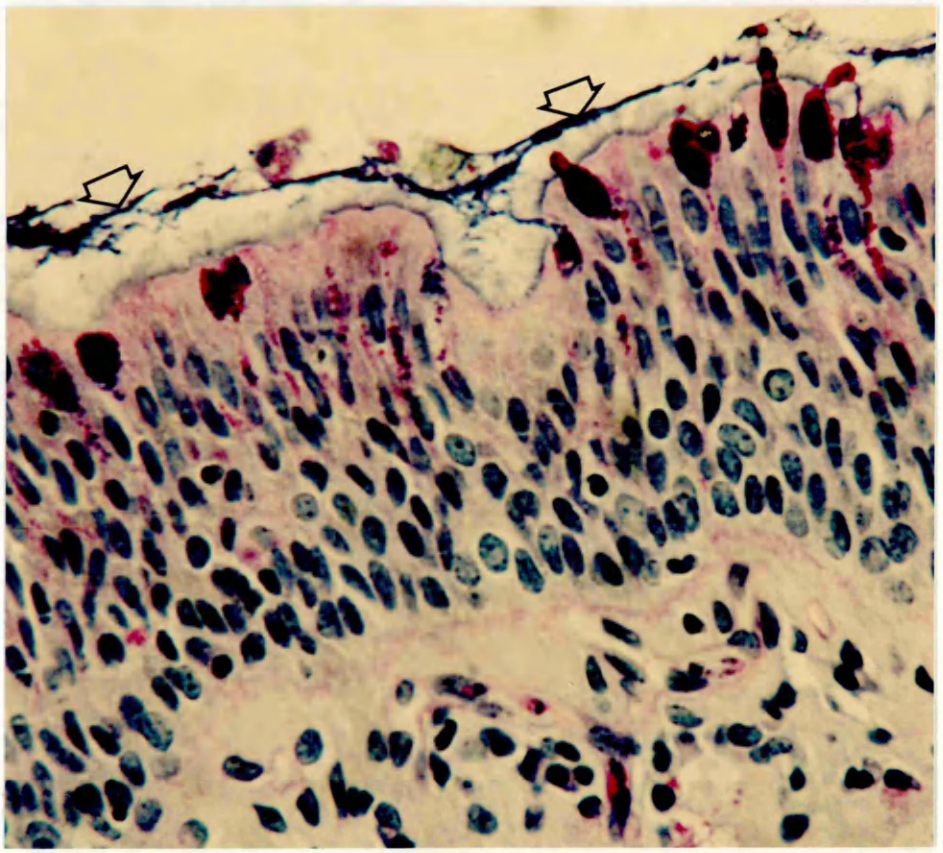
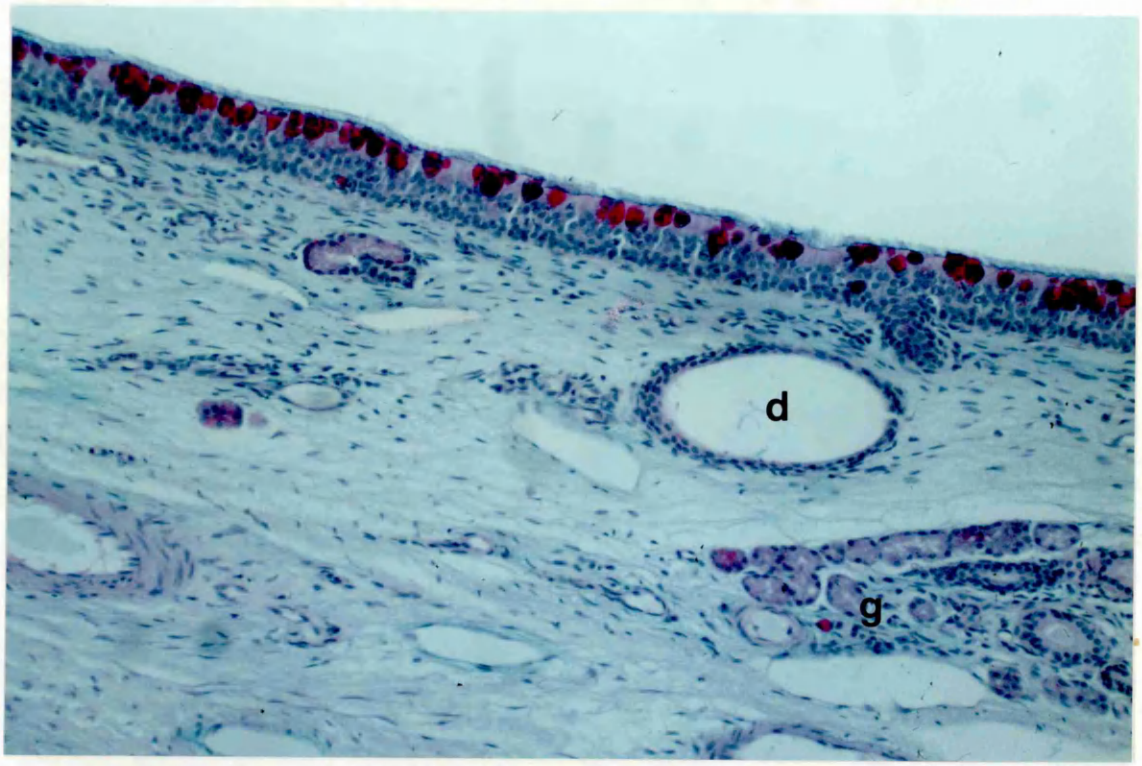


Fig. 6.31 Lobar bronchus. Pseudostratified columnar ciliated epithelium with many mucous cells covers the surface. Sero-mucous glands (G) and their ducts (D) are present below.
AB-PAS x 180

Fig. 6.32 Lung. A terminal bronchiole (T) lined by simple cuboidal epithelium opens into an alveolar duct (A).
HE x 180


d
g

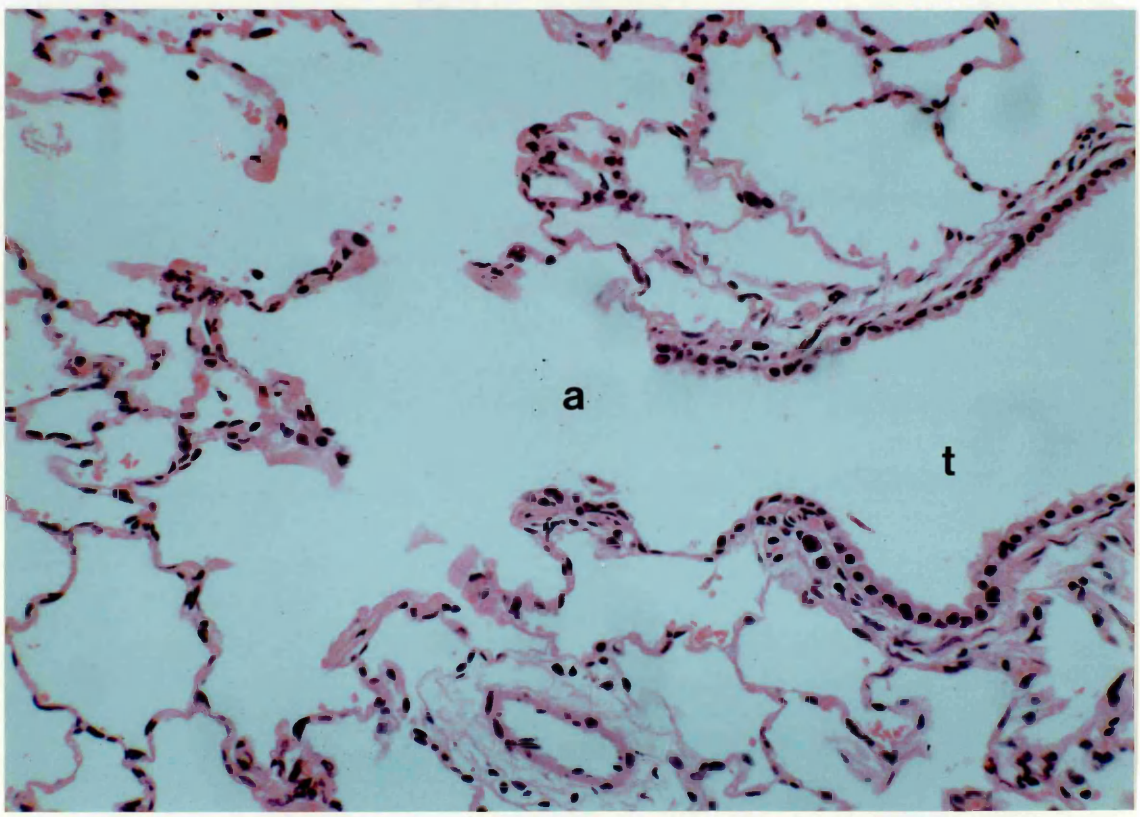

a
t

Fig. 6.33 Lung. A small bronchiole in the centre of the picture is lined by ciliated cells and nonciliated Clara Cells (Arrows). A few alveolar macrophages (Small arrows) are present within the thin walled alveoli.
HE x 400

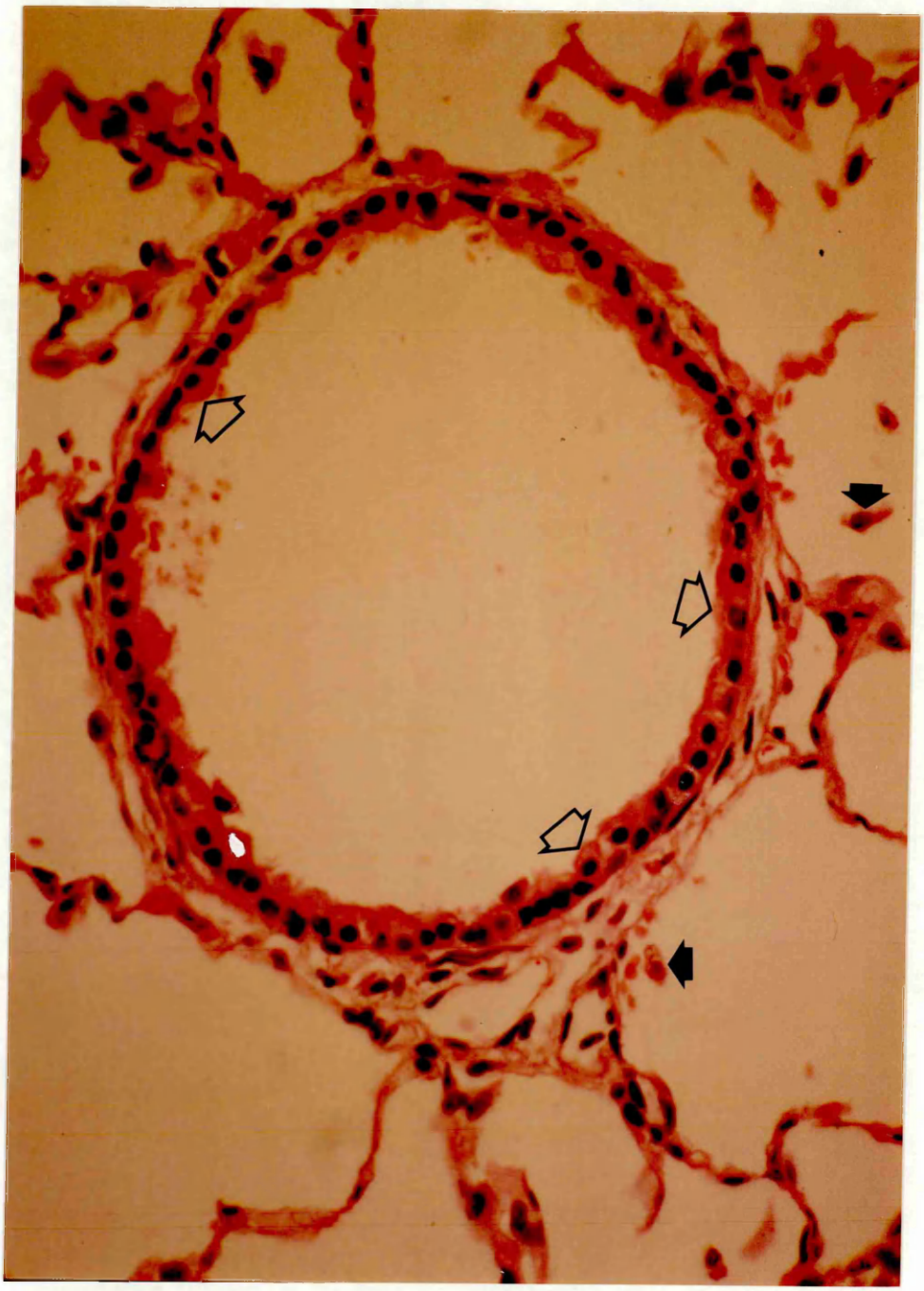


Fig. 6.34 Small bronchus. Ciliated cells (C) and a mucus-secreting cell (M).
TEM x 5,400

Fig. 6.35 Small bronchus. A mucous cell lies between two ciliated cells. Note mucus discharging from the former (Arrow).
TEM x 10,000

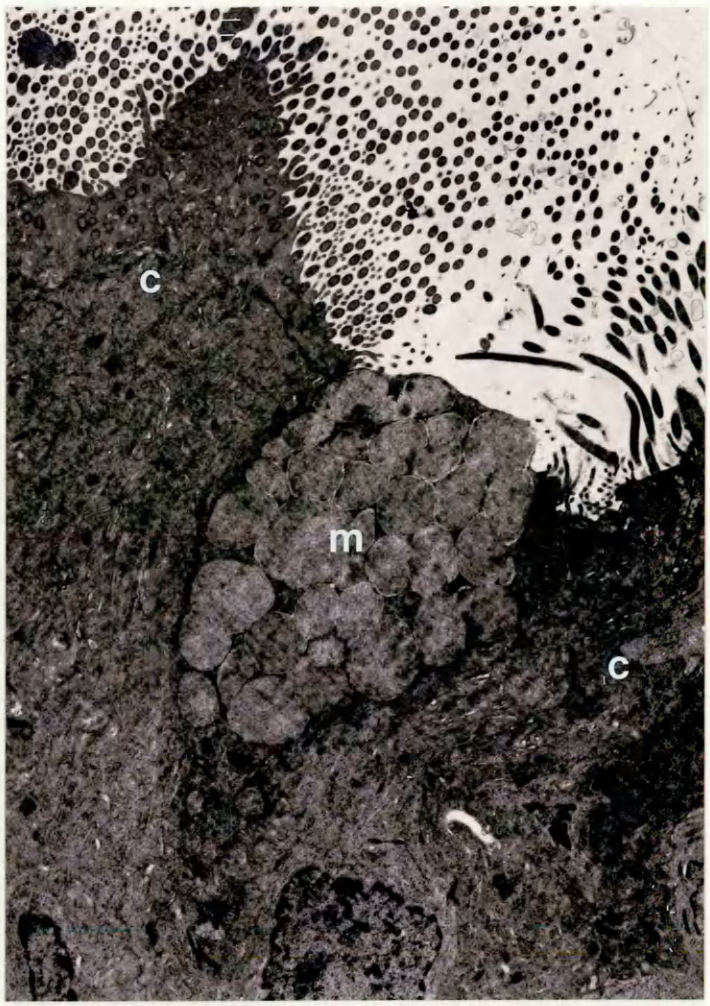

c
m
c

Fig. 6.36 Small bronchus. Ciliated cells (C) and mucous cells (M) extend from the basal lamina (Arrows) to the surface. Note lymphocytes (L), lying inside the basal lamina, in the process of passing through the epithelium. TEM x 8,000

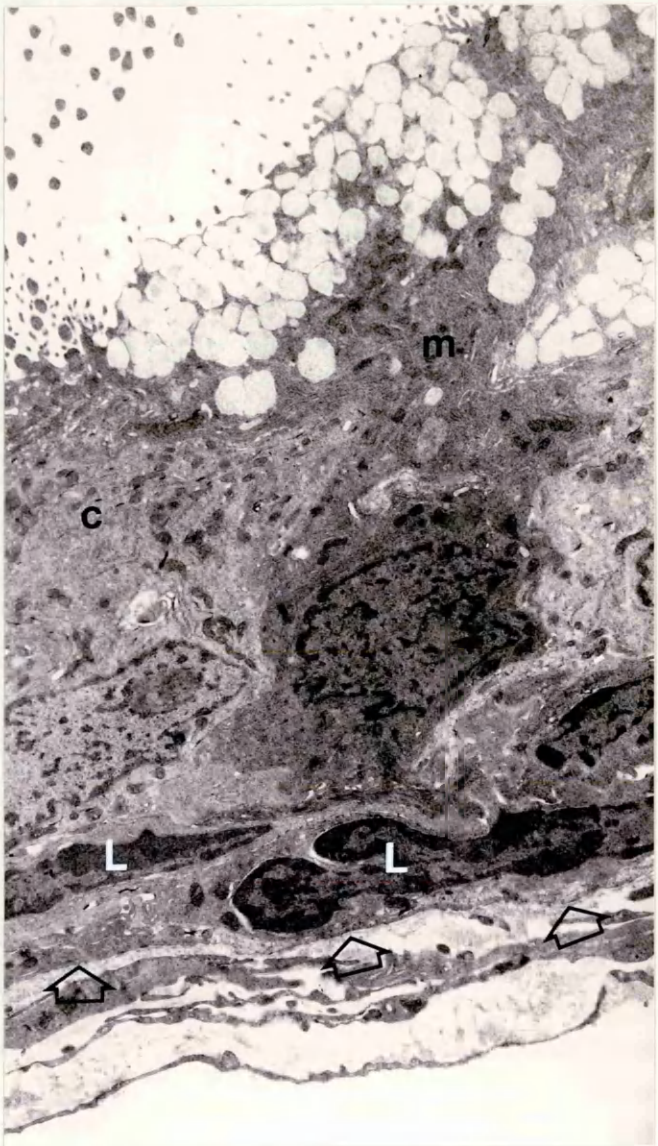
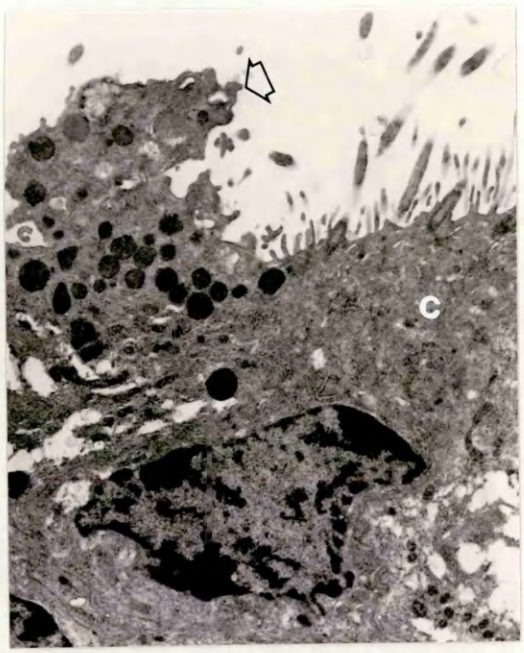

m
c
L
L

Fig. 6.37 Bronchiole. A Clara cell (Arrow) bulges from the surface adjacent to a ciliated cell (C). The electron lucent clefts are probably artefacts due to delayed fixation.
TEM x 8,000

Fig. 6.38 Bronchiole. A typical Clara cell projects from the surface. Many electron dense granules are present in the apical cytoplasm. The cell rests on the basal lamina (Arrows).
TEM x 10,000


C
C

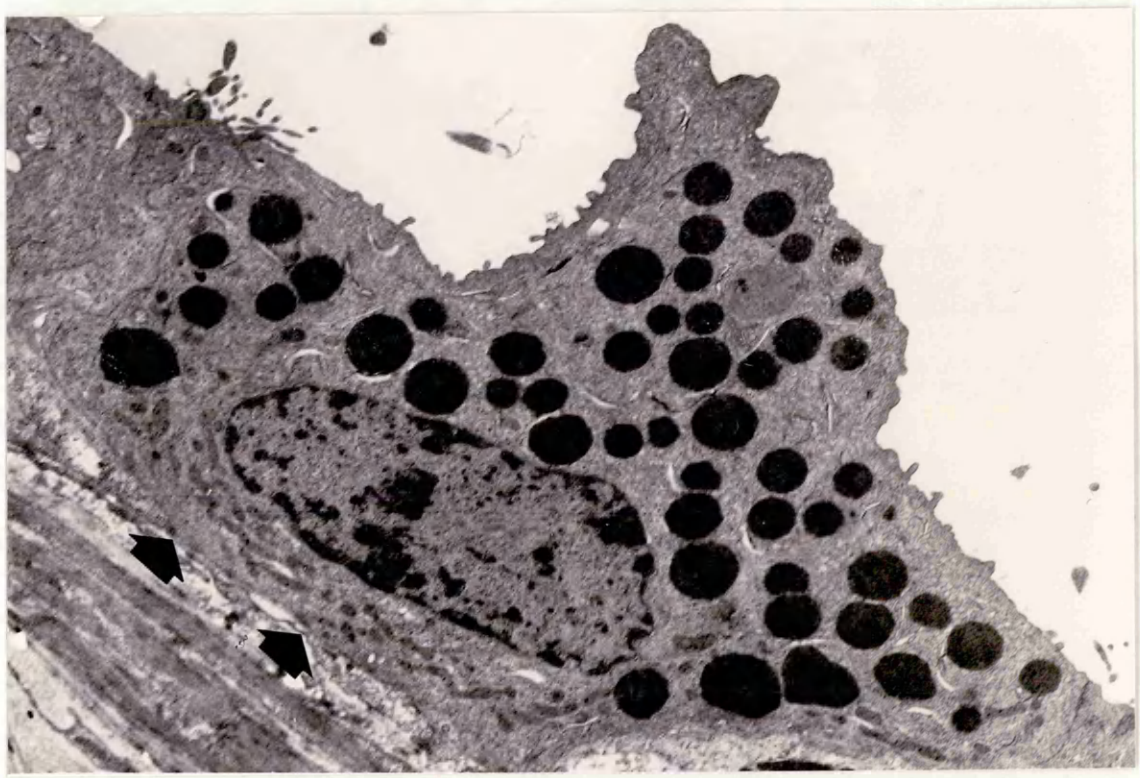


Fig. 6.39 Bronchiole. A Clara cell with abundant smooth endoplasmic reticulum clearly visible in the cytoplasm, particularly in the apical part of the cell where the dense granules are sparse. TEM x 16,000

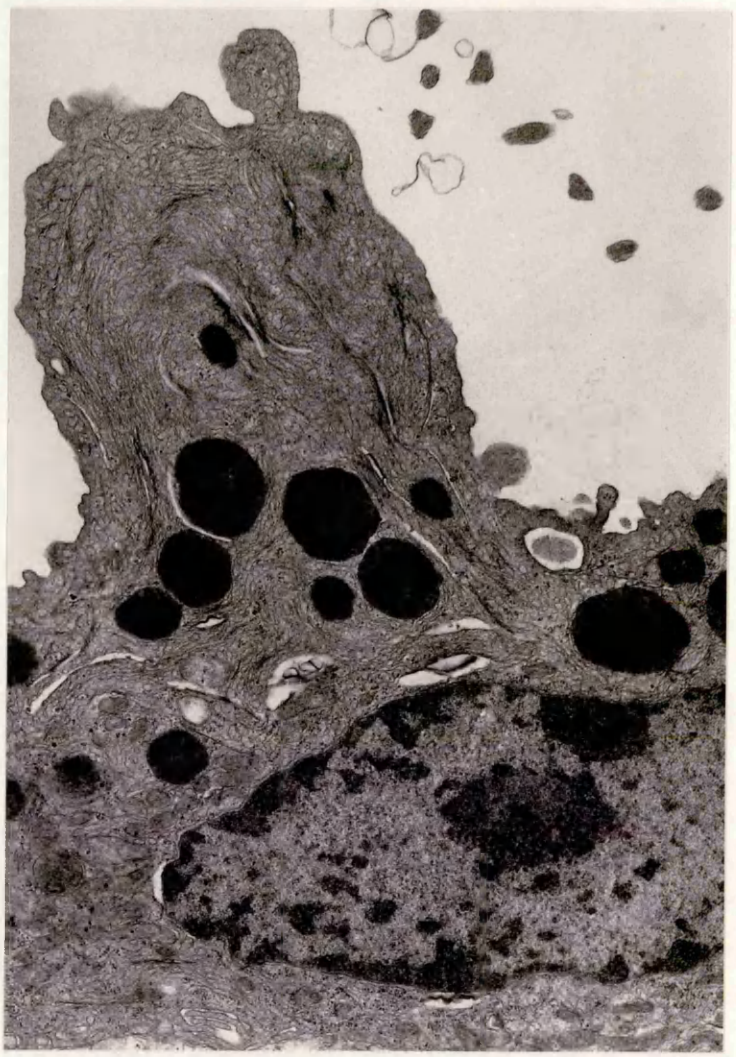
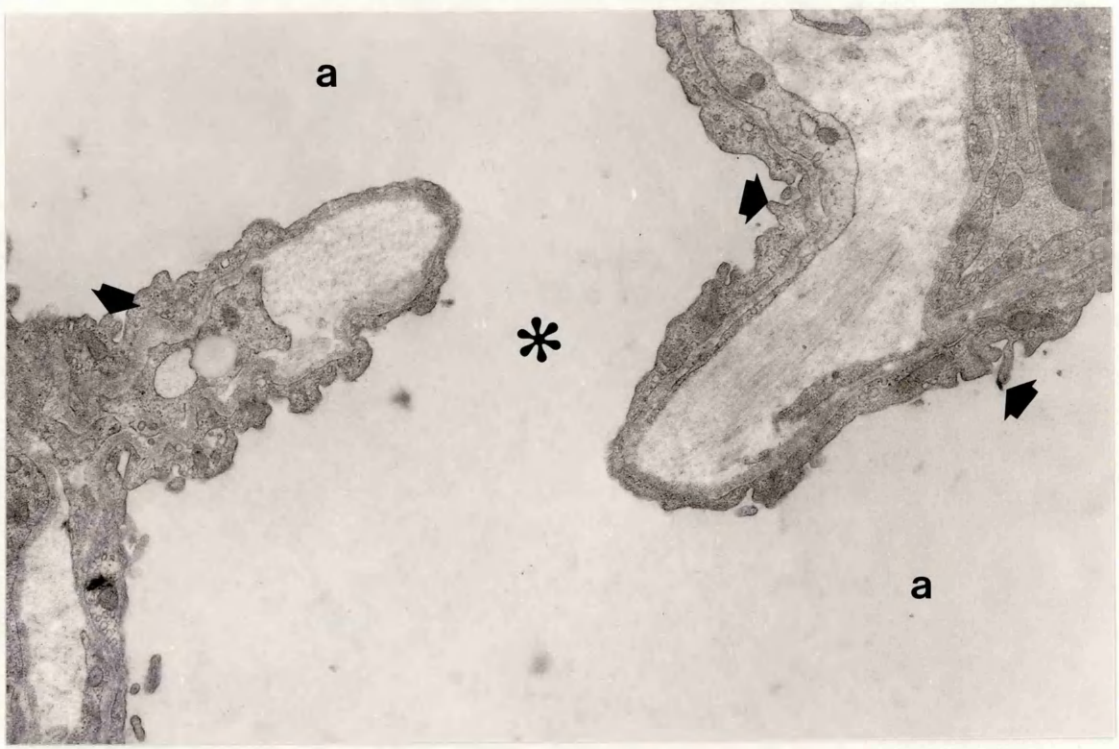


Fig. 6.40 Alveolar membrane. A few stubby microvillous processes (Arrows) project from the surface of the attenuated Type I pneumocyte cytoplasm. Note that the latter is continuous round the edge of an alveolar pore (Asterisk) between the adjacent alveoli (A).

Fig. 6.41 Alveolar membrane. A Type II pneumocyte bulges into the alveolus (A). Note the characteristic osmiophilic inclusion bodies (Arrows). The attenuated cytoplasm of a Type I pneumocyte covers part of the Type II cell and is joined to it by a tight junction (Small arrow).
TEM x 13,400


a
*
a

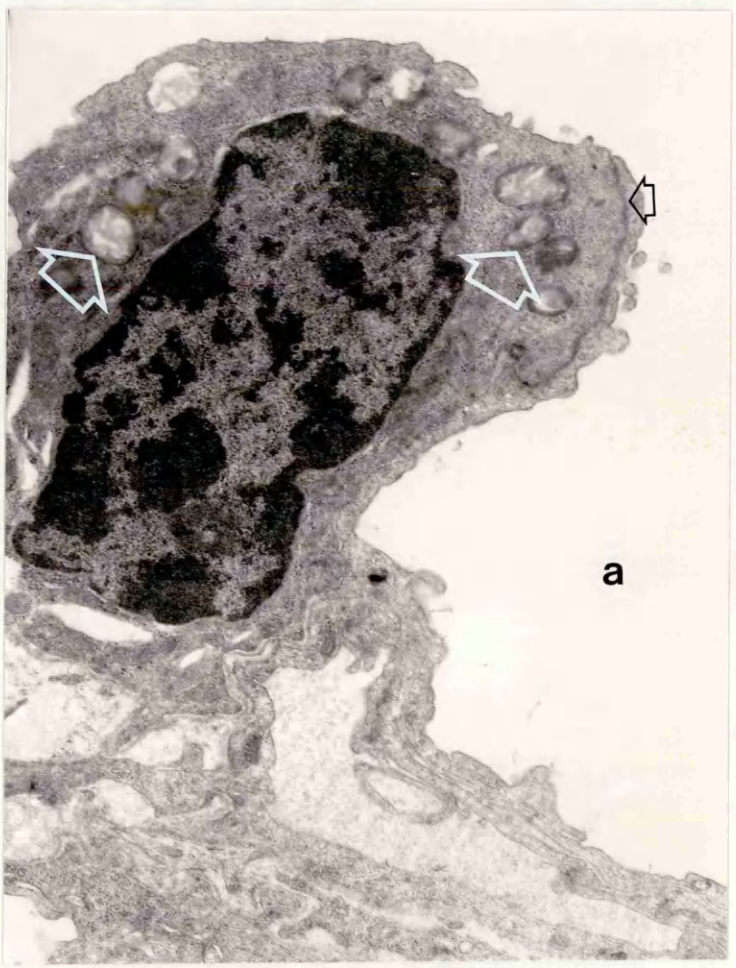
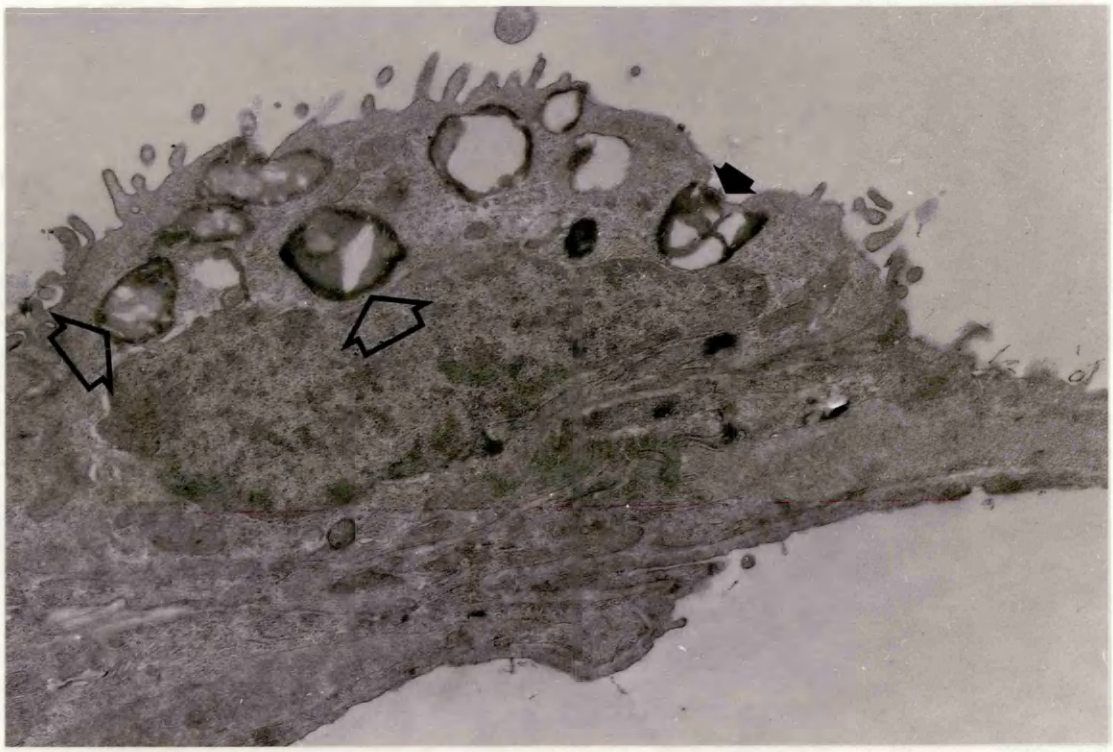

a

Fig. 6.42 Alveolar membrane. A Type II pneumocyte with short surface microvilli and osmiophilic inclusion bodies (Arrows). Note one of the latter extruding through the surface cell membrane (Small arrow). Compare this picture with the SEM appearance of Type II pneumocytes in Figs. 6.20 and 6.21. TEM x 16,000

Fig. 6.43 Alveolar membrane. Two Type II pneumocytes (2) lie together. Compare this with the SEM appearance in Fig. 6.19. TEM x 8,000



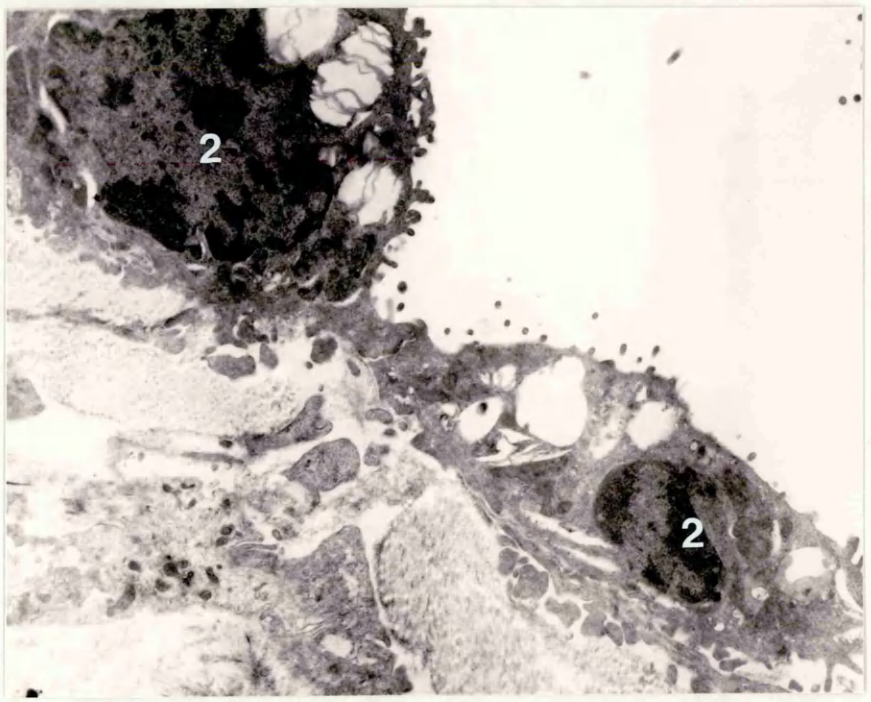
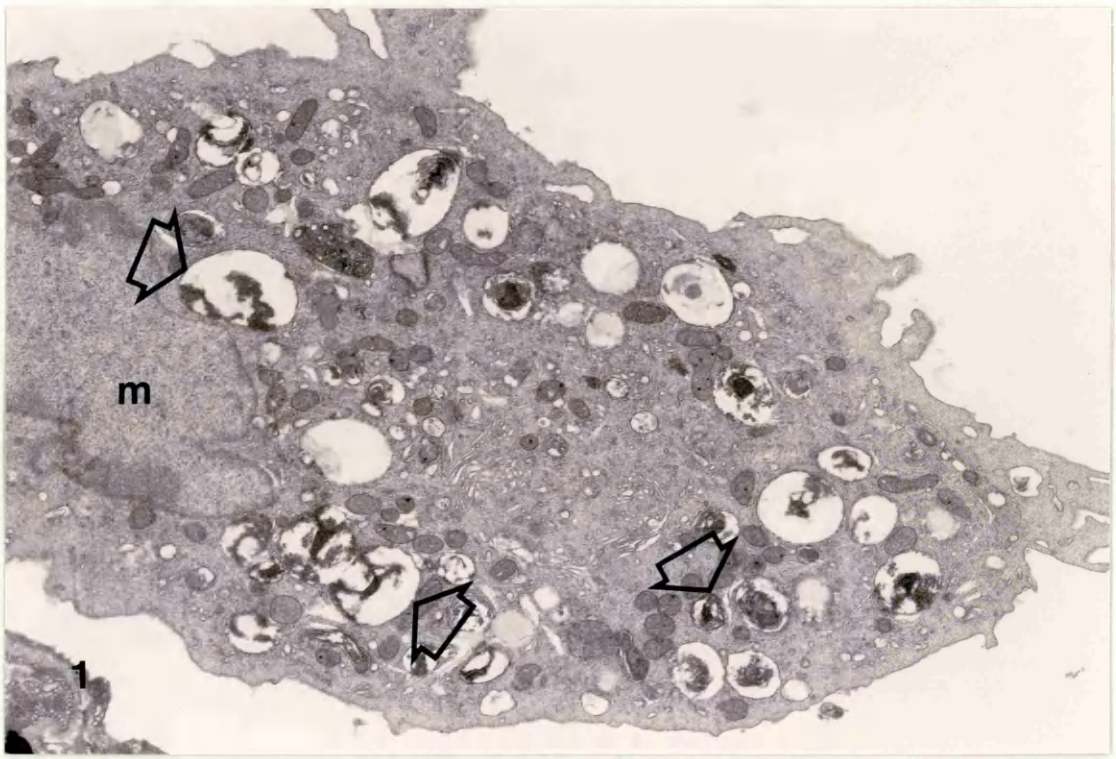
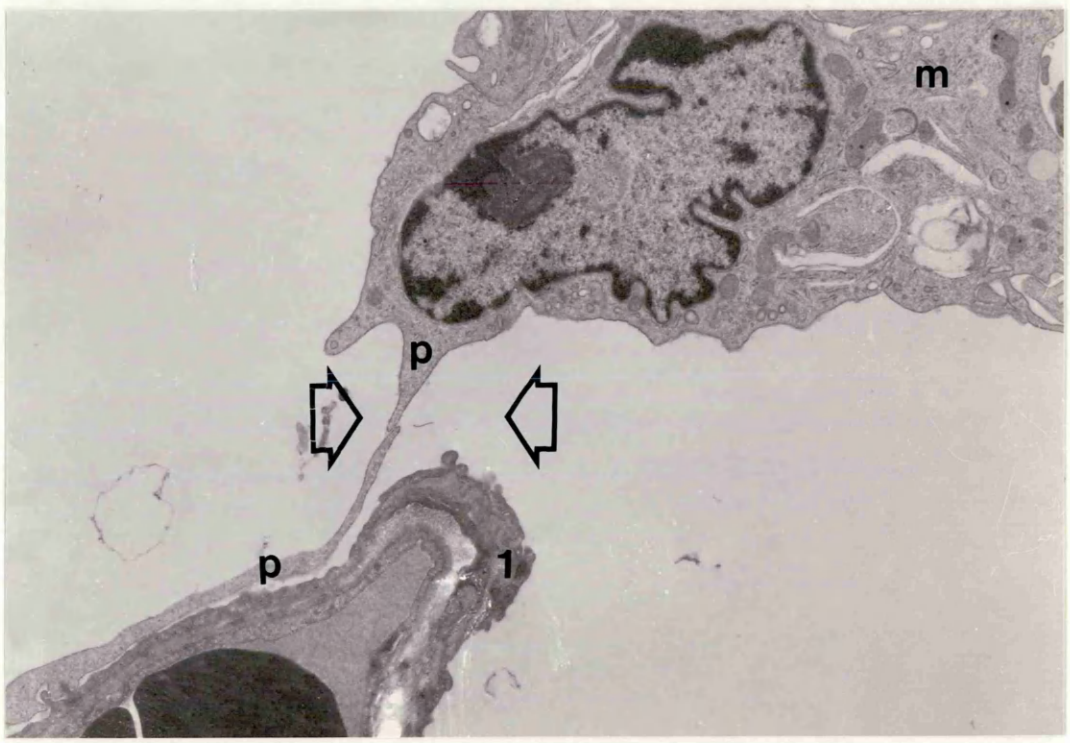

2
2

Fig. 6.44 Alveolar membrane. An alveolar macrophage (M) lies over a Type I pneumocyte (1). The former contains many lysosomes and vacuoles, some of which contain osmiophilic lamellar material (Arrows). Note the numerous cytoplasmic projections.
TEM x 16,000

Fig. 6.45 Alveolar membrane. An alveolar macrophage (M) with a long, slender cytoplasmic process (P) bridging an alveolar pore (Arrows). Note the attenuated cytoplasm of a Type I pneumocyte (1) which continues round the edge of the pore.
Compare the Figures above to the SEM appearance in Figs. 6.20, 6.23 and 6.24.
TEM x 10,000


m
1


m
p
p
1

CHAPTER 7

Fig. 7.1 A sagittal section of the head of a pony affected with Strangles. The tongue, larynx and nasal septum have been removed.

1. Soft palate
2. Nasopharynx
3. Guttural pouch
4. Enlarged retropharyngeal lymph nodes
5. Enlarged mandibular lymph nodes.

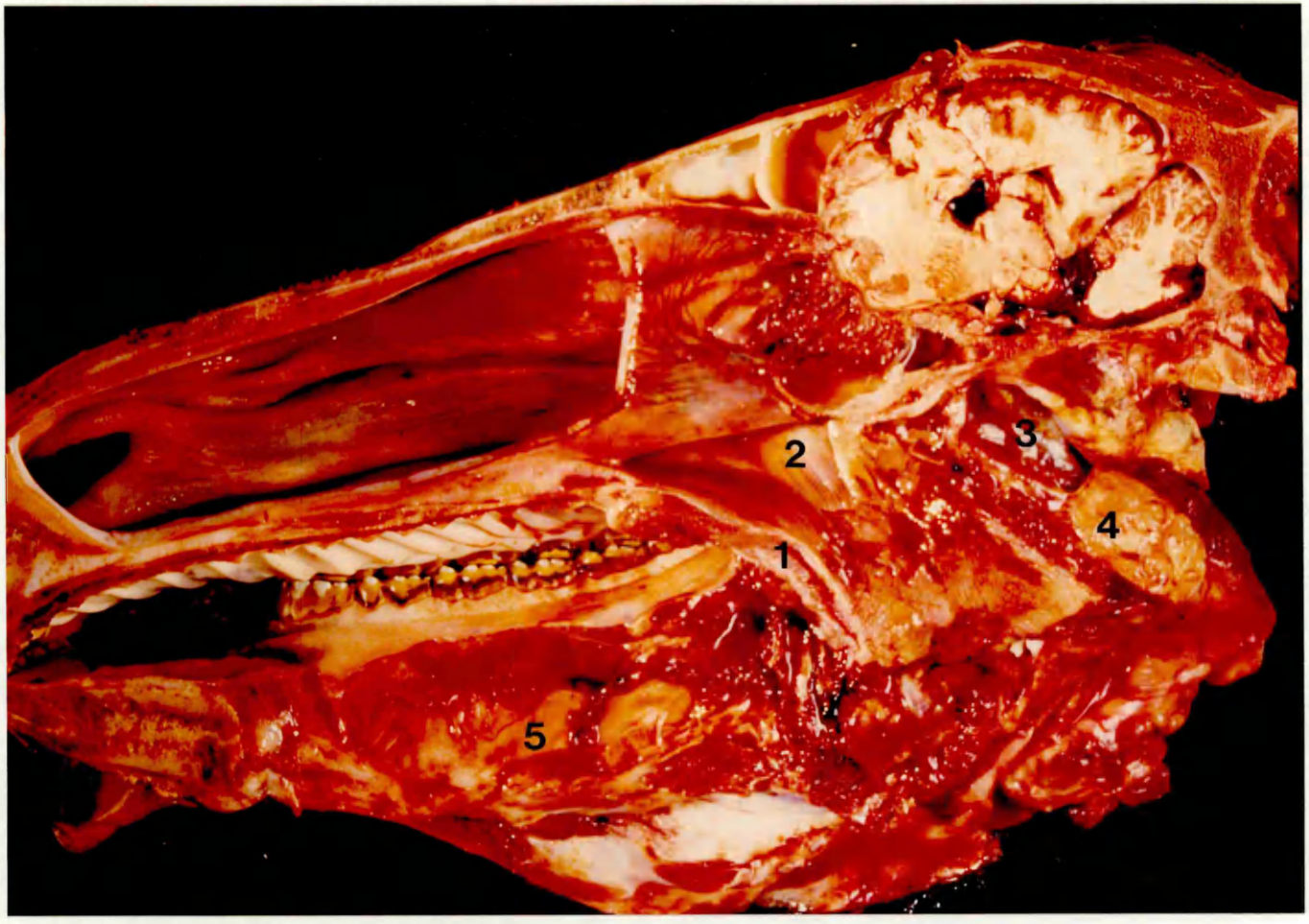

1
2
3
4
5

Fig. 7.2 A sagittal section of the caudal region of the head of a pony affected with Strangles. The tongue and larynx have been removed.

1. Hard palate
2. Soft palate
3. Nasopharynx
4. Large abscess in a retropharyngeal lymph node.

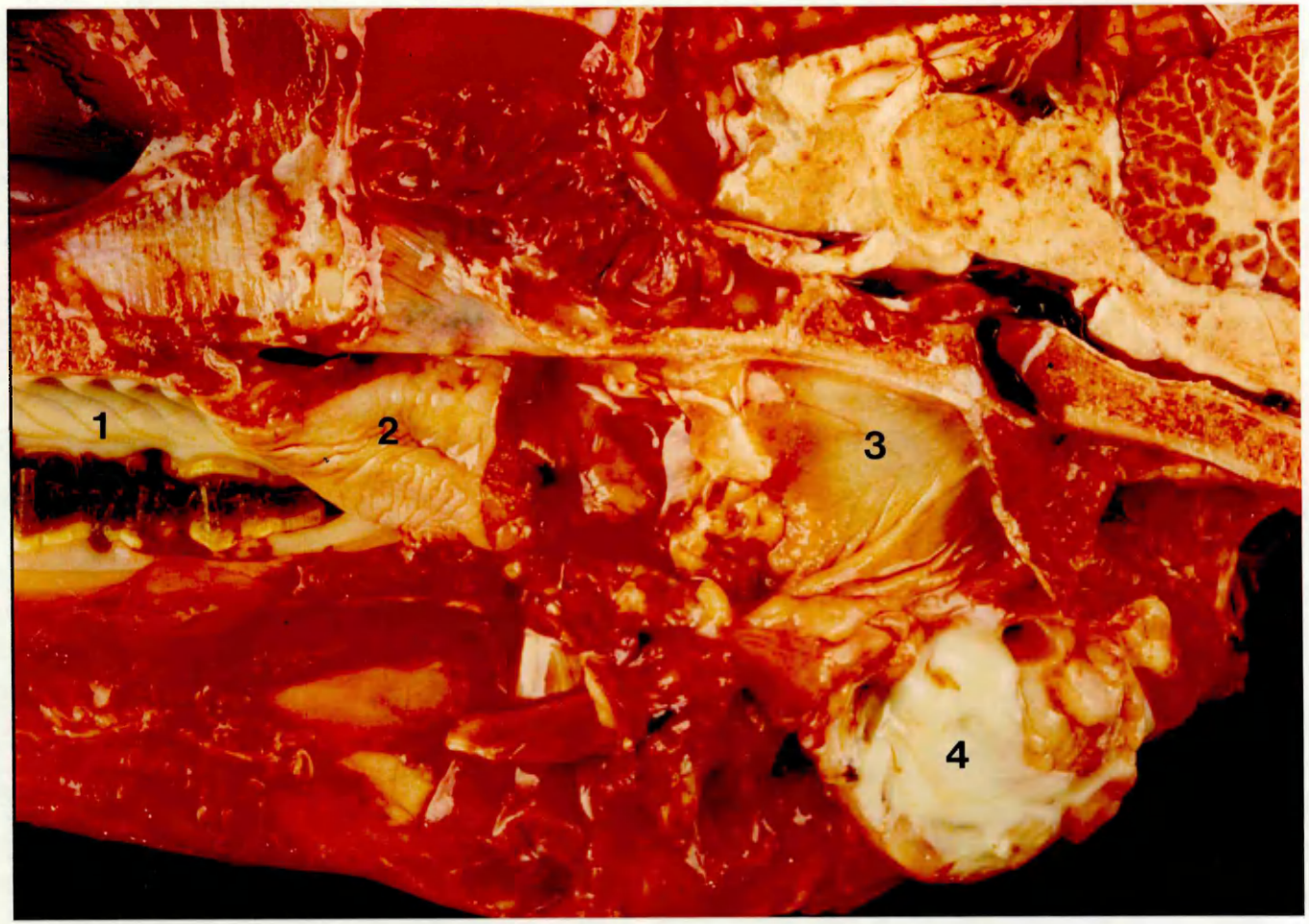

1
2
3
4

Fig. 7.3 A sagittal section of the caudal region of the head of a pony affected with Strangles. The nasal septum, tongue and larynx have been removed.

1. Conchofrontal sinus
2. Hard palate
3. Soft palate
4. Nasopharynx
5. Guttural pouch

An abscess bulges into the guttural pouch (Arrows).


5
4
3
2
1

Fig. 7.4 A transverse section of the head of a pony affected with Strangles, at the level of the occipital condyles (looking forward).
(See Fig. 2.11 for the head of a normal horse).

1. Occipital condyles
2. Pharynx
3. Right guttural pouch containing cream coloured pus (Asterisk).
   Note the thickened, oedematous surrounding tissue (Arrows).


1
1
3
*
2

Fig. 7.5 Nasal septum. A group of cocci adhere to the surface of the microvillous cells (left). A higher power view on the right shows the "fuzzy" surface of the bacteria.
SEM x 5,000 and 20,000

Fig. 7.6 Basal fold of the ventral nasal concha. Rod-shaped bacteria adhere to the squamous cells which have microplicae or short microvilli on their surfaces.
SEM x 10,000

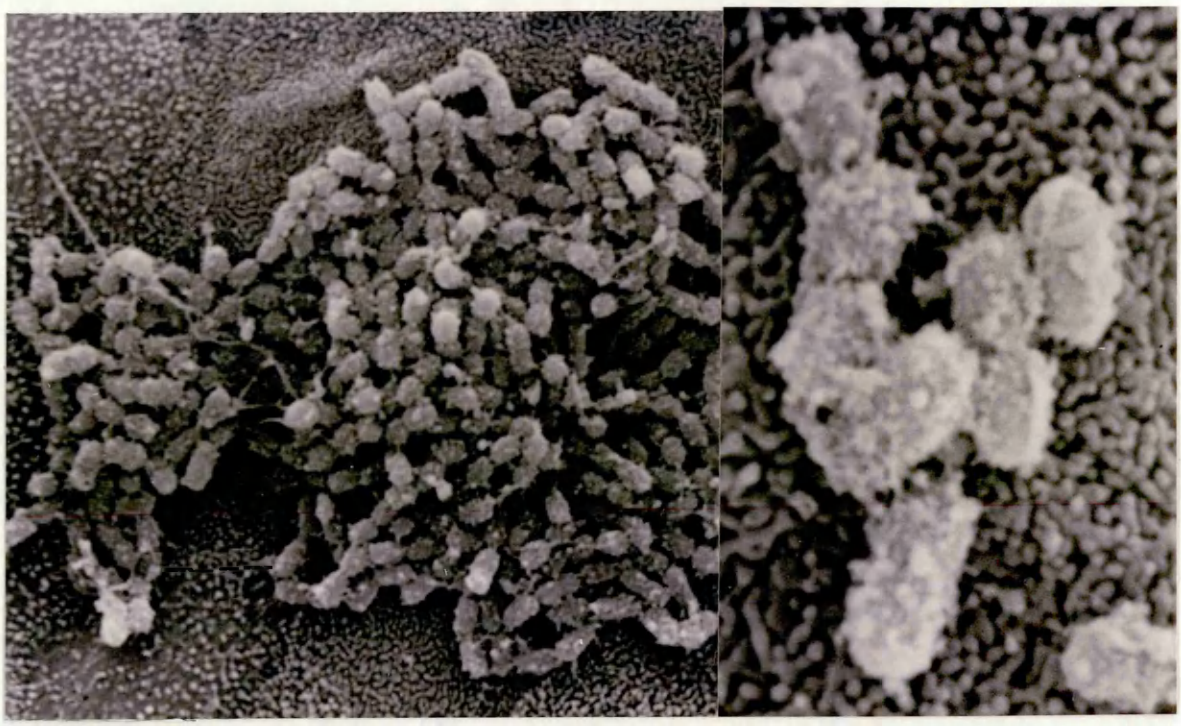


Fig. 7.7 Guttural pouch. Patches of microvillous cells among the ciliated cells. Strands of surface mucus (Arrows) adhere to the cilia.
SEM x 2,500

Fig. 7.8 Pharyngeal opening of the auditory tube. A smooth circumscribed area is raised above the folded mucosal surface. Compare with Fig. 4.29.
SEM x 160

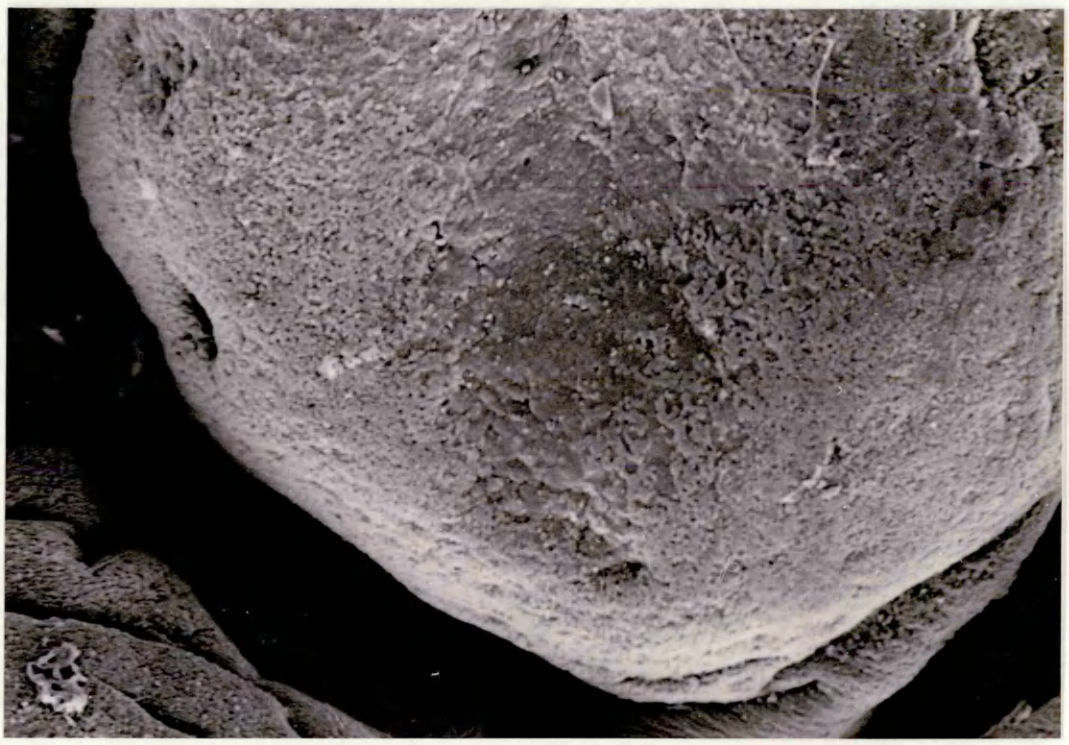


Fig. 7.9 Guttural pouch. Surface mucus (M) traps a group of inflammatory cells.
SEM x 5,000

Fig. 7.10 Guttural pouch. Microvillous cells and cells with sparse stunted cilia cover the surface.
SEM x 5,000


m

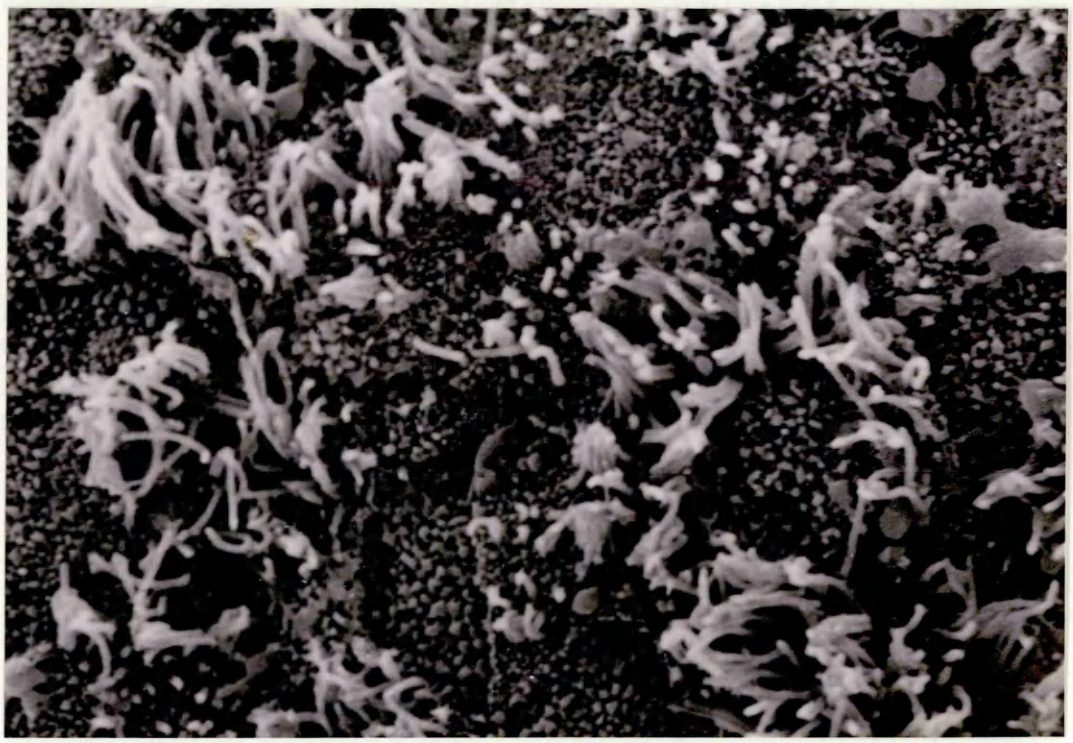


Fig. 7.11 Oral surface of the soft palate. Squamous cells with distinct boundaries are obscured in places by large numbers of adherent cocci.
SEM x 2,500

Fig. 7.12 Oral surface of the soft palate. Numerous cocci, either as single cells or diplococci (Arrows) adhere to the squamous cells. Note the surface microplicae of the latter.
The bacteria have fewer surface filaments and appear smoother than those illustrated in Fig. 7.5 .
SEM x 10,000

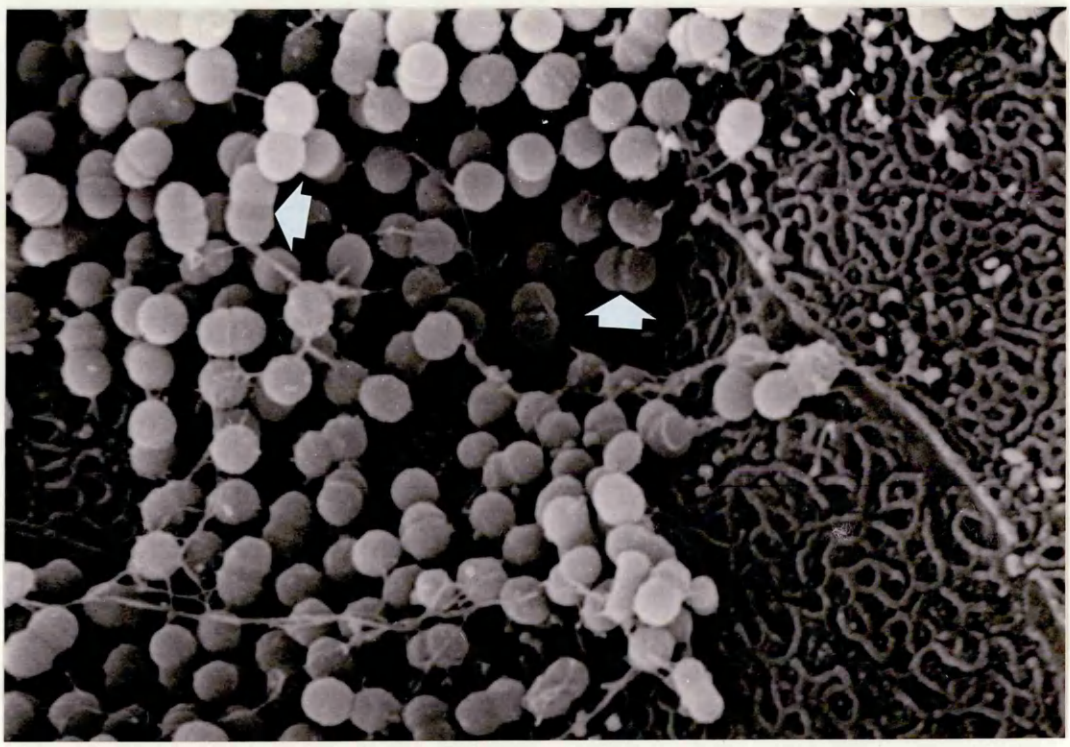
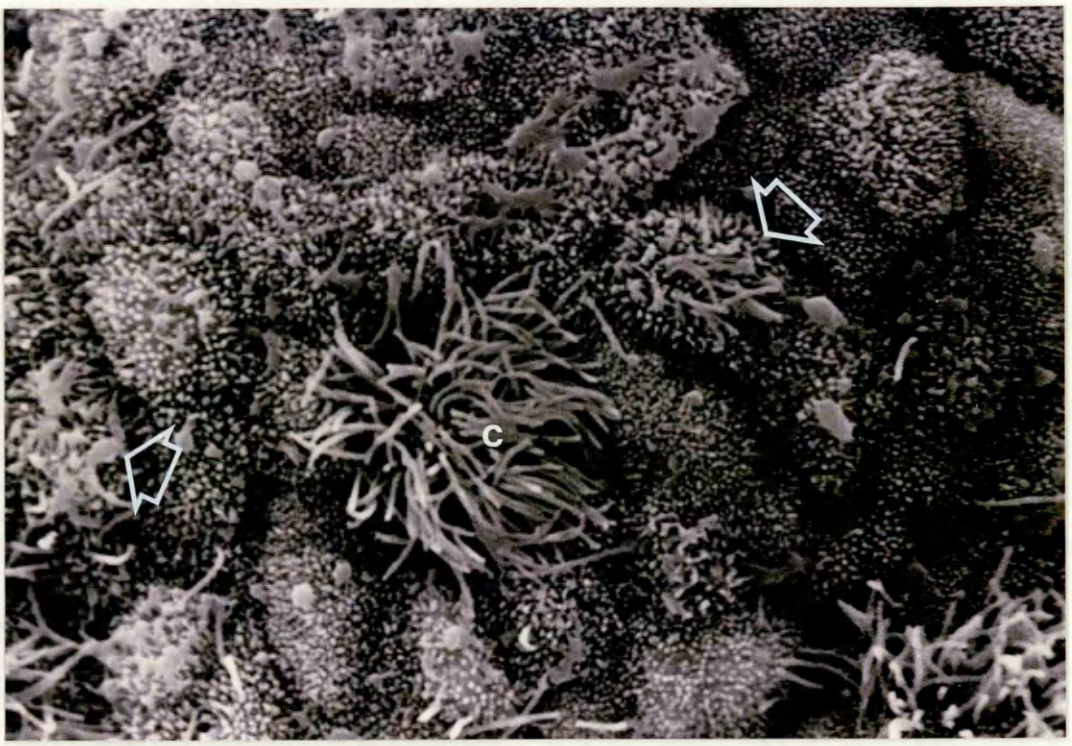


Fig. 7.13 Lobar bronchus. The ciliated surface is interrupted by patches of nonciliated microvillous cells.
SEM x 1,280

Fig. 7.14 Small bronchus. Ciliated cells and patches of nonciliated microvillous cells (left). On the right a single ciliated cell remains among microvillous cells.
Note the mucous cells (Arrows).
SEM x 1,280 and 5,000

Fig. 7.15 Dorsal nasal concha. Loss of surface ciliation with one apparently normal ciliated cell remaining (C) among microvillous cells and cells with damaged cilia (Arrows).
SEM x 5,000

Fig. 7.16 Dorsal nasal concha. On the left cells with microvilli and single cilia (Arrows). A red blood corpuscle (R) lies on a ciliated cell. On the right stunted cilia are coated with mucus.
SEM x 5,000


c


r

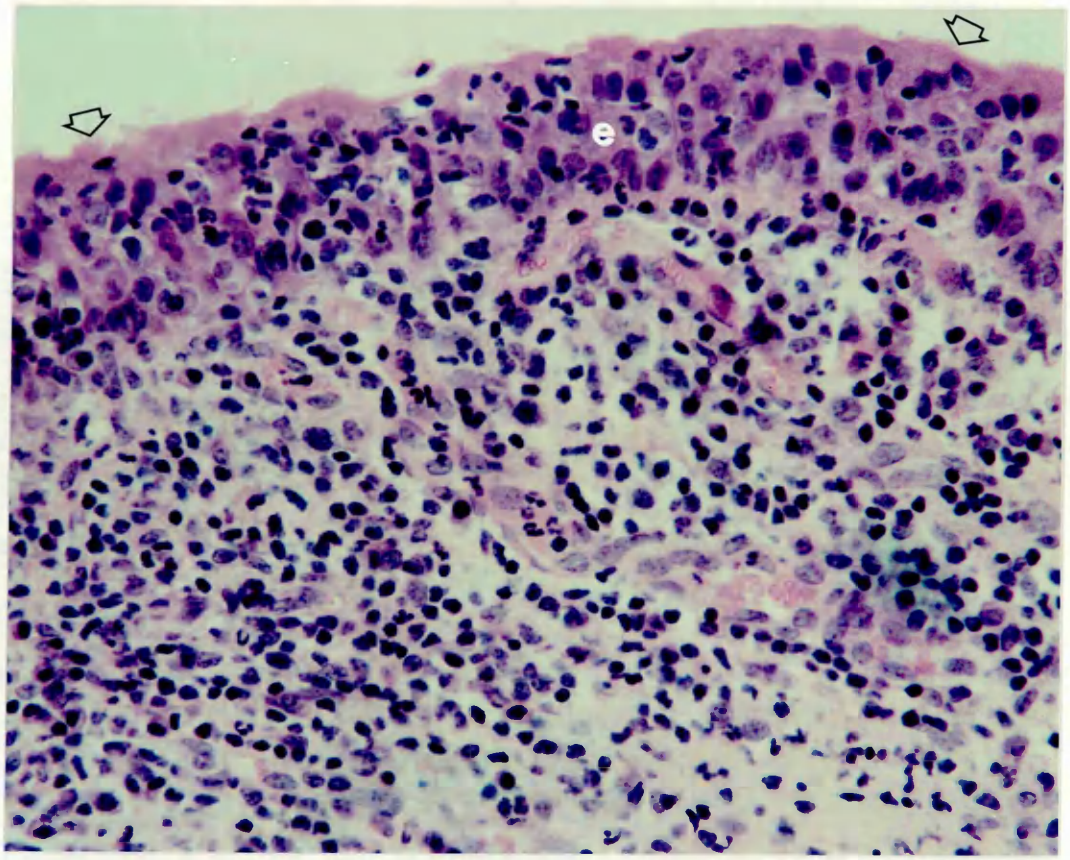
Fig. 7.17 Nasopharynx. Circumscribed smooth areas project from the folded mucosal surface. Compare with similar features in the guttural pouch (Fig. 4.29) and auditory tube (Fig. 7.8). SEM x 80

Fig. 7.18 Nasopharynx. A stratified cuboidal type of epithelium with a few surface ciliated cells (Arrows), covers the surface. Many cells (lymphocytes, plasma cells and neutrophils) have infiltrated the lamina propria and some can be seen within the epithelium.

HE x 250

Fig. 7.19 Nasopharynx. A lymphoid follicle with a germinal centre (Arrows) has developed in the lamina propria. Cells (mainly lymphocytes and a few neutrophils) are seen migrating through the epithelium and accumulate on the surface (Small arrows).

HE x 250


e

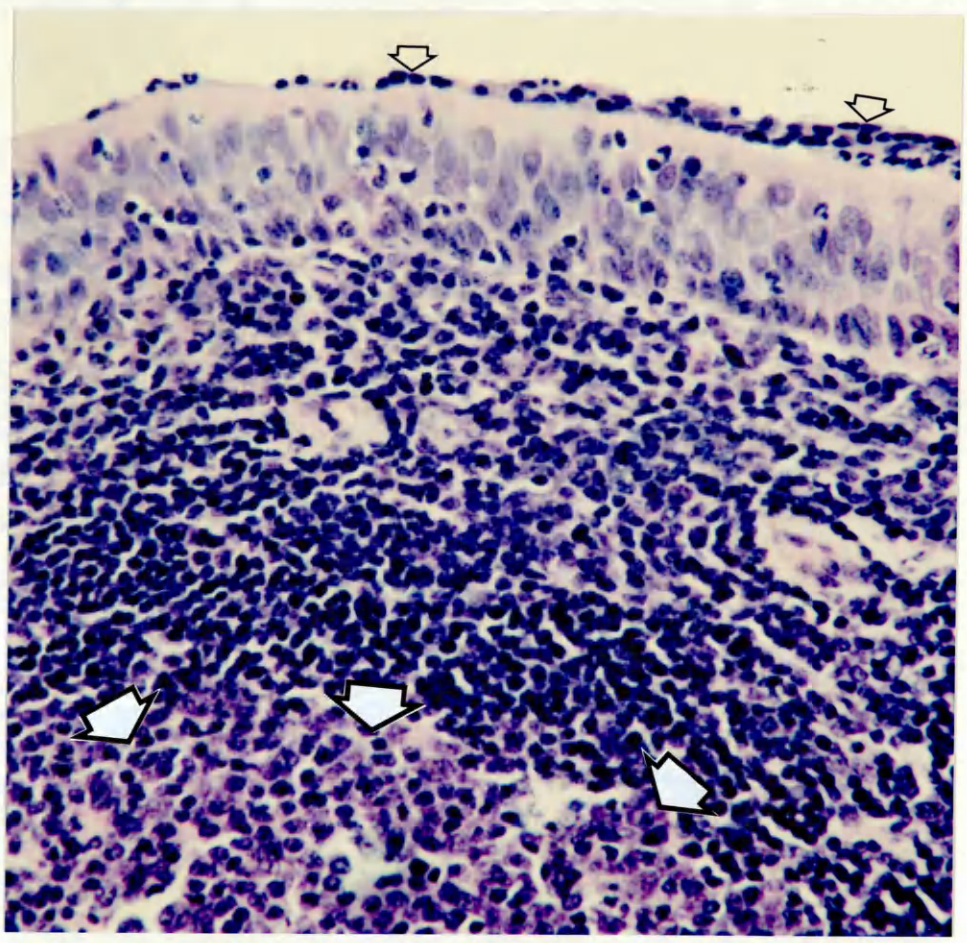


Fig. 7.20 Guttural pouch. There is a massive cellular infiltration of the subepithelial tissue. Inflammatory cells can be seen migrating through the epithelium (E) and many lie on the surface (Arrows).
HE x 180

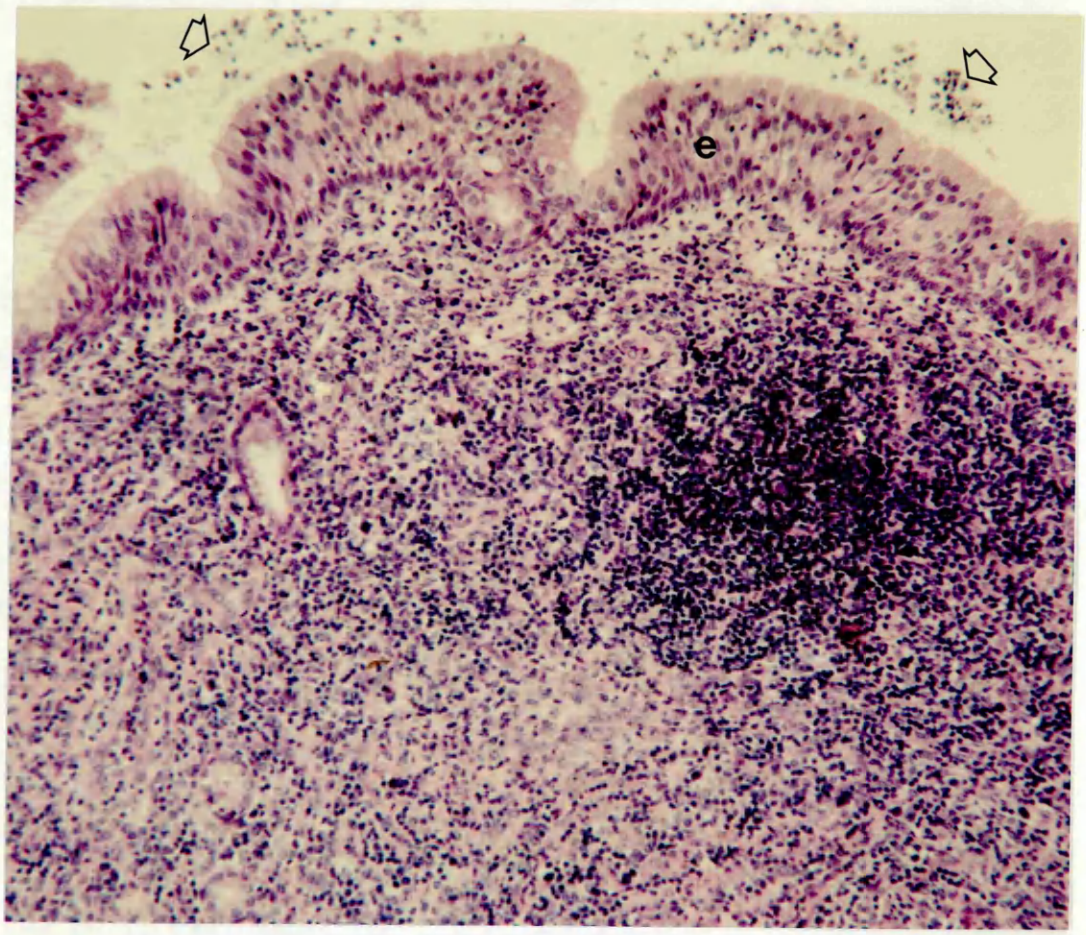
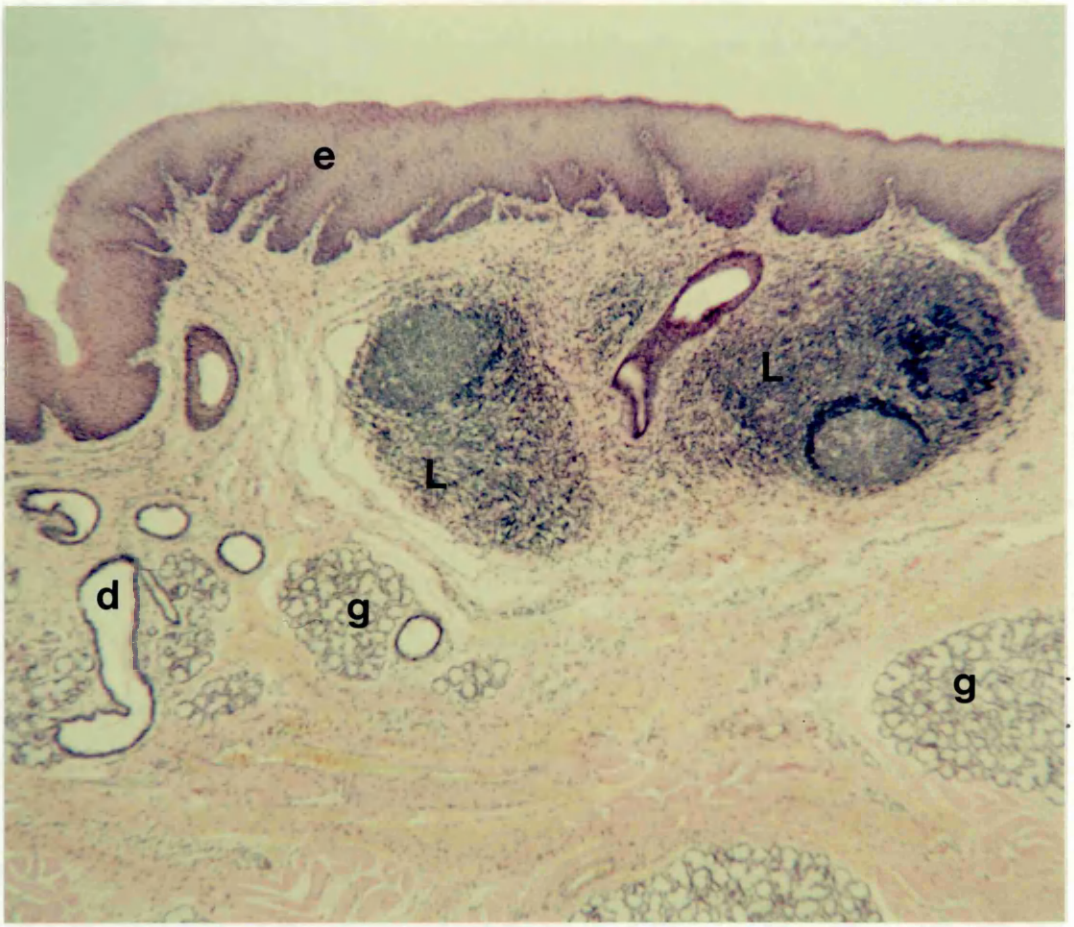

e

Fig. 7.21 Oral surface of the soft palate. Lymphoid follicles (L) with germinal centres lie below the stratified squamous epithelium (E). Note the mucosal glands (G) and their ducts (D).
HE x 100

Fig. 7.22 Oral surface of the soft palate. The outer layers of the stratified squamous epithelium. Many groups of gram positive cocci (Arrows) adhere to the surface squamous cells. This was also an SEM feature (See Fig. 7.11 and Fig. 7.12).
Gram-Engbaek x 400


e
L
L
d
g
g

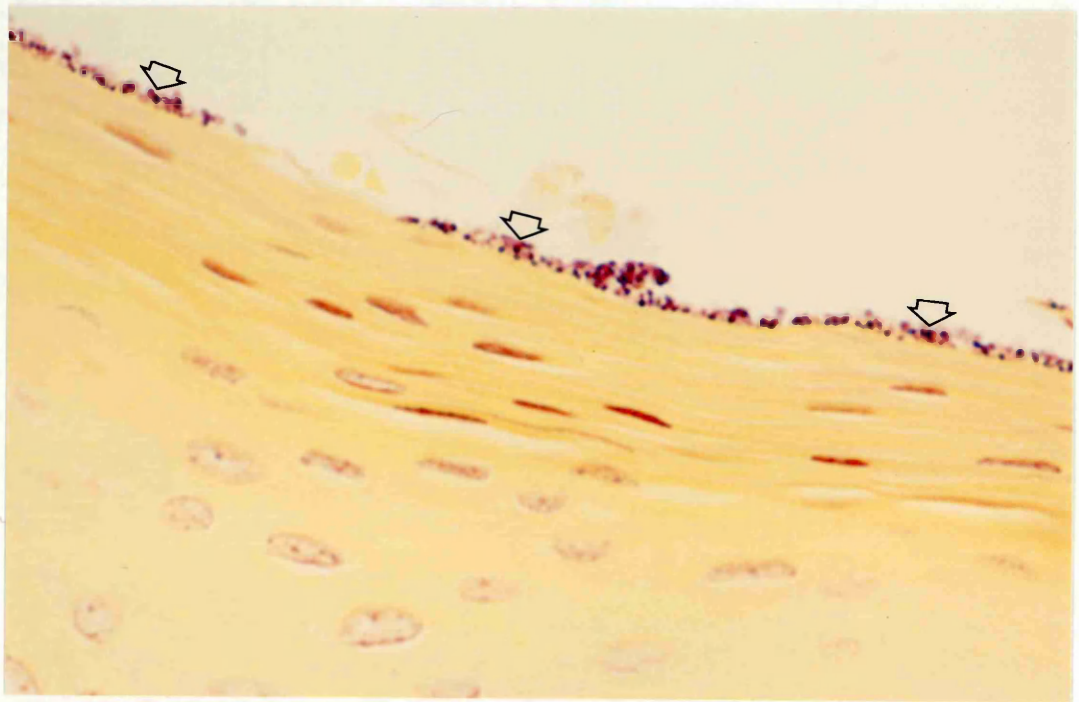
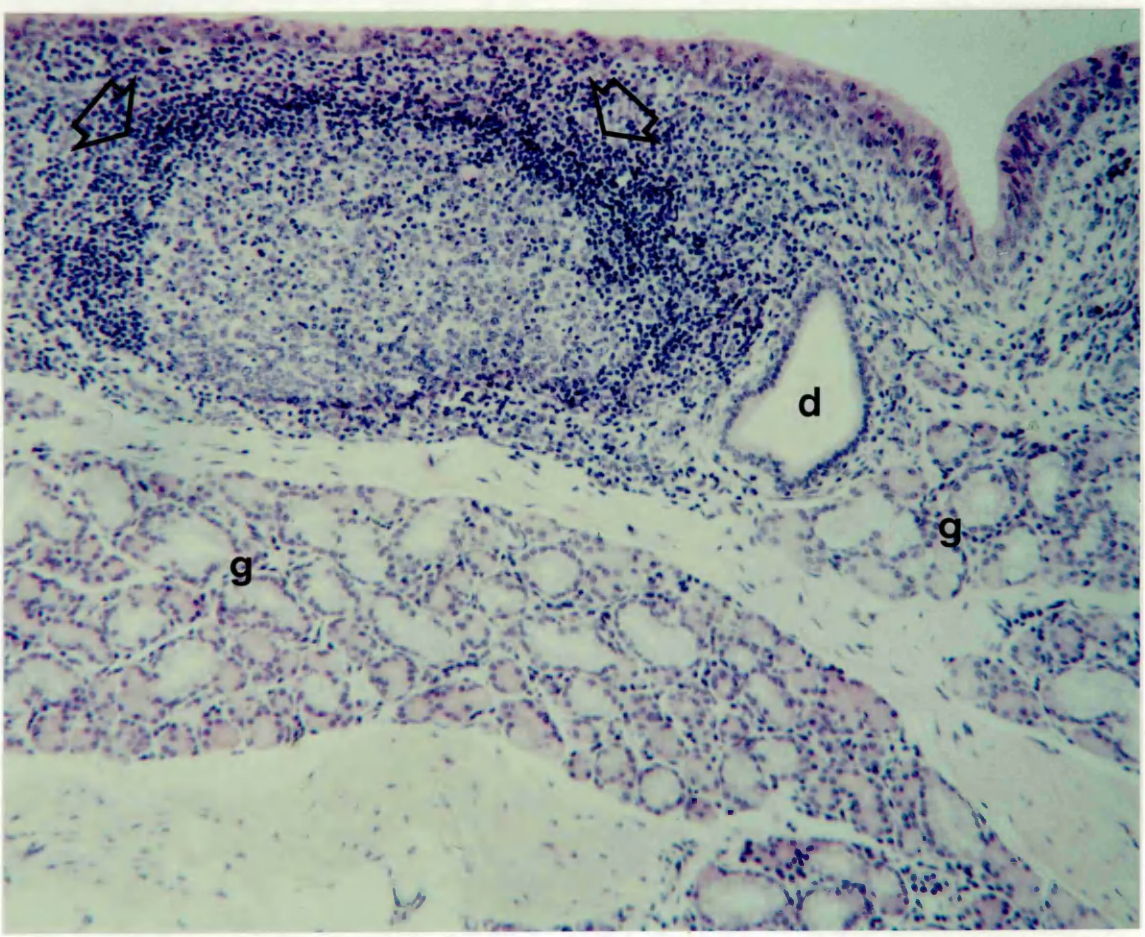


Fig. 7.23 Nasopharynx. Follicular lymphoid hyperplasia (Arrows) with a germinal centre. Many glands (G) and a gland duct (D) are present.
HE x 180


d
g
g

CHAPTER 8

Fig. 8.1 Diagram of a dorsal view of the lungs of a horse with sample sites indicated by black squares for SEM and red squares for light microscopy.

1. Cranial segmental bronchus
2. Caudal segmental bronchus
3. Caudal small bronchus

4 and 5. Lung slices

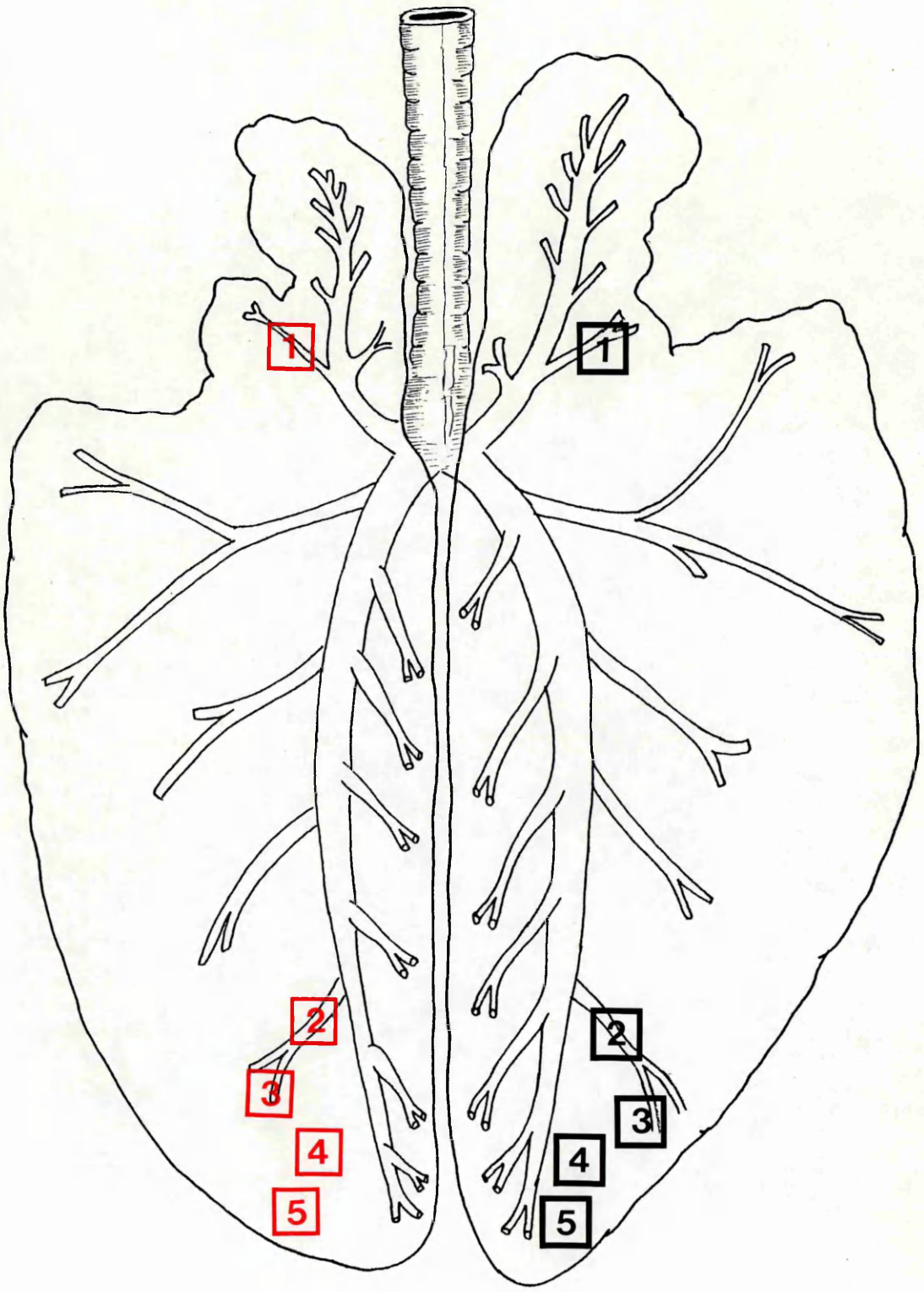

1
1
2
3
4
5
2
3
4
5

Fig. 8.2 Left lung of a horse affected with chronic obstructive pulmonary disease. The whole lung is overinflated and costal impressions can be seen on the dorsal border of the caudal lobe (Arrows). Puffy raised areas in the cranial lobe and ventral border of the caudal lobe are indicated by asterisks.

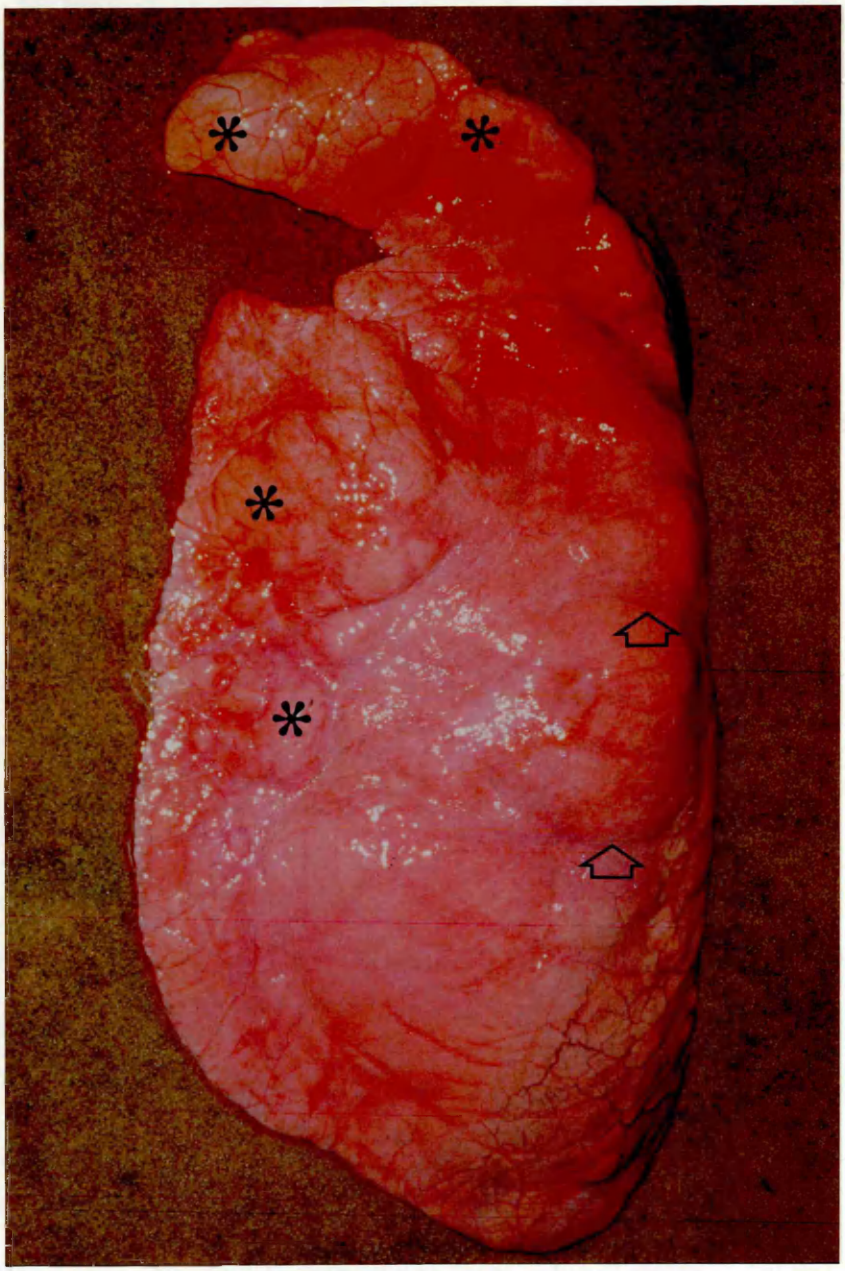


Fig. 8.3 Left lung and heart of a horse affected with chronic obstructive pulmonary disease. The lung is overinflated and pale.
Note the fibrous tags on the ventral border of the caudal lobe (Arrow).
Compare the appearance of the lungs in Figs. 8.2 and 8.3 with those of normal horses illustrated in Figs. 2.14 and 2.15.

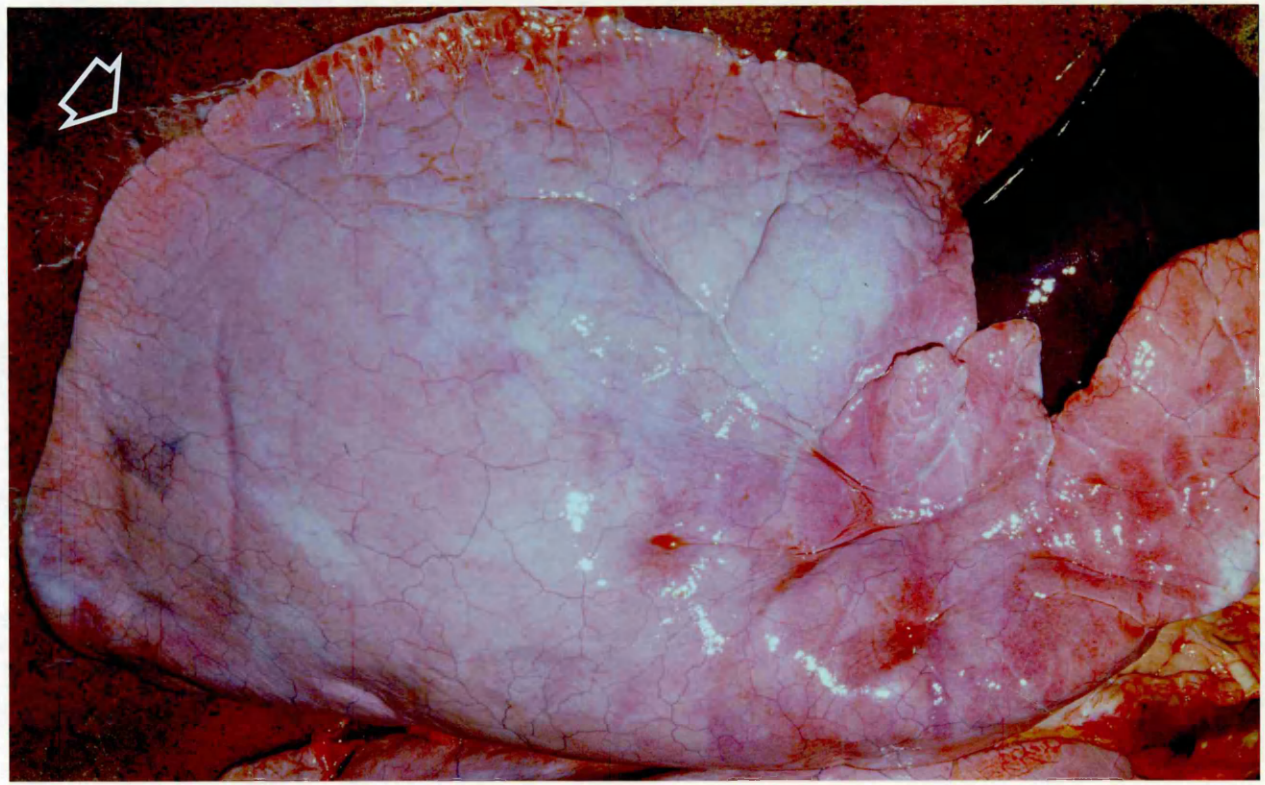
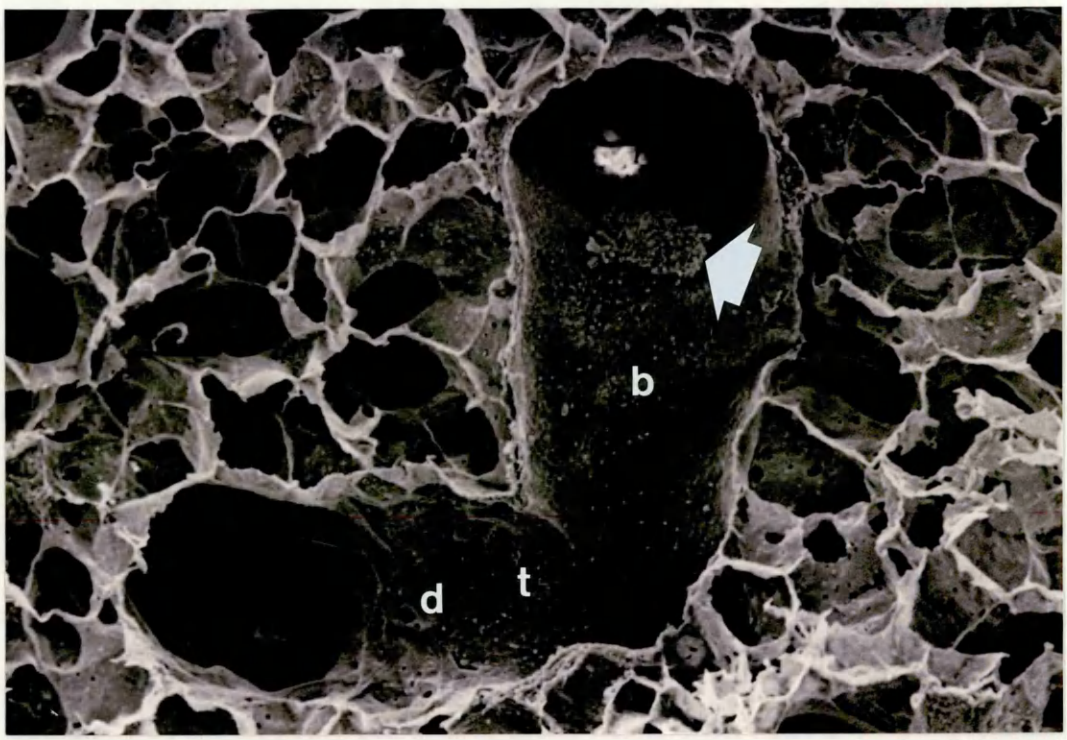


Fig. 8.4 Larynx. The usual well ciliated surface is interrupted by patches of microvillous cells. SEM x 2,500

Fig. 8.5 Lobar bronchus. Microvillous and poorly ciliated cells. SEM x 2,500

Fig. 8.6 Lung. A bronchiole (B) with inflammatory exudate (Arrow) lying on the surface. A terminal bronchiole (T) opens into an alveolar duct (D). SEM x 160

Fig. 8.7 Lung. Mucus (Arrows) which has trapped cell debris, obscures the junction of a terminal bronchiole (T) and alveolar duct (D). SEM x 640


b
d
t

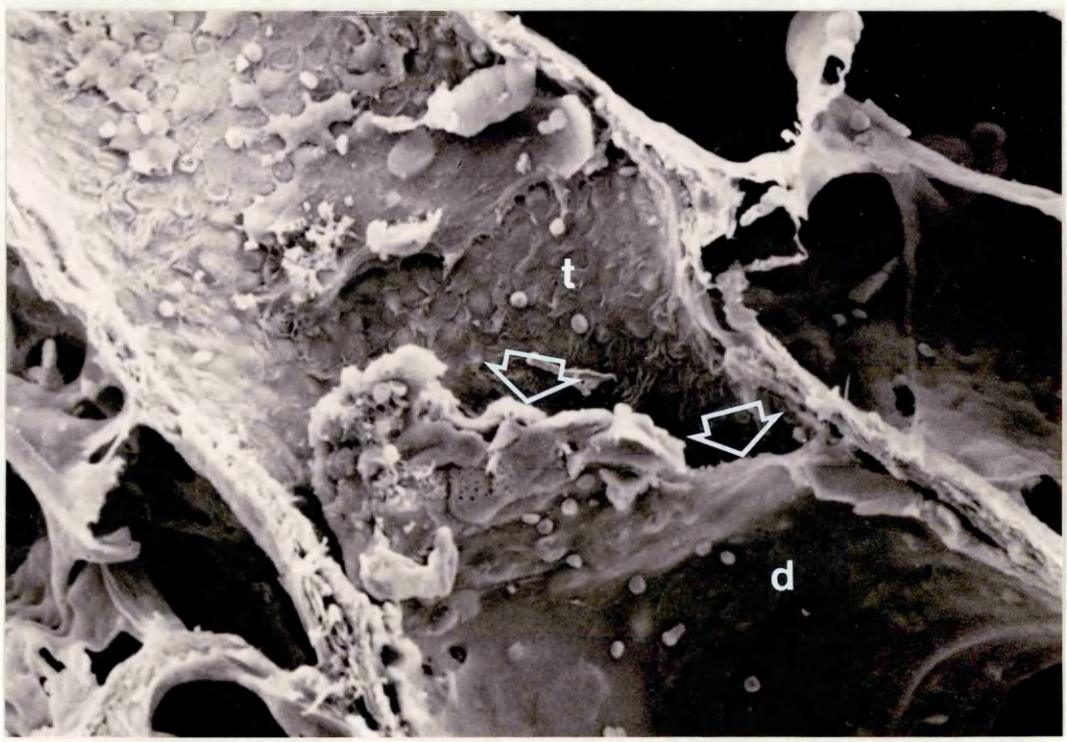

t
d

Fig. 8.8 Bronchiole. Mucus in the lumen traps many degenerate cells, most of which are probably neutrophils and a few desquamated epithelial cells.
SEM x 1,280

Fig. 8.9 Bronchiole. A higher power view showing degenerate neutrophils (N) and red blood corpuscles (R) caught in strands of mucus (Arrows).
SEM x 5,000

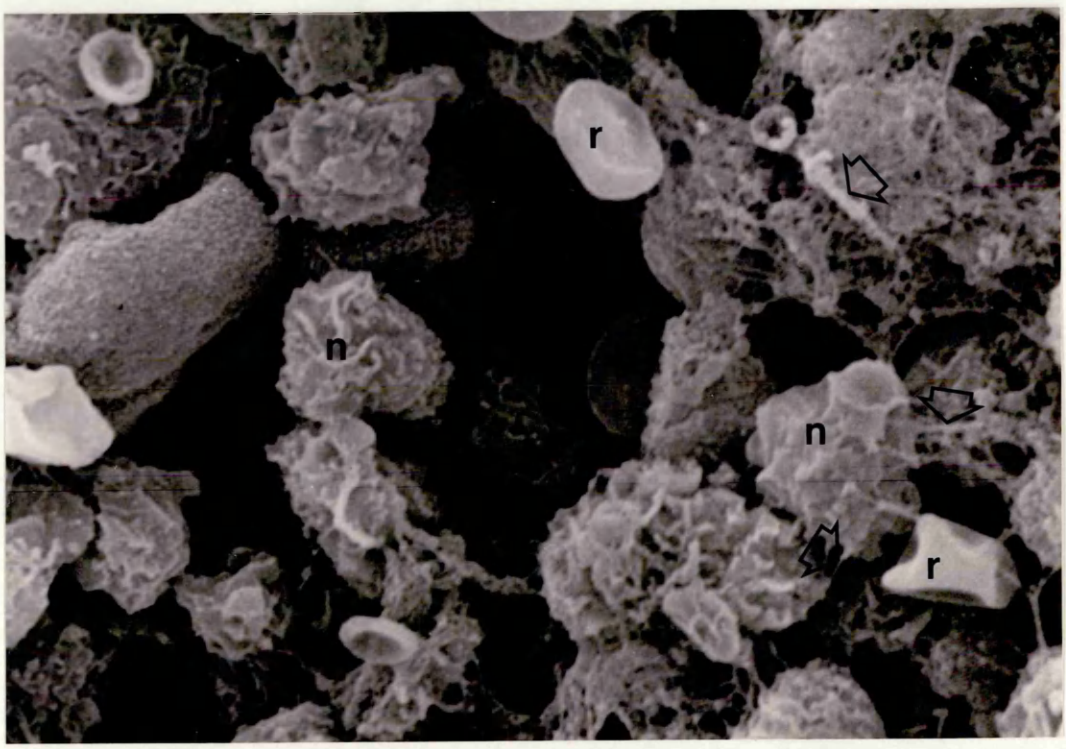

r
n
n
r

Fig. 8.10 Bronchiole. A mucus plaque (M) adheres to the surface. Some ciliated cells have a few peripherally disposed cilia (Arrows) and the Clara cells (C) appear flat.
SEM x 5,000

Fig. 8.11 Bronchiole. Note the crumpled, collapsed appearance of many of the Clara cells.
Compare the Figures above to the appearance of bronchioles in normal horses in Figs. 6.13 and 6.14.
SEM x 5,000

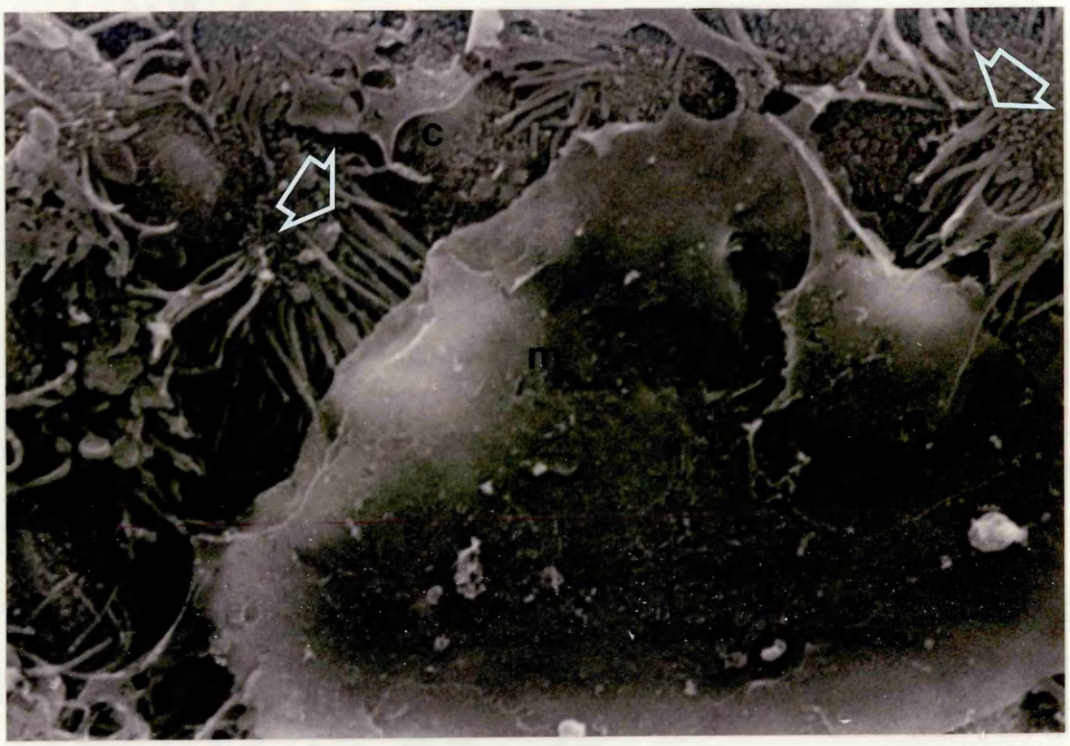
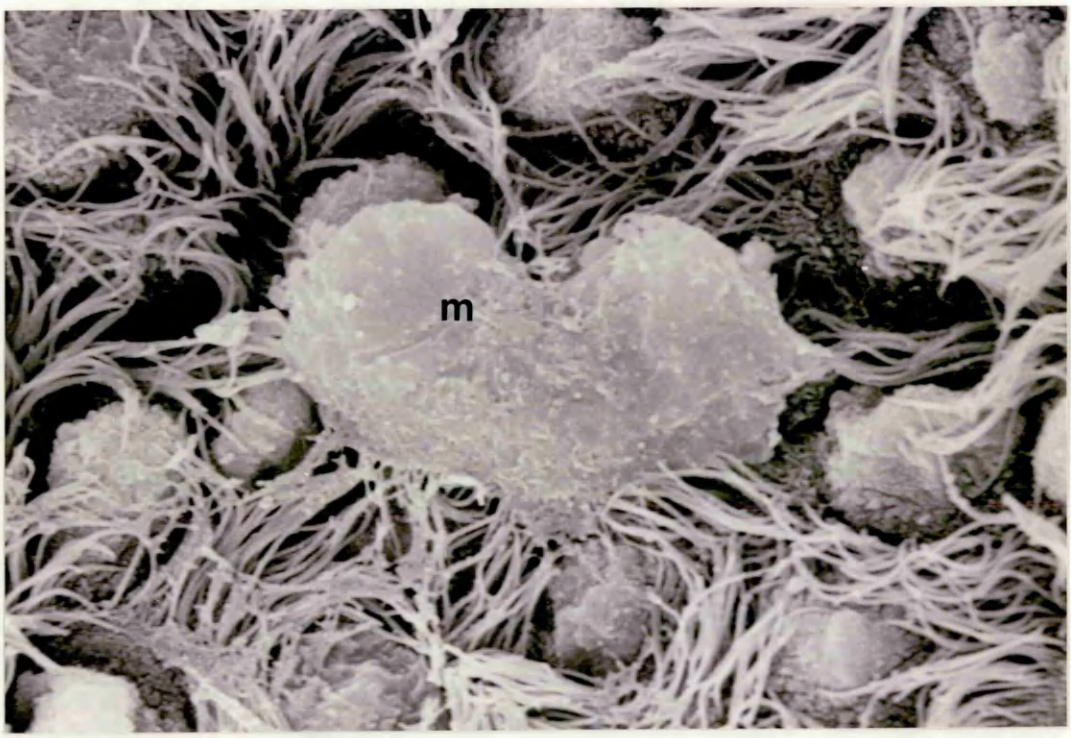

c
n

Fig. 8.12 Bronchiole. A macrophage (M) with a few short cytoplasmic extensions lies on the surface.
SEM x 5,000

Fig. 8.13 Bronchiole/alveolar duct junction. The macrophages (M) lie at the junction. Note the Type II pneumocytes (2) and alveolar pore (P).
(See also Fig. 8.19).
SEM x 2,500


m

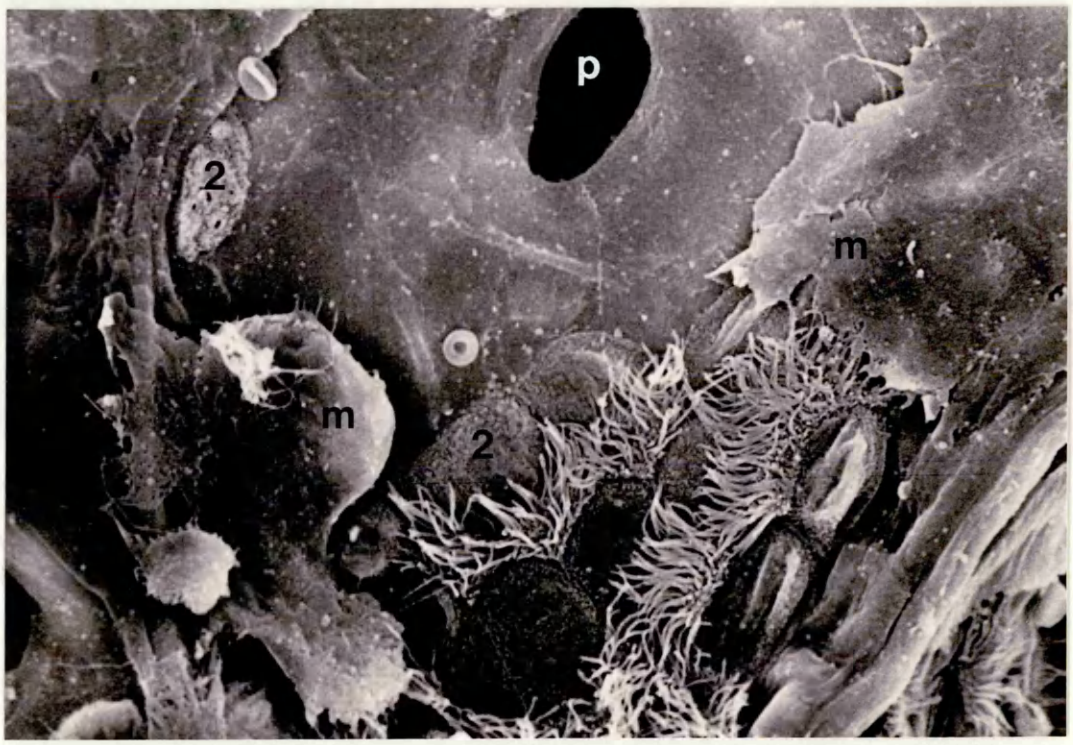
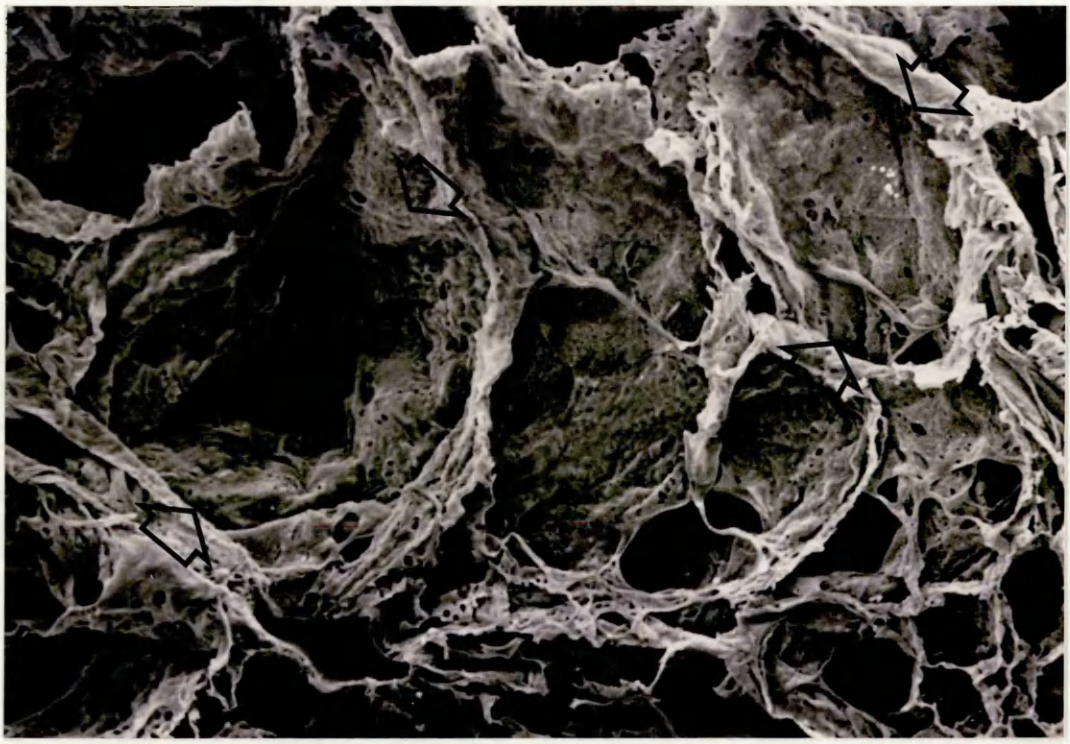

p
2
m
m
2

Fig. 8.14 Lung. Areas of overinflation (Arrows) where normal alveolar structure is lost. Compare with the lung of a normal horse in Fig. 6.11.
SEM x 80

Fig. 8.15 Lung. Localized areas of emphysema (Arrows) directly below the pleura (P). Compare with the normal subpleural structure in Fig. 6.27.
SEM x 80



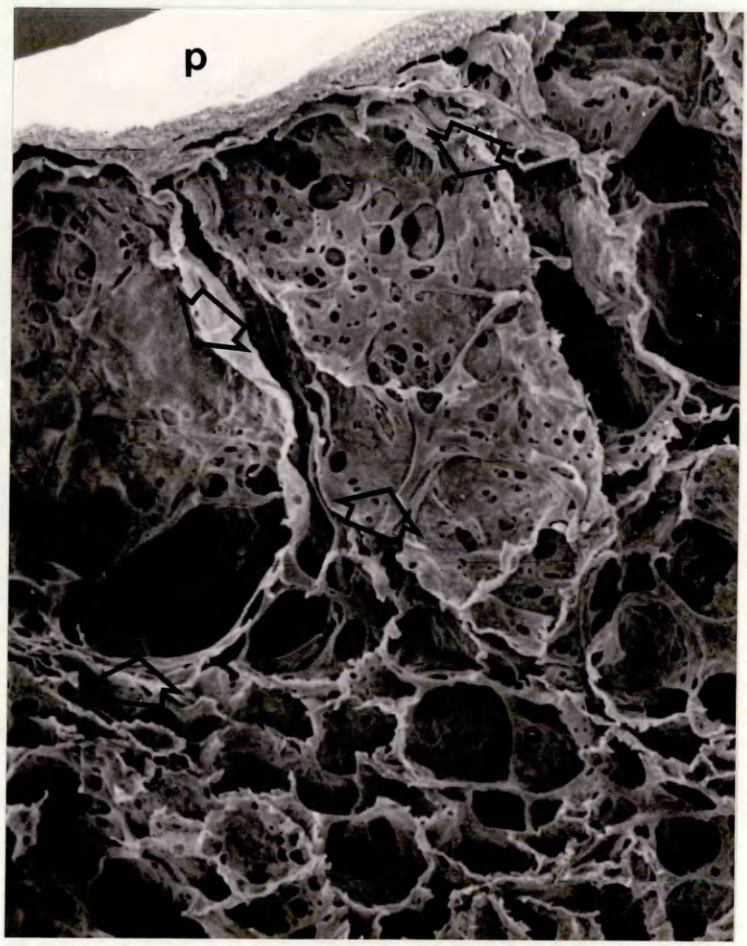
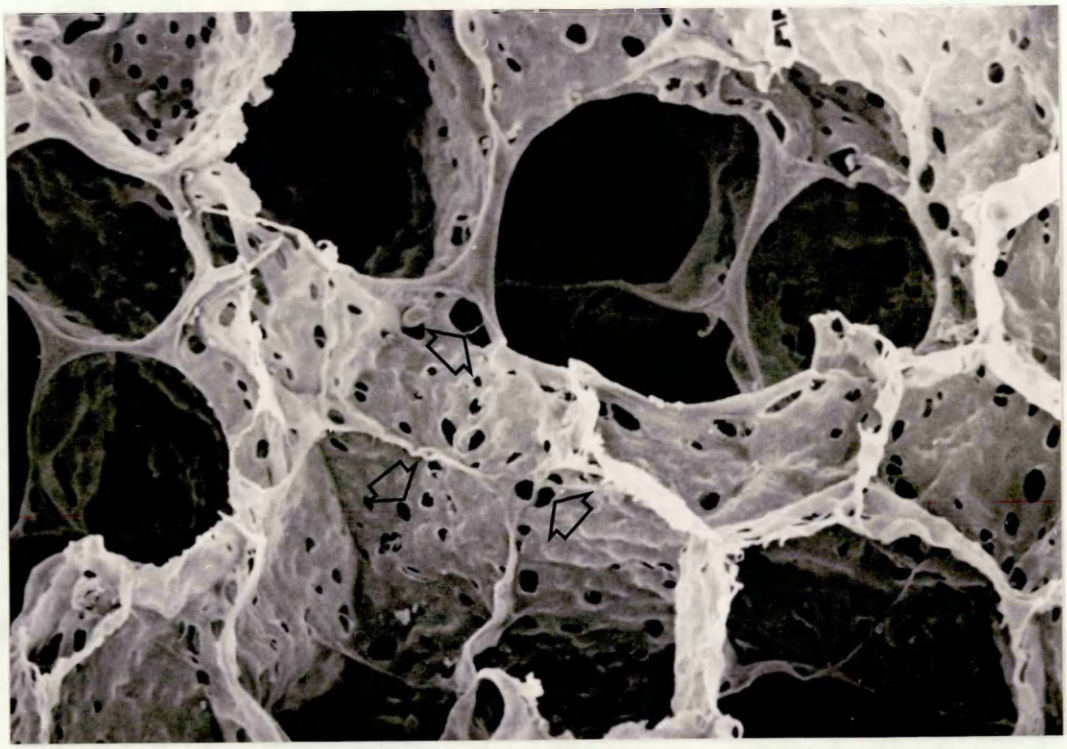

p

Fig. 8.16 Lung. Many alveolar pores (Arrows) are present in affected areas.
SEM x 320

Fig. 8.17 Lung. An area of overinflation with loss of normal alveolar structure. Note the numerous alveolar pores and their varied size and shape (Arrows). Compare the Figures above with normal lung structure in Figs. 6.25 and 6.26.
SEM x 160



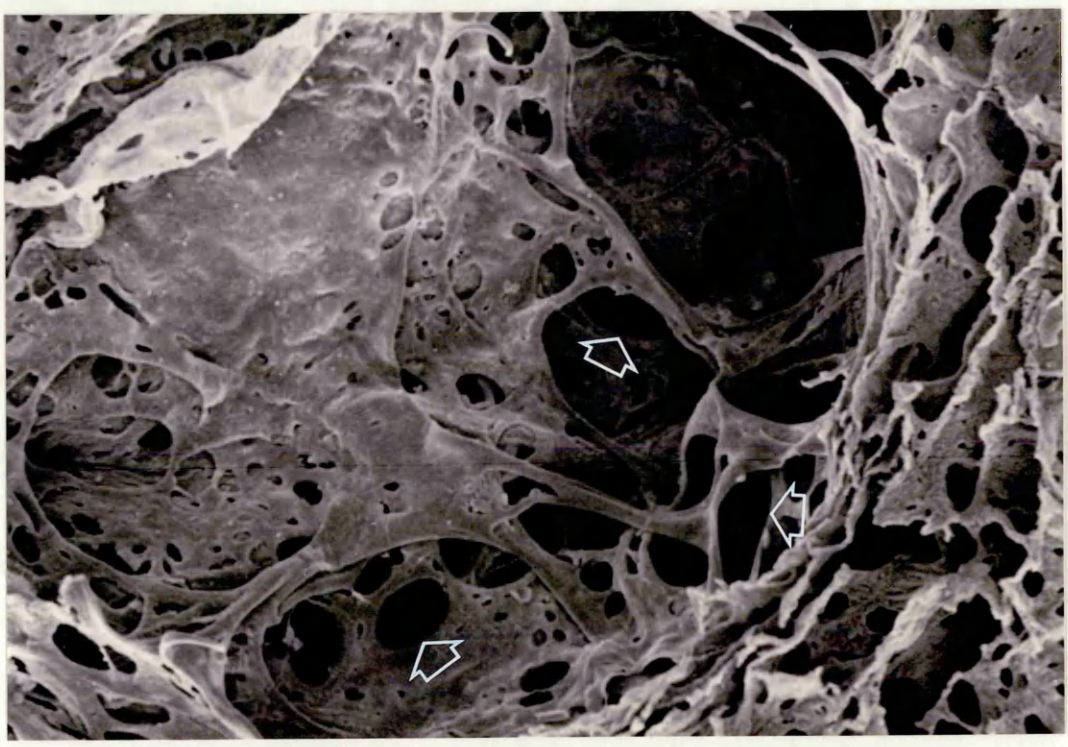


Fig. 8.18 Alveolar membrane. A sheet of mucous exudate (M) almost obscures the surface. Part of a Type I pneumocyte (1) and an alveolar pore (P) are visible.
SEM x 5,000

Fig. 8.19 Alveolar duct/terminal bronchiole junction. Ciliated cells (C) are adjacent to several Type II pneumocytes (2). Macrophages (M) are also present in this area. An obvious cell boundary (Arrow) marks the junction of 2 Type I pneumocytes.


p
c

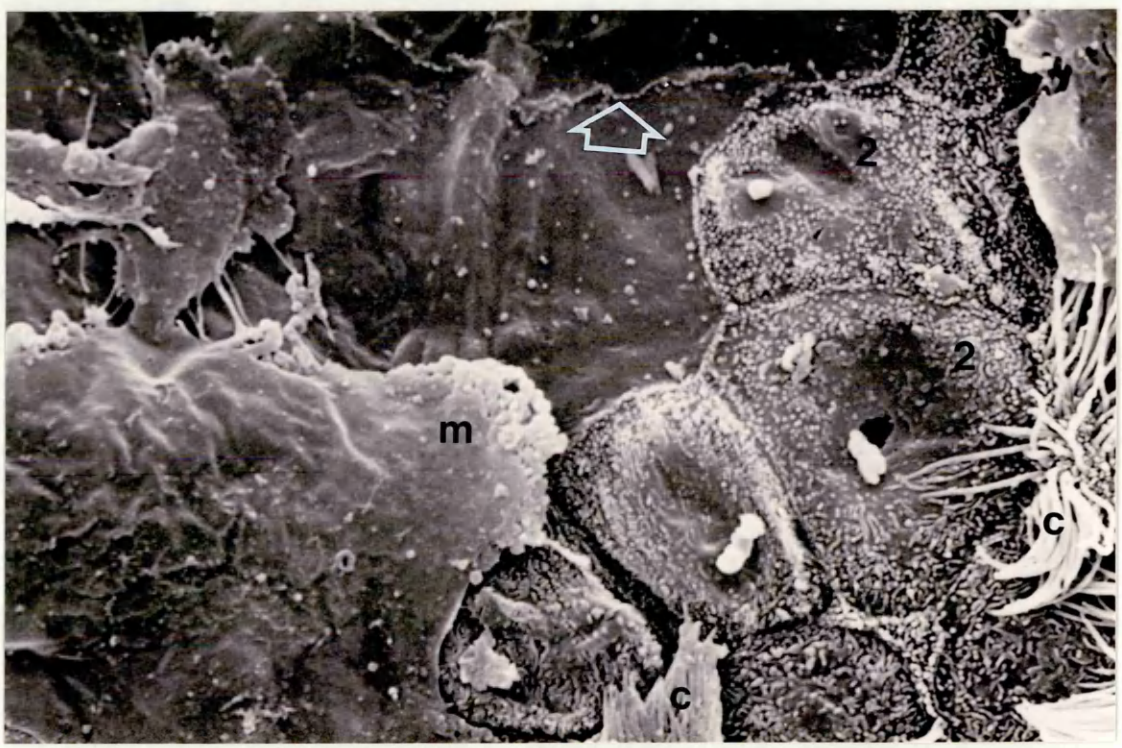
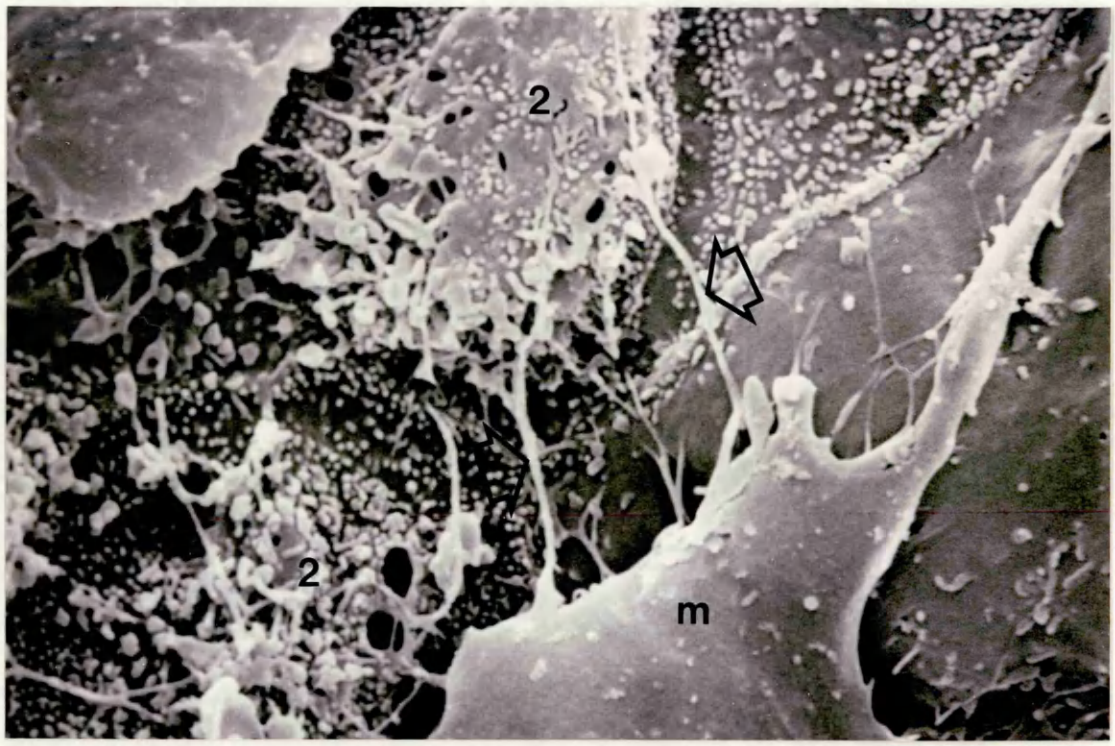

2
2
m
c
c

Fig. 8.20 Alveolar membrane. A Type II pneumocyte, in the centre of the picture, has many central pores. Compare with the appearance of a Type II pneumocyte in a normal horse (Fig. 6.20).
SEM x 10,000

Fig. 8.21 Alveolar membrane. Degenerate Type II pneumocytes (2) with macrophages (M) in close proximity. Note the latter's cytoplasmic processes (Arrows) extending towards the degenerate cells.
SEM x 10,000

Fig. 8.22 Alveolar membrane. A degenerate Type II pneumocyte (2) appears to be in the process of sloughing off the surface. A capillary (C) bulges into the alveolar space.
SEM x 10,000


2
2
m

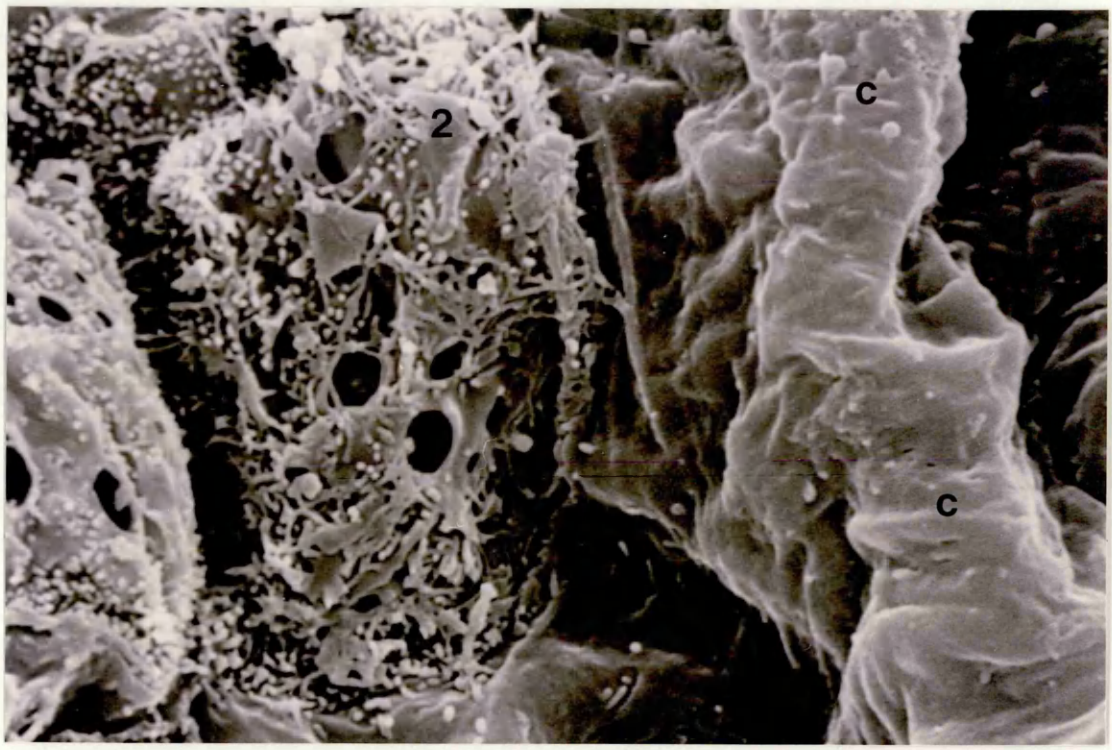
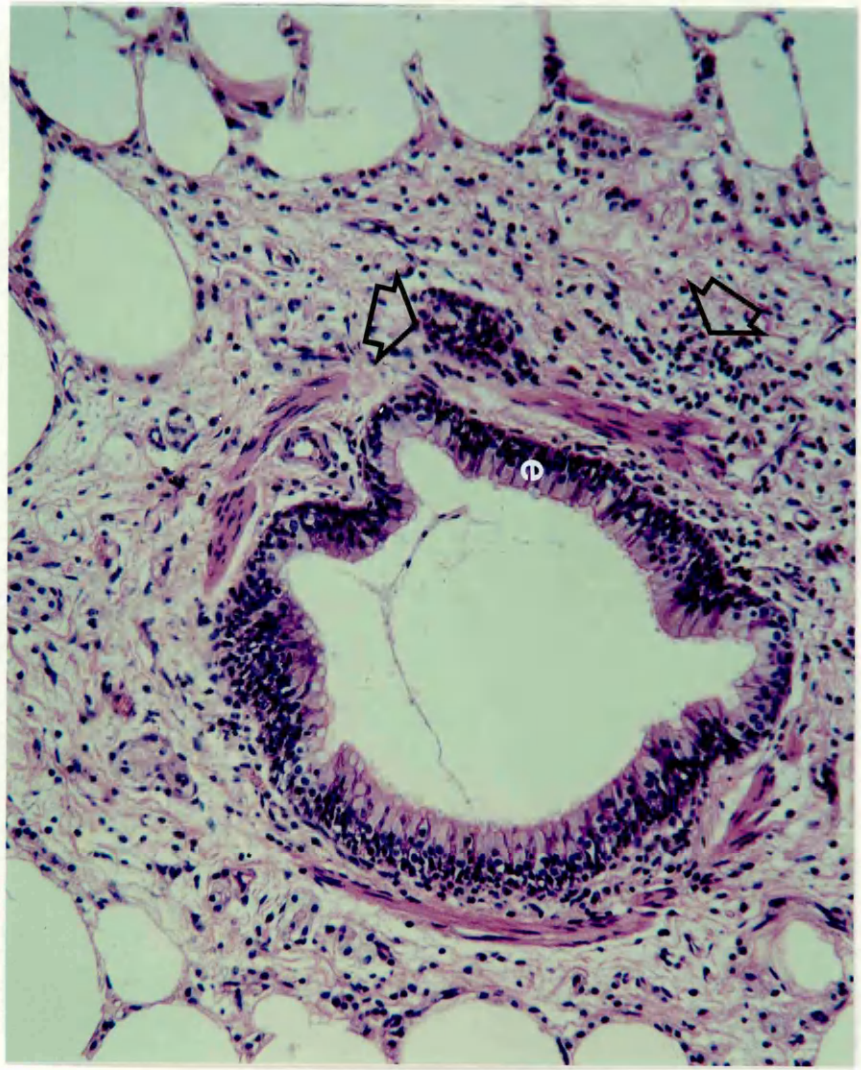

2
c
c

Fig. 8.23 Lung. The lumen of a small bronchus containing inflammatory exudate (Arrow). HE x 80

Fig. 8.24 Bronchiole. The epithelium (E) is hyperplastic (2 - 3 cells deep) and peribronchiolar connective tissue is thickened and contains many mononuclear cells (Arrows). Compare with a normal bronchiole in Fig. 6.33. HE x 180



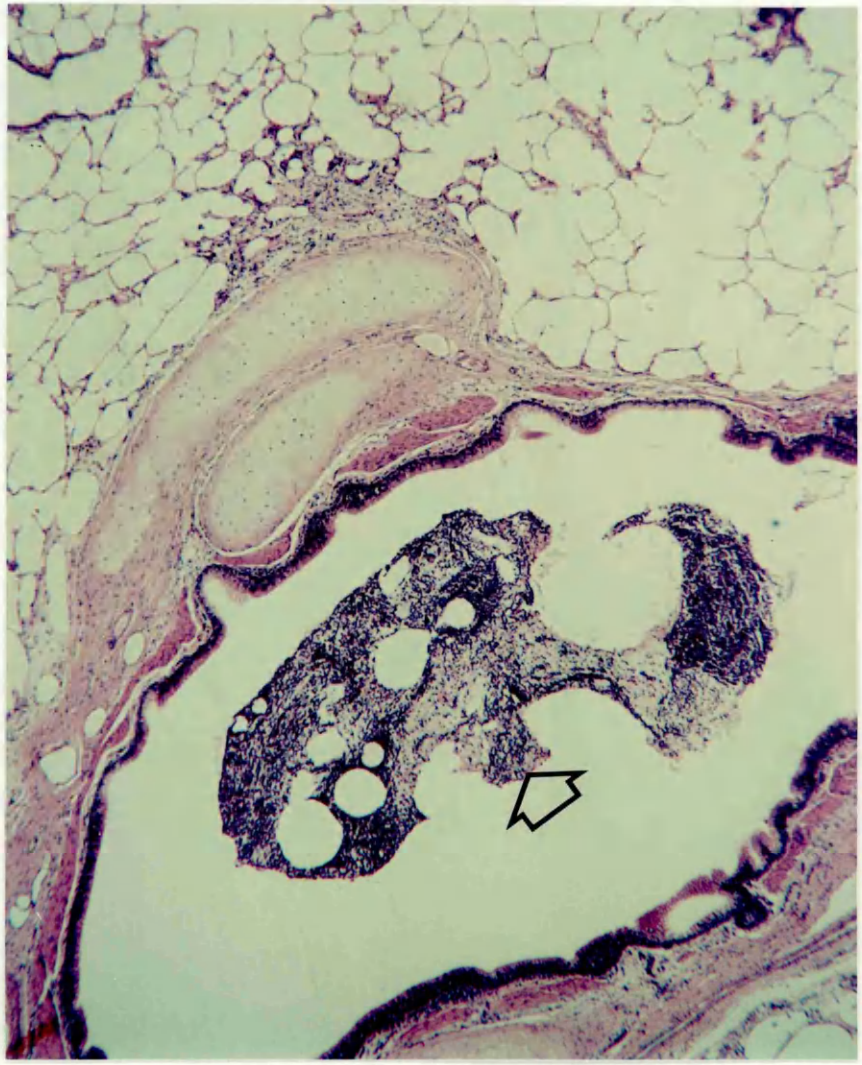
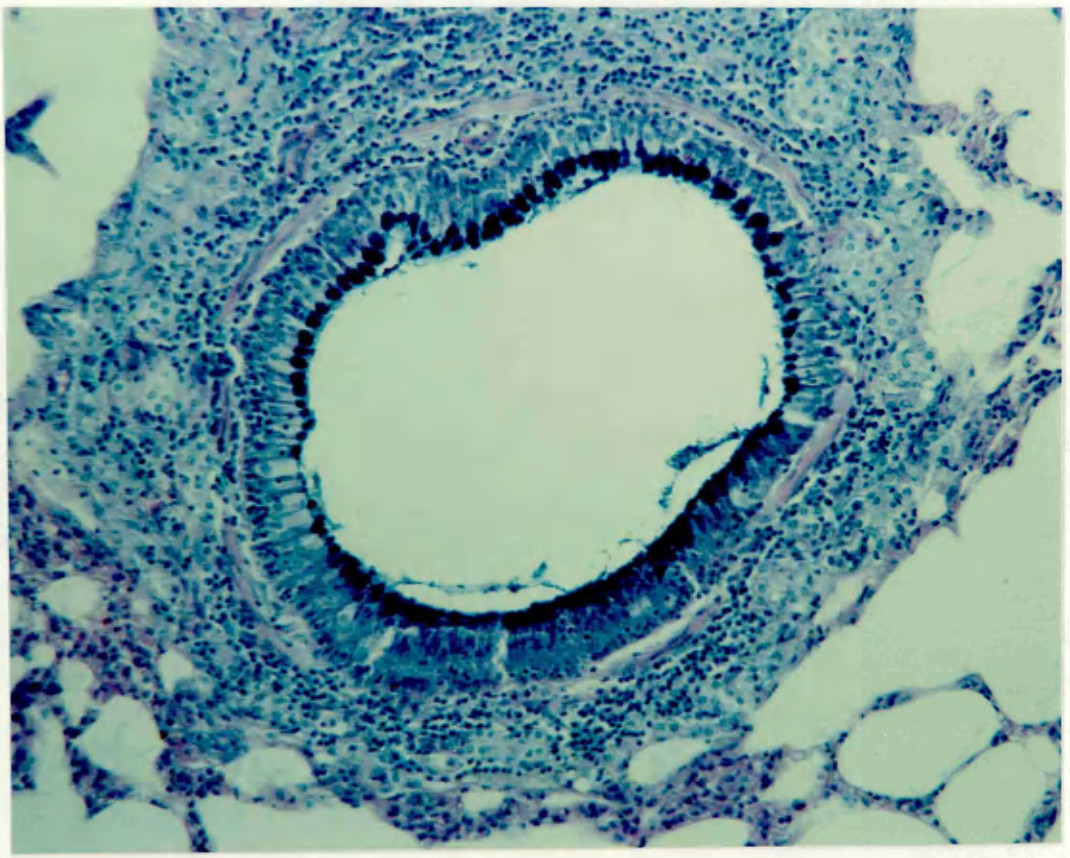


Fig. 8.25 Bronchiole. Epithelial surface cells contain mostly acidic mucosubstances.
AB-PAS x 180

Fig. 8.26 Bronchiole. Note the hyperplastic epithelium (E) and peribronchiolar cellular infiltration (Arrows). The lumen contains mucus and neutrophils.
HE x 180



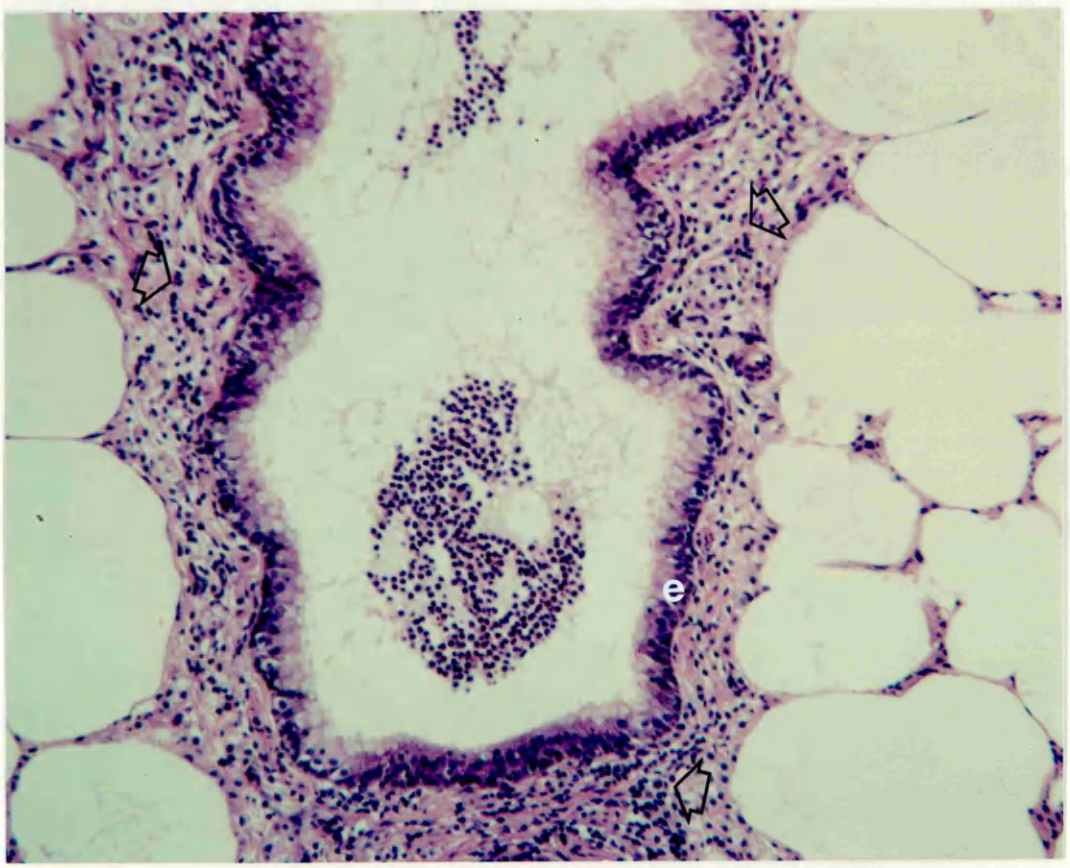
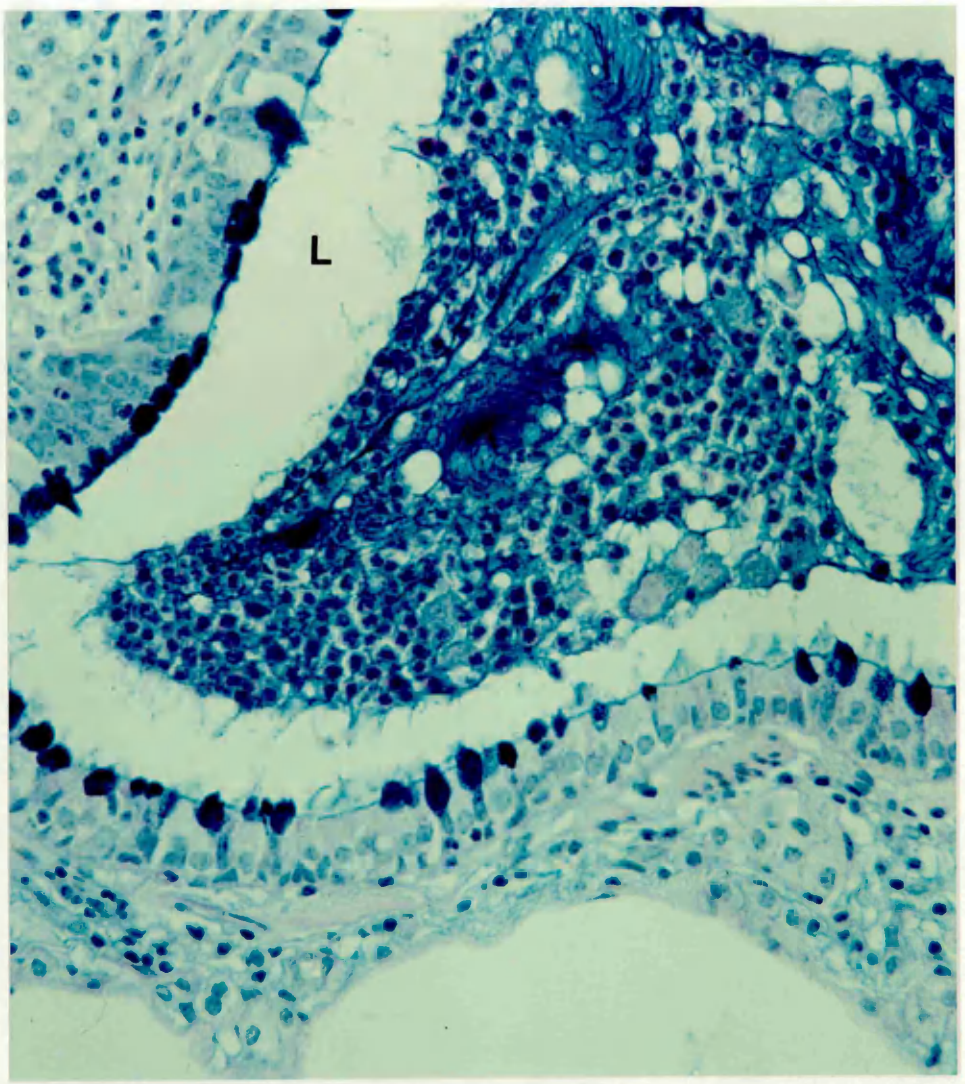

e

Fig. 8.27 Bronchiole. A plug of mucus and inflammatory cells almost fills the lumen (L). Many epithelial surface cells contain mucus.
AB-PAS x 250

Fig. 8.28 Lung. Focal areas of emphysema (Arrows) are present just below the pleura. This is comparable with the SEM appearance in Fig. 8.15.
HE x 80


L

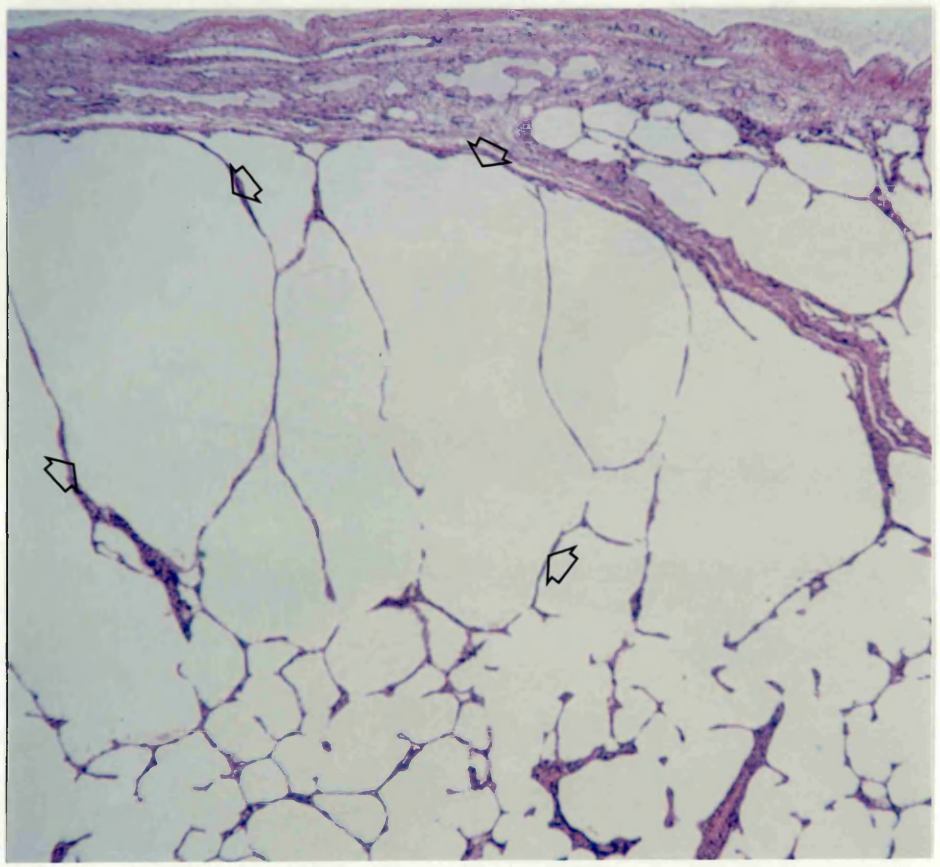
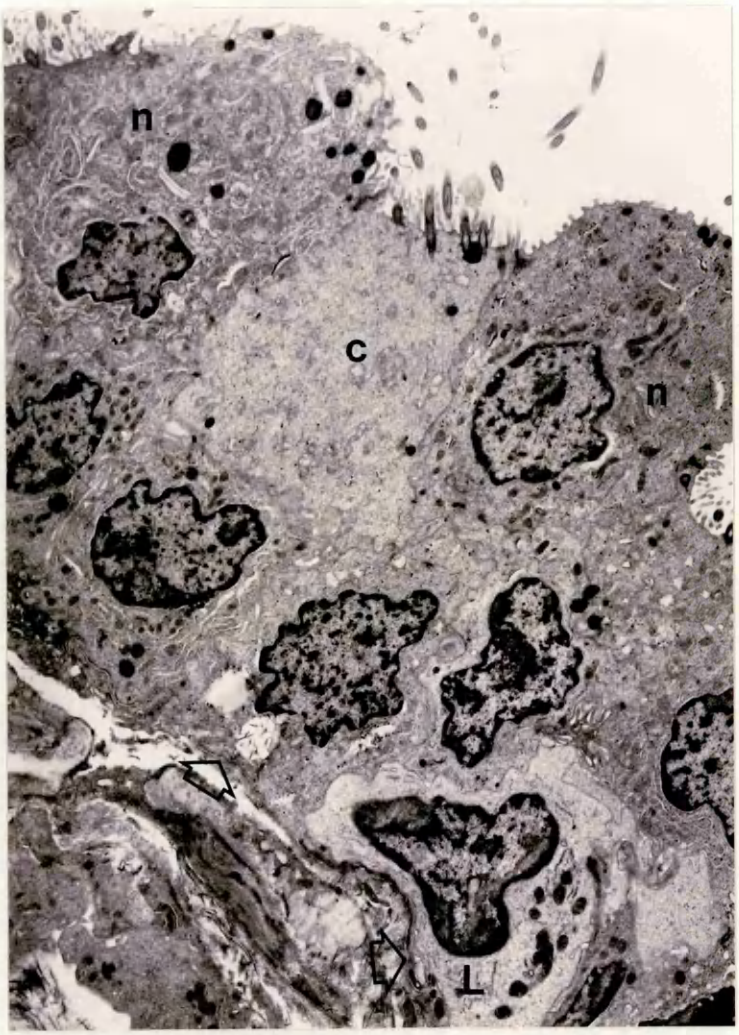


Fig. 8.29 Bronchiole. Hyperplastic epithelium with ciliated cells (C) and nonciliated bronchiolar epithelial (Clara) cells (N) on the surface. The latter have few cytoplasmic granules. Basal cells rest on the basal lamina (Arrows). Note a lymphocyte (L) lying within the latter.
TEM x 5,400

Fig. 8.30 Bronchiole. Hyperplastic epithelium with 2 Clara cells (C), less protuberant than usual, on the surface.
Note the varied size of their cytoplasmic granules which are few in number in the cell on the left. Many cytoplasmic interdigitations (Arrows) are present between adjacent cells.
TEM x 8,000


n
c
n
T

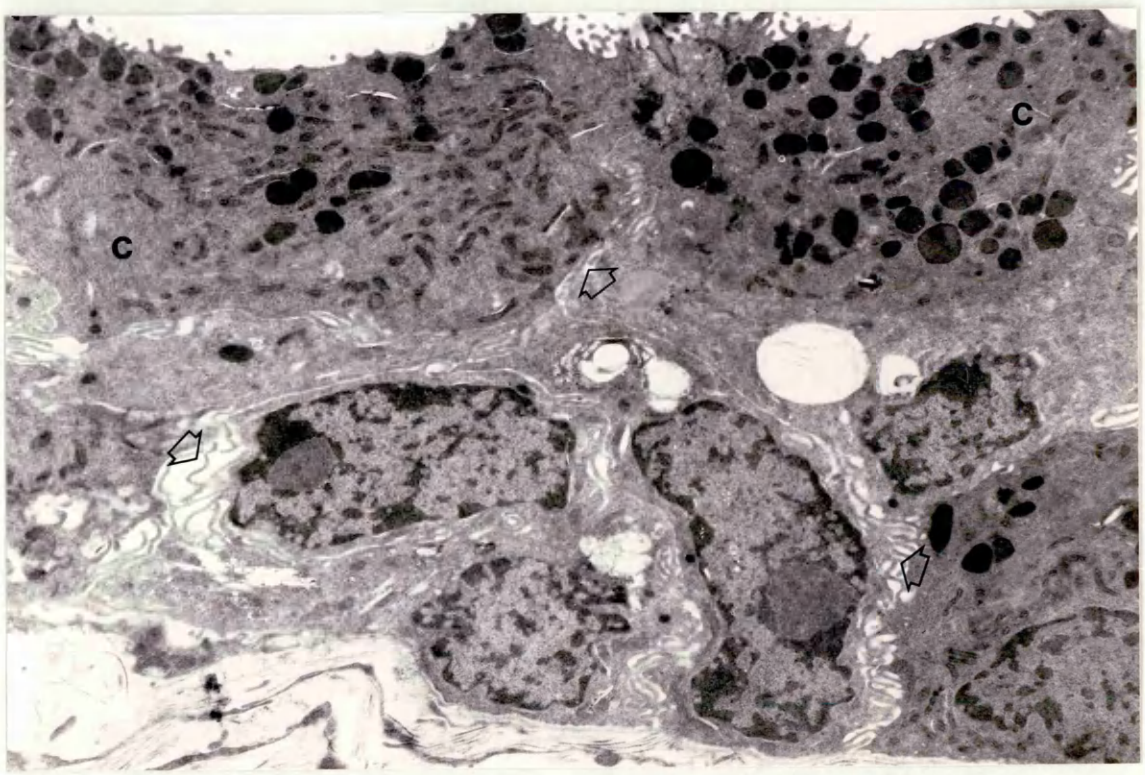
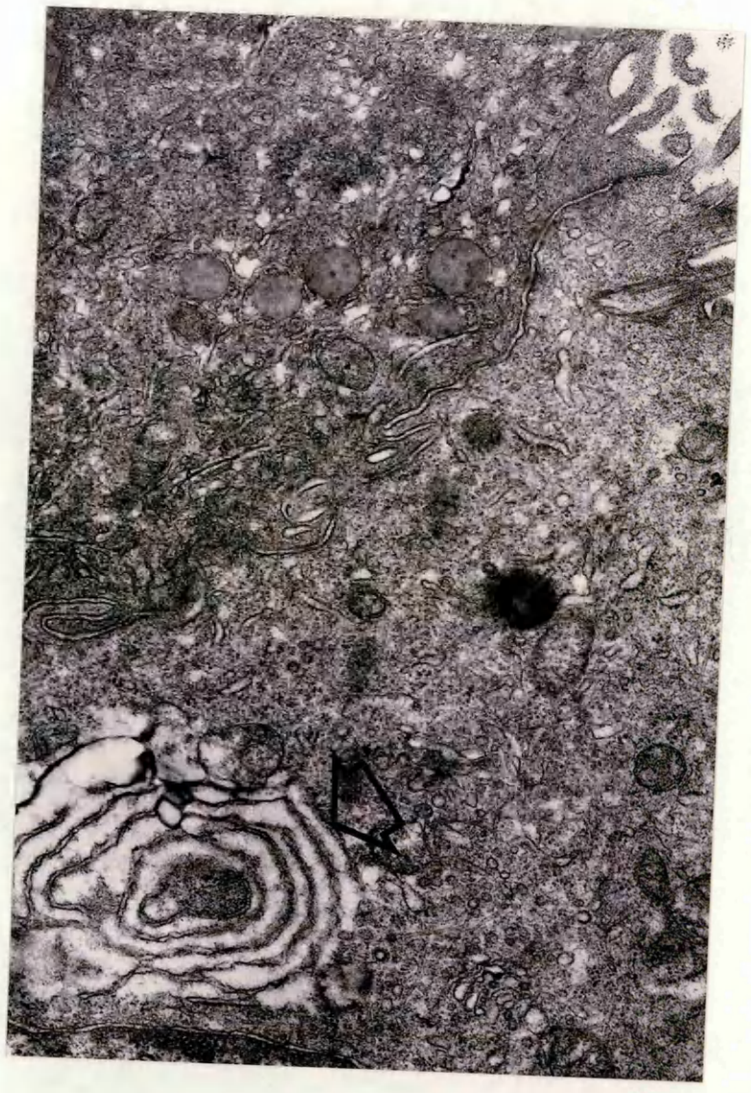

c
c

Fig. 8.31 Bronchiole. A ciliated cell with large cytoplasmic vacuoles (Arrows) which contain membranous remnants and fine granular mucus-like material.
TEM x 20,000

Fig. 8.32 Bronchiole. A ciliated cell with homogeneous lipid-like droplets (Arrows) in the cytoplasm.
TEM x 28,000

Fig. 8.33 Bronchiole. Myelin configuration (Arrow) in a ciliated cell.
TEM x 28,000

Fig. 8.34 Bronchiole. A ciliated cell with a large amount of cytoplasmic glycogen (Arrow). Smaller deposits are also present in the adjacent Clara cell (Small arrows).
The electron-lucent clefts are probably artefacts due to delayed fixation.
TEM x 8,000



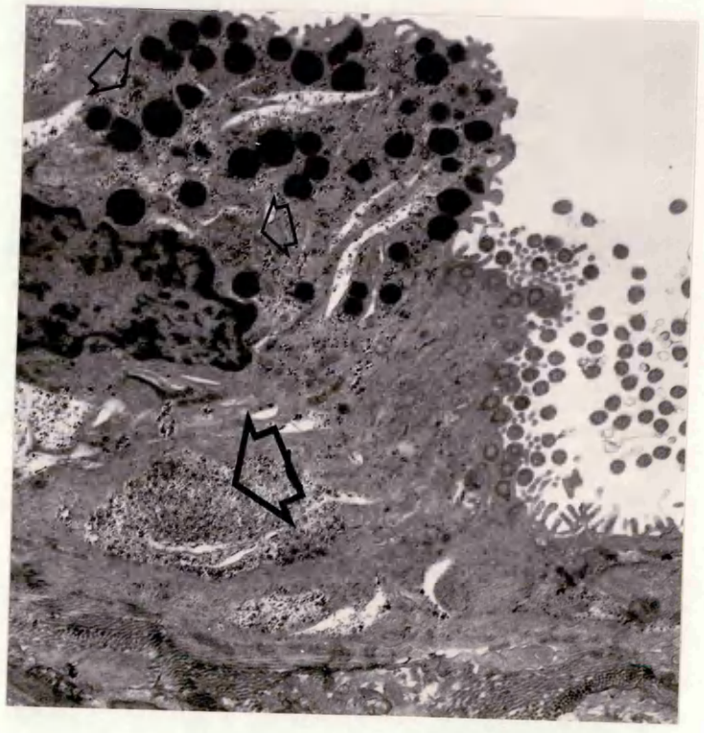
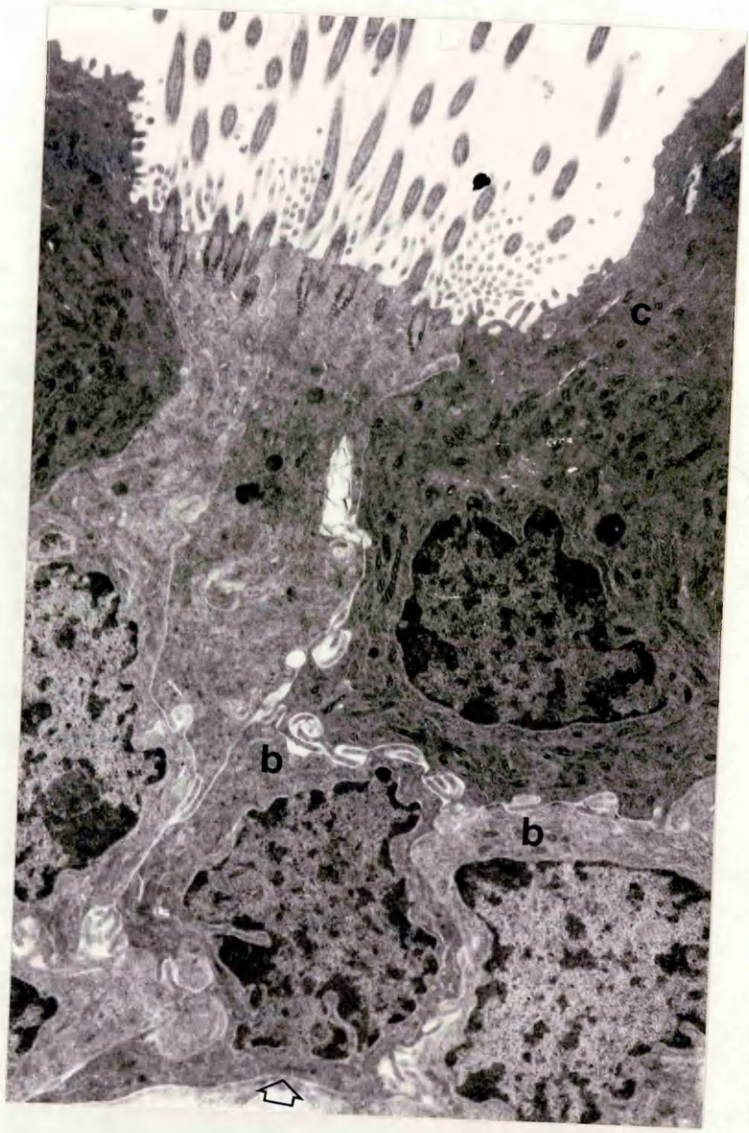


Fig. 8.35 Bronchiole. An agranular Clara cell (C) is adjacent to ciliated cells on the surface and rests on 2 basal cells (B). Arrow indicates the basal lamina.
TEM x 10,000

Fig. 8.36 Bronchiole. A Clara cell with very few granules (Arrows), and a large amount of smooth endoplasmic reticulum. The former appear less electron-dense than normal. Compare the Figures above with Clara cells in normal horses (Figs. 6.37 and 6.38).
TEM x 20,000


c
b
b

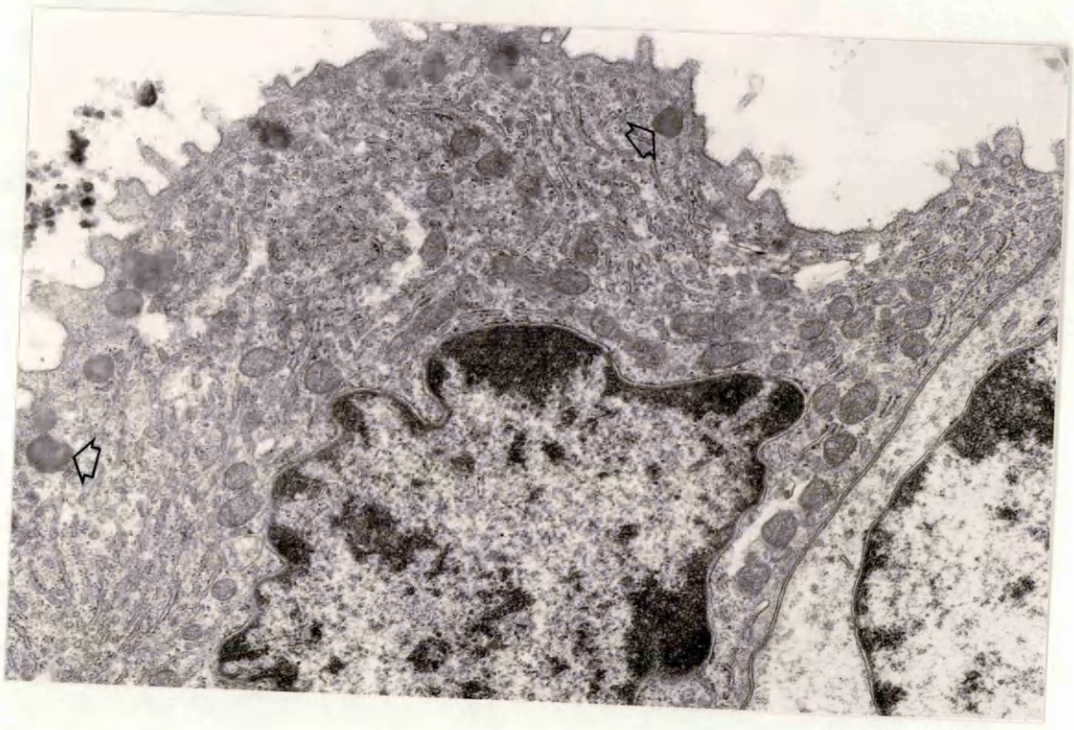
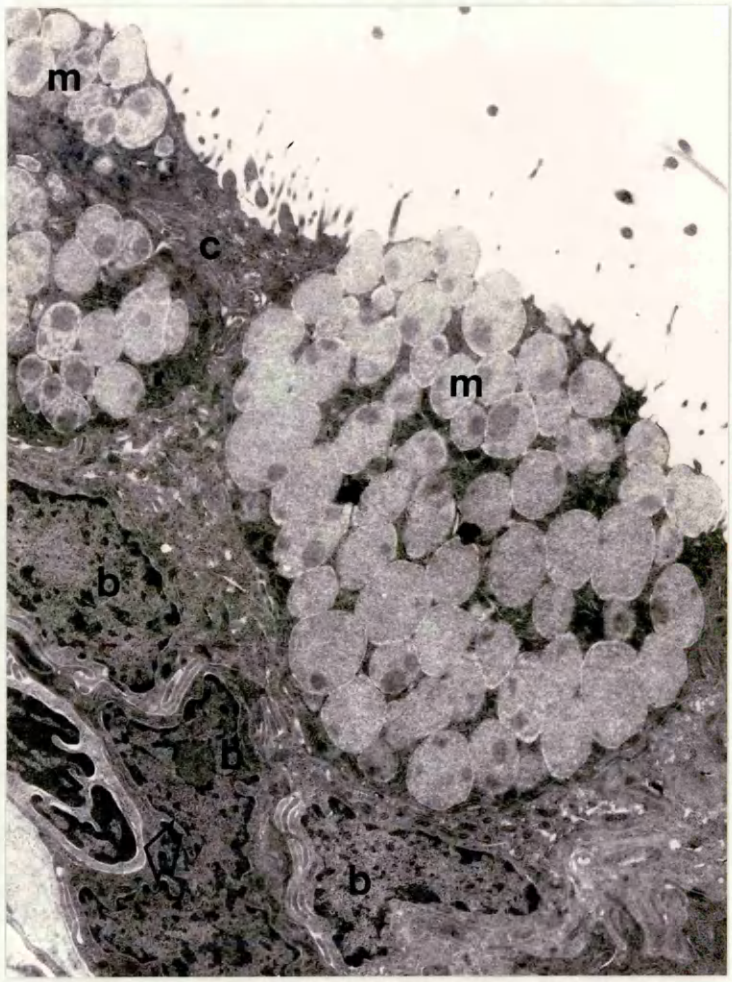


Fig. 8.37 Bronchiole. A ciliated cell (C) flanked by mucus-secreting cells (M) on the surface. Below are basal cells (B) and a lymphocyte (Arrow).
TEM x 8,000

Fig. 8.38 Bronchiole. Cells containing mucous granules (Arrows). Note the floccular appearance of the latter.
TEM x 13,400


m
c
m
b
b
b

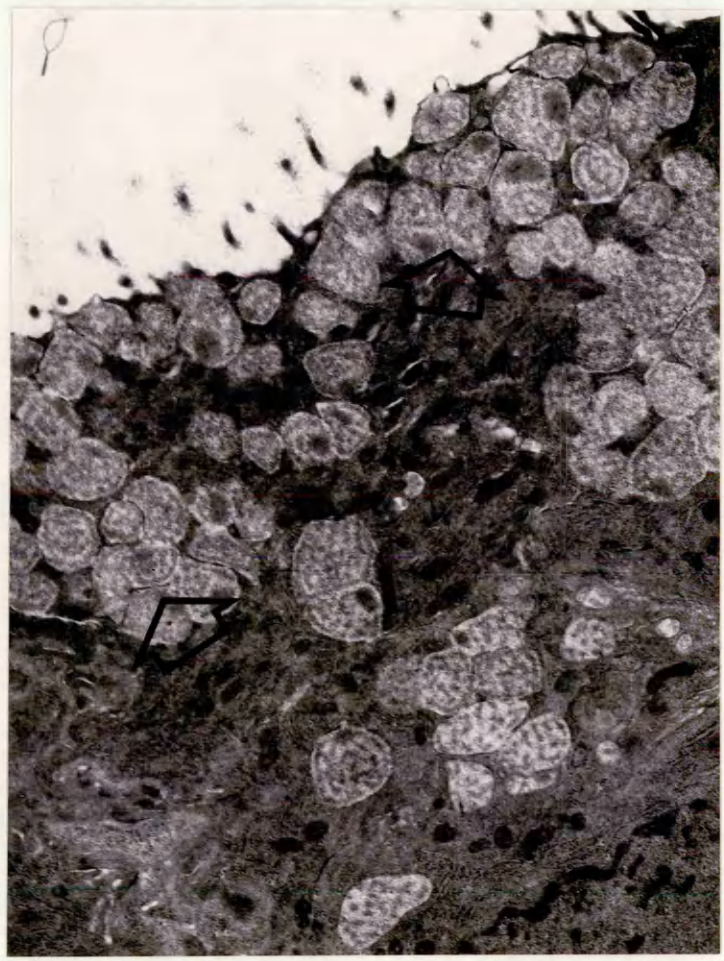
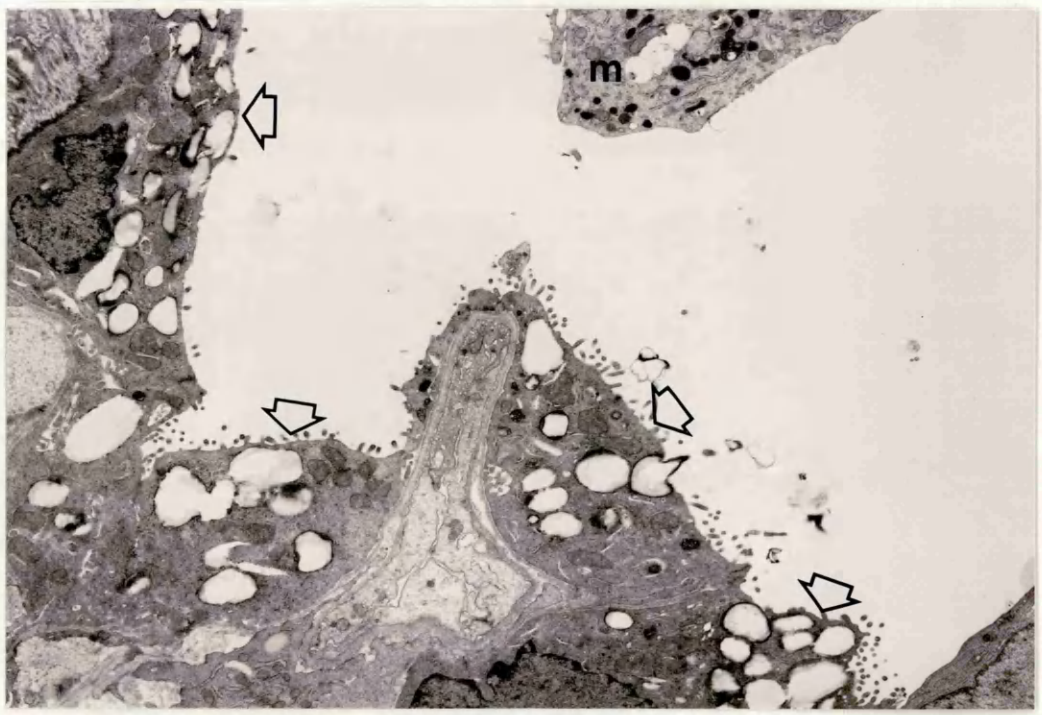


Fig. 8.39 Alveolar membrane. Four Type II pneumocytes (Arrows) lying adjacent to each other. A portion of an alveolar macrophage (M) is visible.
TEM x 5,400

Fig. 8.40 Alveolar membrane. Type II pneumocytes (2) in adjacent alveoli. Note the empty appearance of the cytoplasmic vacuoles (Arrows). Collagen (Asterisks) is prominant in the alveolar septum.
TEM x 5,400


m


2
2
2
*
*

Fig. 8.41 Alveolar membrane. A large number of enlarged, almost empty vacuoles (Arrows) in the cytoplasm of a Type II pneumocyte.
TEM x 8,000

Fig. 8.42 Alveolar membrane. Alveolar macrophages (M) in close proximity to an alveolar pore (Arrow) which is flanked by 2 Type II pneumocytes.
TEM x 7,400