

Table 9-2 Defense Mechanisms Provided by Some Cells and Secretory Products Present in the Respiratory System

Cell/Secretory Product	Action
Interleukins	Chemotaxis, up-regulation of adhesion molecules
Antibodies	Prevent microbe attachment to cell membranes, opsonization
Complement	Chemotaxis; enhances phagocytosis
Antioxidants*	Prevent injury caused by superoxide anion, hydrogen peroxide, and free radicals generated during phagocytosis, inflammation, or by inhalation of oxidant gases (ozone, NO ₂ , SO ₂)

*Superoxide dismutase, catalase, glutathione peroxidase, oxidant free radical scavengers (tocopherol, ascorbic acid).

Impairment of Defense Mechanisms

- Viral-bacterial synergism
 - Impair phagocytic function 5-7 days post-infection
 - Mucociliary effects
- Toxic gases – ammonia, hydrogen sulfide
- Immunodeficiency/suppression – genetic, infectious, toxic
- Effect on cilia – anesthesia, ciliary dyskinesia
- Effect on mucous – dehydration – increase viscosity
- Hypoxia and pulmonary edema –
 - Impair phagocytosis
 - Alter surfactant production

Respiratory Evaluation Methods

- Functional evaluation
 - Respiratory rate, compliance, diffusion capacity, etc
- Imaging
 - Radiography, MRI, etc
- Endoscopy
- Tracheal aspirates and broncho-alveolar lavage (BAL)
- Whole lung biochemistry
- Morphology
 - Biopsy
 - Necropsy – gross and microscopic evaluation

Aspirate/Lavage Evaluation

- Microbiology
- Cytology
 - Cell number and differential
 - Microorganisms
 - Particulates
- Biochemistry
 - Enzymes e.g. LDH, β glucouronidase, sialic acid
 - Protein content

Gross Examination of the Respiratory System

- External evaluation of the head, nares
- Cut diaphragm
- Remove rib cage
- Visually evaluate lung (color, size, etc) and thoracic contents
- Sample for bacteriology if needed
- Remove pluck and examine
- Evaluate lung

Gross Examination of Respiratory Tract

- Lung
 - Size - collapse? – in situ evaluation
 - Color
 - Texture on palpation
 - Lesion distribution
 - Cut surface
 - Airways
- Surface of lung and rib cage
- Contents of thoracic cavity
- Evaluate air sacs in birds
- Head – evaluate nasal passages, sinuses as needed
 - Longitudinal vs transverse sections

Lung Palpation - Texture

- Consistency of whole lung and of lesions
- Spongy - normal
- Firm - pneumonia
- Nodular - abscesses, granulomas, neoplasia
- Rubbery - interstitial pneumonia, edema
- Crepitant - emphysema, overinflation

Gross Lung Exam

- Lesion distribution
 - Diffuse
 - Locally extensive
 - Focal/multifocal
- Estimate of lesion extent e.g. % lung affected
- Artifacts
 - Autolysis
 - Edema
 - Atelectasis
 - Rumenal fluid/food in lungs

Tissue Preparation for Microscopic Examination

- Selection of tissues (affected vs normal)
- Fixation
 - Immersion
 - Intratracheal/intranasal – always in rats, mice
 - Whole body vascular perfusion
 - Artifact induction
- Fixatives
 - Neutral buffered 10% formalin (light microscopy)
 - Tellyesniczky/Feke's (light microscopy, tumor counts)
 - Glutaraldehyde \pm paraformaldehyde (electron microscopy)
 - 4% paraformaldehyde (electron and confocal microscopy, *in situ* hybridization)
- Decalcification – for examination of nasal passages

Morphologic Evaluation

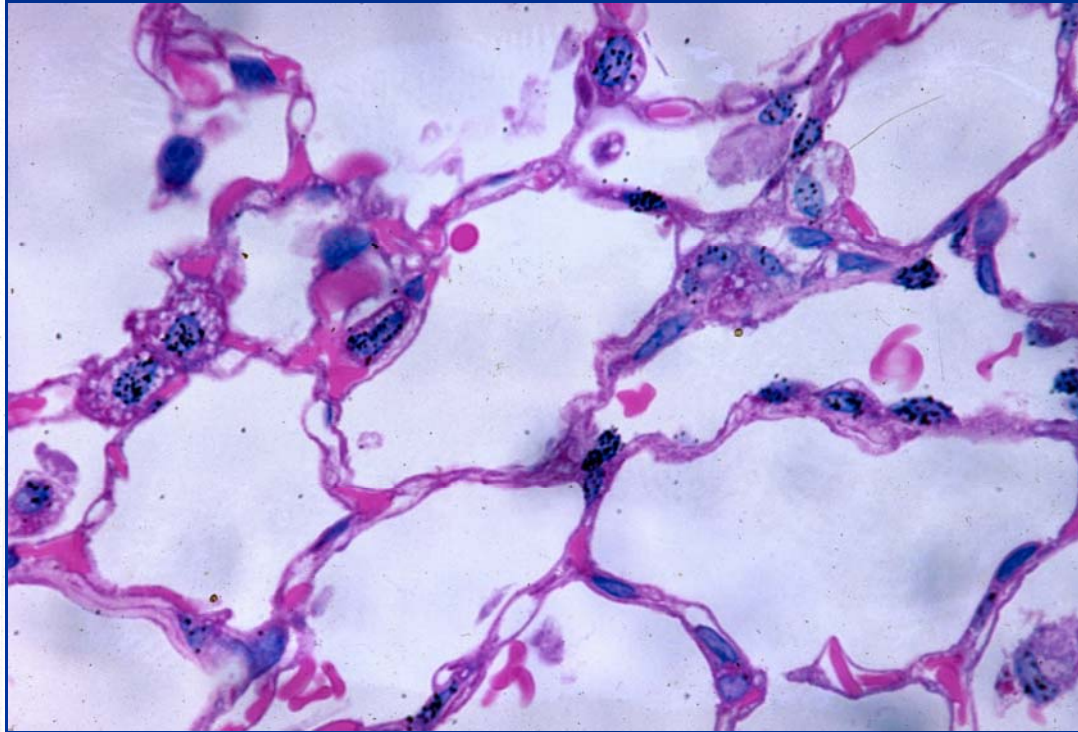
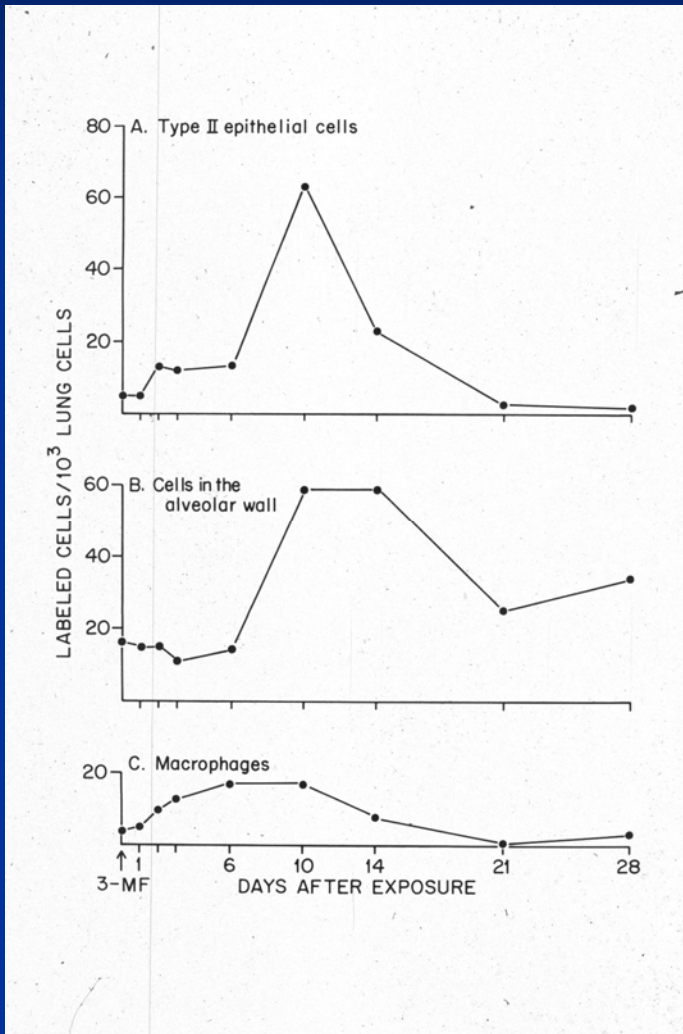
■ Qualitative

- Structural or cellular changes
- Light, electron, and confocal microscopy
- Special stains and immunohistochemistry
- *In situ* hybridization

■ Quantitative

- Morphometry/stereology
 - Number or volume of cells/organelles/matrix
- Cell kinetics - cell proliferation
 - Immunohistochemistry- BrDU, PCNA, etc.

Cell Kinetics



Useful Histochemical Stains

- Elastin
 - Weigert, Verhoeff-hematoxylin, Gomori methods
- Connective tissue
 - Masson's trichrome, Van Gieson's, Sirius Red
 - Snook's reticulin (type III collagen)
- Mucopolysaccharides (goblet cells) and glycosaminoglycans
 - Periodic-acid-Schiff (PAS), Alcian blue, toluidine blue, and ruthenium red (for EM)
- Basement membrane
 - Gomori's methenamine silver (GMS) and PAS

References

- Lopez A. Respiratory system. In: *Special Pathology*. 2nd Edn. McGavin and Zachary, Eds, (2006) In press.
- Haschek W.M., H. P. Witschi, and K. Nikula. Respiratory system. In: *Handbook of Toxicologic Pathology*. Haschek, W. M., Rousseaux, C.G., and Wallig, M.A. 2nd Ed., 2002. Academic Press, San Diego, California. pp. 3-83.
- FOR IMAGES: [Necropsy Show and Tell: Veterinary Pathology Images](#) Dr. John M. King, Professor of Veterinary Pathology College of Veterinary Medicine, Cornell University Ithaca, NY 14853 jmk31@cornell.edu ...
w3.vet.cornell.edu/nst/