EURADOS Annual Meeting - WG7
7-11 February, 2011 Prague, Czech Republic

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Microdistribution and Long-Term Retention of $^{239}Pu(NO_3)_4$ in the Respiratory Tract: A progress report

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"Learning from Plutonium and Uranium Workers"

Background: Case 0269 (Hanford)

- Urinalysis results, fecal data, and terminal lung and lymph node concentrations were fitted (James et al., 2007).
  - Inferred bound fraction, f_b ~ 8%
  - Inferred intake ~ 58 kBq (~1.6 µCi)
- Operator at Hanford (REDOX).
- Accidentally inhaled $Pu(NO_3)_4$ as an acidic aerosol mist.
- Died at age 79 from prostate cancer, 38-y after the inhalation.
- ~27 Bq (~0.7 nCi) of $^{239/240}Pu$ remained in the lungs at the time of death.
  - ICRP 66 predicts zero for Type M material
- Purpose: What is the distribution of Pu in the lungs?

Introduction

Mr. Chris Nielsen

- **Masters student at Pacific Northwest National Laboratory in Richland, WA**

Dr. Xihai Wang

- **Scientist at Pacific Northwest National Laboratory in Richland, WA**

- **Select tissue blocks**
- **Cut blocks and prepare slides**
- **Stain slides**
- **Autoradiography**

Case 0385 (Hanford)

- Used as a control case.
- No reported Pu intakes.
- Periodic Pu urinalyses were <MDA.
- Involved in several contamination incidents, presumably fission products.
- Died at age 90+ from a subdural hematoma, which resulted from a ground level fall.

Beagle Dogs

- Pacific Northwest National Laboratory Lifespan studies conducted during the 1970s.
- Single acute inhalation.
- Plutonium nitrate - $^{239}Pu(NO_3)_4$
- Lung depositions range from 3.6 kBq to 89 kBq (98 to 2410 nCi)
- Provides a bridge between the human and the beagle dog data.

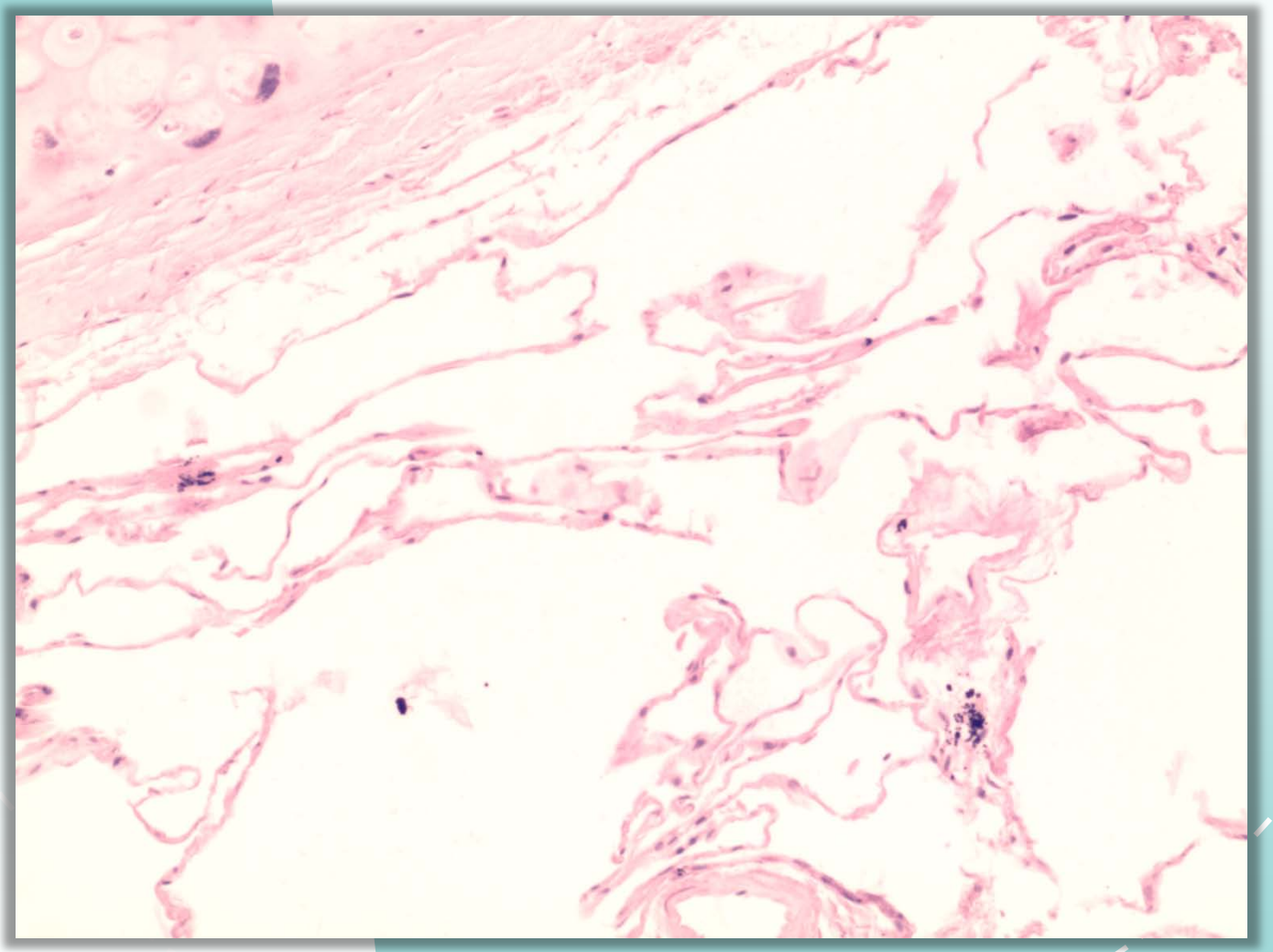
Sectioning of Tissues

- 5-6 tissue blocks per human or exposed dog
  - 2 LN and 3-4 lung samples
- 2 tissue blocks per control dog
- 9 slides prepped per block for autoradiography
- 16 slides prepped per block for staining protocols

H&E

- Hematoxylin and eosin stain
- Shows tissue structures

H&E (Case 0269)



Frozen Lung Tissue

A segment was removed from the frozen lung ~17 years post mortem.

Objective Lens Power X10

H-0269 #10 X10.tif

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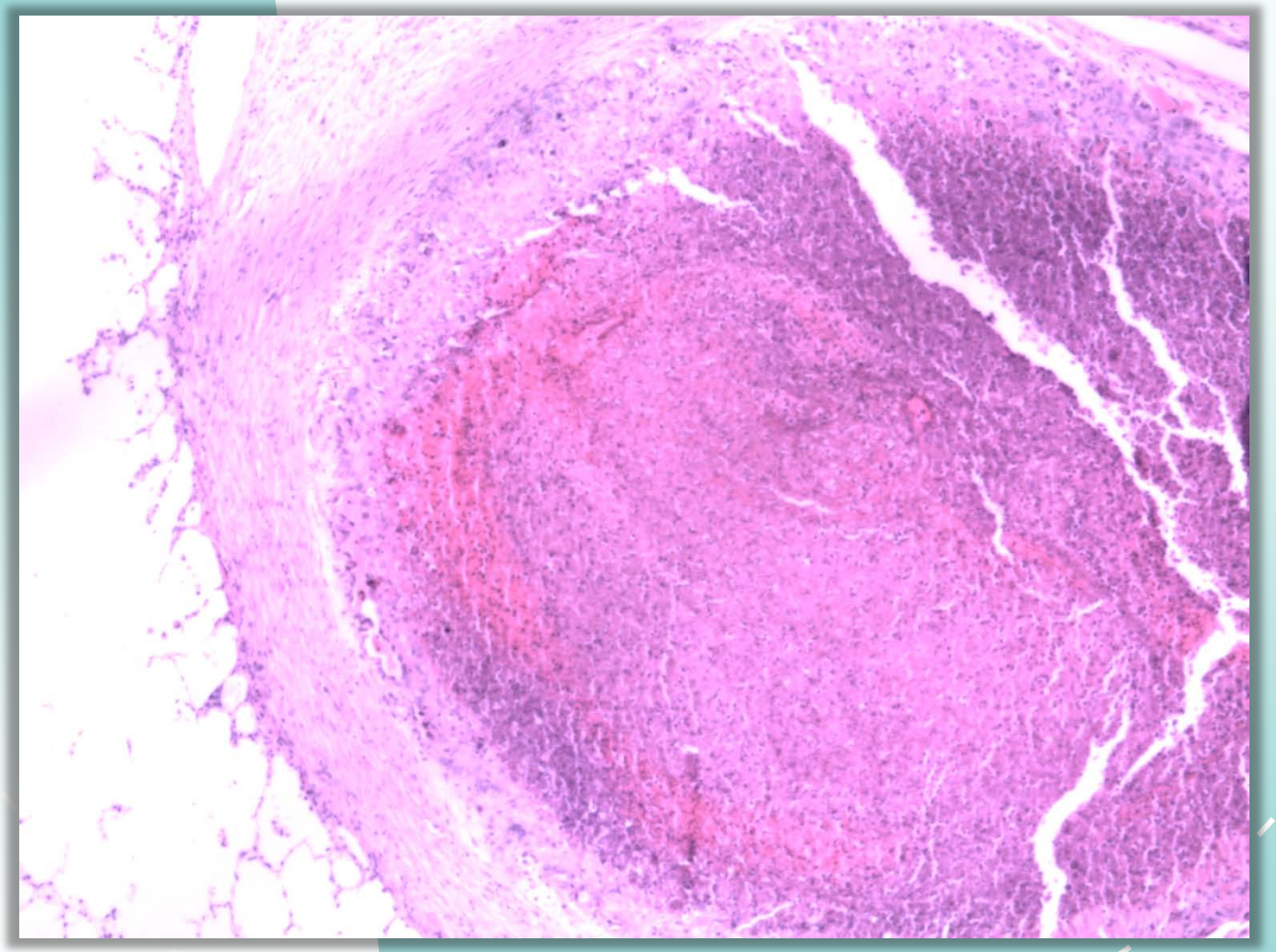
H&E (Dog 2410 nCi, 89 kBq)



Lymph Node
Normal

Objective Lens Power X4

Dog 474 179 2847 12 h2410 x4.tif

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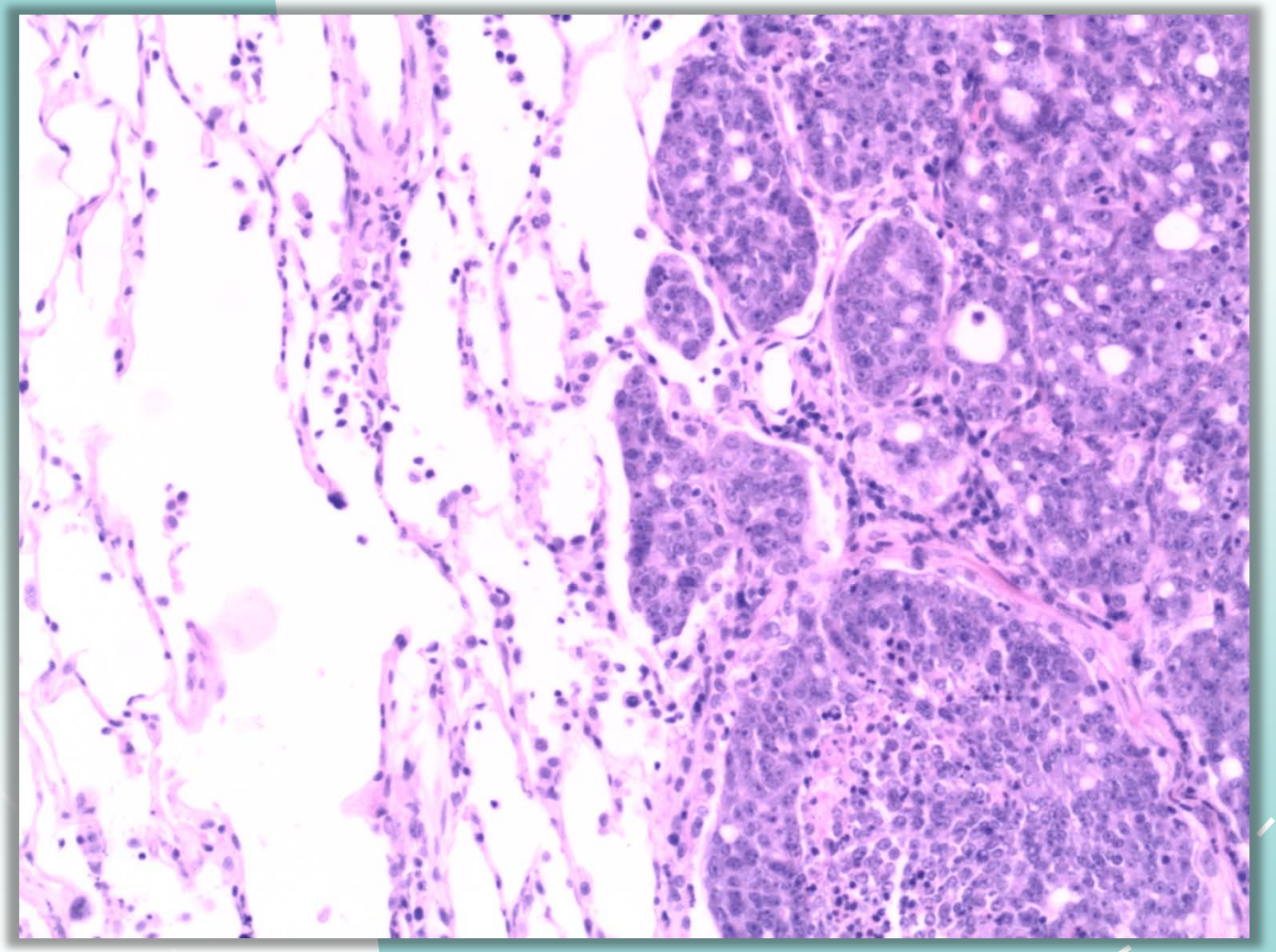
H&E (Dog 217 nCi, 8 kBq)



Lung

Left: Normal Tissue

Right: Tumor

Objective Lens Power X10

DOG 187 86 2849 11 ML217 10X.tif

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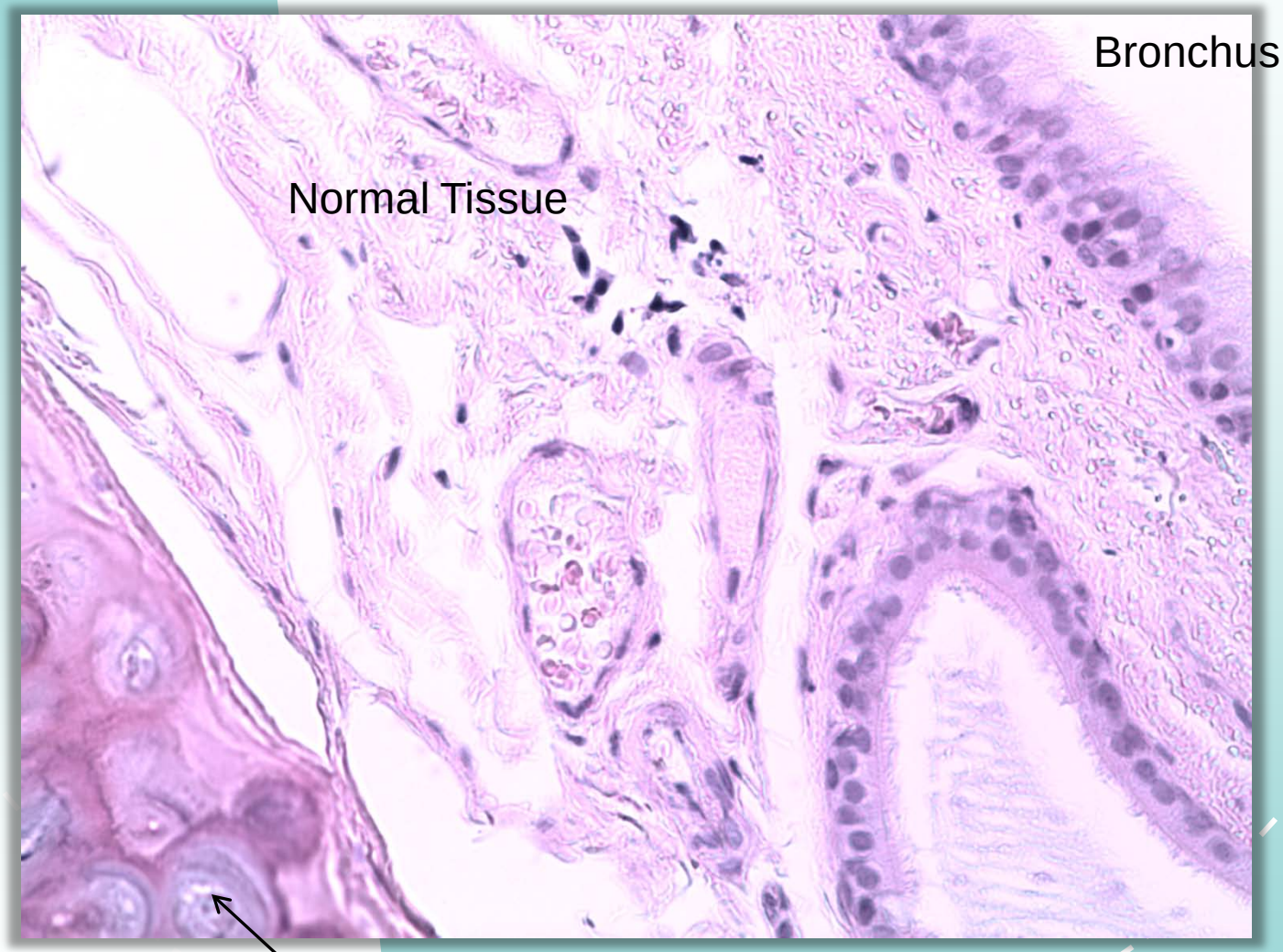
H&E (Dog 98 nCi, 3.6 kBq)



Normal lung tissue

Objective Lens Power X20

Dog 190 474 2500 L98 x20.tif

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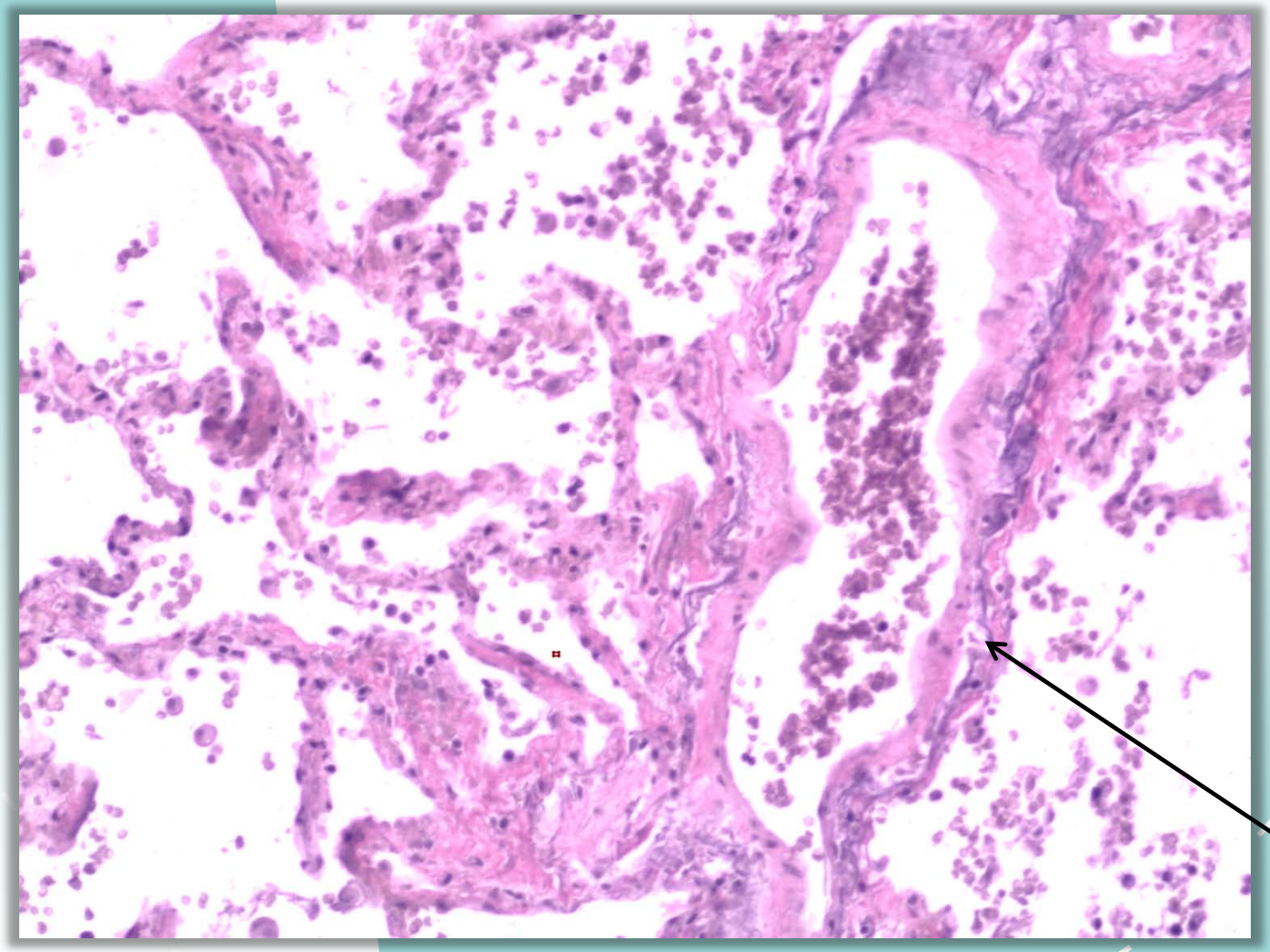
Elastic Van Giesen

• Elastic fibers & nuclei	Black
• Collagen	Red
• Other tissue elements	Yellow

Elastin (Case 0269)



Lung

Fixed as a tissue block 1 day post mortem

Inflamed

Objective Lens Power X10

0269 a84-2 11 10x 2.tif

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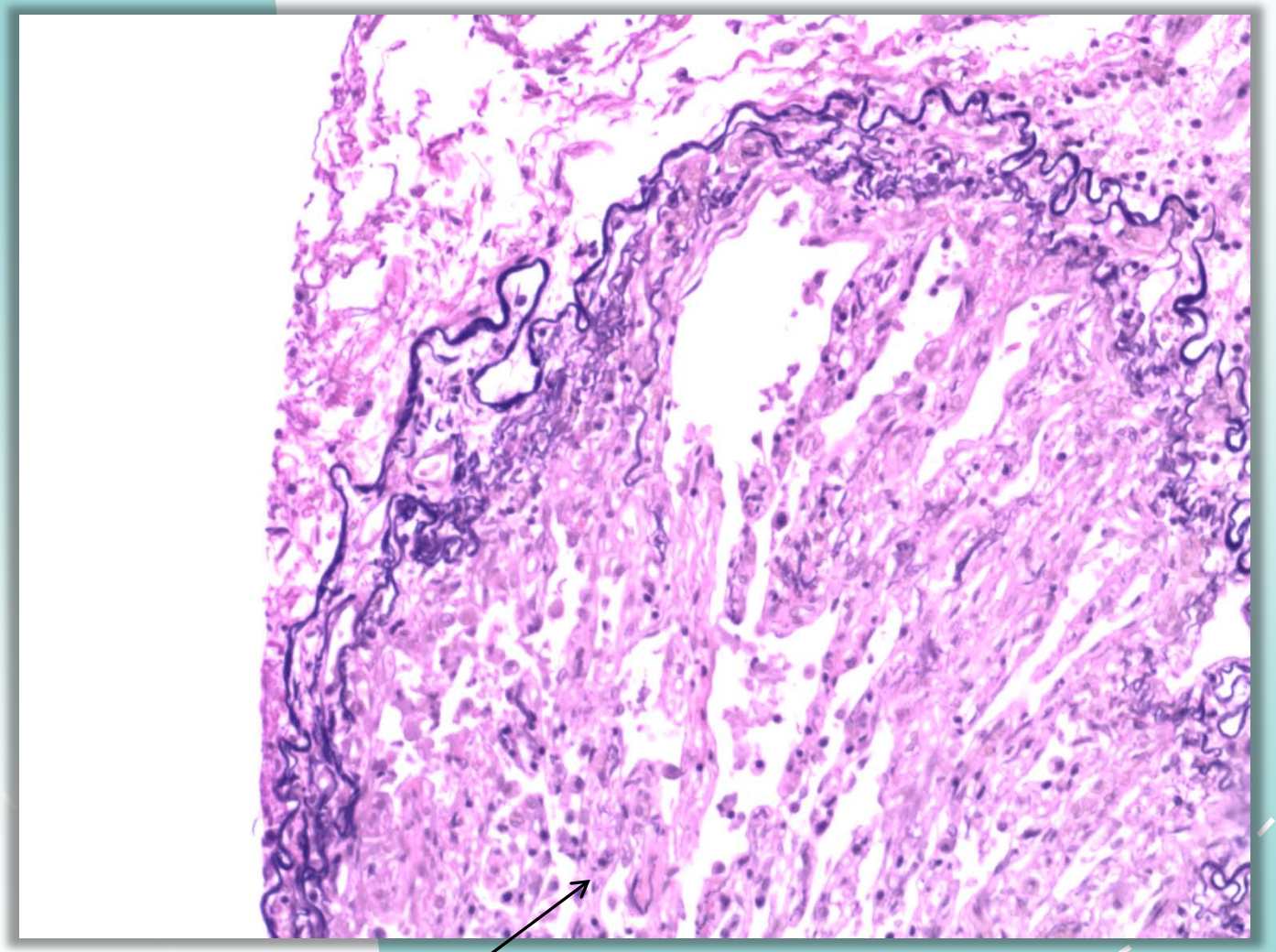
Elastin (Dog 239 nCi, 8.8 kBq)



Lung

Tumor

Objective Lens Power X10

dog 189 288 2847 17 ml293 10x 2.tif

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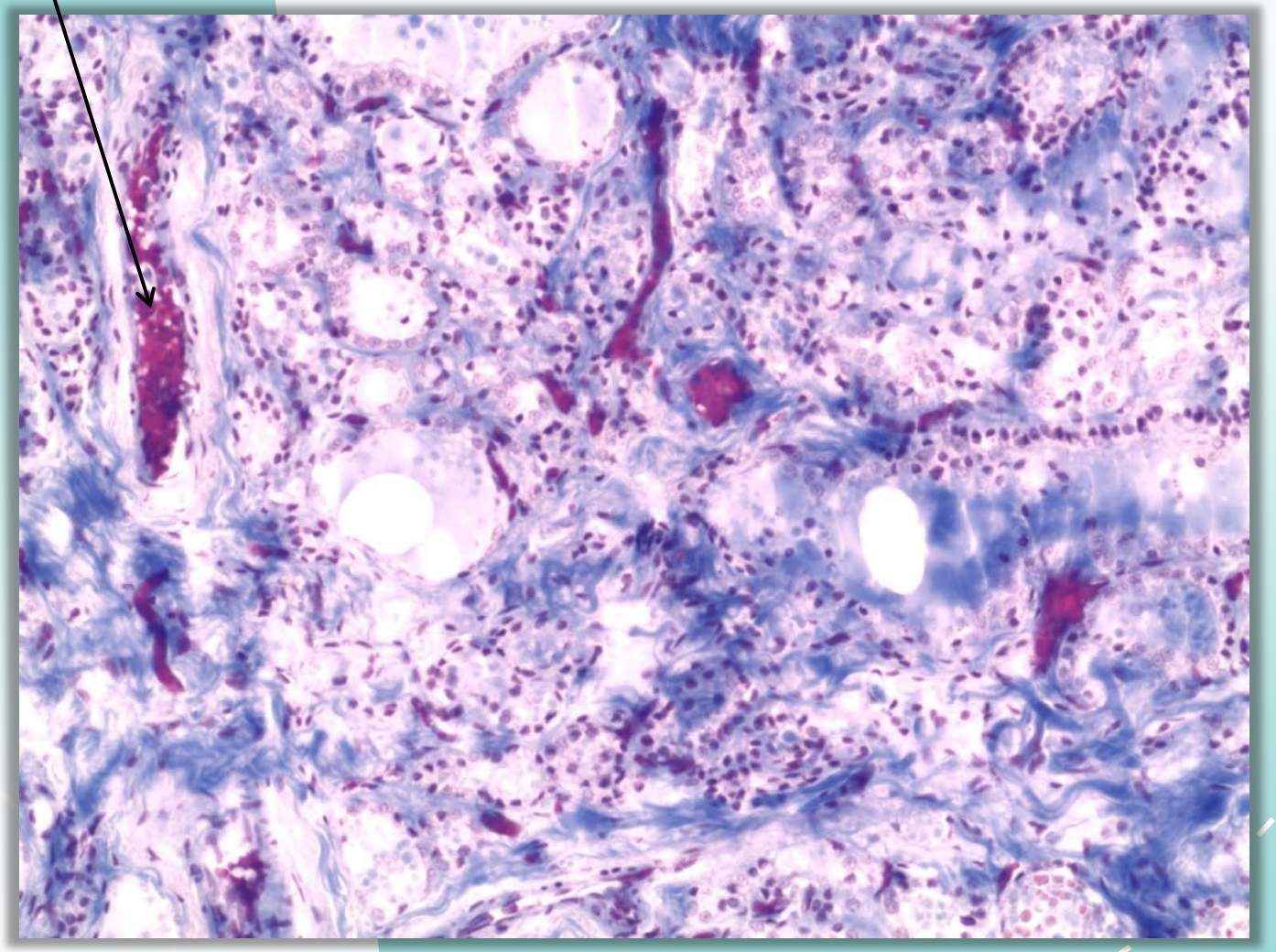
Trichrome

- **Collagen** — **Blue**
- **Nuclei** — **Black**
- **Muscle/cytoplasm/keratin** — **Red**

Trichrome (Case 0269)



Lung

Fixed as a tissue block 1 day post mortem

Blue is Fibrosis

Objective Lens Power X10

0269 A84-2 13 X10.tif

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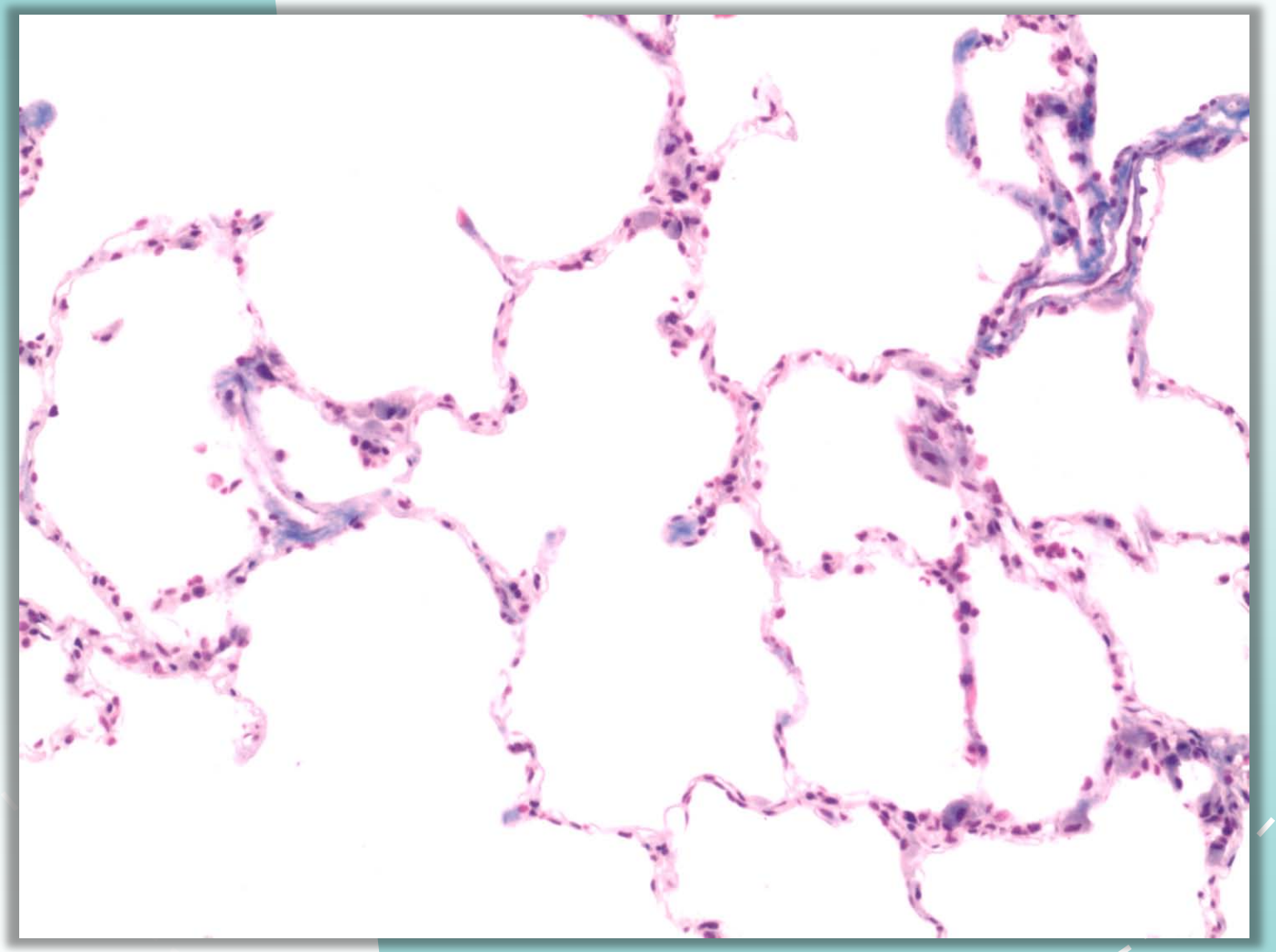
Trichrome (Case 0385)



Lung

There is a little collagen, but less than previous slide.

Objective Lens Power X10

0385 3 X10.tif

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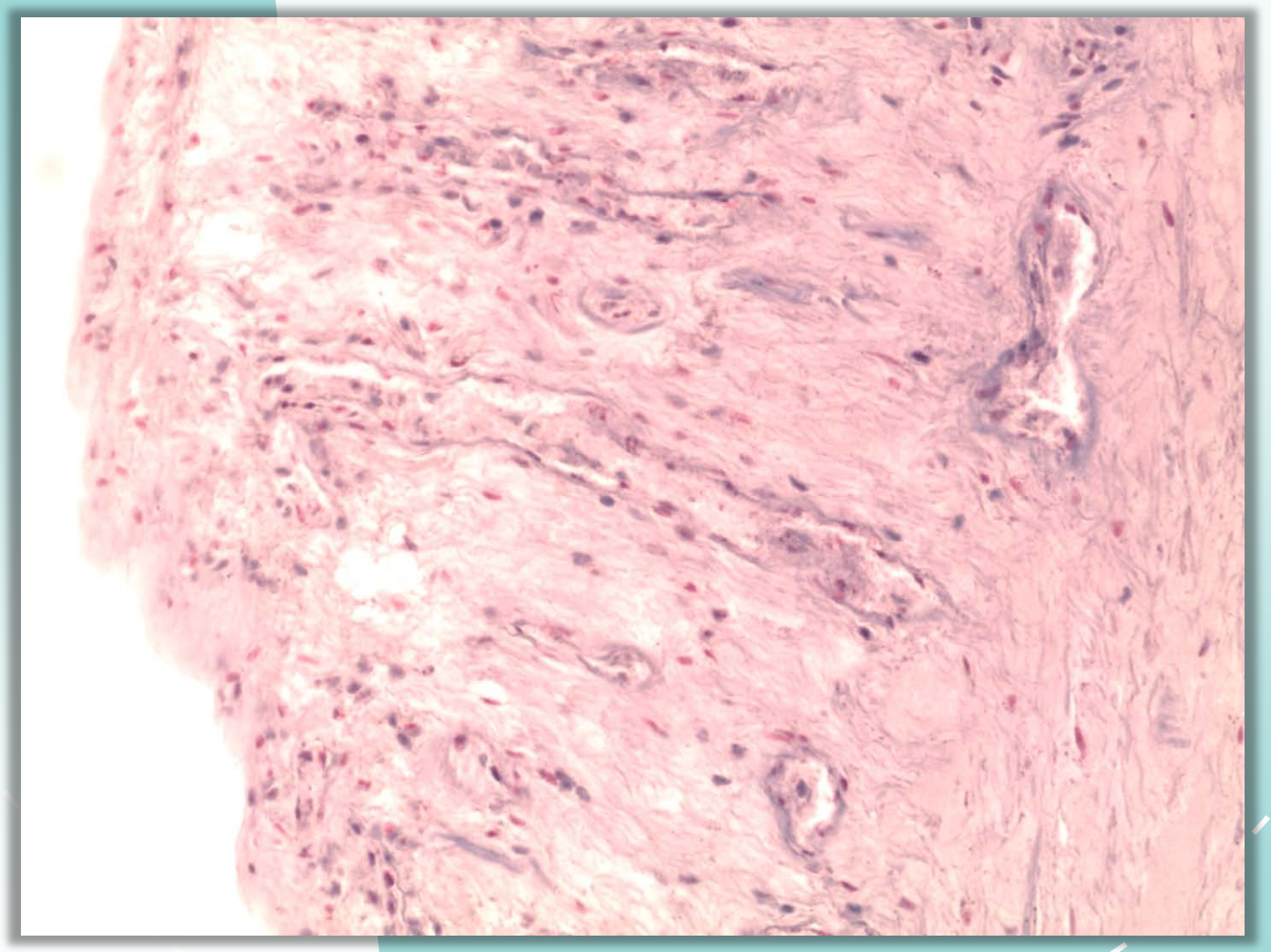
Trichrome (Case 0385)



Bronchus

Very Little Collagen

Objective Lens Power X10

0385 2 X10.tif

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Trichrome (Dog 267 nCi, 9.9 kBq)

Bronchus

Objective Lens Power X10

DOG 188 222 2500 ML267 X10 2.tif

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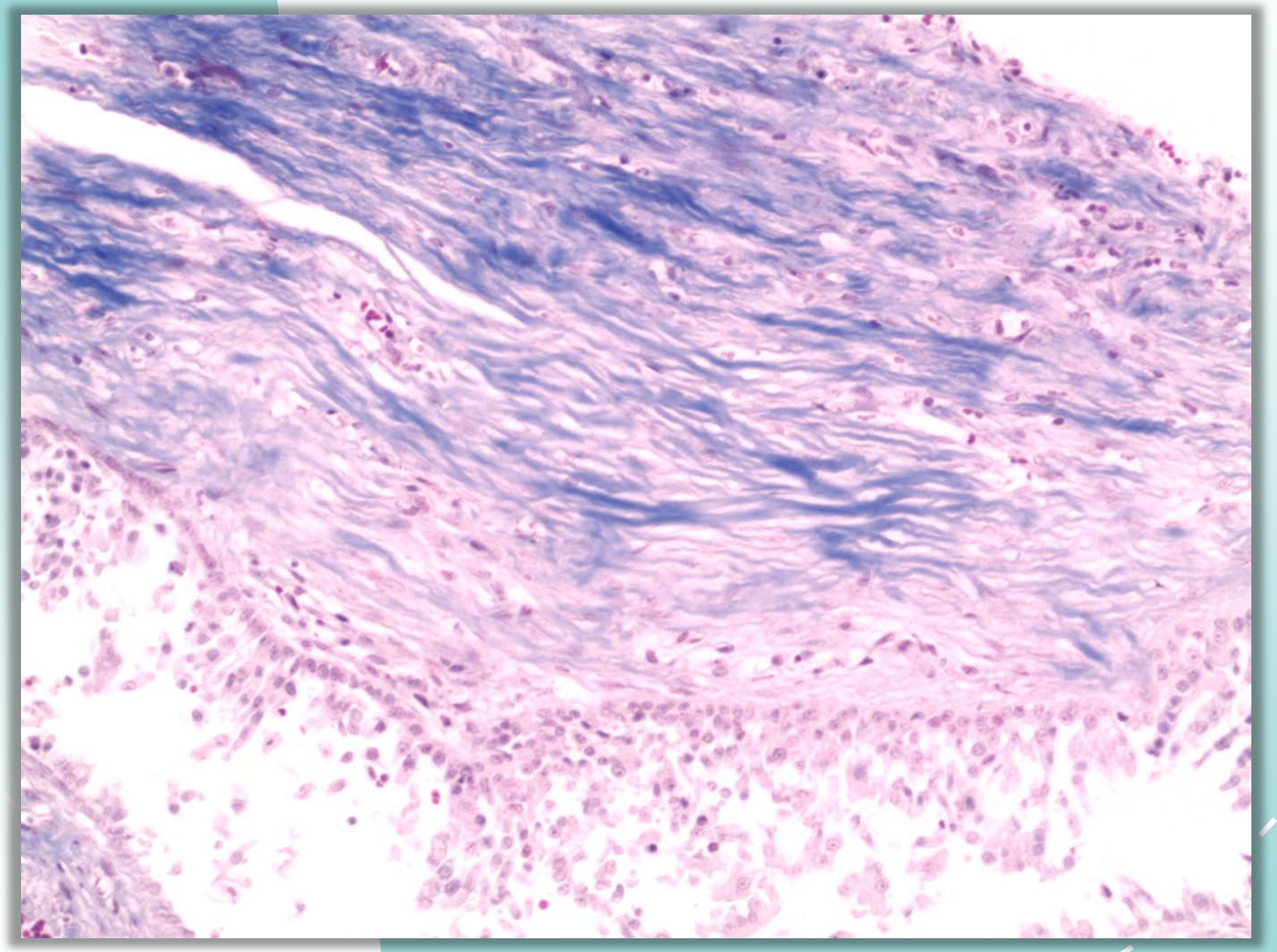
Trichrome (Dog 257 nCi, 9.5 kBq)



Lung

Fibrosis

Objective Lens Power X10

DOG 186 347 2877 11 ML257.tif

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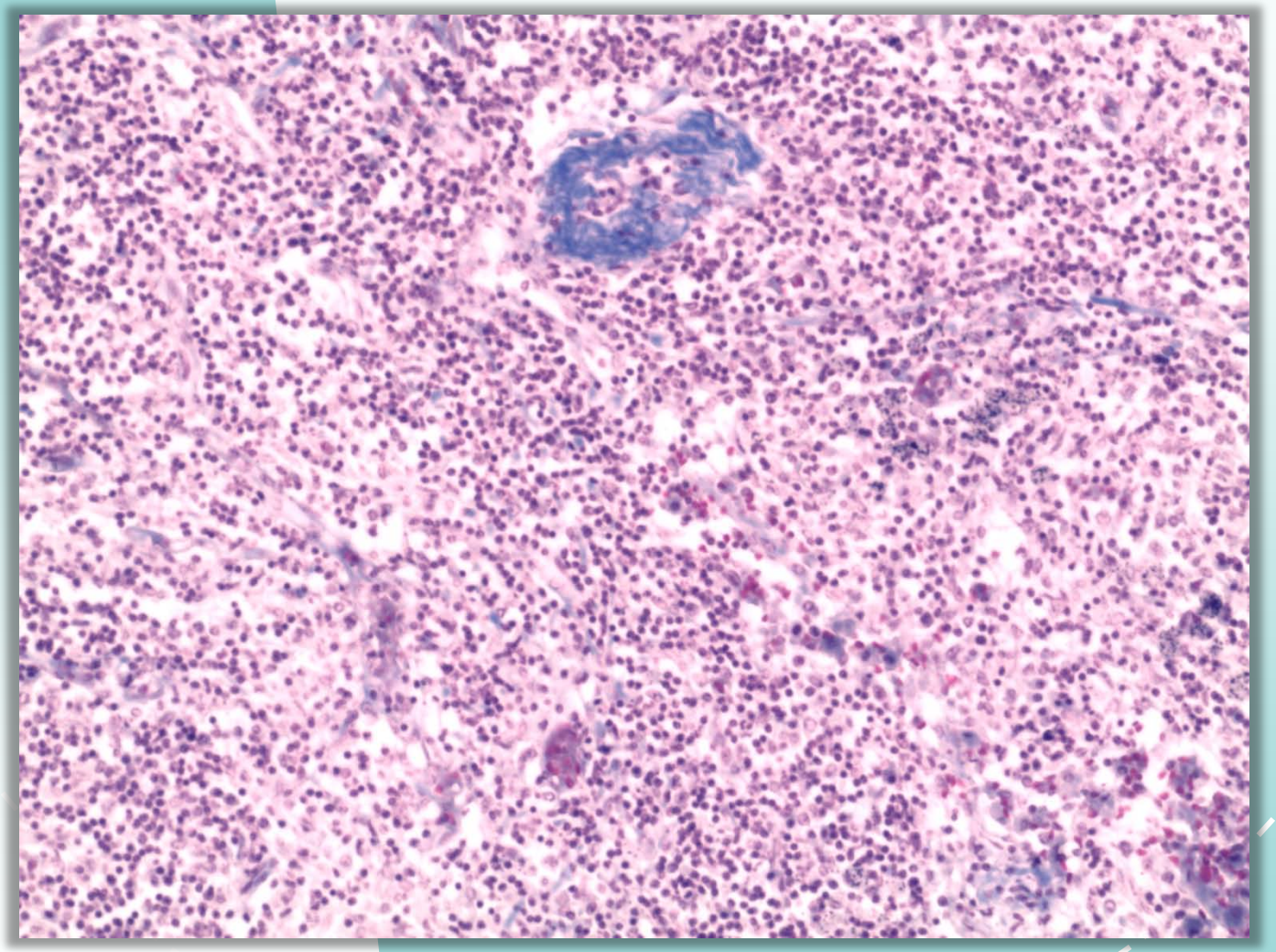
Trichrome (Dog 248 nCi, 9.2 kBq)



Normal Lymph Node

Objective Lens Power X10

DOG 189 259 0887 L248 X10.tif

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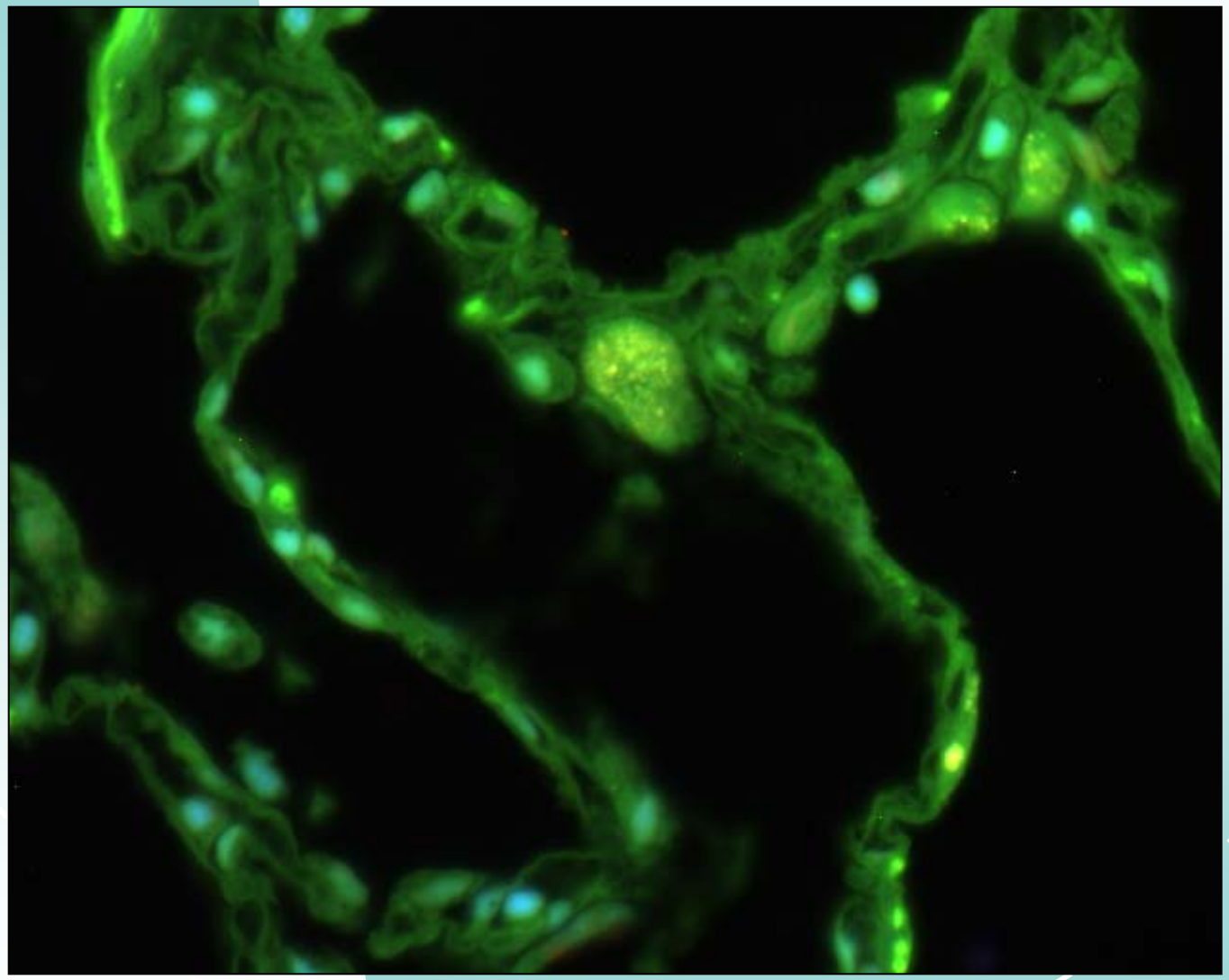
TUNEL (Apoptosis)

- **Apoptosis** — **Red**
- **Normal Nuclear Material** — **Blue**
- **Cytoplasm** — **Green**

Apoptosis (Case 0269)



Alveoli

No apoptosis

Objective Lens Power X60

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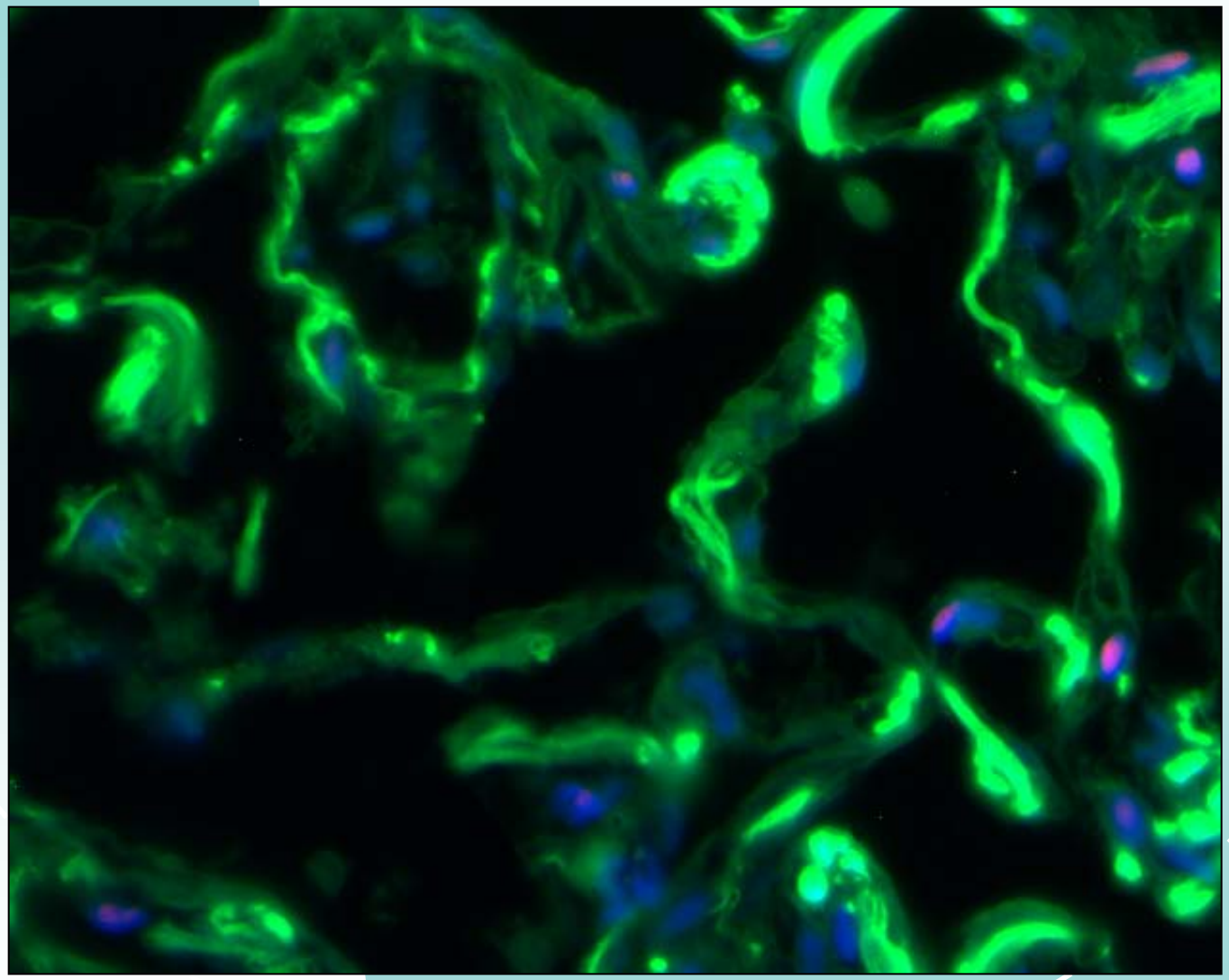
Apoptosis (Case 0385)



Lung tissue from human control

Objective Lens Power X60

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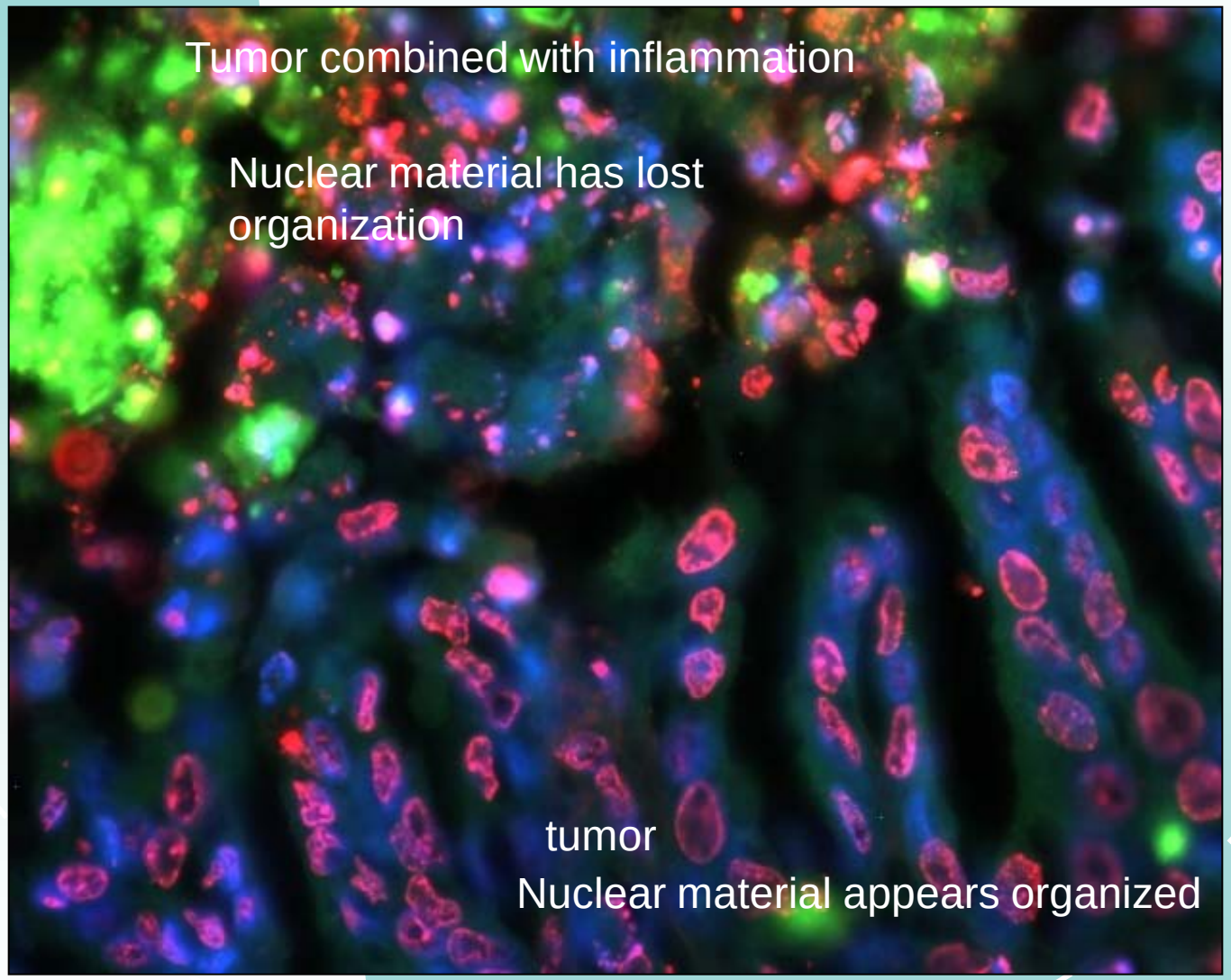
Apoptosis (Dog 463 nCi, 17 kBq)



Tumorous Lung Tissue

Objective Lens Power X60

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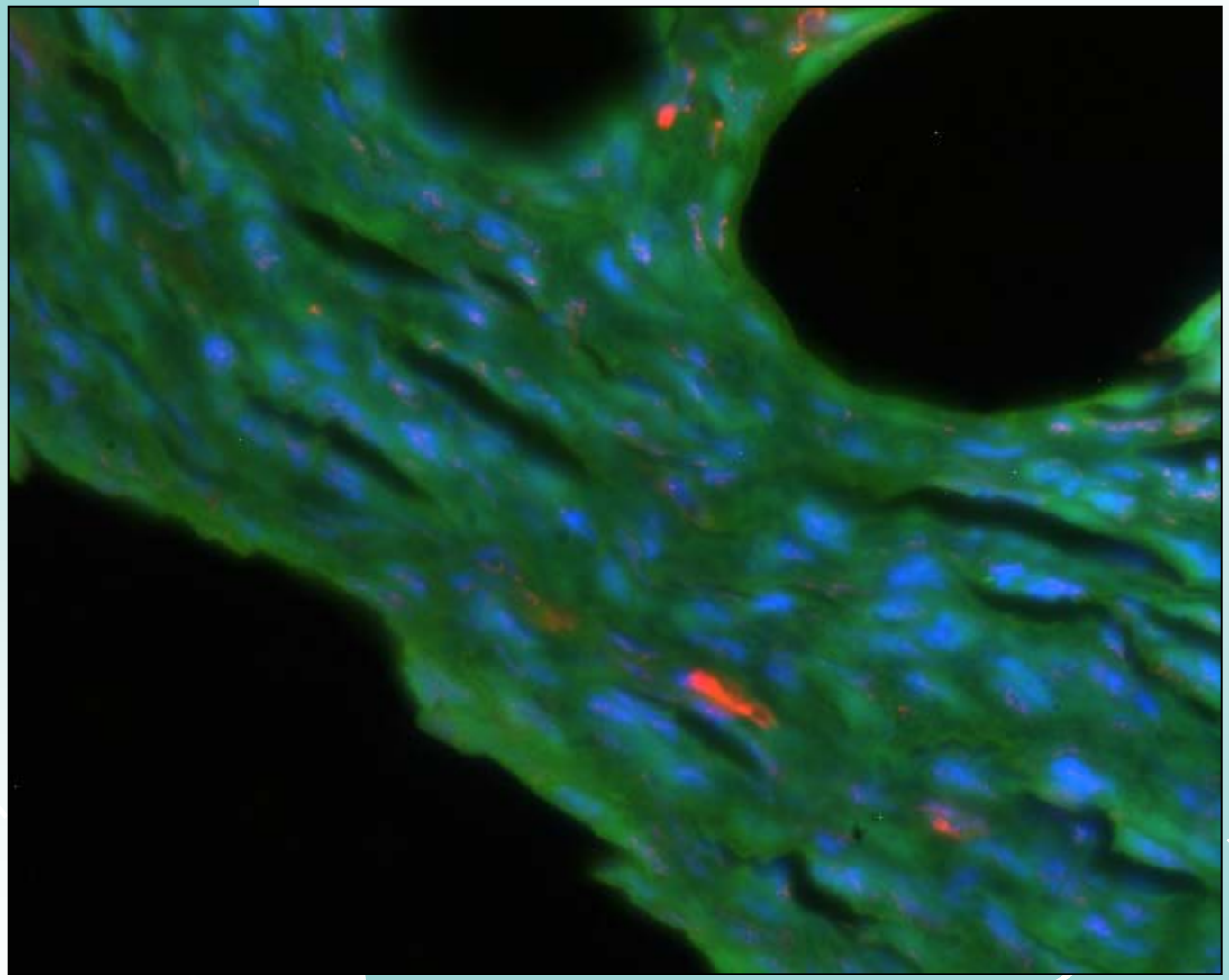
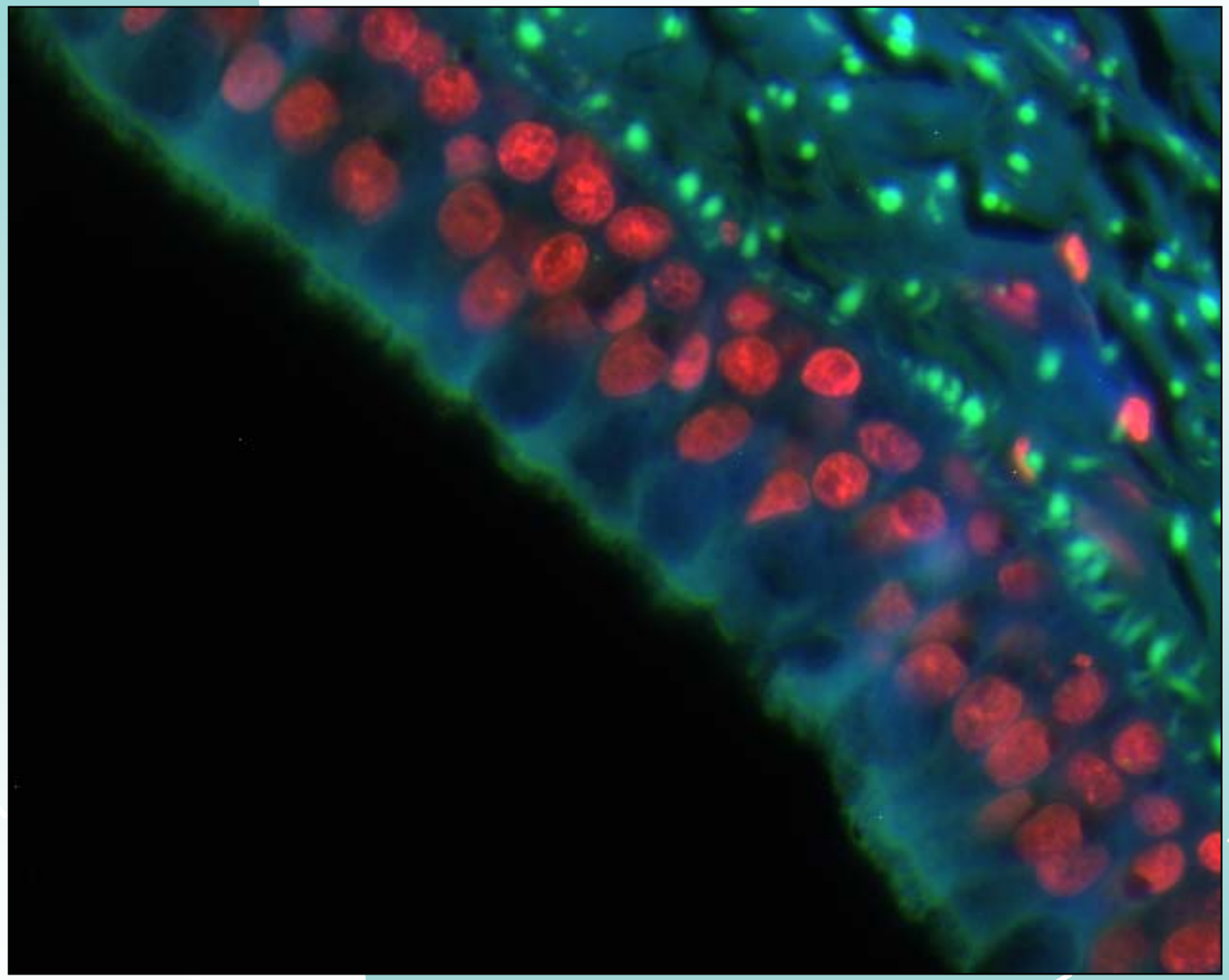
Apoptosis (Dog 191 nCi, 7.1 kBq)



Lung with Insterstitial Fibrosis – thickening of the alveolar walls – but not much apoptosis.

Objective Lens Power X60

Apoptosis (Dog 98 nCi, 3.6 kBq)

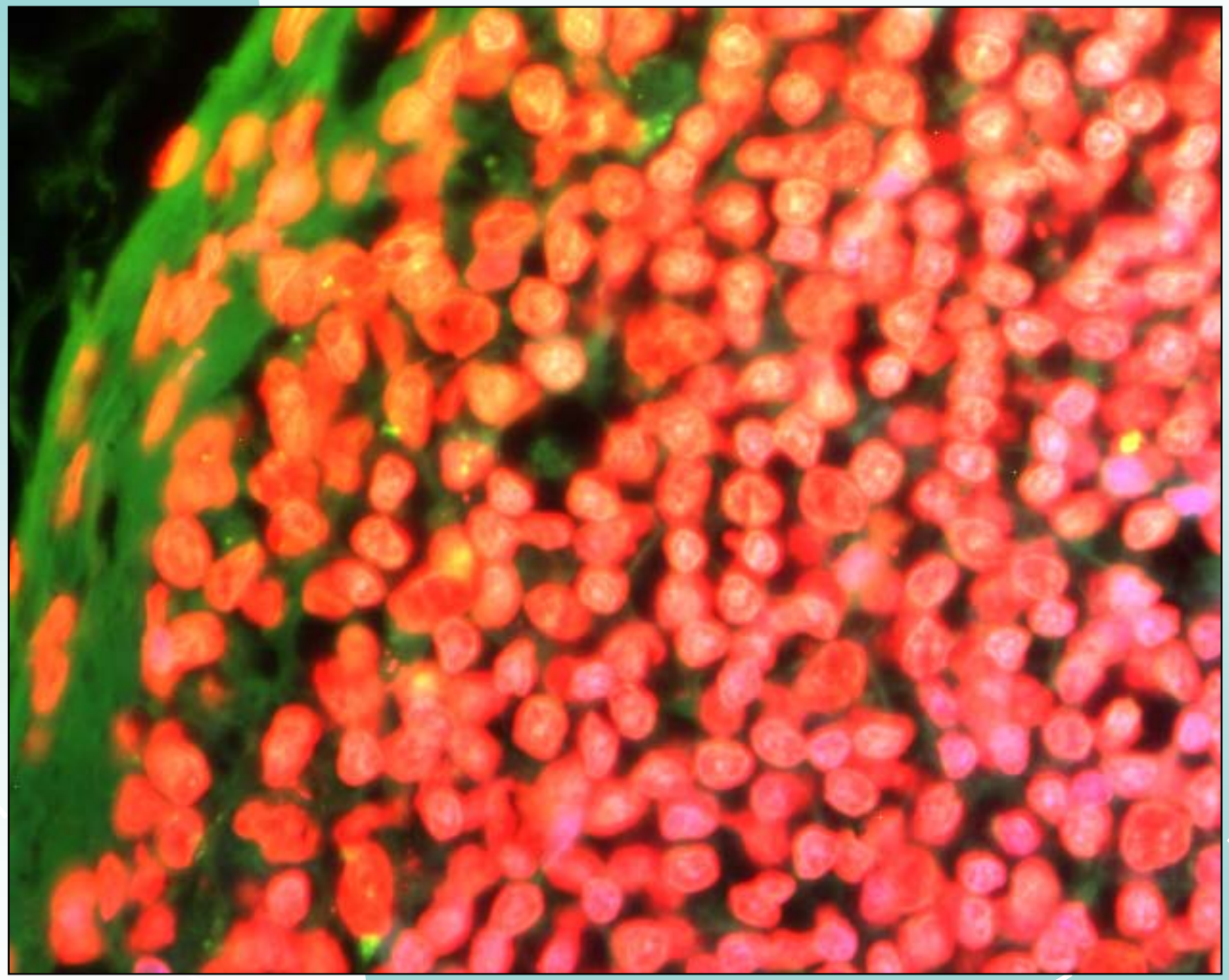


Bronchiole with mucus cells

A lot of apoptosis in the mucus cell layer

Objective Lens Power X60

Apoptosis (Dog 267 nCi, 9.9 kBq)



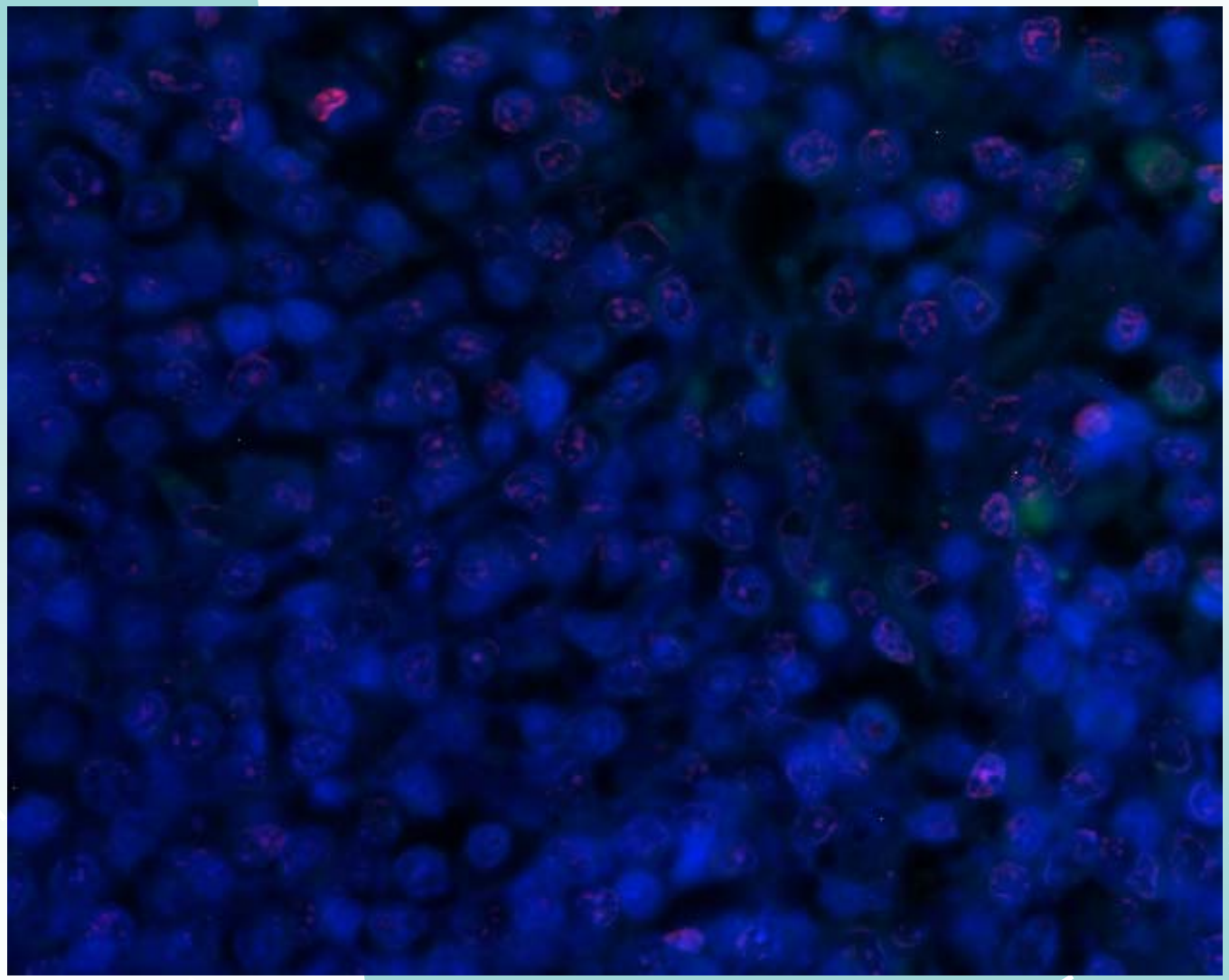
Objective Lens Power X60

Lymph Node

Extensive apoptosis

No tumor

Apoptosis (Dog Control)



Lymph Node

Very little apoptosis

Objective Lens Power X60