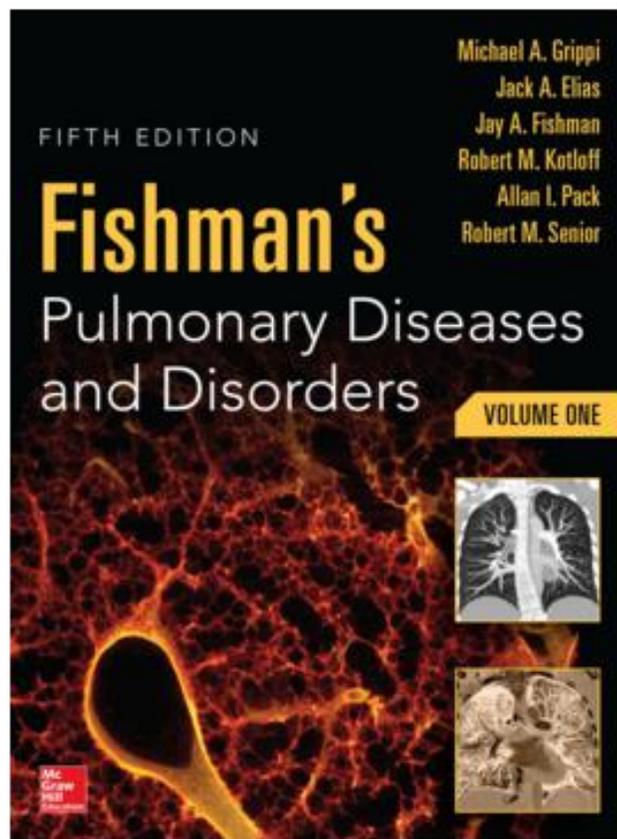
The background is a dark grey, textured surface with faint, light-colored sketches of various scientific and medical concepts. These include a globe, a microscope, a human torso, a cross, a book, a percentage sign, and other geometric shapes.

# Basic Pulmonary Physiology

Joshua Bucher, MD

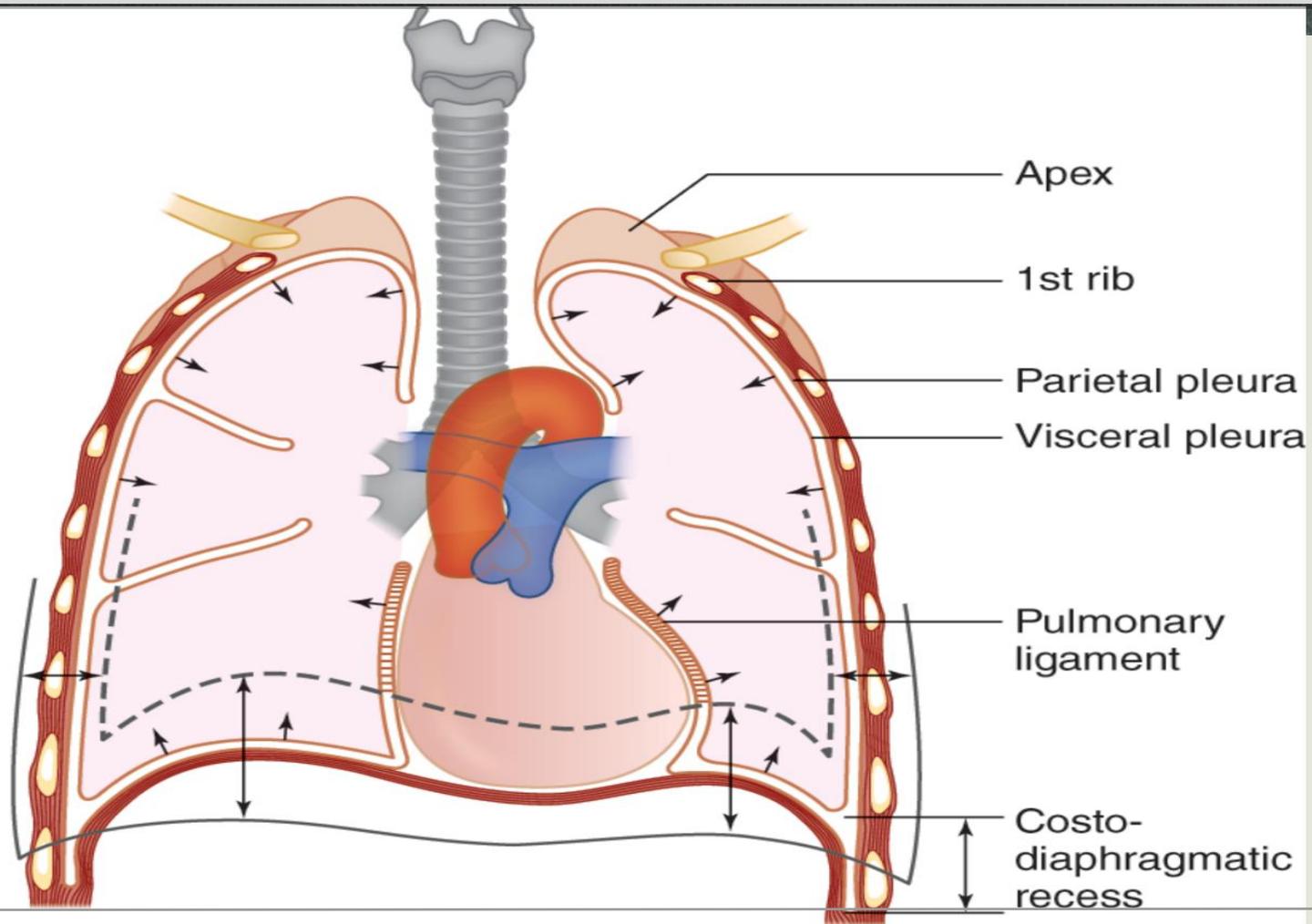
EMS Fellow, Atlantic Health Systems, Morristown Memorial Hospital



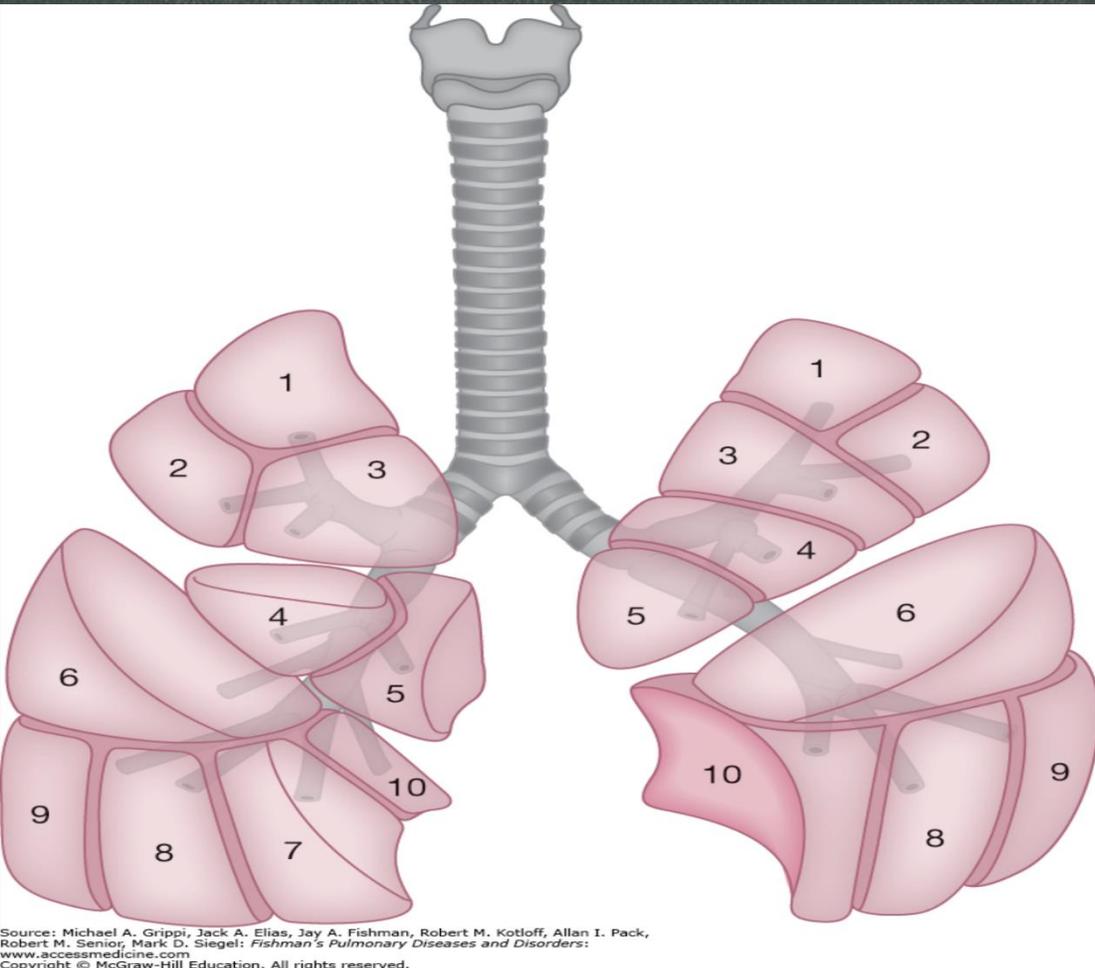
## **Fishman's Pulmonary Diseases and Disorders**

Michael A. Grippi, Jack A. Elias, Jay A. Fishman, Robert M. Kotloff, Allan I. Pack, Robert M. Senior, Mark D. Siegel

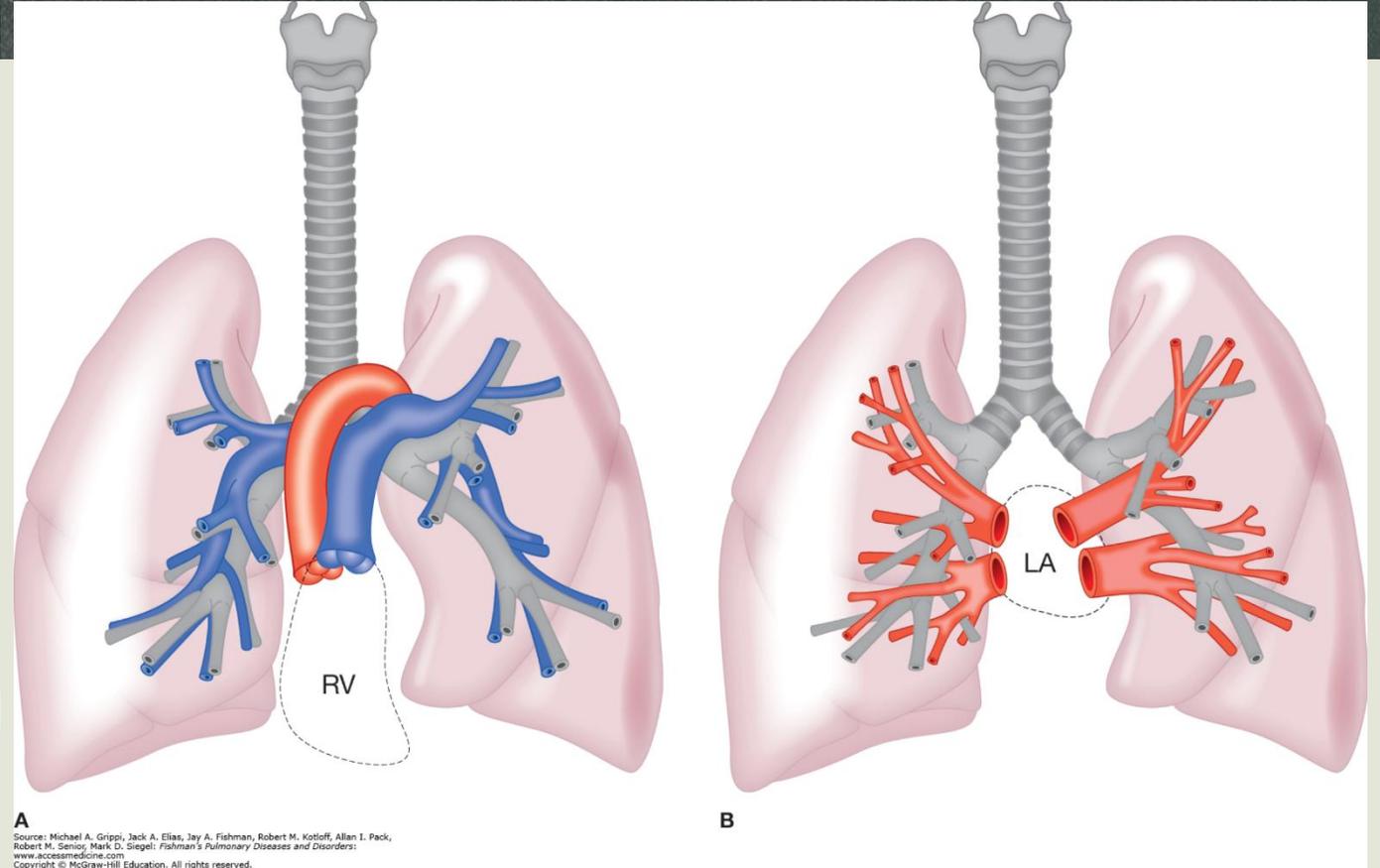
From: Scientific Basis of Lung Function in Health and Disease  
Fishman's Pulmonary Diseases and Disorders, 2015



From: Functional Design of the Human Lung for Gas Exchange  
Fishman's Pulmonary Diseases and Disorders, 2015



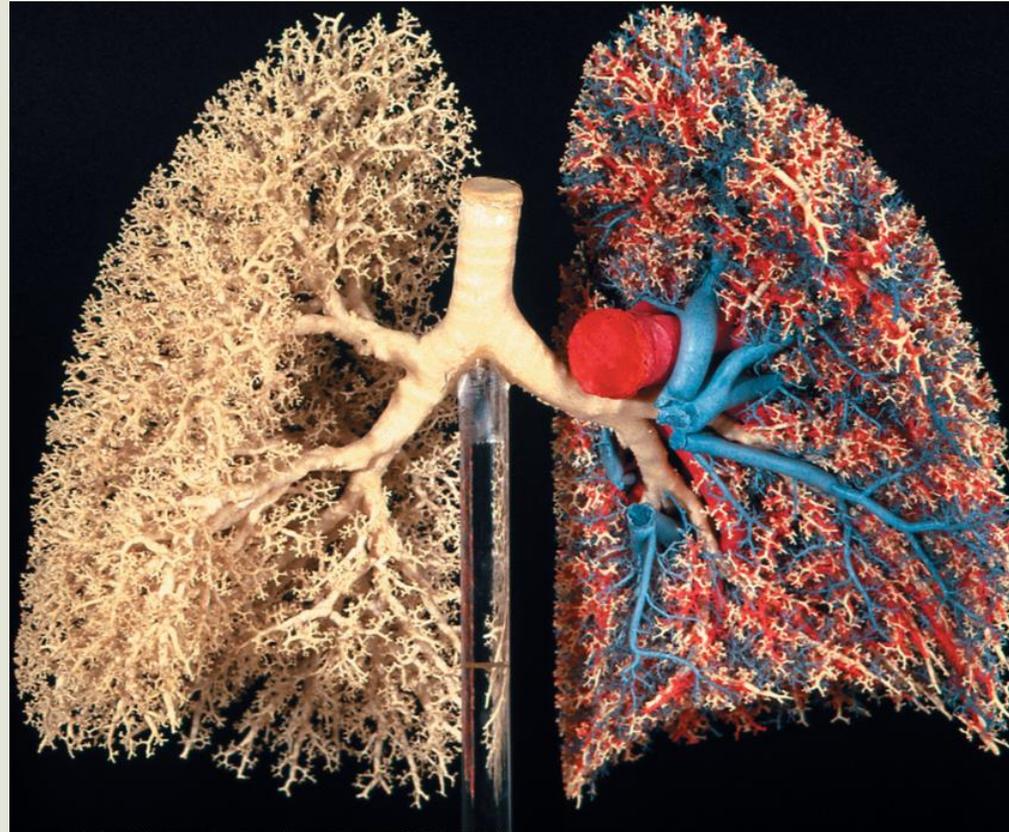
Source: Michael A. Grippi, Jack A. Elias, Jay A. Fishman, Robert M. Kotloff, Allan I. Pack, Robert M. Senior, Mark D. Siegel: *Fishman's Pulmonary Diseases and Disorders*: www.accessmedicine.com Copyright © McGraw-Hill Education. All rights reserved.



A  
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B

From: Functional Design of the Human Lung for Gas Exchange  
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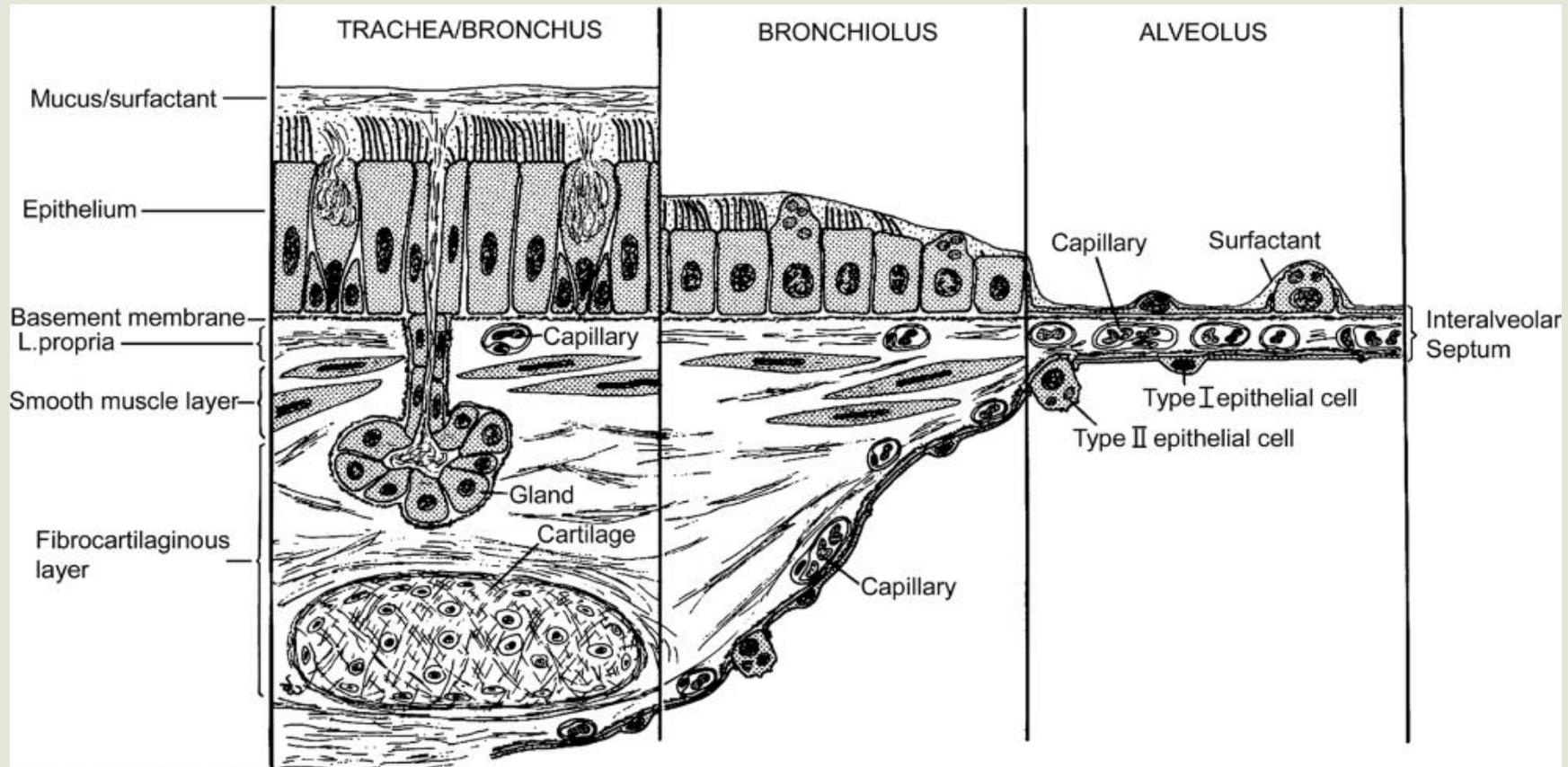


Source: Michael A. Grippi, Jack A. Elias, Jay A. Fishman, Robert M. Kotloff, Allan I. Pack, Robert M. Senior, Mark D. Siegel: *Fishman's Pulmonary Diseases and Disorders*: [www.accessmedicine.com](http://www.accessmedicine.com)  
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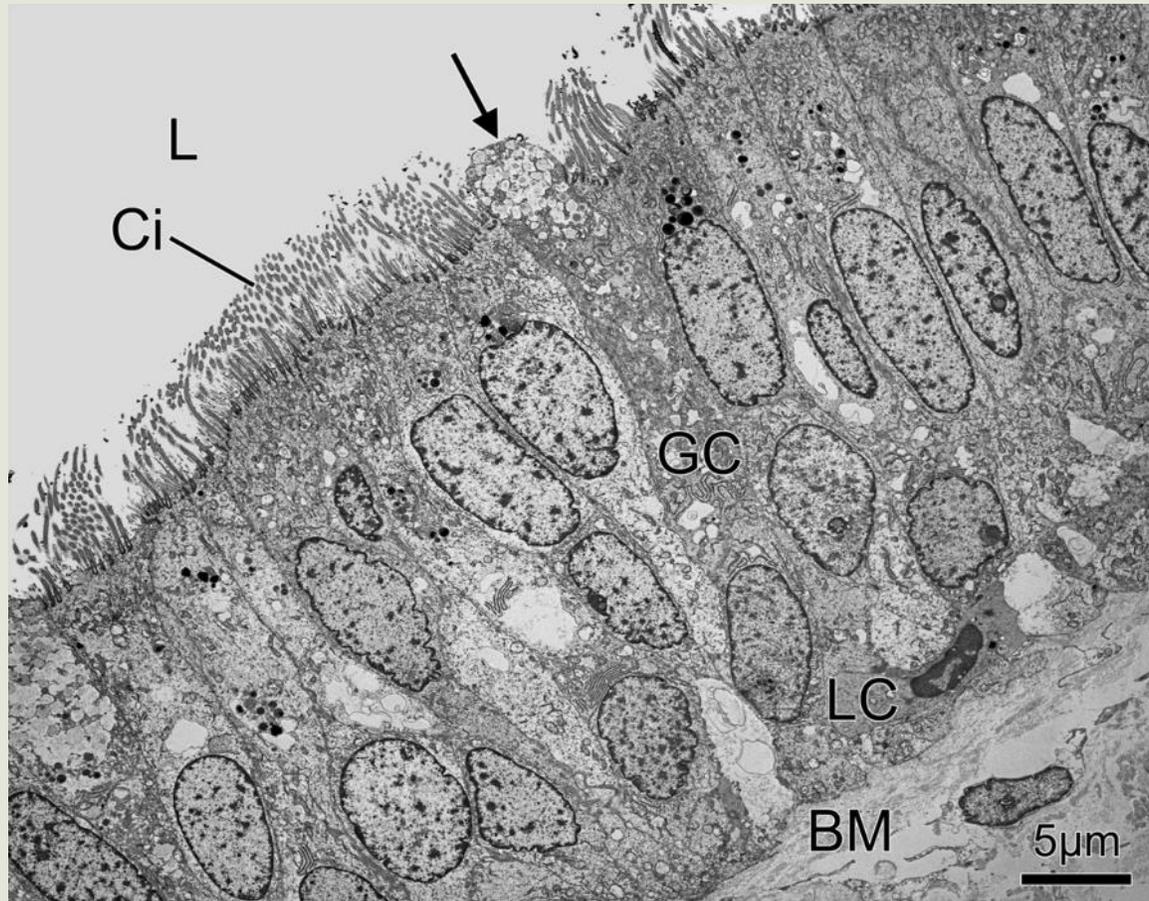
Conducting airways	Trachea		Z	
			0	
	Bronchi		1	
			2	
			3	
	Bronchioles		4	
	5			
	Terminal bronchioles	14	Z'	
Acinar airways	Transitional bronchioles	15	0	
	Respiratory bronchioles	16	1	
		17	2	
		18	3	
	Alveolar ducts	19	4	
		20	5	
		21	6	
		22	7	
Alveolar sacs	23	8		

From: Functional Design of the Human Lung for Gas Exchange  
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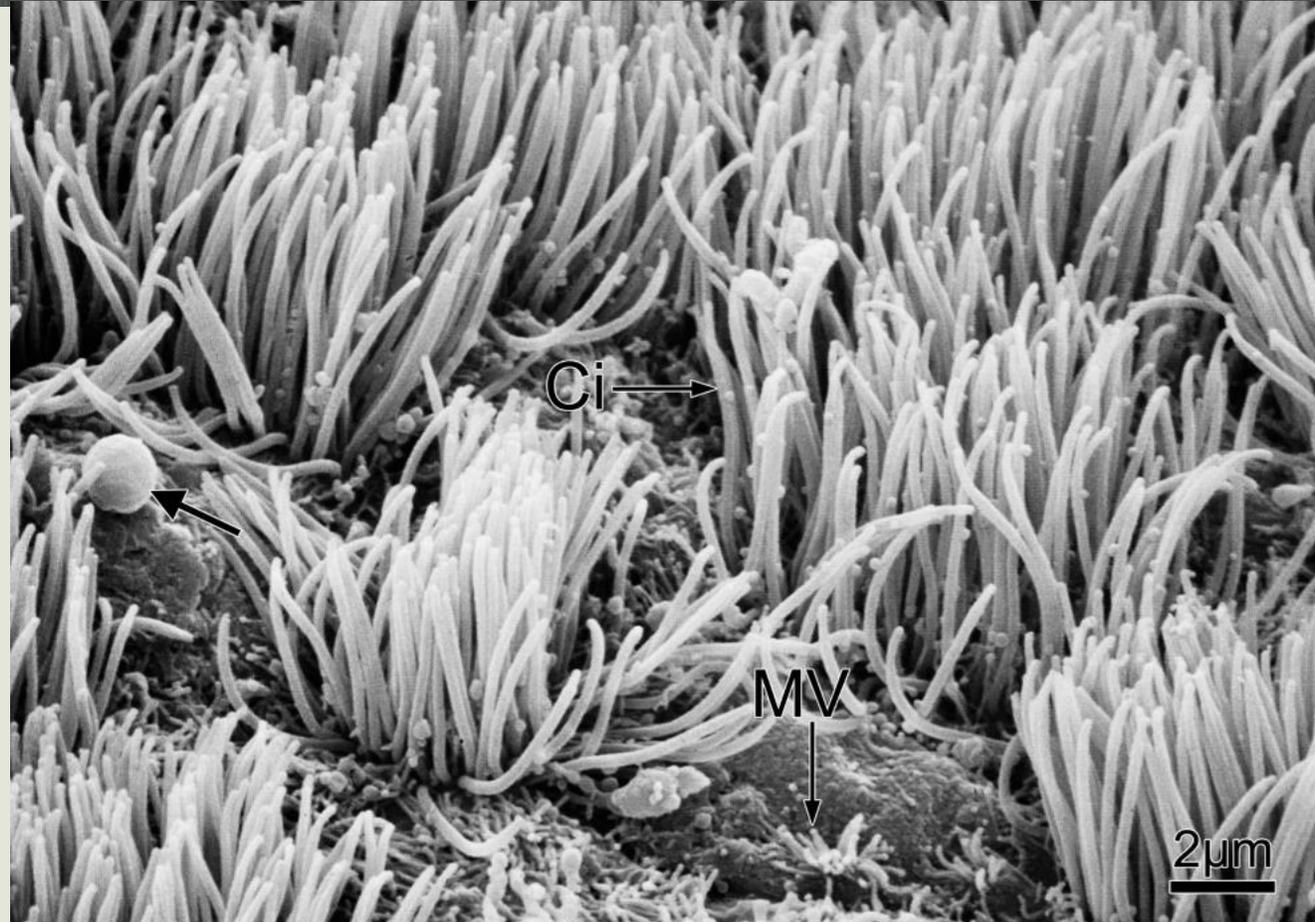
Source: Michael A. Grippi, Jack A. Elias, Jay A. Fishman, Robert N. Kottloff, Allan I. Pack, Robert M. Senior, Mark D. Siegel; Fishman's Pulmonary Diseases and Disorders; www.accessmedicine.com  
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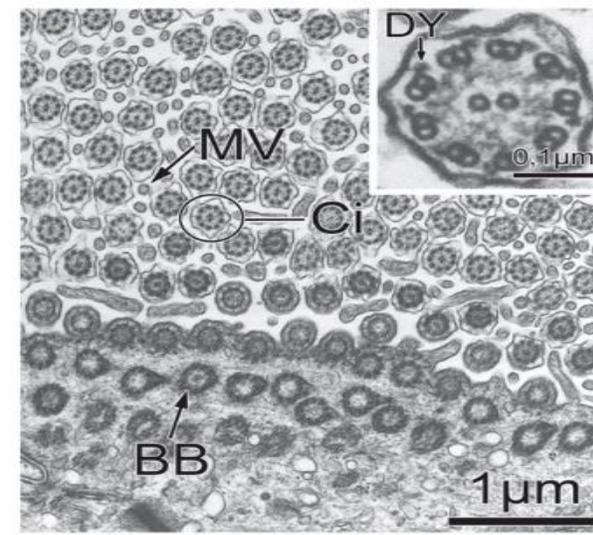
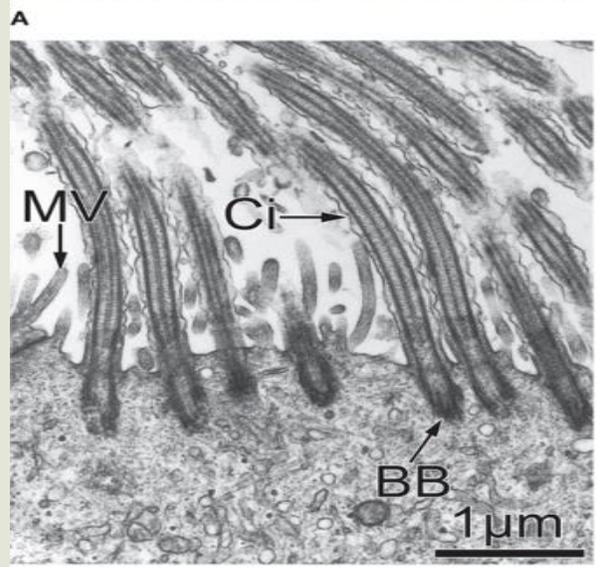
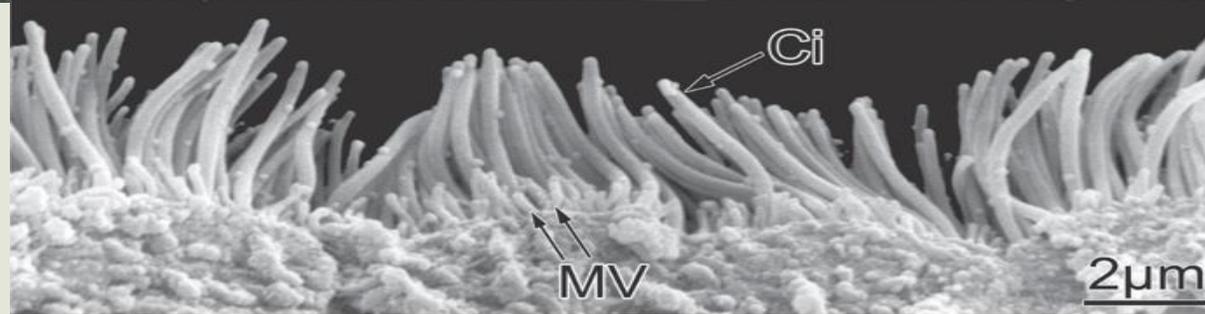
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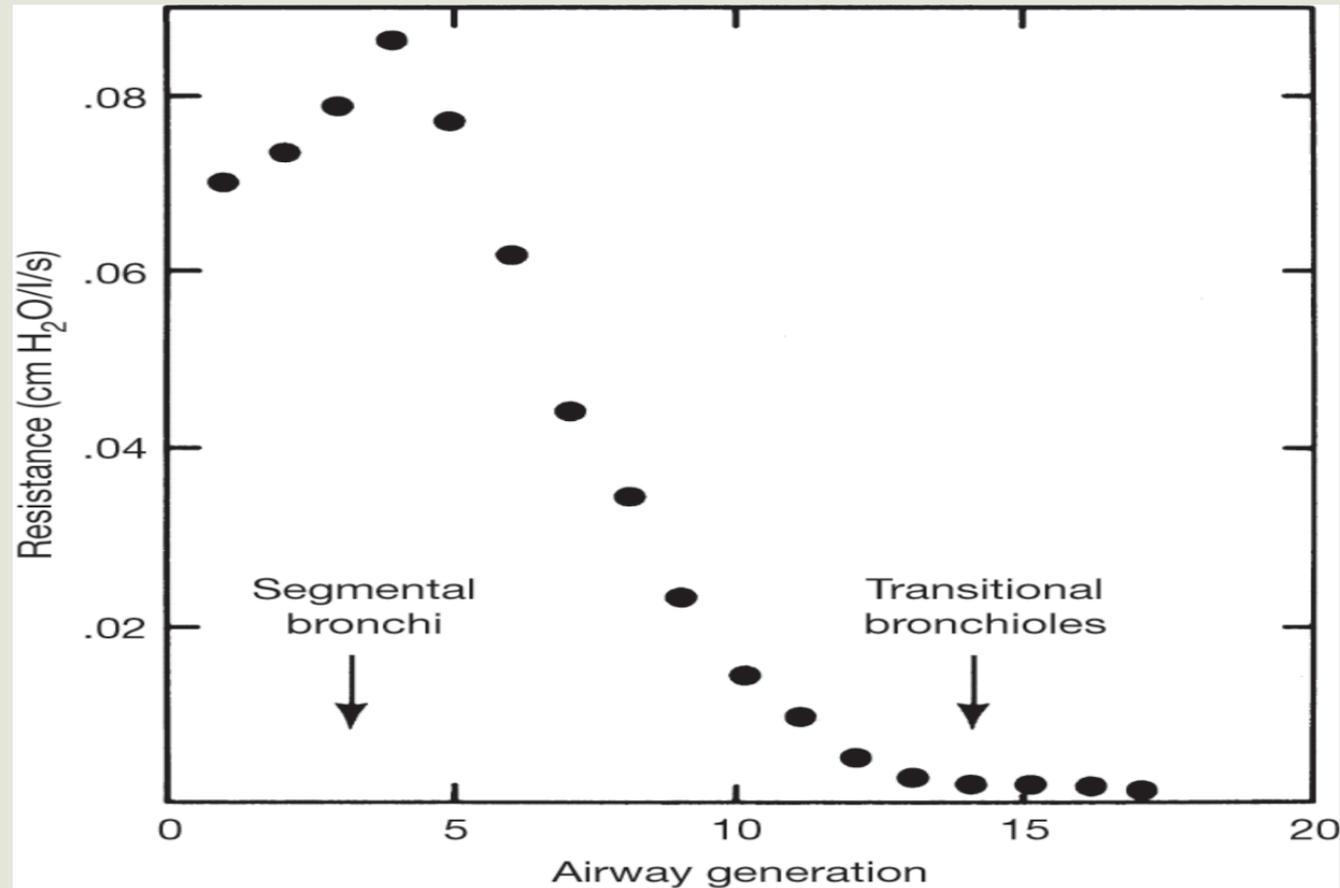
From: Functional Design of the Human Lung for Gas Exchange  
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Source: Michael A. Grippi, Jack A. Elias, Jay A. Fishman, Robert M. Kotloff, Allan I. Pack, Robert M. Senior, Mark D. Siegel: *Fishman's Pulmonary Diseases and Disorders*:  
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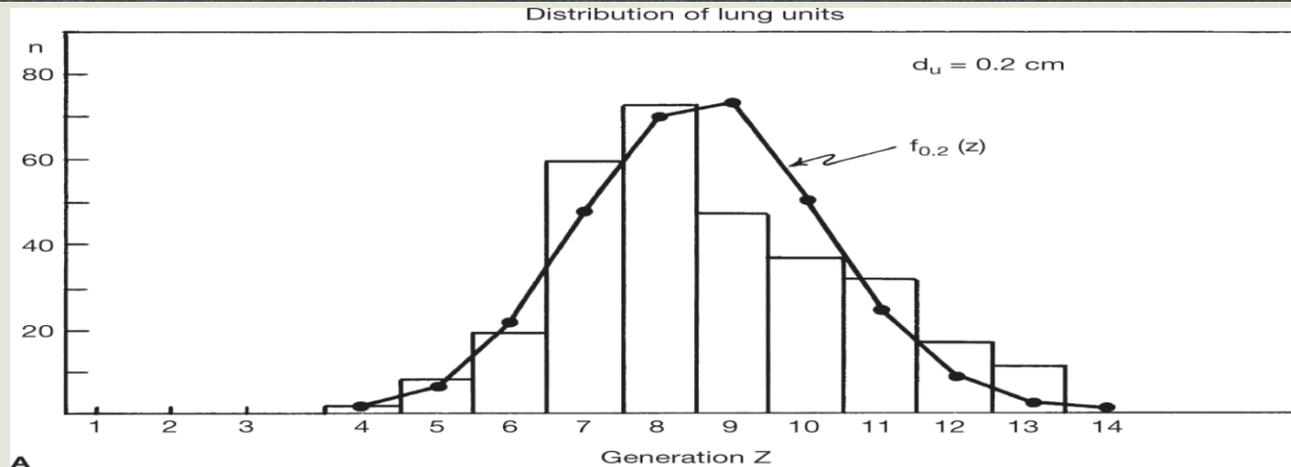
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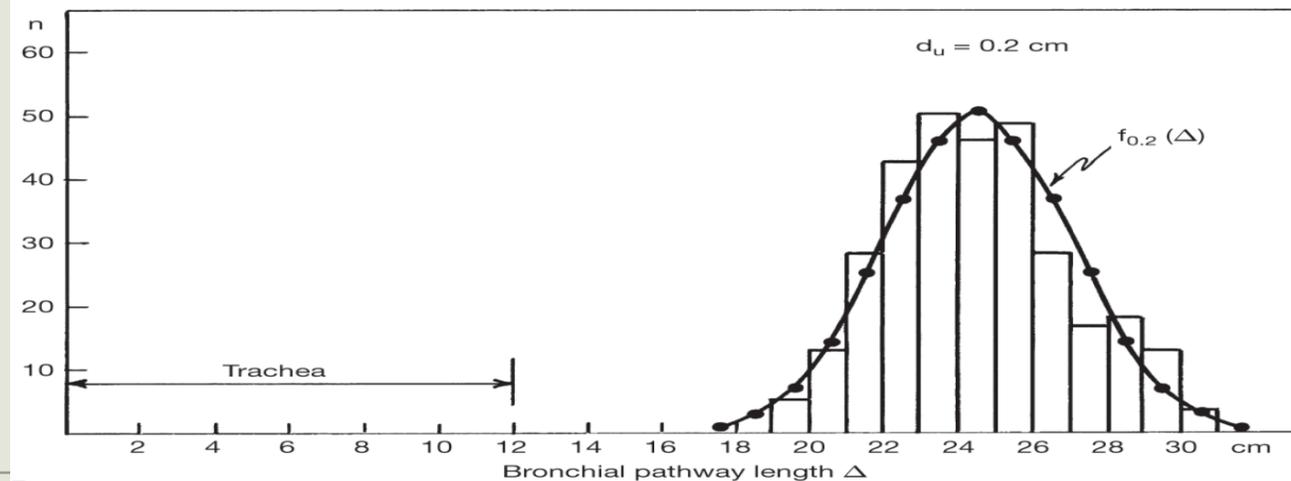


Source: Michael A. Grippi, Jack A. Elias, Jay A. Fishman, Robert M. Kotloff, Allan I. Pack, Robert M. Senior, Mark D. Siegel: *Fishman's Pulmonary Diseases and Disorders*: www.accessmedicine.com  
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**A**

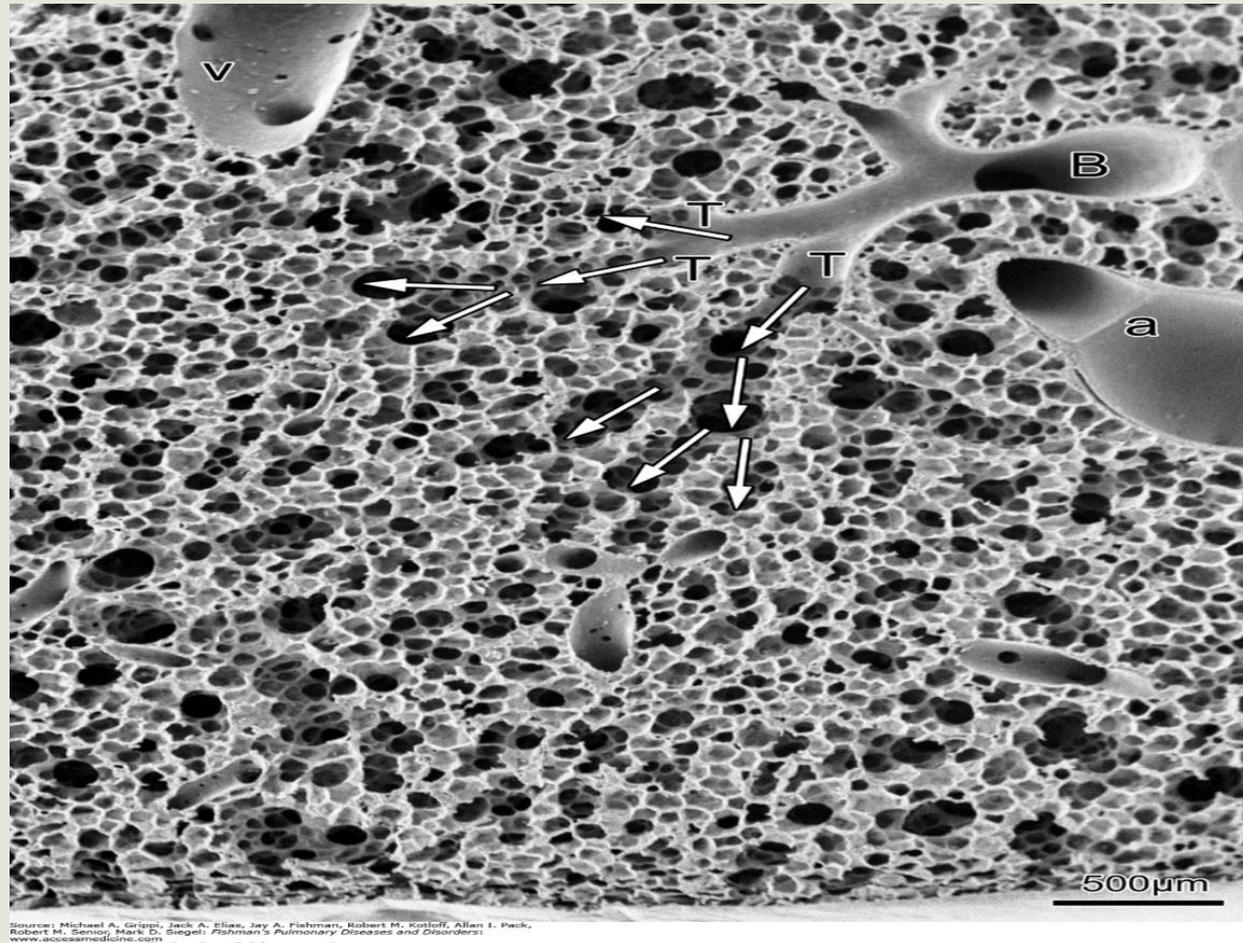


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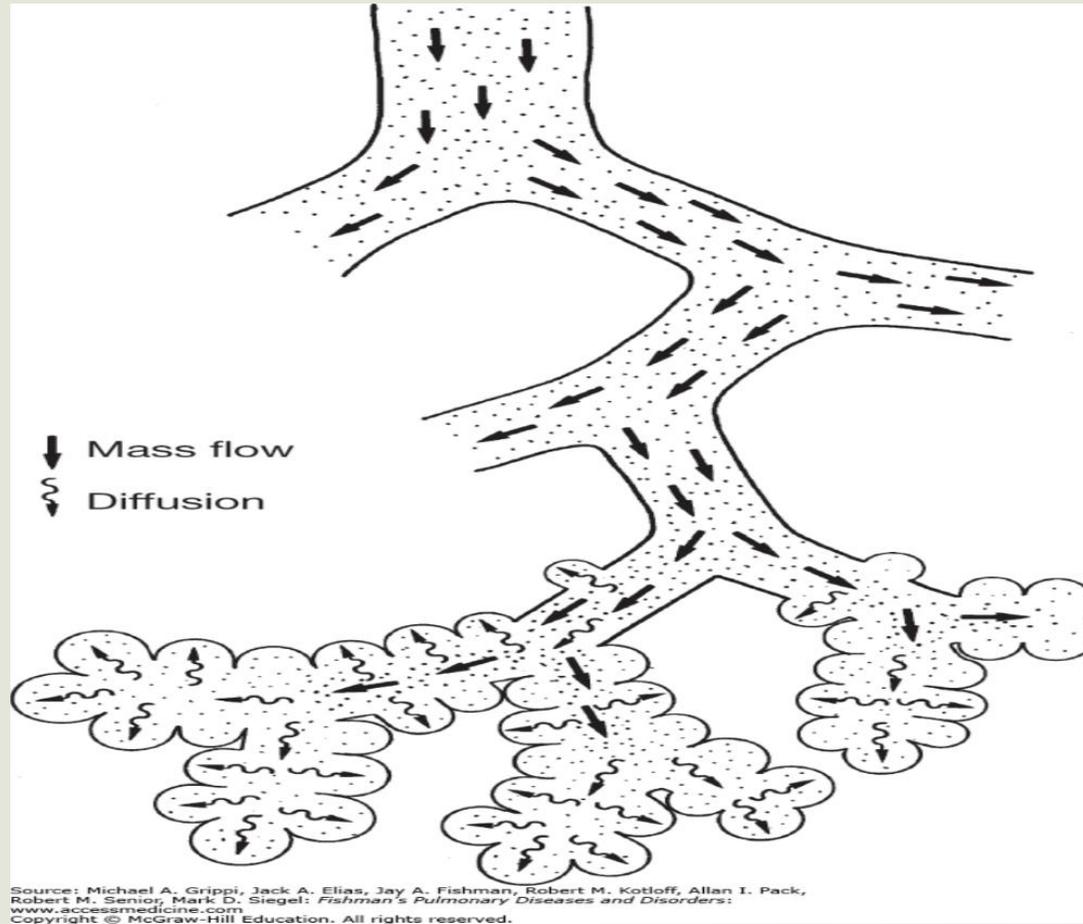
Source: Michael A. Grippi, Jack A. Elias, Jay A. Fishman, Robert M. Kotloff, Allan I. Peck, Robert N. Sienko, Mark D. Siegel. *Fishman's Pulmonary Diseases and Disorders*.  
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Distribution of airways of diameter  $d_u = 2 \text{ mm}$  with respect to (A), generations of branching and (B), bronchial pathway lengths

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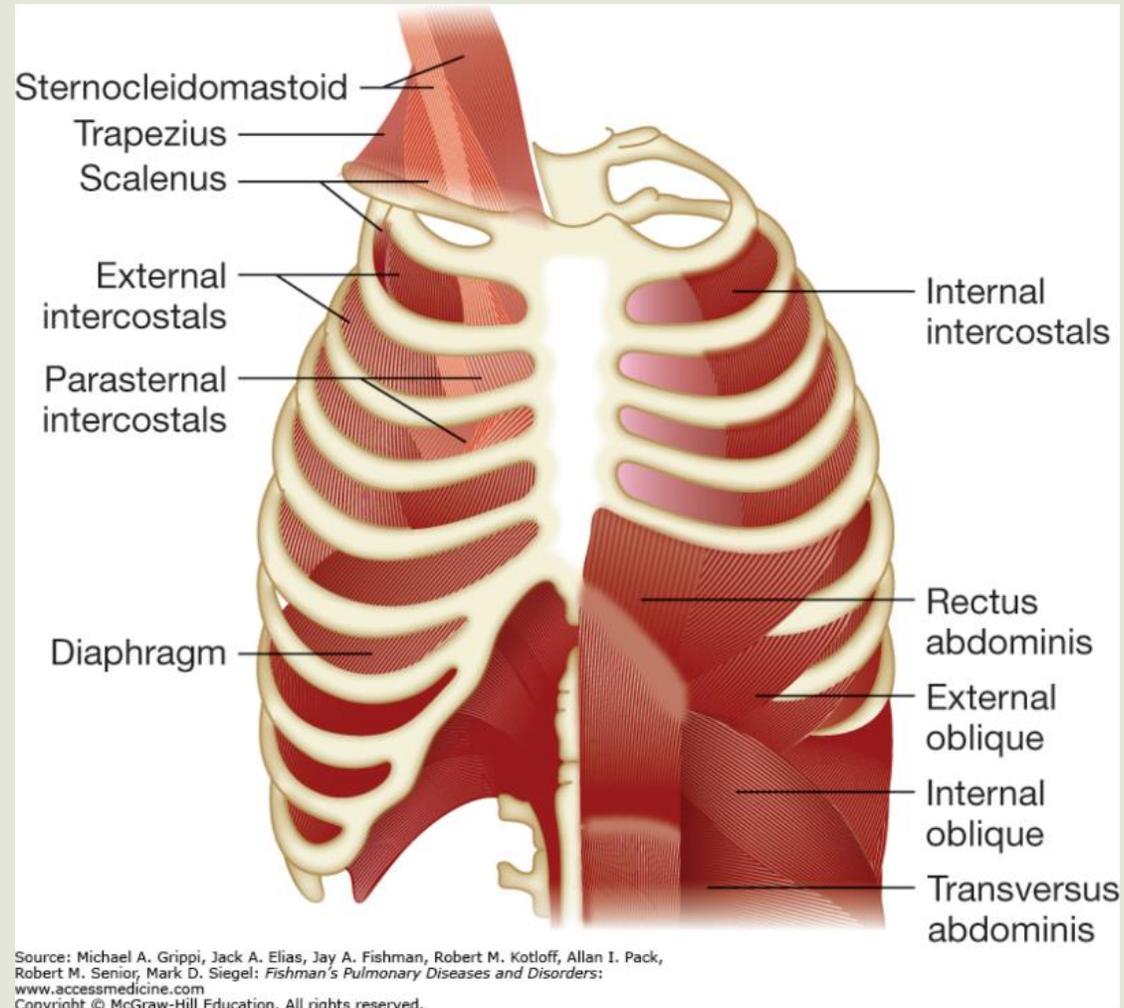


From: Functional Design of the Human Lung for Gas Exchange  
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**From: The Respiratory Muscles**

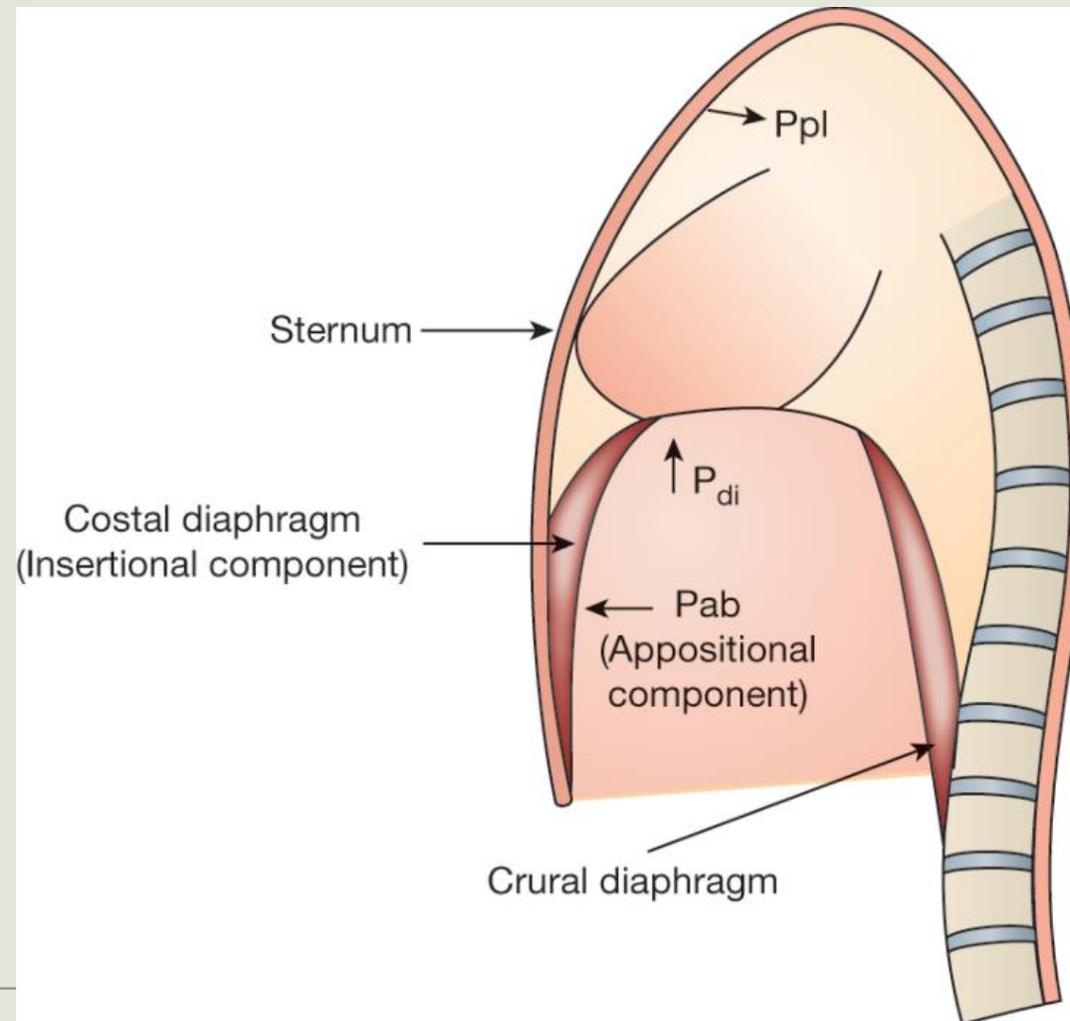
Fishman's Pulmonary Diseases and Disorders, 5e, 2015



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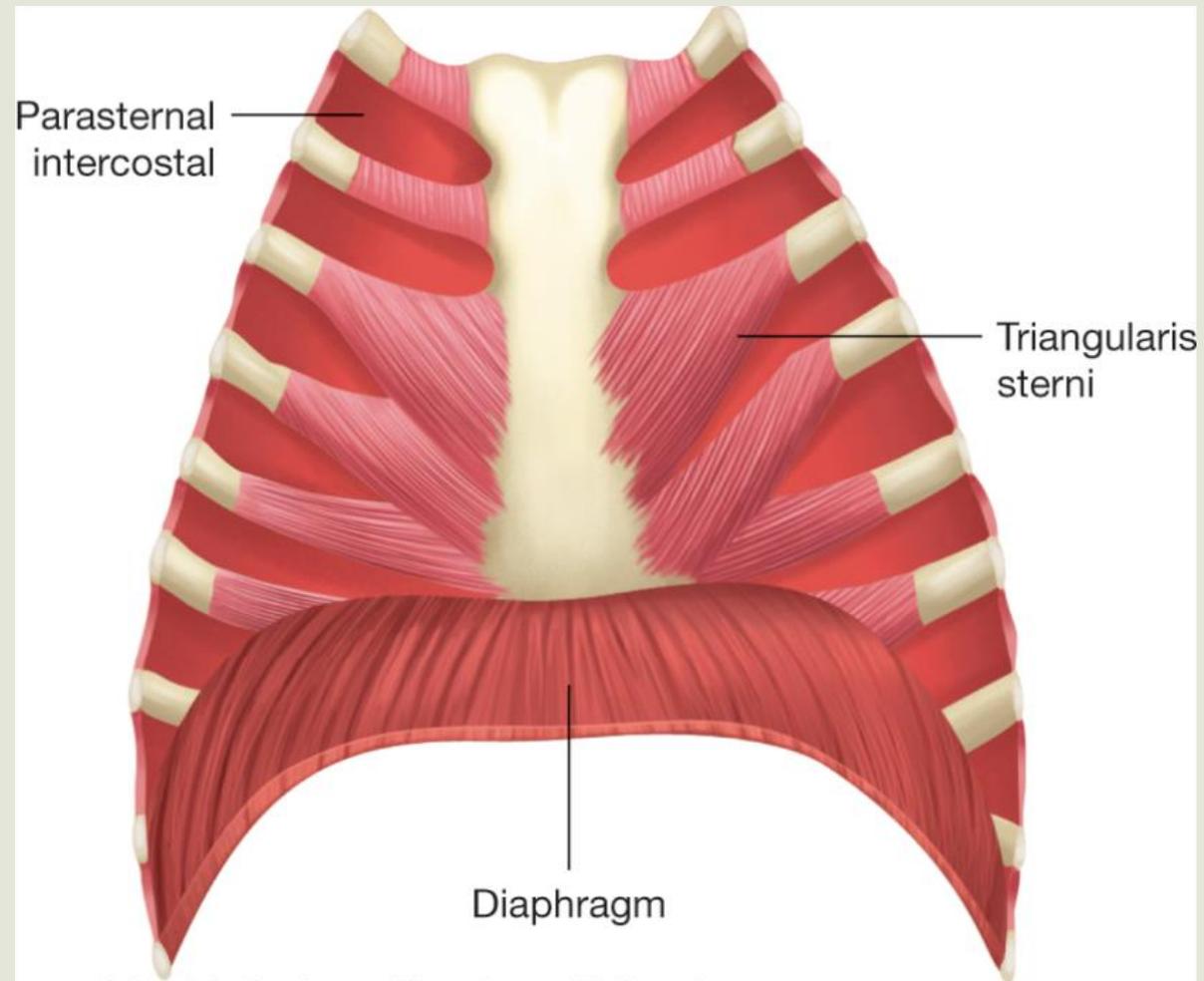
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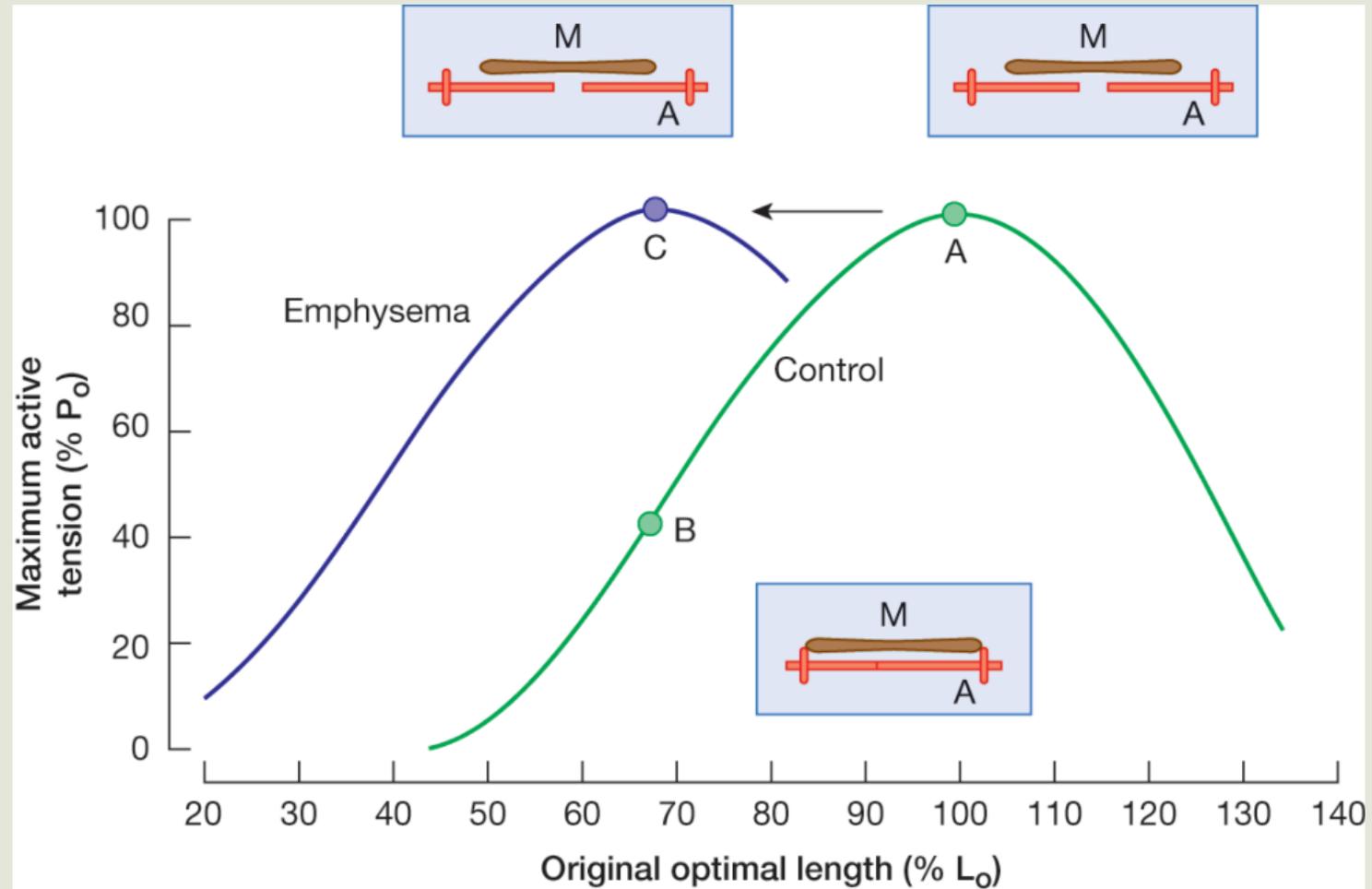
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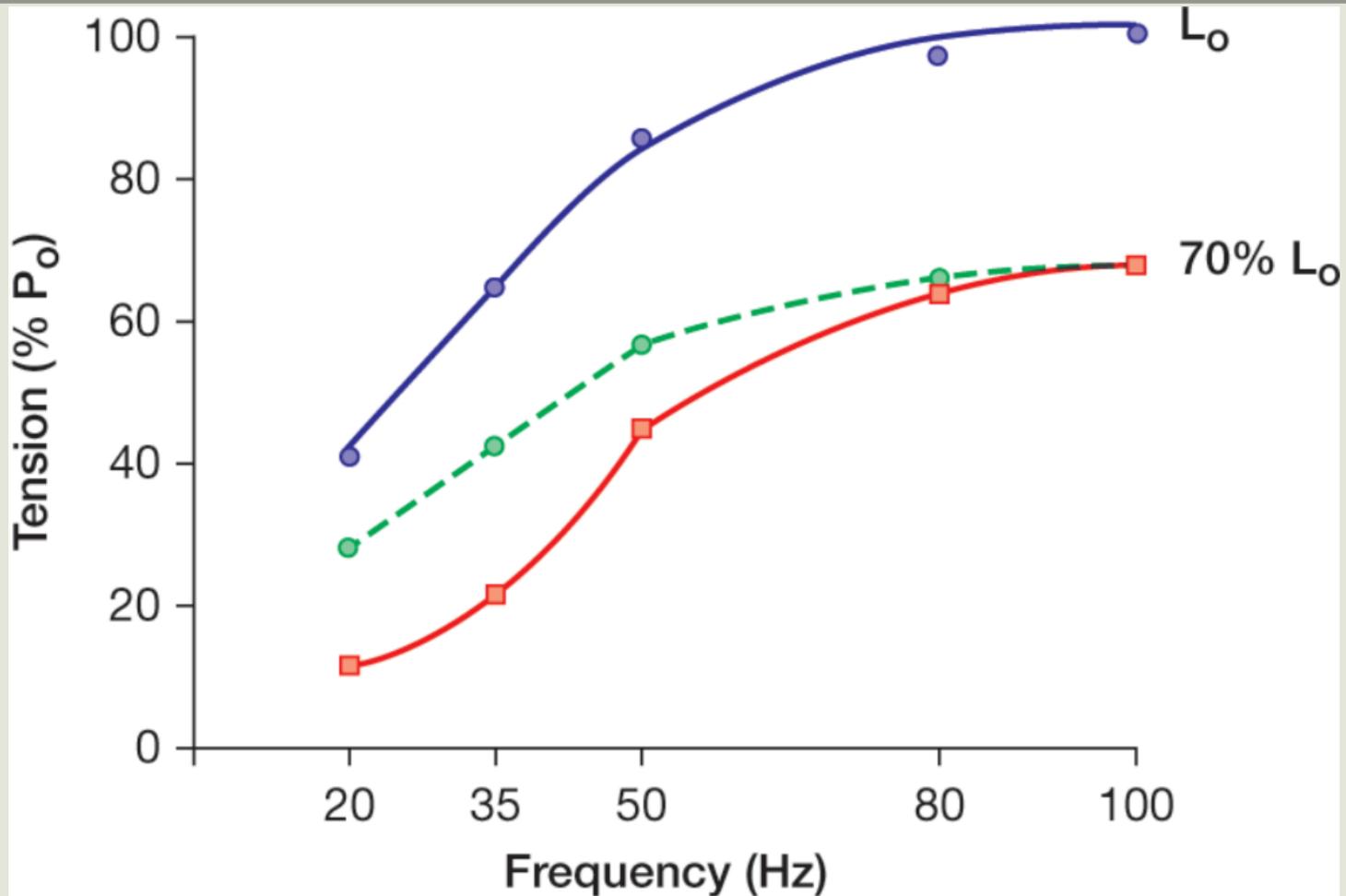
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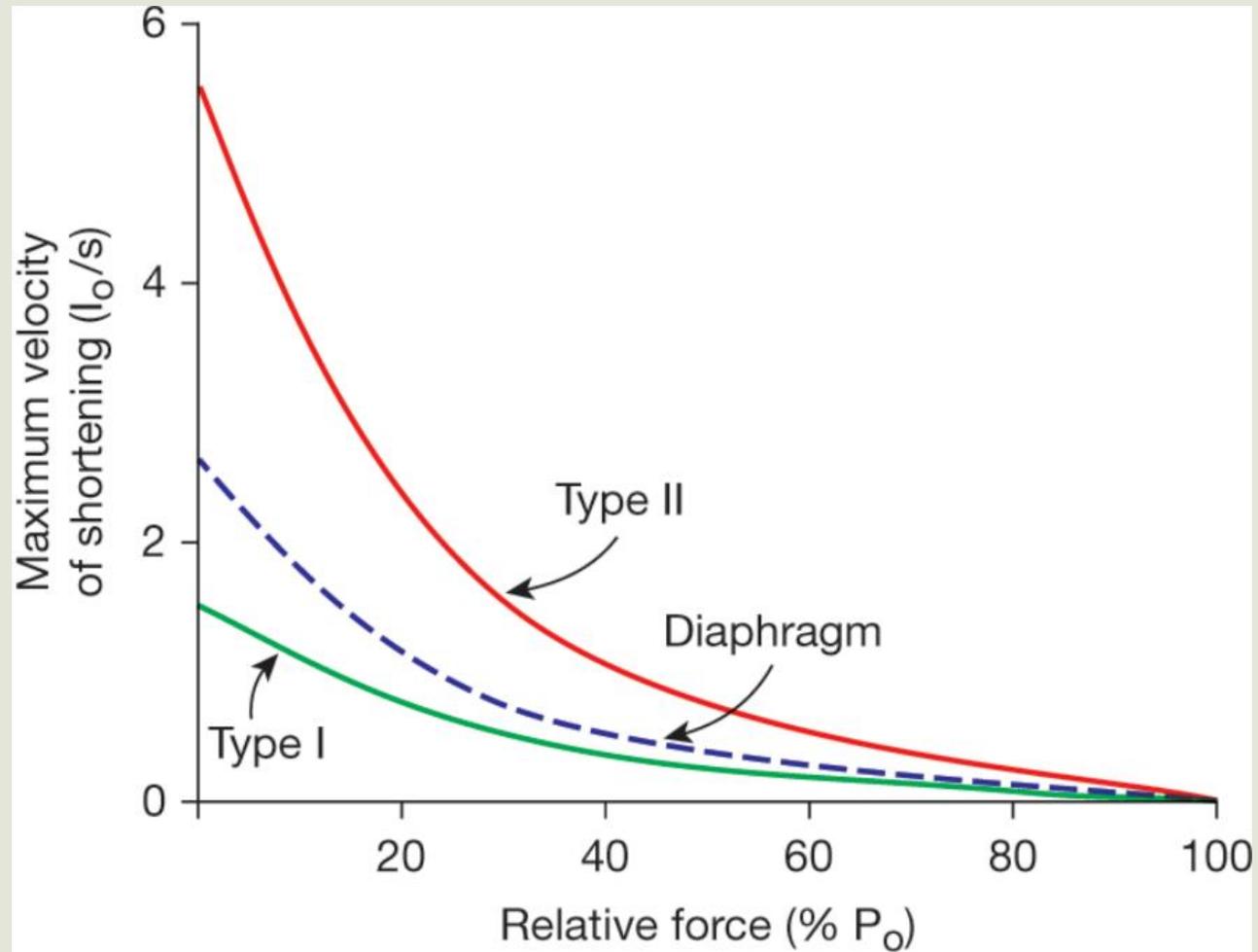
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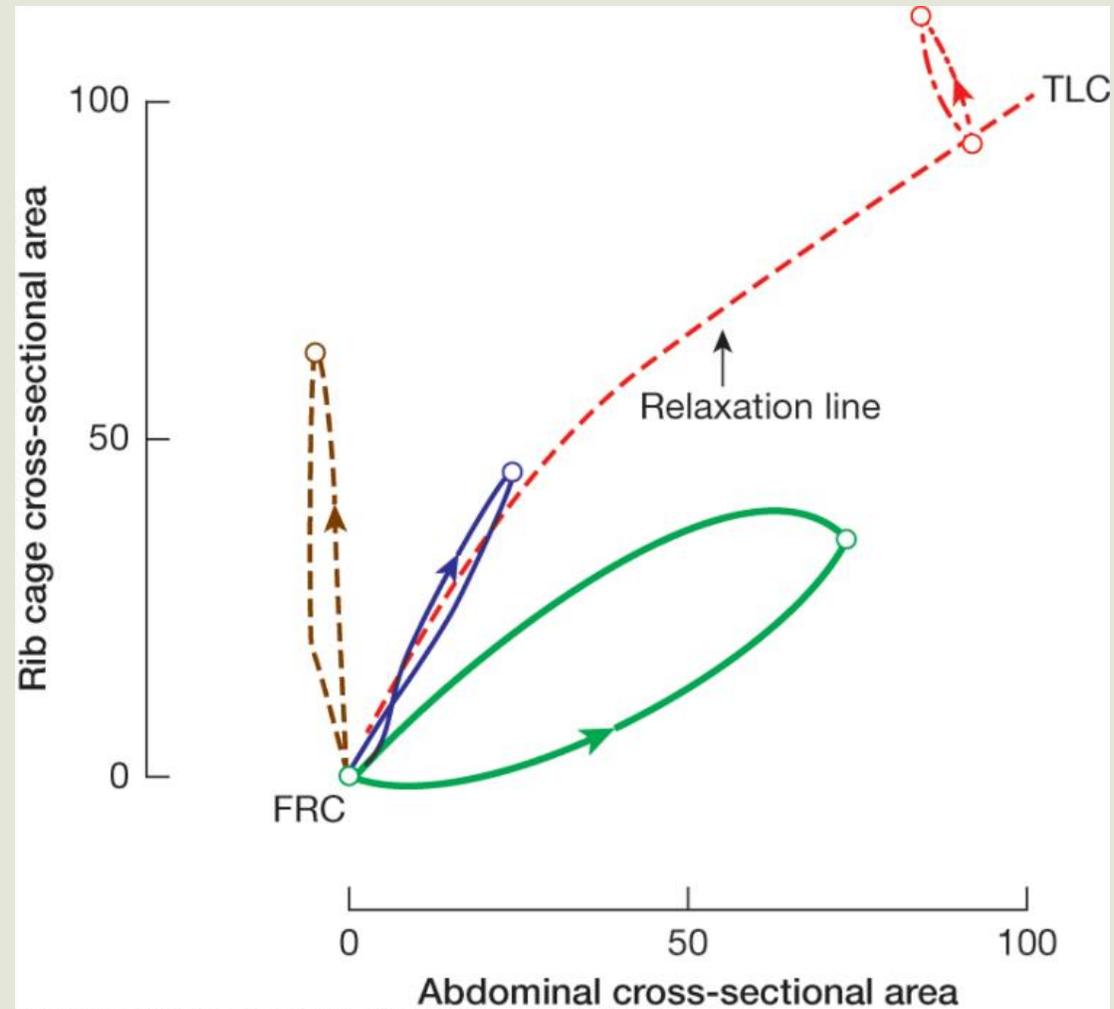
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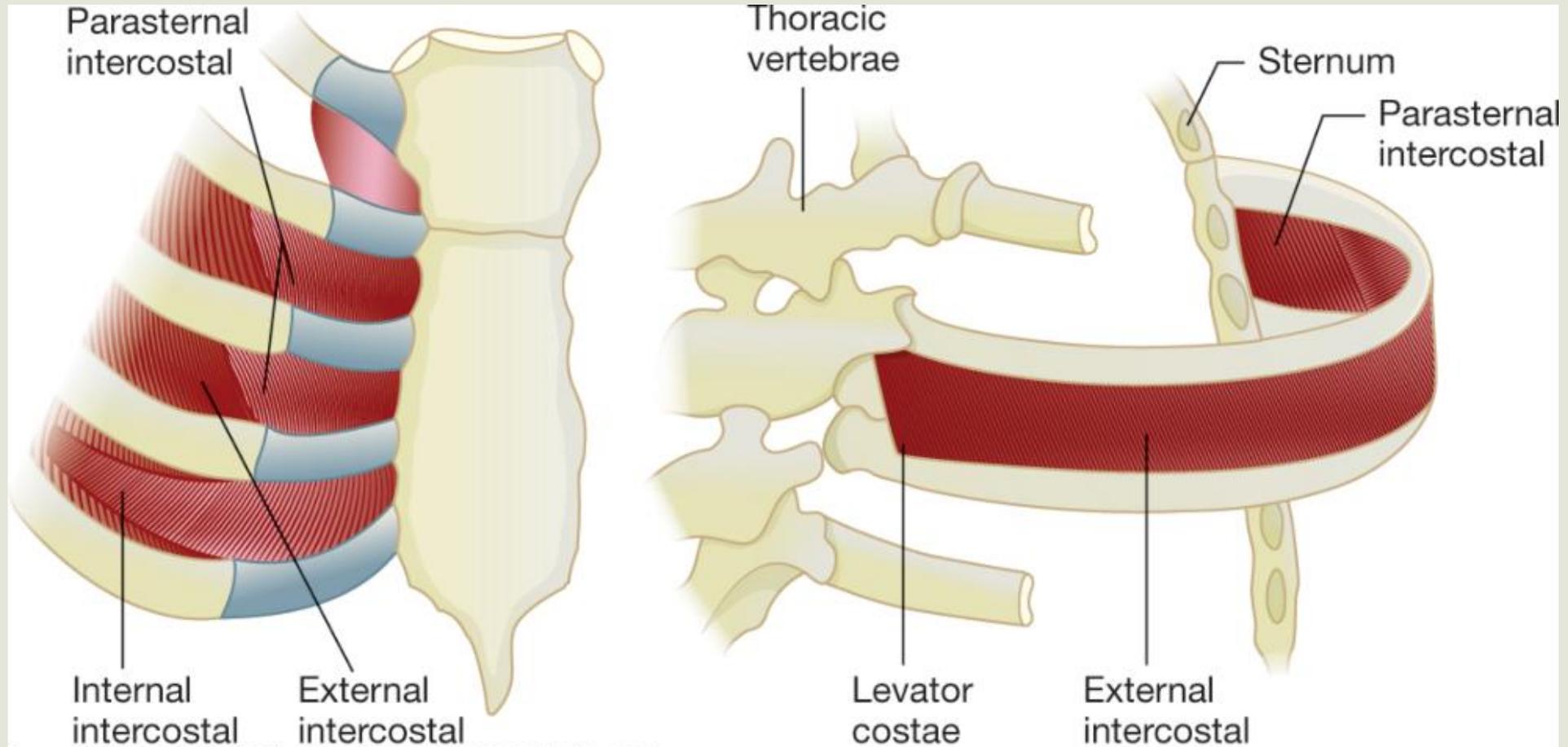
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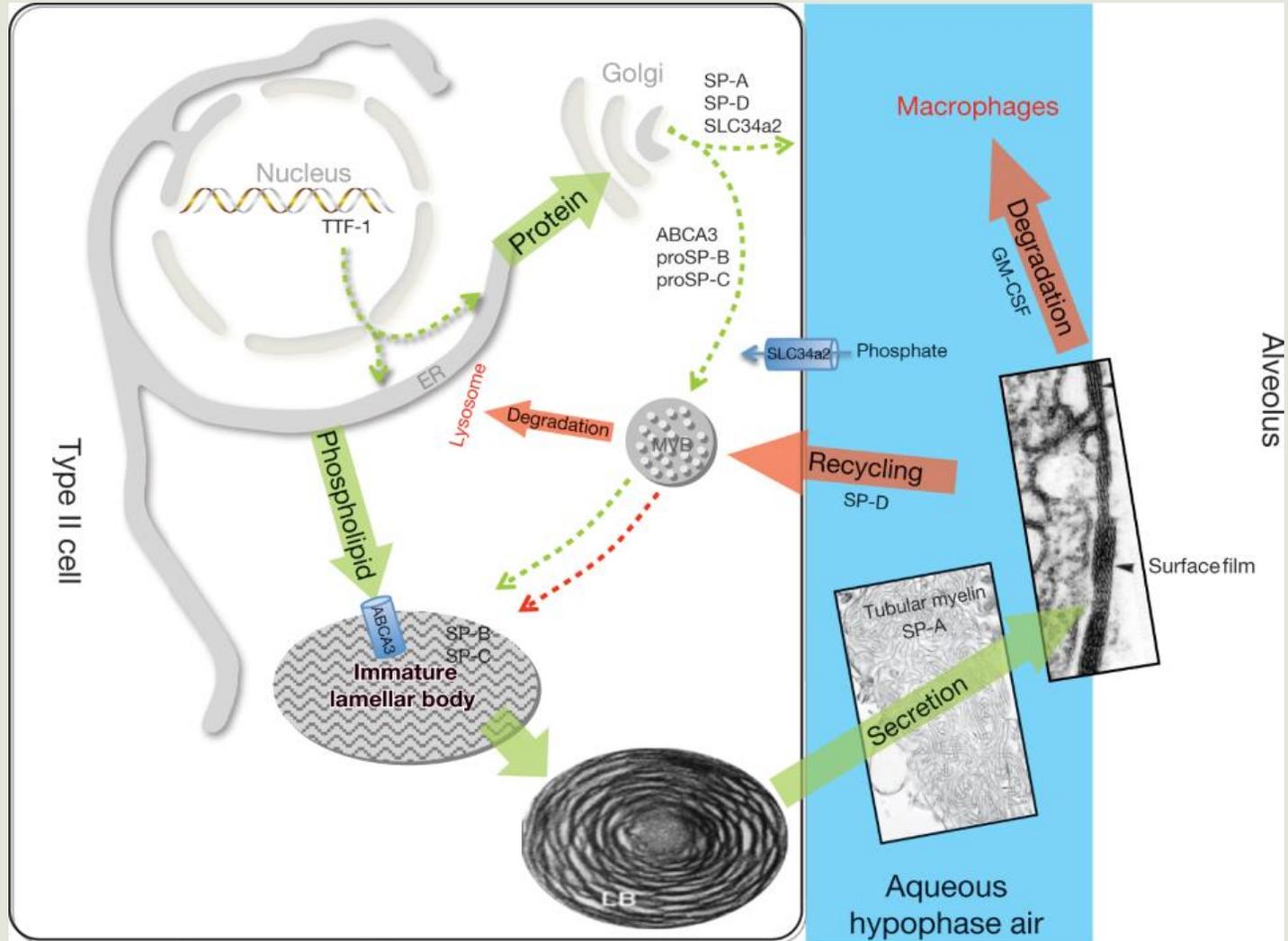


From: The Respiratory Muscles

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From: Pulmonary Surfactant and Disorders of Surfactant Homeostasis  
Fishman's Pulmonary Diseases and Disorders, 5e, 2015



# Surfactant

- Complex mixture of phospholipids and protein
- Interface between alveolar gas and liquid
- Maintains lung volume
- Reduces surface tension
- ARDS, RDS, premature infants

# Fishman's Pulmonary Diseases and Disorders, 5e > Oxygen Therapy and Toxicity

[Print](#)

Table 144-1

## Causes of Arterial Hypoxemia and Response to Oxygen Therapy

Cause	Clinical Examples	Response to Oxygen Therapy
Decreased oxygen intake	Altitude (reduced $P_{iO_2}$ )	Rapid increase in $P_{aO_2}$
Alveolar hypoventilation	COPD, obesity hypoventilation	Increase in $P_{aO_2}$ , may depress minute ventilation, however
Diffusion defect	Interstitial pneumonitis	Moderately rapid increase in $P_{aO_2}$
Ventilation–perfusion mismatch	COPD	Moderately rapid increase in $P_{aO_2}$
Shunt	Atrial septal defect, with right-to-left shunting	Variable increase in $P_{aO_2}$ , depending on size of shunt

## Fishman's Pulmonary Diseases and Disorders, 5e > Oxygen Therapy and Toxicity

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Table 144-3

### Guidelines for Acute Oxygen Therapy

#### Accepted Indications

Documented hypoxemia, defined as  $\text{Pa}_{\text{O}_2}$  below the normal range. Usually  $\text{Pa}_{\text{O}_2} < 60$  mm Hg or  $\text{Sa}_{\text{O}_2} < 90\%$ .

Acute care situation in which hypoxemia is suspected, such as respiratory distress. Requires substantiation of hypoxemia (by  $\text{Sa}_{\text{O}_2}$  or  $\text{Pa}_{\text{O}_2}$ ) in a reasonable time.

Severe trauma

Acute myocardial infarction with hypoxemia

Low cardiac output with metabolic acidosis

Hypotension (systolic blood pressure  $< 100$  mm Hg)

#### Questionable Indications

Acute myocardial infarction without hypoxemia

Dyspnea without hypoxemia (palliative)

Sickle cell pain crisis

Pneumothorax

*Source: Data from Kallstrom TJ; American Association for Respiratory Care (AARC). AARC Clinical Practice Guideline: oxygen therapy for adults in the acute care facility— 2002 revision & update. Respir Care. 2002;47(6):717–720; O'Driscoll BR, Howard LS, Davison AG; British Thoracic Society. BTS guideline for emergency oxygen use in adult patients. Thorax. 2008;63 Suppl 6:vi1–vi68; Fulmer JD, Snider GL. American College of Chest Physicians (ACCP)—National Heart, Lung, and Blood Institute (NHLBI) Conference on oxygen therapy. Arch Intern Med. 1984;144(8):1645–1655.*

# Fishman's Pulmonary Diseases and Disorders, 5e > Oxygen Therapy and Toxicity

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Table 144-7

Approximate  $Fi_{O_2}$  Using Various Oxygen Devices (Assumes Perfect Fit of Mask)

100% $O_2$ Flow Rate (L/min)	$Fi_{O_2}$ (%)
<b>Nasal Cannula</b>	
1	24
2	28
3	32
4	36
5	40
6	44

100% $O_2$ Flow Rate (L/min)	$Fi_{O_2}$ (%)
<b>Oxygen Mask</b>	
5–6	40
6–7	50
7–8	60
<b>Mask with Reservoir Bag</b>	
6	60
7	70
8	80
9	90
10	>99

100% $O_2$ Flow Rate (L/min)	$Fi_{O_2}$ (%)
<b>Nonrebreathing Mask</b>	
4–10	60–100
<b>Venturi Mask<sup>a</sup></b>	
3 (80)	24
6 (68)	28
9 (50)	35
12 (50)	40
15 (41)	50

Oxygen Toxicity is BAD

### **AMA Citation**

Ochs M, Weibel ER. Functional Design of the Human Lung for Gas Exchange. In: Grippi MA, Elias JA, Fishman JA, Kotloff RM, Pack AI, Senior RM, Siegel MD. eds. *Fishman's Pulmonary Diseases and Disorders, Fifth Edition*. New York, NY: McGraw-Hill; 2015. <http://accessmedicine.mhmedical.com/content.aspx?bookid=1344&Sectionid=72260577>. Accessed January 14, 2016.