



Evaluating Lung Structure and Function

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INTRODUCTION

The satisfactory functioning of all organ systems depends on their capacity to consume oxygen and eliminate carbon dioxide. The primary function of the lung is to deliver oxygen to the pulmonary capillary blood and to excrete carbon dioxide. To accomplish this, the lung must generate a flux of air into and out of the alveoli (ventilation) while absorbing oxygen into the pulmonary blood and eliminating carbon dioxide from alveolar air (gas exchange). This is accomplished in a manner that attempts to optimize gas exchange (ventilation-perfusion matching). This remarkably efficient process allows the human to maintain optimal oxygenation and acid-base balance over a range of activities, from resting breathing to moderately strenuous activity. This chapter provides an overview of the anatomy and physiology that enable the respiratory system to perform its life-sustaining functions as well as a discussion of tests available to evaluate lung structure and function.

ANATOMY

Airway

Inspired air travels through the nose and nasopharynx, where it is warmed to body temperature, humidified, and filtered of airborne particles greater than 10 μm in diameter. Air then enters a complex system of dichotomously branching airways that form a tree occupying the thorax. The first 15 divisions, beginning with the trachea, the mainstem bronchi, segmental and subsegmental bronchi down to the terminal bronchioles, are simply a set of conducting tubes that do not participate in gas exchange. Together, they constitute the *conducting zone* of the lung, also known as the *anatomic dead space* (about 1 mL per pound of ideal body weight, or approximately 150 mL) (Fig. 15-1). Cartilaginous rings help to maintain the patency of these large airways. In the mainstem bronchi, the rings are circumferential, whereas in the trachea, the cartilaginous rings are U-shaped, with the posterior membrane of the trachea sharing a wall with the esophagus.

Airway subdivision	Order No.	Cross-sectional area (cm ²)	Resistance (cm H ₂ O • L ⁻¹ • sec)
Larynx	0		0.5
Trachea	0	2.5	0.5
Bronchi	1	2.0	
Bronchioles	2	5.0	0.2
	16		
Respiratory bronchioles	17	1.8 x 10 ²	
Alveolar ducts	19		
Alveoli	22	9.4 x 10 ²	
	23	5.8 x 10 ³	
		5.6 x 10 ⁷	

FIGURE 15-1 The subdivisions of the airways and their nomenclature. (Modified from Weibel ER: Morphometry of the human lung, Berlin, 1963, Springer.)