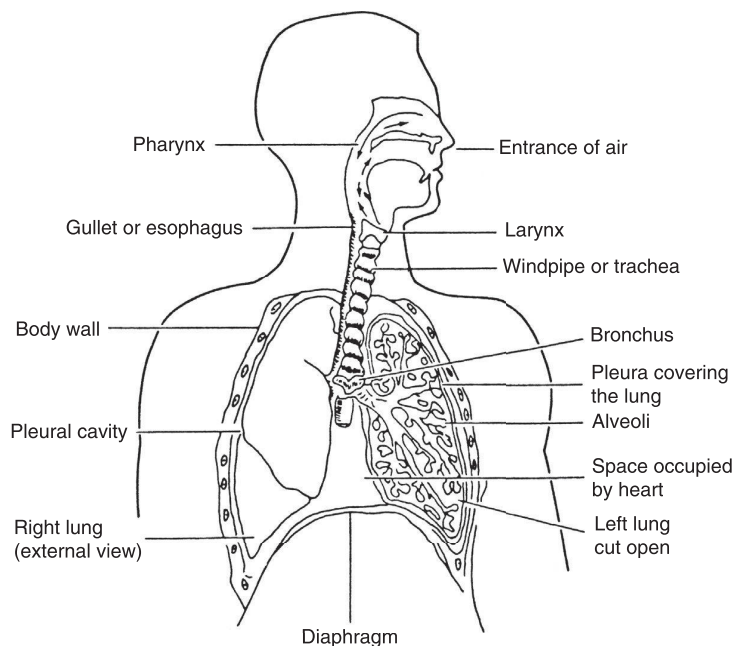


FIGURE 9.1 Anatomy of the human respiratory system. Vallero DA. *Fundamentals of air pollution*. 4th ed. Burlington (MA): Elsevier Academic Press; 2008.



the gaseous molecules in the linings of the different regions of the respiratory system. The aerodynamic properties of particles are related to their size, shape, and density. The behavior of a chain type or fiber may also be dependent on its orientation to the direction of flow. The deposition of particles in different regions of the respiratory system depends on their size. The nasal openings permit very large dust particles to enter the nasal region, along with much finer airborne PM. Particles in the atmosphere can range from less than $0.01\ \mu\text{m}$ to more than $50\ \mu\text{m}$ in diameter.^b The relationship between the aerodynamic size of particles and the regions where they are deposited is shown in Figure 9.2. Larger particles are deposited in the nasal region by impaction on the hairs of the nose or at the bends of the nasal passages. Smaller particles pass through the nasal region and are deposited in the tracheobronchial and pulmonary regions. Particles are removed by impacts with the walls of the bronchi when they are unable to follow the gaseous streamline flow through subsequent bifurcations of the bronchial tree. As the airflow decreases near the terminal bronchi, the smallest particles are removed by Brownian motion, which pushes them to the alveolar membrane.

The respiratory system has several mechanisms for removing deposited aerosols. The walls of the nasal and tracheobronchial regions are coated with a mucous fluid. Nose blowing, sneezing, coughing, and swallowing help to remove particles from the upper airways.

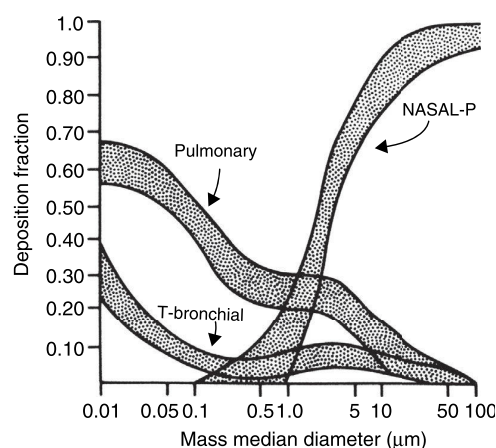


FIGURE 9.2 Particle deposition as a function of particle diameter in various regions of the lung. The nasopharyngeal region consists of the nose and throat; the tracheobronchial (T-bronchial) region consists of the windpipe and large airways; and the pulmonary region consists of the small bronchi and the alveolar sacs. *Task group on lung dynamics. Health Phys 1996;12:173.*

The tracheobronchial walls have fiber cilia, which sweep the mucous fluid upward, transporting particles to the top of the trachea, where they are swallowed. This mechanism is often referred to as the mucociliary escalator. In the pulmonary region of the respiratory system, foreign particles can move across the epithelial lining of the alveolar sac to the lymph or blood systems,

^b Particles larger than $50\ \mu\text{m}$ deposit soon after emission, so are seldom found in ambient measurements.