The bronchioles are honeycombed with pouches, each containing a cluster of tiny air sacs called alveoli. Each alveolus is less than .04 inch (1mm) wide. Surrounding each alveolus is a network of tiny blood vessels called capillaries. It is in the capillaries that dissolved oxygen and carbon dioxide are exchanged between the lungs and the bloodstream. The walls of alveoli and their capillaries are only one cell thick, semi-permeable, and close together so gas transfers easily. There are about 300 million alveoli in each lung, so gas transfers quickly. This process is shown in Figures 3.6 and 3.7.

3.2.2 Mechanics of Respiration

The volume of air breathed in and out is called tidal volume; like the tide, it comes in and goes out. Tidal volume at rest averages about 0.5 liter.

Normal inhalation requires the contraction of the inspiratory rib muscles (external intercostals) and the diaphragm muscle below the lungs. As the chest cavity enlarges, it pulls on the double membrane around the lungs called the pleura. In turn, the pleura pulls on the lungs, enlarging them. As lung volume increases, pressure within decreases allowing air to flow into the lungs to equalize pressure. To exhale, the diaphragm and inspiratory muscles relax, pushing on the lungs by elastic recoil and pushing air out.

Normal inspiration can be increased by adding contraction of some of the neck muscles (accessory muscles), and more rib muscles. Exhalation can be increased by contracting the abdominal wall and the expiratory muscles of the chest (internal intercostals).

Vital capacity refers to the largest volume exhaled after maximum inhalation. This volume is usually determined by size and age; larger individuals usually have higher vital capacity. Vital capacity alone does not determine capacity for exercise, the ability to breathe adequately during exertion, or the ability to deliver oxygen to the blood.

Additional air that can be inhaled after a normal inspiration is the inspiratory reserve. Inspiratory reserve averages three liters. After exhaling normally, one can forceably exhale another liter or so of air, called the expiratory reserve. Even after forcefully expelling all the air possible, there is still just over a liter in the lungs. This residual volume keeps the lungs from collapsing.

Besides exchanging oxygen and carbon dioxide, lungs have several other interesting functions, including filtering. Lungs are directly exposed to all the pollutants, dust, smoke, bacteria, and viruses in the air. Particles not trapped by bronchiole mucus enter the alveoli. There, special cells called alveolar macrophages engulf or destroy them. Lungs also filter the blood supply, removing harmful particles, such as fat globules and small blood clots. Special cells and enzymes break down and remove the trapped particles. The lungs even filter gas bubbles generated during diving ascents, preventing bubbles, in most cases, from going back to the heart and being pumped from there to the rest of the body. However, too many bubbles will overwhelm this pulmonary filter.

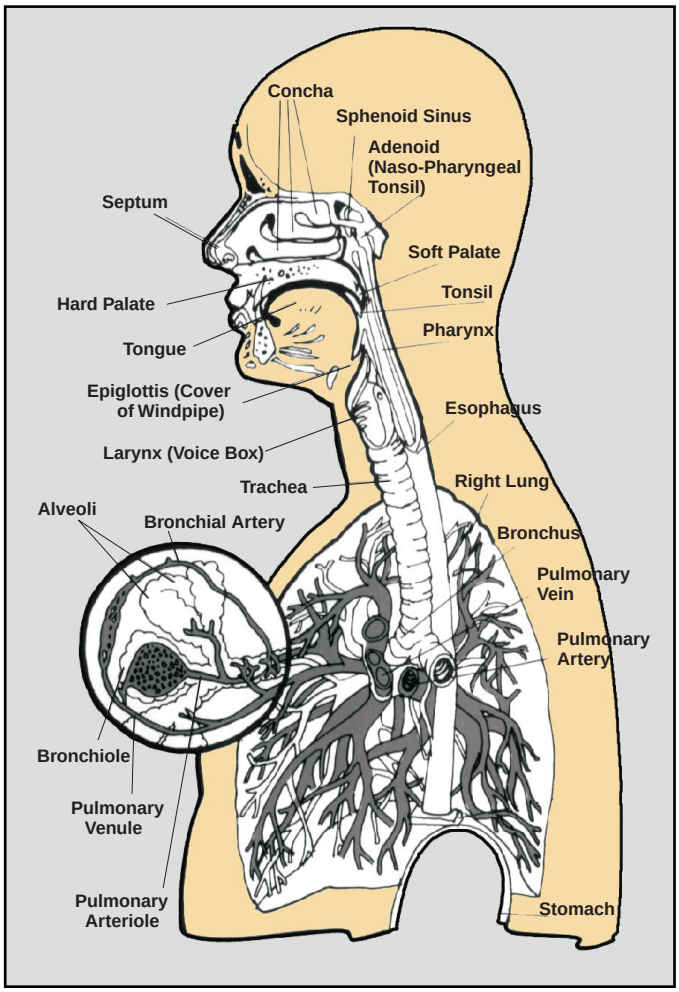

FIGURE 3.6
Process of Respiration

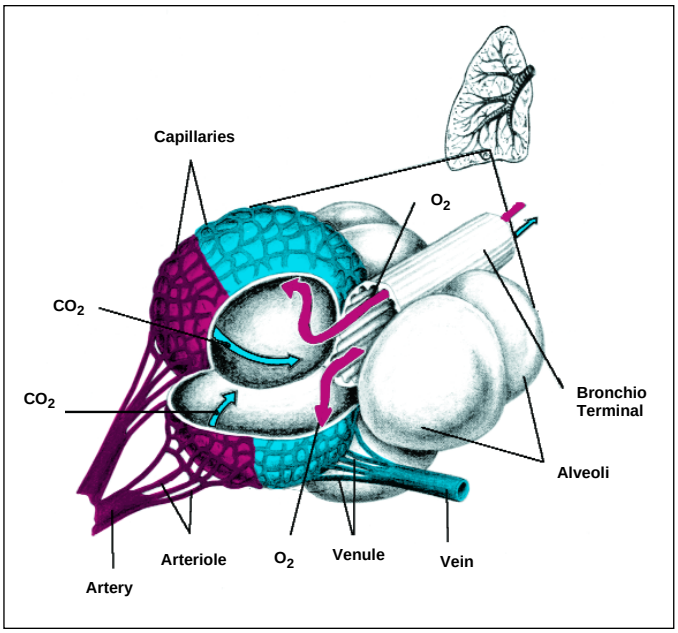

FIGURE 3.7
Lung Air Sacs (Aveoli)

Hyperbaric Chambers and Support Equipment

18

18.0 GENERAL

Hyperbaric chambers are used to support a variety of tasks in scientific and research diving (see Figures 18.1, 18.2, 18.4). Principally, chambers outfitted for diving are used for surface decompression, omitted decompression, recompression of injured divers, training, research, and pressure testing of equipment. This type of chamber is often referred to, interchangeably, as a decompression chamber, recompression chamber, or hyperbaric chamber. The hardware is essentially the same for all three descriptive names:

- **Decompression chamber** generally denotes a chamber that is deployed for the primary purpose of conducting surface decompression. During surface decompression, a diver completes a portion of his decompression obligation in the water, then surfaces and is pressurized to depth in the chamber, normally 30 or 40 feet, where he completes the remainder of his decompression. The amount of time a single individual is under pressure is usually fairly short. This type of chamber is also commonly called a Deck Decompression Chamber, or a DDC.

- **Recompression chamber** is the term used to denote a chamber that is used to treat injured divers. Common maladies treated in these facilities include decompression illness (i.e., decompression sickness and/or arterial gas embolism), and carbon monoxide poisoning.

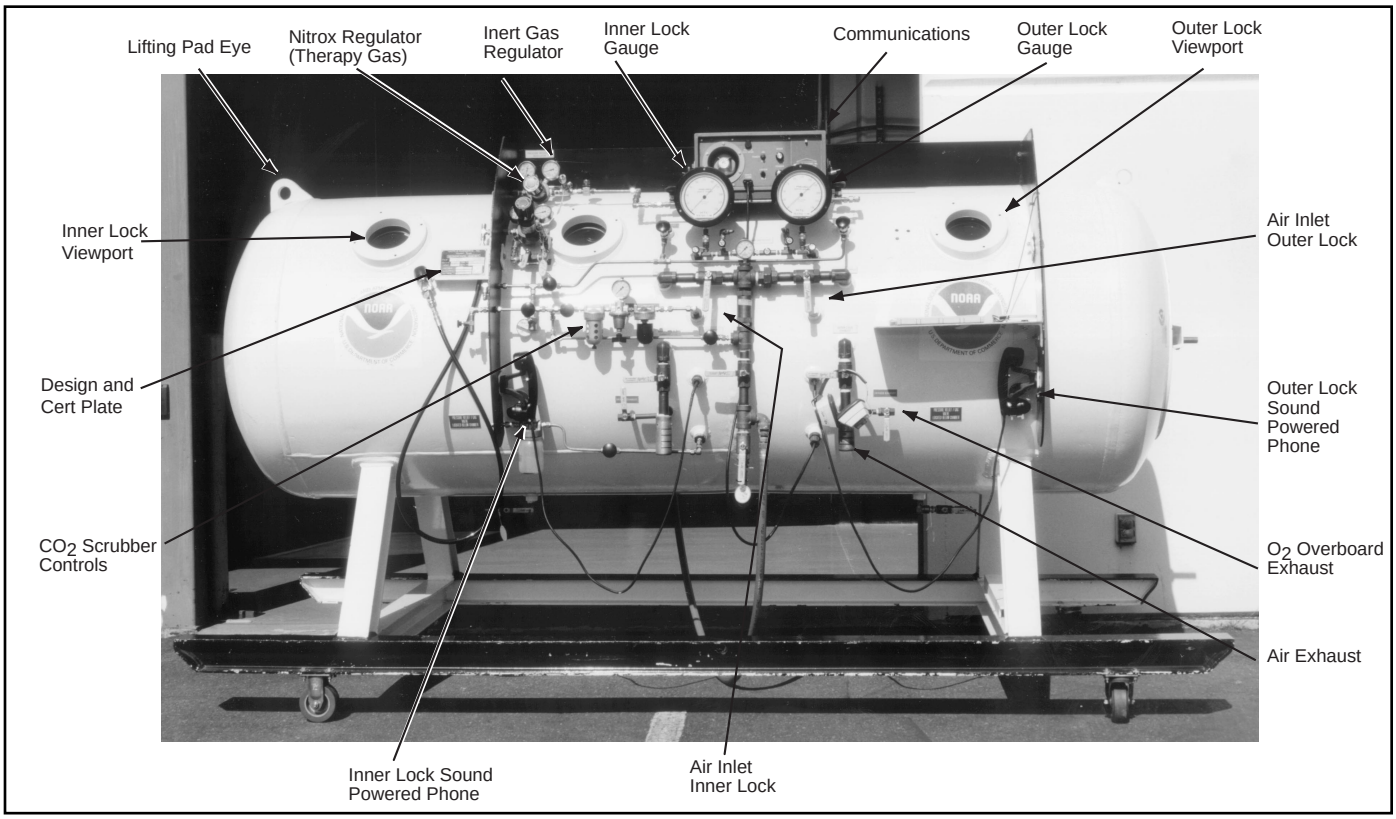

FIGURE 18.1
Portable Multiplace Hyperbaric Chamber—Exterior View