system governed by their partial pressure in the blood supply to the brain. The following examples are arranged in the order of their decreasing anesthetic action compared with other actions: (*a*) acetylene hydrocarbons (acetylene, allylene, crotonylene); (*b*) olefin hydrocarbons (ethylene to heptylene); (*c*) ethyl ether and isopropyl ether; (*d*) paraffin hydrocarbons (propane to decane); (*e*) aliphatic ketones (acetone to octanone); (*f*) aliphatic alcohols (ethyl, propyl, butyl, and amyl); (*g*) esters (not particularly anesthetic, but placed here for want of a better classification)—they hydrolyze in the body to organic acids and alcohols.

4. Systemic Poisons

(*a*) Materials that cause organic injury to one or more of the visceral organs: the majority of the halogenated hydrocarbons

(*b*) Materials damaging the hematopoietic system: benzene, phenols, and to some degree toluene, xylene, and naphthalene

(*c*) Nerve poisons: carbon disulfide, methyl alcohol, thiophene

(*d*) Toxic metals: lead, mercury, cadmium, antimony, manganese, etc.

(*e*) Toxic nonmetal inorganics: compounds of arsenic, phosphorus, selenium, and sulfur; fluorides

5. Particulate Matter Other Than Systemic Poisons

(*a*) Fibrosis producing dusts: silica, asbestos

(*b*) Inert dusts: carborundum, carbon, emery

(*c*) Dusts causing allergic reactions: pollen, wood, resins, and many other organic dusts

(*d*) Irritants: acids, alkalies, fluorides, chromates

(*e*) Bacteria and fungi

II. Respiration

A. MECHANICS OF RESPIRATION

During inspiration, air forced by atmospheric pressure enters the nasal openings, passes through the pharnyx, larnyx, trachea, bronchi and bronchioles, through the terminal bronchioles, the respiratory bronchioles and alveolar ducts, into the air sacs or alveoli, filling the void created by involuntary muscular expansion of the thoracic cavity. Expiration may be either by muscular effort or by elastic contraction of lung tissue, but in quiet breathing contraction is thought to be entirely passive. The normal function of respiration is to supply atmospheric oxygen through the alveolar walls to the blood for distribution to the tissues, and to remove carbon dioxide resulting from oxidation within the cells. The oxygen and carbon dioxide exchange in the tissues is sometimes referred to as tissue or internal respiration, as distinguished from the aeration of the lungs or external respiration.

B. LUNG STRUCTURE, VITAL CAPACITY, AND THE DEAD SPACE

The tracheobronchial tree as described by Miller[2] is supported by cartilage, the trachea being a series of open cartilaginous rings or crescents connected on the posterior side by bundles of muscle. The rings are joined to each other by a dense layer of connective tissue. The result is a rather rigid ribbed tube capable of some adjustment in diameter. This tube divides into the right and left main bronchi extending downward at approximately 20 degrees for the right, and 40 degrees for the left branch. The bronchi are further divided and subdivided into smaller and smaller bronchial passages. There is a muscular network essentially transverse to these passages, and as the passages decrease in diameter the cartilaginous rings become less complete, finally losing their crescent shape to become merely small plates of cartilage. As the cartilage decreases there is an increase in the proportion of muscular tissue. Cartilaginous support finally disappears toward the outer end of the bronchioles, where the diameter is about 0.5 mm. These terminal bronchioles connect with respiratory bronchioles which branch into alveolar ducts, terminating in the alveoli. These bronchioles range from 1.5 to 0.2 mm. in length and are about 0.2 to 0.4 mm. in diameter.

Normally the lungs fill about 80 per cent of the total chest cavity. An average man can inhale about 3½ liters of air by forced effort after an ordinary exhalation. Likewise, he can forcibly exhale about 1 liter after an ordinary exhalation. The sum of these, about 4½ liters, is called the vital capacity. There is in addition about 1 to 1½ liters residual air which cannot be expelled by forced exhalation but remains in the lungs to aerate the blood during exhalation. Thus there is a total volume in excess of 5½ liters, of which less than 10 per cent is used in normal breathing. The approximately 500 ml. of air inhaled and exhaled during normal respiration is called tidal air, and of this 500 ml. about 150 ml. is required to fill the tracheobronchial tree or anatomical dead space—that portion of the respiratory tract consisting of thick-walled passages through which no interchange of gases between blood and air can occur. During an ordinary 500 ml. inspiration then, 150 ml. practically unaltered atmospheric air fills the dead space, while 350 ml. enters the alveoli and respiratory exchange area of the lungs. Then during expiration, alveolar air containing 5 to 6 per cent carbon dioxide, and 12 to 14 per cent oxygen, is forced from the alveoli through the dead space, leaving this dead space filled with alveolar air. The first part of the exhalation is essentially atmospheric air and the last part alveolar air, with the mixture growing richer in alveolar air throughout expiration. Undiluted alveolar air can be obtained successfully only from air forcibly exhaled at the end of an ordinary respiration. Failure to consider this well-established fact can lead to serious errors in sampling expired air, as for instance in the determination of the radon content of the alveolar air. The maximum rate of physical activity that can be maintained by an individual is probably more dependent upon his maximum breathing capacity, minute ventilation, than upon lung volume. This minute ventilation is

[2] W. S. Miller, *The Lung*. Thomas, Springfield, Ill., 1937.