forced to recede from the wick in order to carry a sufficient quantity of oxygen to the flame front. Not only is vaporization of the fuel of the candle flame progressively inhibited, but also the flame literally blows itself out. It has, however, been possible to maintain hydrogen flames in air at altitudes somewhat in excess of that for the candle flame since combustion of hydrogen is not dependent on the melting and vaporization of the fuel by the heat of the flame.

While relatively few data are at hand to indicate the quantitative effect of increasing atmospheric pressure on the metabolism of living systems, effects of oxygen and carbon dioxide at high pressure[80] indicate that marked influences on metabolism do occur.

1. *Oxygen and Carbon Dioxide*

The pressure-labile chemical combination of oxygen and carbon dioxide with the blood is a reciprocal relation involving the binding power of hemoglobin

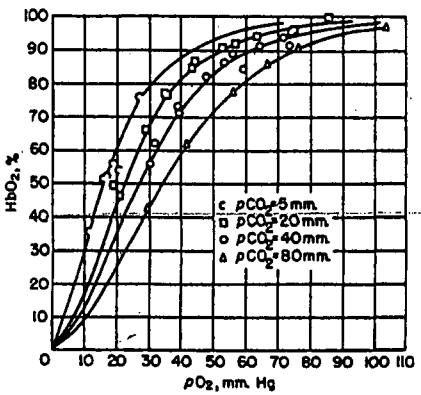

Figure 4. Oxygen dissociation curves of blood of a man at work.[83]

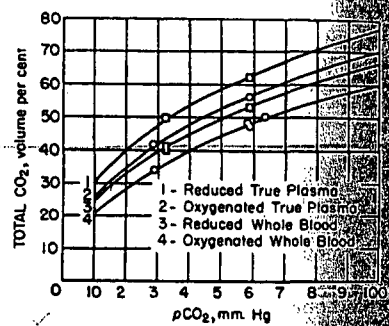

Figure 5. Carbon dioxide dissociation curves of blood of a man at work.[83]

and bases in the blood complex for these two gases of the atmosphere. Essentially there is an involved chemical redistribution of ions between blood plasma and tissue solutes[81] for every change in partial pressure of the constituent gases. Under conditions of normal atmospheric pressure these relations are given by curves shown in Figures 4 and 5.[82] Further codification of these relationships

[80] From unpublished data of the author.
[81] J. W. Bean, *Physiol. Revs.*, **25**, 1 (1945).
[82] A. V. Bock, H. Field, Jr., and G. S. Adair, *J. Biol. Chem.*, **59**, 353 (1924).
[83] A. V. Bock, D. B. Dill, L. M. Hurxthal, J. S. Lawrence, T. C. Coolidge, M. E. Daley and L. J. Henderson, *J. Biol. Chem.*, **73**, 749 (1927).

between the multiple factors known to affect this system has been developed by Henderson and his associates,[83] but for the present purpose these need not be discussed here in detail. It is sufficient to point out that, since dependence on partial pressure of the gases has been established, the relationship holds regardless of the external cause of the change in partial pressure.

Therefore, in the case of oxygen it is possible to interpret the partial pressure data for the dissociation curve for hemoglobin in terms of altitude. In this case a correction for converting the atmospheric partial pressure to that actually found in the alveolar surface must be made. Figure 6 shows theoretical and equilibrium

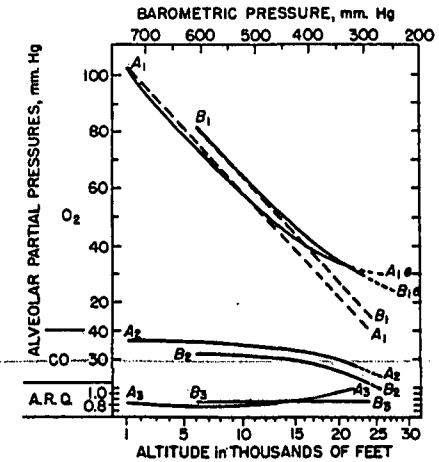

Figure 6. Effect of decreasing pressure on alveolar oxygen and carbon dioxide partial pressures.[84] Curves A_1e, A_2, and A_3: average of experimental data, subjects acclimatized to 1000 feet (300 meters). Curves B_1e, B_2, and B_3: average of experimental data, subjects acclimatized to 6200 feet (1900 meters). Curves A_1 and B_1: theoretical fall in oxygen partial pressure with no increased ventilation. A.R.Q. = alveolar respiratory quotient.

values for both carbon dioxide and oxygen pressures at the lung-blood interface for different altitudes. The deviations of the experimental data are due mainly to compensations of the body and not to the simple chemical relationships of the gases and their absorbent substrates.[84]

2. *"Inert" Gases*

In contrast to the properties of chemically active gases as discussed above, the behavior of the so-called inert gases of the atmosphere, such as nitrogen,

[84] L. J. Henderson, A. V. Bock, H. Field, Jr., and J. L. Stoddard, *J. Biol. Chem.*, **59**, 379 (1924). L. J. Henderson, *Blood*. Yale Univ. Press, New Haven, 1928.
[85] W. R. Boothby, *Proc. Staff Meetings Mayo Clinic*, **20**, 209 (1945).