The adaptability of human physiological processes to significant variations in environmental conditions is remarkable. The ability of the respiratory system to modify its function in response to altitude is an example. As seen in the last issue of this guide, there is a decreasing partial pressure of oxygen (O₂) as one ascends. Carbon dioxide (CO₂), the other major gas of importance in cellular respiration, also diminishes in pressure, but its content is negligible (0.04%) in the present earth atmosphere.

Interestingly, CO₂, not O₂, is the gas that normally regulates minute-to-minute ventilation (breathing). As the level of CO₂ increases in the blood, the acidity of the blood increases slightly (pH decreases); specialized neurons in the brainstem sense this and cause an increased ventilatory drive (heavier breathing). This is the usual control system of breathing. In the normal circumstance, if the lungs/ventilatory system is maintaining adequately low CO₂ levels, the O₂ levels will be just fine.

In decreased O₂ environments (high altitude, for example), this well-ordered system is perturbed. Rates of ventilation adequate to “blow off” the CO₂, and thus appease the brainstem respiratory center, no longer result in sufficient O₂ levels in the blood. This is sensed by specialized chemoreceptors in the aorta and carotid arteries, and the decreased O₂ concentration results in neural stimulation of the respiratory center to increase ventilation (heavier breathing). There is a struggle, however, between the signals from the O₂ receptors (which sense low O₂ and demand more ventilation) and the CO₂ / pH receptors (which sense low CO₂ / high pH and demand less ventilation). The adaptation of the respiratory center to accept the signals from the O₂ receptors and let them supersede the normal minute-to-minute control of the CO₂ / pH receptors is the physiological basis for acclimatization to high altitude.

This adaptation occurs over a variable time, usually about a week. Through this process, resting ventilatory rates (amount of air moved in and out of the lungs per minute) may increase several-fold, to as high as five to seven times normal at extreme altitudes.