GRAND TETON GUIDE no. 2

AN AMATEUR'S REVIEW OF BACKPACKING TOPICS

FOR THE

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T254 EXPEDITION TO GRAND TETONS / YELLOWSTONE

HIGH ALTITUDE PHYSIOLOGY

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 (O_2) as one ascends. Carbon dioxide (CO_2), 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, CO_2 , not O_2 , is the gas that normally regulates minute-to-minute ventilation (breathing). As the level of CO_2 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 CO_2 levels, the O_2 levels will be just fine.

In decreased O_2 environments (high altitude, for example), this well-ordered system is perturbed. Rates of ventilation adequate to "blow off" the CO_2 , and thus appease the brainstem respiratory center, no longer result in sufficient O_2 levels in the blood. This is sensed by specialized chemoreceptors in the aorta and carotid arteries, and the decreased O_2 concentration results in neural stimulation of the respiratory center to increase ventilation (heavier breathing). There is a struggle, however, between the signals from the O_2 receptors (which sense low O_2 and demand more ventilation) and the CO_2 / pH receptors (which sense low CO_2 / high pH and demand less ventilation). The adaptation of the respiratory center to accept the signals from the O_2 receptors and let them supersede the normal minute-to-minute control of the CO_2 / 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.