Water boosts hemoglobin's lust for oxygen

Hemoglobin, the iron-rich protein pigment in red blood cells, ferries oxygen throughout the body. Despite intensive study, hemoglobin still baffles scientists because it grabs on to oxygen in the lungs more readily than its molecular structure would suggest. Now, three biophysicists have discovered that water whets hemoglobin's appetite for this vital gas.

In experiments at the National Institute of Diabetes and Digestive and Kidney Diseases in Bethesda, Md., the researchers found that at least 60 water molecules latch on to a hemoglobin molecule as it takes up oxygen in the lungs. The water sops up energy that otherwise makes hemoglobin rebuff oxygen. Thus, other oxygen molecules can attach more easily, report V. Adrian Parsegian, Donald C. Rau and Marcio Colombo, who described their findings last week at a meeting of the American Physical Society in Cincinnati.

Each hemoglobin molecule consists of four peptide chains and can carry up to four oxygen molecules. To do so, the complex protein changes its shape – but only slightly, and not enough to account for the energetics of the oxygen loading, says Parsegian, now a visiting scientist at Princeton (N.J.) University.

In hemoglobin's oxygen-lacking configuration, attractions between the peptide chains keep the protein structure taut. These attractions tie up a lot of energy and make it difficult for oxygen molecules to enter. But in the lungs, high concentrations of the gas help jam that first oxygen into the protein molecule, Parsegian explains. The binding of oxygen strains the hemoglobin structure, and the peptide chains twist a little.

Scientists had speculated that chemical bonds in the protein took up the energy released by this twisting. But Parsegian and his colleagues have shown that the energy also transfers to the hemoglobin surface, where it gets bound up in holding on to water molecules. This wetting seems to cause the hemoglobin to relax and open up, increasing the protein's affinity for oxygen by a factor of 100 to 1,000, he says.

"The fact that there are 60 water molecules tells us there's a lot of energy involved," Parsegian told SCIENCE NEWS. He and his co-workers do not yet know how quickly the water molecules attach to hemoglobin, but "I think it's a rather sudden event," he adds.

The energy tied up in the linkages between the chains roughly equals that involved in wetting the hemoglobin surface, he says. The addition or removal of oxygen tips the balance in favor of one energy state or another.

The new findings could affect efforts to develop oxygen-carrying blood substitutes, biochemist Enrico Bucci told SCIENCE NEWS. Bucci, an expert in blood substitutes at the University of Maryland School of Medicine in Baltimore, thinks Parsegian's results may mean that blood substitutes need to be encapsulated with water in order to work. If so, approaches that use free-floating hemoglobin substitutes (SN: 9/26/87, p.200) may not pan out.

However, he adds, "it remains to be seen just how important this regulation by water is." Bucci suggests conducting further experiments to investigate water's role in the red blood cells of living organisms.

Parsegian's group looked at hemoglobin's behavior by adding the protein to various sugar and polymer solutions. The type of solution did not matter, they found, but its concentration did. The more concentrated the solution, the more difficult it was for the hemoglobin to grab water molecules, and the more reluctant the hemoglobin was to take up oxygen molecules.

By comparing results from sugar solutions and plain water, the researchers calculated how hard the hemoglobin had to work to get wet. That enabled them to determine that the protein's conversion to an oxygen-loving state involved 60 to 80 water molecules. *– E. Pennisi*

Trauma disorder strikes many young adults

Contrary to much psychiatric opinion, highly stressful experiences that can lead to post-traumatic stress disorder (PTSD) occur surprisingly often, at least among young adults living in a metropolitan region, according to a new study. In fact, in a random sample of 1,007 young adults, about 40 percent reported such experiences and 9 percent had developed PTSD at some time in their lives. This finding places PTSD among the more common psychiatric disorders of that age group, report psychologist Naomi Breslau of Henry Ford Hospital in Detroit and her colleagues.

The researchers say their work challenges the standard view, set forth in the American Psychiatric Association's diagnostic manual of mental disorders, that PTSD-inducing events lie "outside the range of usual human experience."

Symptoms of the disorder include recurring memories and dreams about a traumatic experience, emotional detachment from loved ones, extreme suspicion of others and difficulty concentrating.

Almost all previous PTSD studies have focused on people exposed to extreme stress, such as victims of natural disasters, combat veterans and former prisoners of war (SN: 2/2/91, p.68). Breslau's team now provides "a very valuable study that begins to establish an estimate of PTSD prevalence in the general population," says psychiatrist John E. Helzer of the University of Vermont School of Medicine in Burlington.

The scientists randomly interviewed 21- to 30-year-old members of a large health maintenance organization in the Detroit area. The sample represents working families of Detroit and its suburbs.

A total of 394 volunteers – 40 percent of the sample – described exposure to one or more traumatic events previously defined as "PTSD stressors," the researchers report in the March ARCHIVES OF GENERAL PSYCHIATRY. These stressors include a sudden injury or serious accident, physical assault or rape, seeing someone seriously hurt or killed, or receiving news of the sudden death of a close relative or friend. Of those who experienced traumatic events, 93 developed PTSD – about 9 percent of the entire sample.

In one of the few previous attempts to gauge PTSD's prevalence in the general population, a team led by Helzer documented a 3 percent rate among people exposed to a physical attack. But that study, reported in the Dec. 24, 1987 NEW ENGLAND JOURNAL OF MEDICINE, included middle-aged and elderly participants who show more resiliency following traumas than young adults, Helzer says.

Otherwise, the two studies yielded largely consistent results. For instance, both show a higher prevalence of PTSD in women than in men. Rape proved especially traumatic to the women in Breslau's study. Of the 16 women who experienced a rape, 13 developed PTSD.

Both research teams found that PTSD sufferers ran an increased risk of other anxiety or mood disorders, such as severe depression. Moreover, the surveys revealed that severe trauma quickly triggers PTSD symptoms. Only one person in Breslau's sample reported a "delayed onset" of PTSD more than six months after a traumatic episode.

Her findings also support the theory that specific risk factors increase a person's likelihood of exposure to traumatic events and that other factors promote PTSD after traumatic events. Men with prior behavior problems, extroverted personalities, limited education and a family history of psychiatric disorders experienced the greatest number of traumatic events. Women with preexisting anxiety or depression, early separation from parents and a family history of anxiety proved most vulnerable to PTSD following a traumatic experience.

The prevalence data suggest that urban young adults experience PTSD more often than all other psychiatric disorders except phobias, severe depression and dependence on alcohol or drugs, Breslau's group concludes. *– B. Bower*