OXYGEN IS A RATE-LIMITING FACTOR FOR BRAIN ACTIVITY

Any decrease in oxygen supply can threaten our cognitive functions. For example, the impact of high altitudes. As climbers work their way beyond 8,000 feet above sea level, they must contend with drops in barometric pressure and oxygen in the air that can affect their thinking and their judgment. For the unprepared, these stresses on physiology can impair the ability to focus as well as jostle memory, judgment, and control over emotions.

The brain's ability to perform complex tasks weakens when a pressure reading of oxygen in the arteries falls to 65 millimeters of mercury from normal readings around 100 millimeters. Things deteriorate further from there. Short-term memory becomes foggy at 55 millimeters. By the time the arterial oxygen pressure falls to 30 millimeters, fainting and loss of consciousness occurs.

In the hyperbaric oxygen chamber, a test group breathed 100% oxygen at twice sea-level pressure (increasing their blood oxygenation about 15 times normal levels) and another group, the control group, breathed normal air with 21% oxygen at normal atmospheric pressure. The group with the higher oxygen levels scored higher in both executing physical and cognitive tasks separately and multiple tasks simultaneously. Oxygen is indeed a rate-limiting factor for brain activity even in young healthy individuals.

The highest concentration of neuronal stem cells is in the hippocampus, two small areas located on the medial part of the temporal lobe, at the level of our ears. The hippocampus is part of the system that controls our emotions (limbic system), short- and long-term memory, and imagination. The high metabolic activity of the hippocampus makes it highly dependent on blood and oxygen supply. Any reduction of blood flow (ischemia) or oxygen supply (hypoxia) can shrink the hippocampus and lead to memory loss, memory disturbance, dementia, and the dreadful senile dementia of Alzheimer's disease.

Neural stem cells have the potential to generate most, if not all, different types of neurons and glial cells found in the brain. These neural stem cells multiply in numbers by dividing in two and producing either one or two new stem cells and/or one or two new daughter cells that will become a neuron or a glia cell.

Once a neuron is born, it must travel to the place in the embryonic brain where it will do its work. Neurons in the embryo use several different methods to travel. Some migrate by following blood vessels along tubes of specific glial cells. Other neurons migrate along neuron chains, which are formed by special molecules on the surface of neurons (adhesion molecules).

The long-distance migration in one direction is guided by directional cues. Molecules serving as chemical signals usually provide these directional cues, guiding the neuron to its final location. Not all neurons succeed in their journey. In fact, most do not. It is estimated that only a third reach their destination, even in a healthy embryonic brain.

Four critical supporting elements are required for a migration of newly formed neurons to succeed in reaching their destination. Three of these elements that any tissue in our body requires are: *access tracks*—arteries and veins; energy supply—nutritional and oxygen needed for energy generations; and *repairments*—stem cells that can replace the damaged cells. The fourth element is a system that cleans up the garbage. In other parts of the body, this is the *lymphatic system*. In the brain, it is the *glymphatic system*.