Giulio Tononi MD, PhD and Chiara Cirelli MD, PhD

Giulio Tononi received his medical degree from the University of Pisa, Italy, where he specialized in Psychiatry. After serving as a medical officer in the Army, he obtained a Ph.D. in neuroscience as a fellow of the Scuola Superiore for his work on sleep regulation. From 1990 to 2000, he was a member of The Neurosciences Institute, first in New York and then in San Diego. He is currently Professor of Psychiatry, Distinguished Professor in Consciousness Science, the David P. White Chair in Sleep Medicine at the University of Wisconsin–Madison, and the Director of the Wisconsin Institute for Sleep and Consciousness. In 2005 he received the NIH Director's Pioneer Award for his work on sleep. His laboratory studies consciousness and its disorders as well as the mechanisms and functions of sleep.

Chiara Cirelli received her medical degree and Ph.D. in Neuroscience from the University of Pisa, Italy, where she began her investigation of the molecular correlates of sleep and wakefulness and the role of the noradrenergic system in sleep regulation. She continued this work at the Neuroscience Institute in San Diego, California as a fellow in experimental neuroscience, and subsequently at the University of Wisconsin–Madison, where she has been a Professor in the Department of Psychiatry since 2001.

Drs. Tononi and Cirelli's main contribution in the study of sleep has been the development of a comprehensive hypothesis about the function of sleep, the synaptic homeostasis hypothesis. According to the hypothesis, sleep serves to renormalize synaptic strength, counterbalancing a net increase of synaptic strength due to plasticity during wakefulness. In short, according to this hypothesis sleep is the price to pay for brain plasticity during wakefulness.

On the basis of the *synaptic homeostasis hypothesis*, Drs. Tononi and Cirelli have shown (using molecular and electrophysiological markers in both invertebrates, rodents, and humans) that synaptic strength does in fact increase during wake and decrease during sleep in much of the brain. Moreover, using a combination of genetic, molecular, and electrophysiological approaches, they have

found that sleep need is increased by the amount of plastic changes during wake and that sleep can be induced on a local basis by learning and plasticity. Current experiments in transgenic flies and mice use confocal and repeated in vivo two-photon microscopy and block-face scanning electron microscopy to confirm that an essential function of sleep is to promote a homeostatic reduction in synaptic strength. Other experiments are also testing whether lack of sleep, especially during adolescence, may have long-term consequences for the functional and anatomical connectivity of the brain.