Question 1: Battlefield trauma victims who have lost large volumes of blood often express a craving to drink water. Why?

Answer: Under conditions of lowered blood volume or pressure, kidneys secrete renin into the bloodstream. Renin in the blood promotes the synthesis of the peptide angiotensin II, which excites the neurons in the subfornical organ. The subfornical neurons stimulate the cells in the lateral area of the hypothalamus, causing an increase in vasopressin (ADH) production and an overwhelming feeling of thirst. So, to a limited extent, the kidneys control the brain. This is why battlefield trauma victims who have lost large volumes of blood crave water.

Question 2: You've stayed up all night trying to meet a term paper deadline. You now are typing frantically, keeping one eye on the paper and the other on the clock. How has the periventricular zone of the hypothalamus orchestrated your body's physiological response to this stressful situation? Describe in detail.

Answer: Under conditions of physiological stress, the periventricular hypothalamus secretes corticotropin-releasing hormone (CRH) into the hypothalamo-pituitary portal circulation. This triggers the release of adrenocorticotropic hormone (ACTH) into the general circulation. ACTH stimulates the release of cortisol from the adrenal cortex. Cortisol is a steroid with a significant effect on neuronal activity. It acts by mobilizing energy reserves and suppressing the immune system. In the brain, cortisol interacts with specific receptors that inhibit CRH release, ensuring that circulating cortisol levels do not increase drastically.

Question 3: Why is the adrenal medulla often referred to as a modified sympathetic ganglion? Why isn't the adrenal cortex included in this description?

Answer: The adrenal medulla receives preganglionic sympathetic innervation and secretes epinephrine into the bloodstream when activated. The release of adrenaline from the adrenal medulla into the blood ensures that all the cells of the body are exposed to sympathetic stimulation even if no postganglionic neurons reach them directly. For this reason, the adrenal medulla is referred to as a modified sympathetic ganglion. The adrenal cortex, which produces the steroid hormone cortisol, is under the control of pituitary hormones rather than the sympathetic division of the autonomic nervous system.

Question 4: A number of famous athletes and entertainers have accidentally killed themselves by taking large quantities of cocaine. Usually the cause of death is heart failure. How would you explain the peripheral action of cocaine?

Answer: *Cocaine* is a powerful CNS stimulant that exerts its effects at the synapses made by the dopaminergic and noradrenergic systems. Cocaine gives its users a feeling of increased alertness and self-confidence, a sense of exhilaration and euphoria, and a decreased appetite. It is sympathomimetic, which causes peripheral effects that mimic the activation of the sympathetic division of the ANS. Some peripheral effects are increased heart rate and blood pressure and dilation of the pupils. Large increases in heart rate and blood pressure when consuming sizeable quantities of cocaine can trigger heart failure.

Question 5: How do the diffuse modulatory and point-to-point synaptic communication systems in the brain differ? List four ways.

Answer: 1) Point-to-point communication in the sensory and motor systems requires anatomical precision. In contrast, diffuse modulatory systems form widely divergent axonal connections over a broad expanse of the brain, which communicate with several thousands of other cells.

2) Point-to-point communication requires mechanisms that restrict synaptic communication to the cleft between the axon terminal and its target. On the other hand, diffuse modulatory neurons release their neurotransmitters into extracellular fluid rather than into the synaptic cleft, and their transmitter molecules diffuse to many neurons rather than being confined to the vicinity of the synaptic cleft. 3) Point-to-point communication is brief. Only minute quantities of neurotransmitters are released with each impulse, and these molecules are quickly destroyed enzymatically or taken up by neighboring cells. In contrast, diffuse modulatory systems tend to act relatively slowly — the time ranges from seconds to minutes — and the molecules linger for long periods. Because of their broad, protracted action, diffuse systems can orchestrate entire behaviors. 4) Point-to-point connections originate with discrete sensory and motor systems, such as visual, auditory, and somatosensory. Neurons of the diffuse system that projects to each system arise from a common source at the central core of the brain and mostly originate from the brain stem.

Question 6: Under what behavioral conditions are the noradrenergic neurons of the locus coeruleus active? The noradrenergic neurons of the ANS?

Answer: Recordings from awake, behaving rats and monkeys show that locus coeruleus neurons are most activated by new, unexpected, nonpainful sensory stimuli in the animal's environment. They are least active when the animals are not vigilant and are sitting around quietly, digesting a meal. The locus coeruleus may participate in general arousal of the brain during interesting events in the outside world. Because NE can make neurons of the cerebral cortex more responsive to salient sensory stimuli, the locus coeruleus may function to increase brain responsiveness, speed up information processing by the point-to-point sensory

and motor systems, and make them more efficient. The noradrenergic neurons of the ANS, or the sympathetic division, are activated by crises, frenetically mobilizing the body for short-term emergencies, such as fight, flight, and fright. This system also participates in the final stages of coitus.