Question 1: Imagine rubbing your finger across a pane of smooth glass and then across a brick. What kinds of skin receptors help you distinguish the two surfaces? As far as your somatic sensory system is concerned, what is different about the two surfaces?

Answer: Smooth glass might produce a stimulus with no vibrations and no changes in pressure. To detect this surface, mechanoreceptors, such as Merkel's disks or Meissner's corpuscles, should be close to the surface of the skin. To be detected, the stimulus that glass creates would have to excite slowly adapting mechanoreceptors because its surface does not change. Merkel's disks are slowly adapting and have small receptive fields. A brick might produce a stimulus with vibrations and changes in pressure related to the raised parts of its surface. This is a good stimulus for the Pacinian corpuscles and Ruffini's ending. To detect the successive peaks and valleys on the surface of the brick, a rapidly adapting receptor might best detect the stimulus. This requirement might make a Pacinian corpuscle the ideal receptor for this stimulus because Pacinian corpuscles are rapidly adapting, whereas Ruffini's endings are slowly adapting.

Question 2: What purpose is served by the encapsulations around some sensory nerve endings in the skin?

Answer: Encapsulations around Pacinian corpuscles provide a mechanism that makes the Pacinian corpuscles rapidly adapting, which is a property that makes them sensitive to vibrating high-frequency stimuli. If the encapsulations are stripped away, as done by Loewenstein and colleagues in the 1960s, the naked nerve terminals become less sensitive to vibrating stimuli and more sensitive to steady pressure.

Question 3: If someone tossed you a hot potato and you caught it, which information would reach your CNS first — news that the potato was hot or that it was relatively smooth? Why?

Answer: If someone tossed you a hot potato and you caught it, news about the smooth surface would reach your CNS faster than news about the temperature of the potato. In the CNS, C fibers mediate the pain and temperature sensations. They are the slowest axons, conducting at about 0.5-2 m/sec. C fibers are slow because they are the smallest axons, with diameters of less than 1 μm, and they do not contain myelin. On the other hand, cutaneous mechanoreceptors mediate touch sensations. The relatively large Aβ axons, which can conduct at up to 75 m/sec, convey these sensations. As a result, the sensation of the smooth surface reaches the CNS faster than the sensation of temperature.

Question 4: At what levels of the nervous system are *all* types of somatic sensory information represented on the contralateral side: the spinal cord, the medulla, the pons, the midbrain, the thalamus, the cortex?

Answer: Information from the dorsal columns crosses at the level of the medulla after synapsing in the dorsal column nuclei, so dorsal column information is contralateral as it courses through the medial lemniscus to synapse in the thalamus and then in the cortex. The trigeminal touch pathway crosses at the level of the pons to synapse contralaterally in the VP nucleus of the thalamus. Information in the spinothalamic tract crosses early, at the level of the spinal cord, so all its information is contralateral by the time the afferents reach their targets in the thalamus. As a result, all types of somatic sensory information are represented on the contralateral side at the level of the thalamus.

Question 5: What lobe of the cortex contains the main somatic sensory areas? Where are these areas relative to the main visual and auditory areas?

Answer: Most of the cortex concerned with the somatic sensory system is located in the parietal lobe. These include Broadman's area 3b, which is the primary somatosensory cortex, and areas 3a, 1, and 2, which are all in the postcentral gyrus. Additional somatosensory areas include areas 5 and 7 in the adjacent posterior parietal cortex. In contrast, the main visual areas are in the occipital lobe at the back of the brain, and the main visual areas are in the superior temporal gyrus of the temporal lobe on the lateral surface of the brain.

Question 6: Where can pain be modulated in the body, and what causes its modulation?

Answer: Pain is modulated at many places. It can be modulated at the level of pain receptors by simultaneous activity in low-threshold mechanoreceptors; this is why it feels good to rub the skin around a bruise. Strong emotions via activity in the periventricular and periaqueductal gray (PAG) matter of the midbrain also modulate pain. For example, electrical stimulation of the PAG can produce analgesia. In addition, the nervous system produces endogenous opiates or endorphins. Endorphins and their receptors are widely distributed in the CNS and are particularly concentrated in the PAG, the raphe nuclei, and the dorsal horn of the spinal cord. Endorphins and their receptors at these sites may prevent the passage of nociceptive signals into higher levels of the brain where pain perception takes place.

Question 7: Where in the CNS do information about touch, shape, temperature, and pain converge?

Answer: The posterior parietal cortex is the area where segregated streams of somatosensory information converge to generate complex neural representations. Neurons in this cortical area have large receptive fields with stimulus preferences that are a challenge to characterize because they are so elaborate. This area is also concerned with visual stimuli and movement planning. Lesions in this area can result in agnosia, the inability to recognize objects even though simple sensory skills are normal. The posterior parietal cortex is essential for the perception and interpretation of spatial relationships, accurate body image, and the learning of tasks involving coordination of the body in space, all of which involve input from the visual system.

Question 8: Imagine this experiment. Fill two buckets with water, one relatively cold and one hot. Fill a third bucket with water of an intermediate, lukewarm temperature. Put your left hand into the hot water, your right hand into the cold, and wait one minute. Now quickly plunge both hands into the lukewarm water. Predict what sensation of temperature you will feel in each hand. Will they be the same?

Answer: No, they will not feel the same. The hand previously placed in hot water will feel much cooler in lukewarm water than the hand previously placed in cold water. The lukewarm water will feel relatively warm to the hand previously placed in cold water. These differences, however, will be transient.