

NOCICEPTION

The Pain Pathway

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From a physiologic standpoint, mammals and humans process pain in the same way; by nociception and cognition. Nociception, derived from the Latin word *nocere* (to injure), uses specific pathways; transduction, transmission, modulation and perception. The pain pathway begins at the point of tissue trauma, such as a site of inflammation, injury, or surgical incision, where nociceptors (pain receptors) are stimulated. These specialized nerve endings convert mechanical, chemical, and/or thermal energy into electrical impulses (transduction). If the noxious stimulus is large enough to exceed the nociceptor's threshold, a nerve impulse is generated and transmitted along peripheral nerves to the spinal cord (transmission). Once at the spinal cord, a nerve impulse is either projected upward to the thalamus and then to other parts of the brain, including the cerebral cortex or it may be transmitted to a nerve cell located entirely within the central nervous system that modifies nerve signals and links sensory and motor neurons that in turn activates sympathetic reflexes damping the pain sensation (modulation). Finally, assuming the subject is conscious, the experience of "painfulness" occurs. This last phase (perception) is obliterated by general anesthesia but anesthesia alone does not prevent the nociceptive process. The physiological ramifications of pain still occur and are quite evident as soon as the patient returns to consciousness.

This physiology gives rise to the concept of multimodal analgesia. That is, attacking pain from many angles is more effective than from only one. Since the pain pathway has distinct phases, pain can be interrupted at various points. For example, we may want to do a local block (transduction or transmission) in addition to pre-emptive NSAIDs (transduction and modulation) as well as postoperative opioid administration (modulation and perception). Using drugs from three different classes provides better pain control and has the added benefit of allowing us to use lower doses of individual agents thereby reducing side effects. Effective analgesia can also reduce the amount of gaseous anesthesia required for a procedure.

