Pain Pathways and Theories

- **Introduction**

In 1986, the International Association for the Study of Pain (IASP) defined pain as a sensory and emotional experience associated with real or potential injuries, or described in terms of such injuries. Painful manifestations can be explained on the basis of neural substrates mediating the sensory, affective, and nociceptive functions, as well as neuro-responses. While the sensory, discriminative–perceptive component permits the spatial and temporal localization, physical qualification and the intensity quantification of the noxious stimulus, the cognitive–affective component attributes emotional coloring to the experience, being responsible for the behavioral response to pain.

- **Peripheral receptors**

The propagation of pain is initiated with the activation of physiological receptors, called nociceptors, widely found in the skin, mucosa, membranes, deep fascias, connective tissues of visceral organs, ligaments and articular capsules, periosteum, muscles, tendons, and arterial vessels. The receptors correspond to free nerve endings and represent the more distal part of a first-order afferent neuron consisting of small-

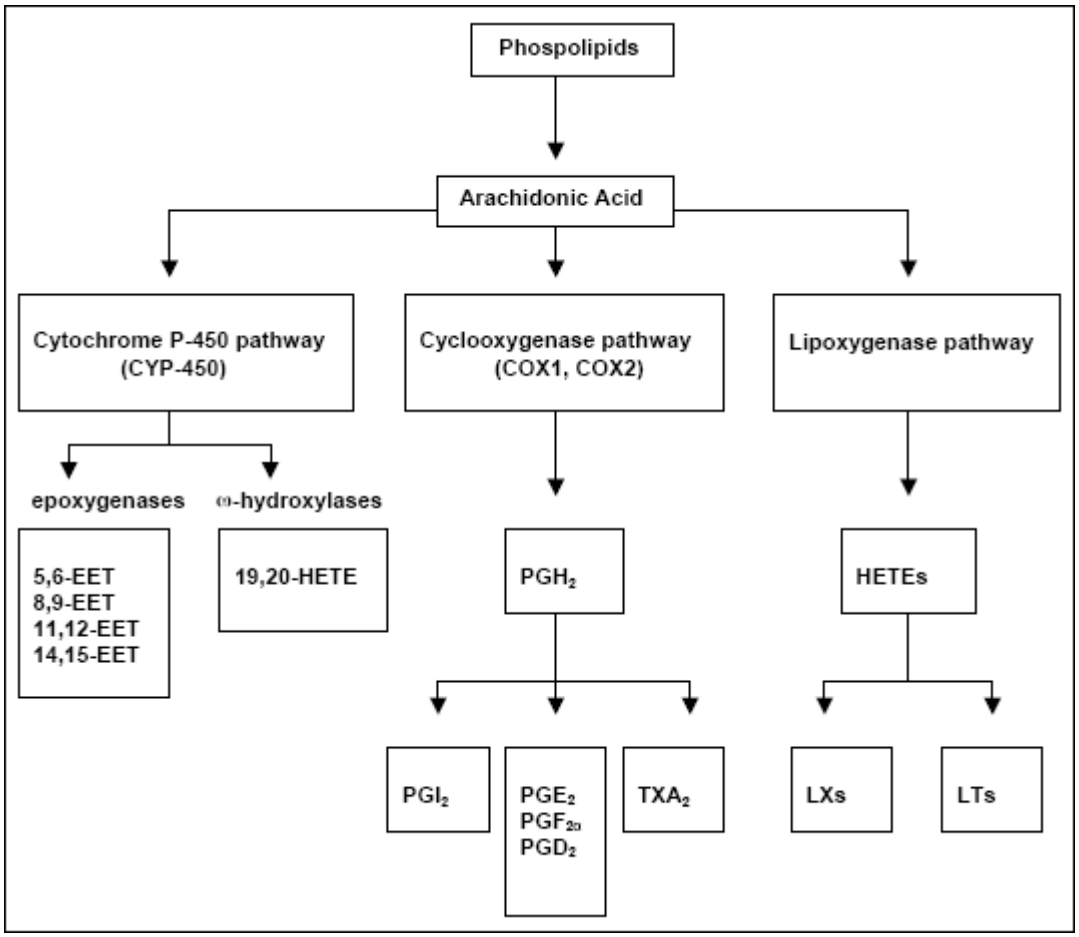
diameter fibers, with little or unmyelinated, of the A-Delta or C type, respectively. Their receptor fields can consist of areas ranging from small regions to regions measuring several millimeters in diameter, or even of more than one site in distant territories

- **Pain Mediators:**

Many types of dental pain arise as a result of infection or damage to tissue. Both events initiate an inflammatory response that is intimately linked with pain. The passage of nociceptive impulses generated in the peripheral nerve fibers depends on the release of various neurotransmitters. These neurotransmitters act either peripherally of centrally.

Examples of pain mediators include the following:

- Plasma kinins: e.g. bradykinin
- Serotonin
- Histamine
- Prostaglandins
- Leukotrienes
- Cytokines
- Neuropeptids



Pain is provoked when a variety of substances are released or injected into the tissues. These pain-producing substances can be released by trauma, infection, allergenic reaction, neurogenic reflexes and central changes from cell membranes, mast cells and nerve endings. This leads t the excitation of free nerve endings which act as nociceptors or peripheral sense organs that respond to noxious stimulus. This group of substances include histamine, bradykinin, potassium, acetylcholine, prostaglandins, leukotrienes, and the neuropeptides. Arachidonic acid is derived from cell membrane phospholipids by the action of enzyme phospholipase A2. This enzyme is activated by trauma or infection. Once released, arachidonic acid is acted on by two further enzyme systems. Cyclo-oxygenase activity results in the formation of prostaglandins,

thromboxane, and prostacycline, whereas lipo-oxygenae activity results in the production of the leukotrienes.

The analgesic effect of aspirin and other NSAIDS is believed t be due to inhibition of cyclo-oxygenase. In addition of their peripheral action, NSAIDS seem to possess a central analgesic action as well.

- **Nerve fibers:**

First-order afferent fibers are classified in terms of structure, diameter, and conduction velocity. C-type fibers are unmyelinated, ranging in diameter from 0.4 to 1.2 μm and have a velocity of 0.5–2.0 m/s; A-Delta fibers are barely myelinated, ranging in diameter from 2.0 to 6.0 μm and have a velocity of 12–30 m/s. The A-Beta fibers are myelinated, with a diameter of more than 10 μm and a velocity of 30–100 m/s, and do not propagate noxious potentials in normal situations; however, they are fundamental in the painful circuitry because they participate in the mechanisms of segmental suppression.

In the presence of a noxious stimulus, the primary nociceptive afferents show differentiated patterns of propagation. The A-Delta fibers propagate modally specific information, with marked intensity and short latency. They promote a quick sensation of first phase or acute pain, triggering withdrawal actions. The C-type fibers propagate information in a slower way, at times secondary to the action of the A-Delta afferents. Their prolonged potentials undergo summation along time and induce

the manifestations of dull pain. Although widely used, this differentiation does not apply to all organs, being more evident in the skin.

- **Spinal cord:**

When approaching the spinal cord, large nerve fibers detach from thicker fibers, organizing themselves in the ventrolateral bundle of roots. They form synapses with second-order neurons distributed along the dorsal horn of the spinal cord About one-third of the ventral roots are sensitive and predominantly painful, although their cell bodies are located in the dorsal root ganglion. The integration with the neurons of the dorsal horn of the spinal cord occurs after the passage through the anterior horn or by the fibers that, before penetrating in the ipsilateral anterior horn, are directed to the dorsal horn.