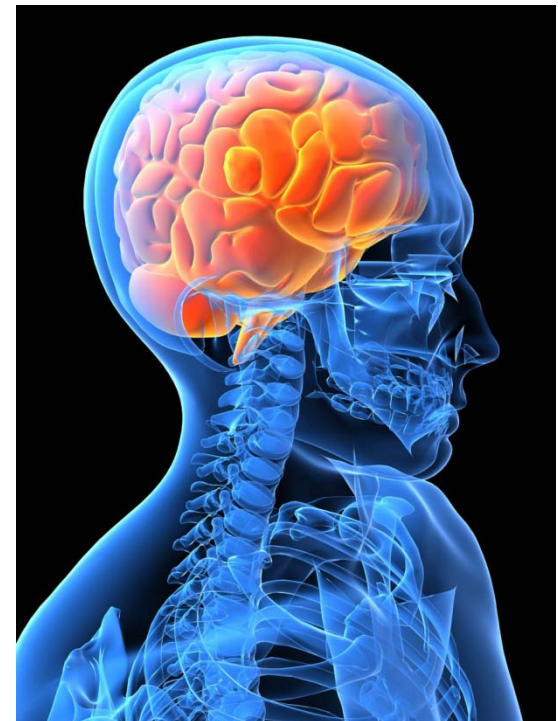


Physiology of Pain

- **Nociception**
Basic, but complex neural process of encoding noxious (damaging to normal tissues) stimuli.
- **Nociceptor**
 - High-threshold sensory receptors of the peripheral somatosensory nervous system capable of transducing and encoding noxious stimuli.
- **Categories of noxious stimuli**
 - mechanical (pressure, swelling, abscess, incision, tumor growth)
 - thermal (burns from heat or cold sources)
 - chemical (toxic substances, excitatory neurotransmitter, ischemia, infection)



Steps in the Normal Pain Pathway

- Transduction
- Transmission
- Perception
- Modulation



Transduction

Damage to tissues from thermal, chemical or mechanical forces releases substances such as prostaglandins, bradykinin, histamine, & substance P, that activate nociceptors to begin the process of alerting the brain that something is causing harm to the body.



Transmission

The transmission process occurs in three stages.

1. The pain impulse is transmitted from the site of transduction along the nociceptor fibers (A beta, A delta or C fibers) to the dorsal horn in the spinal cord;
2. Release of substance P and other neurotransmitters carry the action potential across the cleft to the dorsal horn of the spinal cord to ascend the spinothalamic tract to the thalamus and midbrain;
3. From the thalamus, fibers send the nociceptive message to the somatosensory cortex, parietal lobe, frontal lobe, and the limbic system, where the third nociceptive process -- perception -- occurs.



Perception

- Conscious multidimensional experience.
- Affected by many factors: level of consciousness, meaning of pain, environment, physical, emotional and social factors.
- The multidimensional experience of pain has affective-motivational, sensory-discriminative, emotional and behavioral components.



Modulation

- The modulation of pain involves changing or inhibiting transmission of pain impulses in the descending pathways of the spinal cord.
- Modulation leads to either an increase in the transmission of pain impulses (excitatory) or a decrease in transmission (inhibition).
- Inhibitory neurotransmitters block or partially block the transmission of pain impulses, and therefore produce analgesia.
- Inhibitory neurotransmitters involved with the modulation of pain include:
 - enkephalins
 - serotonin (5-HT)
 - norepinephrine (noradrenalin)
 - gamma-aminobutyric acid (GABA)
 - neurotensin
 - acetylcholine
 - oxytocin
- These neurons stimulate the release of additional neurotransmitters, which ultimately trigger the release of endogenous opioids and inhibit transmission of the pain impulse at the dorsal horn.

Nociceptive versus Neuropathic Pain

- Nociceptive (Normal processing of a painful stimulus) results from tissue damage such as that resulting from burns, lacerations, fractures, obstructions, etc.

Two types:

- Somatic—arises from bone, joint, muscle, skin or connective tissue.
- Visceral—arises from visceral organs

- Neuropathic (abnormal processing of sensory input) results from damaged or dysfunctional nerves in the periphery, spinal cord or brain.

Two types

- Peripherally generated
- Centrally generated pain.

Nociceptive vs. Neuropathic Pain

- **Nociceptive**

Resulting from a pain stimulus e.g., post-operative pain, arthritis, burns, lacerations, sports injuries.

Note: Certain pain syndromes develop from a nociceptive injury and progress to neuropathic pain, while others can have a mix of both types of pain.

- **Neuropathic**

Resulting from actual nerve damage or a dysfunction in the nervous system e.g., neuralgias (post-herpetic, trigeminal), diabetic neuropathies, phantom limb pain, central stroke pain.

Preventing or Stopping Pain by Interrupting the Pain Pathway

Pathway	Methods
Transduction	<ul style="list-style-type: none"> • Ice • NSAIDs inhibit prostaglandin formation • Local anesthetics interfere with nociceptor activation by blocking sodium channels needed for transduction • Anticonvulsants affect calcium and potassium needed for transduction
Transmission	<ul style="list-style-type: none"> • Anticonvulsants • Opioids • NMDA-receptor antagonists • Tricyclic antidepressants
Perception	<ul style="list-style-type: none"> • Opioids • General anesthesia • Patient education and involvement in decisions about pain prevention/treatment • Reduction of contributors to pain (physical, psychological/social, environmental issues)
Modulation	<ul style="list-style-type: none"> • Counter irritants e.g., massage and electrical stimulation (TENS) • Distraction, relaxation techniques, imagery, hypnosis • Exercise • Acupuncture • Opioids • Tricyclic antidepressants • Reduction of fear, anxiety, depression