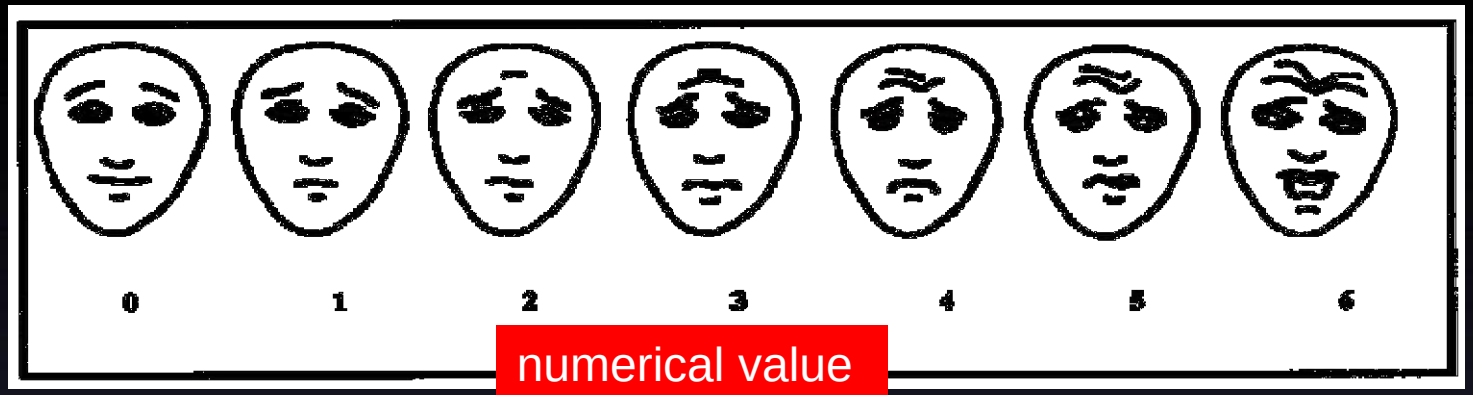
PAIN MODULATION



numerical value

adjectives

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OBJECTIVES

At the end of this lecture you should be able to describe:

- Nociceptors, Referred Pain, radiating pain
- “Gating” of Pain
- Pain Suppression (“Analgesia”) System in the Brain and Spinal Cord
- Transcutaneous Electrical Nerve Stimulation (TENS)
- Transcranial Direct Current Stimulation (tDCS)
- Applied aspects of pain

Nociceptive & Neuropathic Pain

- **Nociceptive pain** is detected by specialized transducers connected to A-delta and C-fibers (stimuli from somatic and visceral structures)

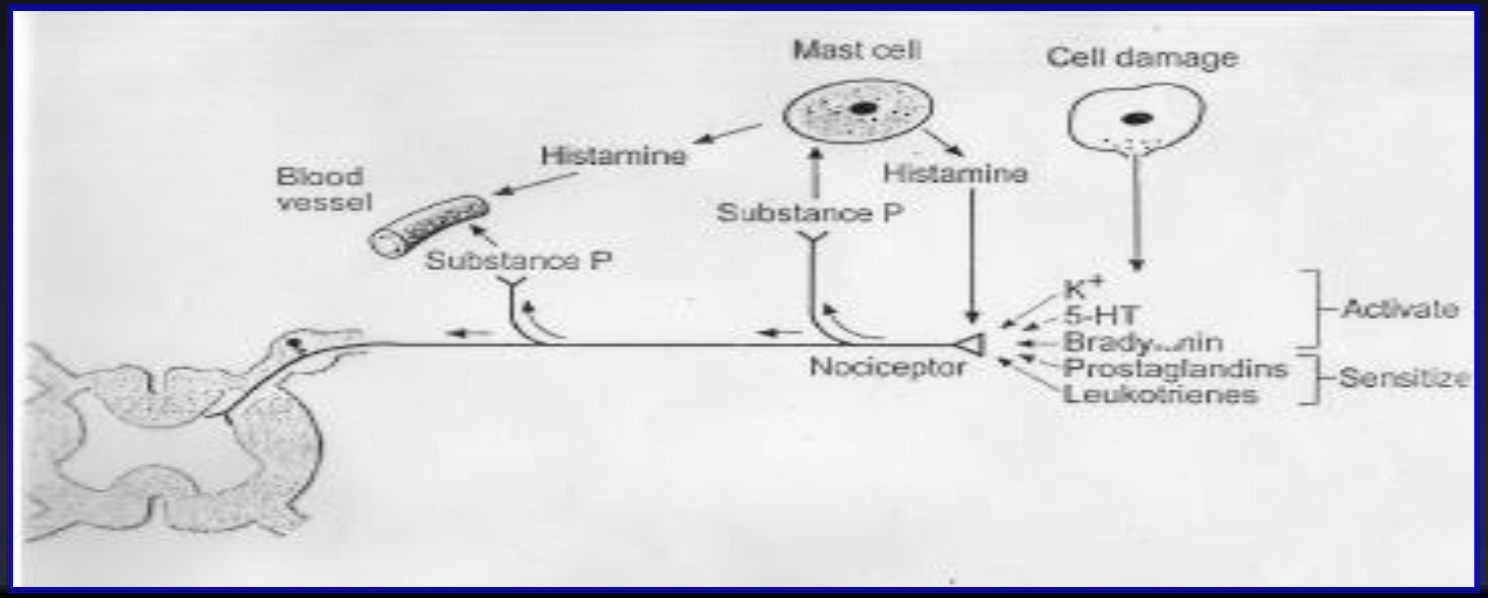
- **Neuropathic pain** damage to nerves (trigeminal neuralgia, postherpetic pain, diabetic neuropathy)

4 Basic Processes

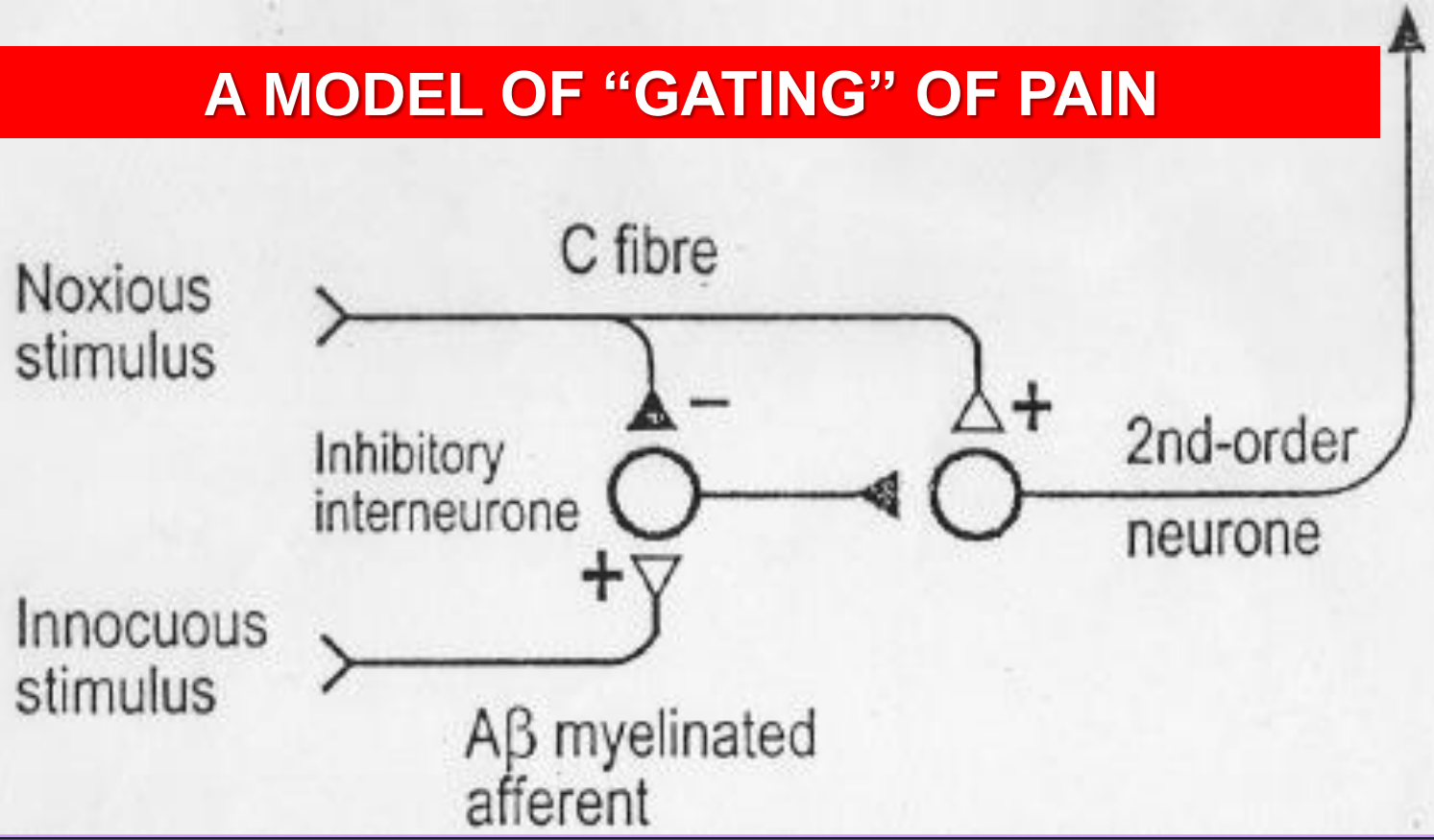
1. **Transduction**—nociceptors free nerve endings
2. **Transmission**
3. **Perception** of Pain-At cortical Level
4. **Modulation** of Pain, Changing or inhibiting pain impulses in the descending tract (brain→ spinal cord) [norepinephrine and serotonin]

Chemical agents that produce pain

- **Nociceptors are activated by**: Bradykinin, serotonin, Histamine, K^+ ion, Acids, acetyl choline, & proteolytic enzymes.
- **Nociceptors are sensitized by**: Prostaglandins & substance P



A MODEL OF "GATING" OF PAIN



Implies a non-painful stimulus can block the transmission of a noxious stimulus. Is based on the premise that the gate, located in the dorsal horn of the spinal cord, modulates the afferent nerve impulses.

1. **A-Delta fibres (sharp pain)**
2. **C fibres (dull pain)**
3. **A-Beta fibres that carry messages of light touch**

Conditions that open or close the gate

	Conditions that open the gate	Conditions that close the gate
Physical conditions	Extent of the injury	Medication
	Inappropriate activity level	Counterstimulation, eg massage
Emotional Conditions	Anxiety or worry	Positive emotions
	Tension	Relaxation
	Depression	Rest
Mental conditions	Focusing on the pain	Intense concentration or distraction
	Boredom	Involvement and interest in life activities

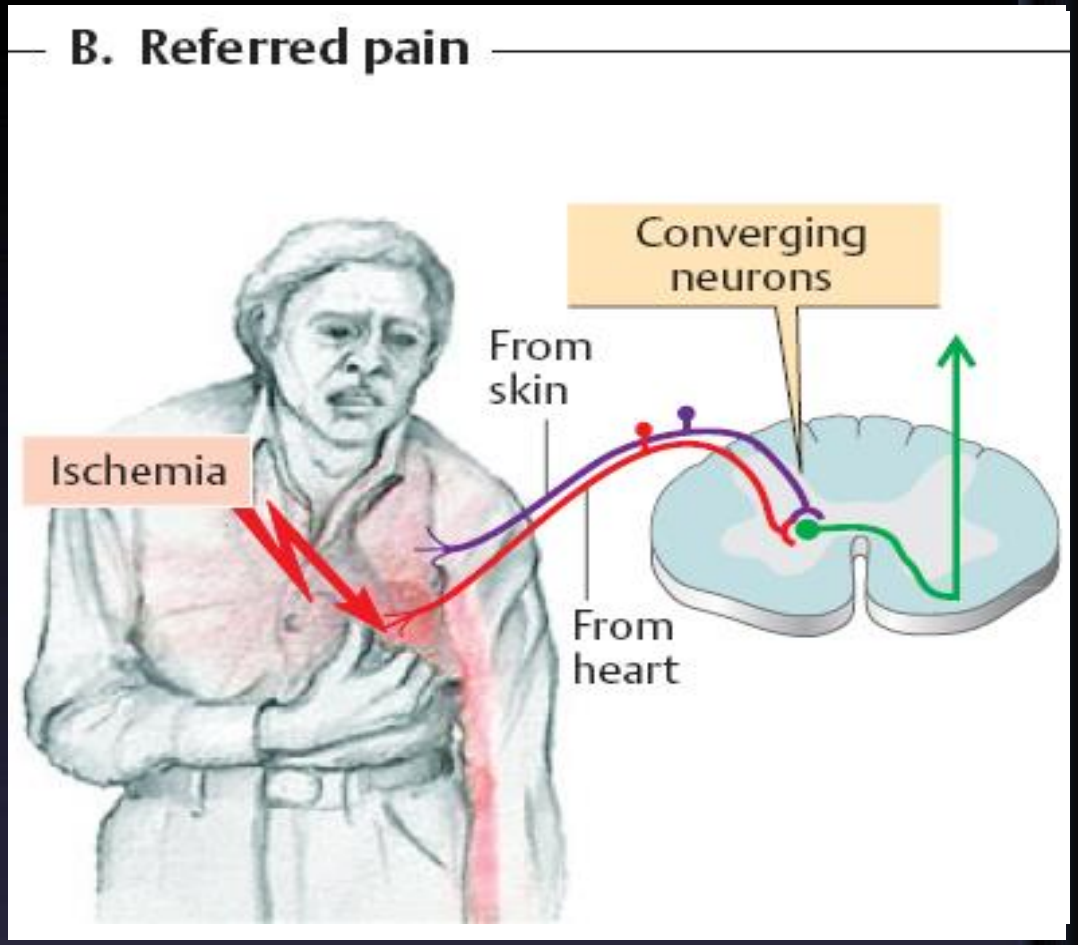
REFERRED PAIN

- Pain that is not felt in the diseased structure itself, but at another place in the body far away from the site of origin.
- Visceral and deep somatic pain are often referred, but superficial pain is not.
- Mechanism of referred pain
  - Convergence of peripheral & visceral pain on the same second order neuron that project to brain
  - Facilitation theory: Impulses from diseased viscus pass through afferents which give collaterals to ST neurons receiving pain fibers from skin dermatomes

REFERRED PAIN

Convergence

Branches of visceral pain fibers synapse in the spinal cord on the same second-order Neurons that receive pain signals from the skin



REFERRED PAIN

When visceral pain is referred to the surface of the body, the person generally localizes it in the dermatomal segment from which the visceral organ originated in the embryo, not necessarily where the visceral organ now lies.

Dermatomal rule

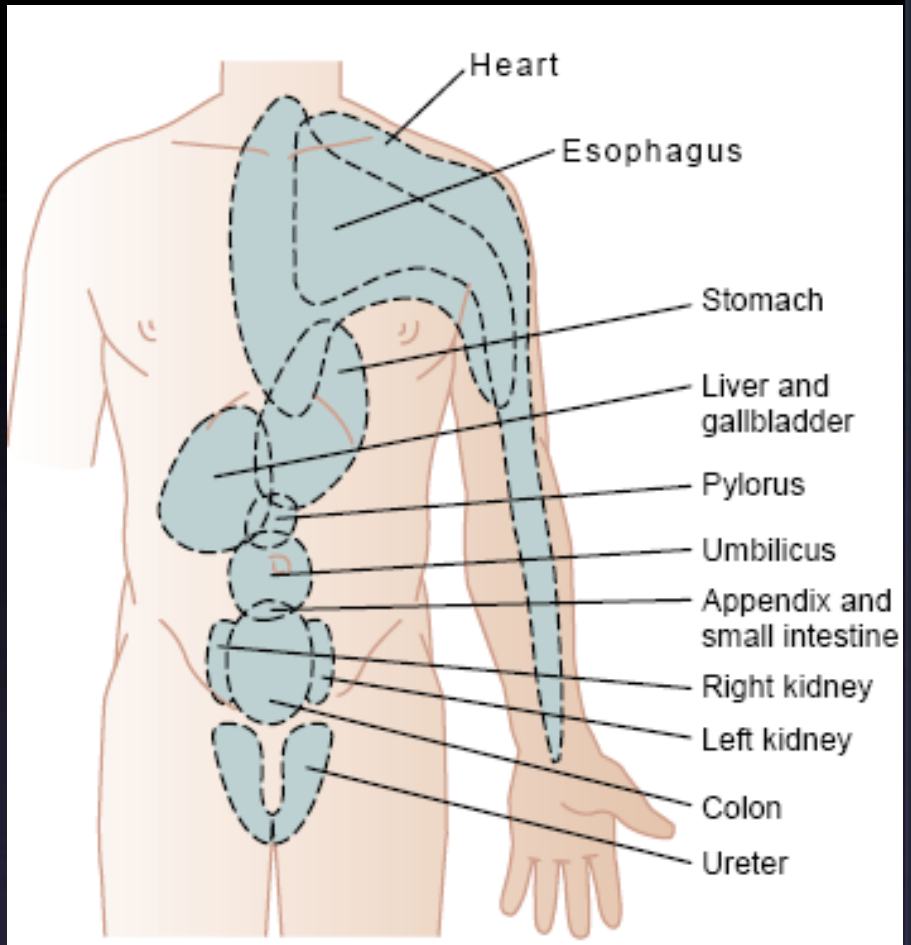


Figure 48–6

Surface areas of referred pain from different visceral organs.

REFERRED PAIN

Localization of Visceral Pain "Visceral" and the "Parietal" Pain Transmission Pathways

When pain migrates/referred from its original site of localization it called RADIATING PAIN

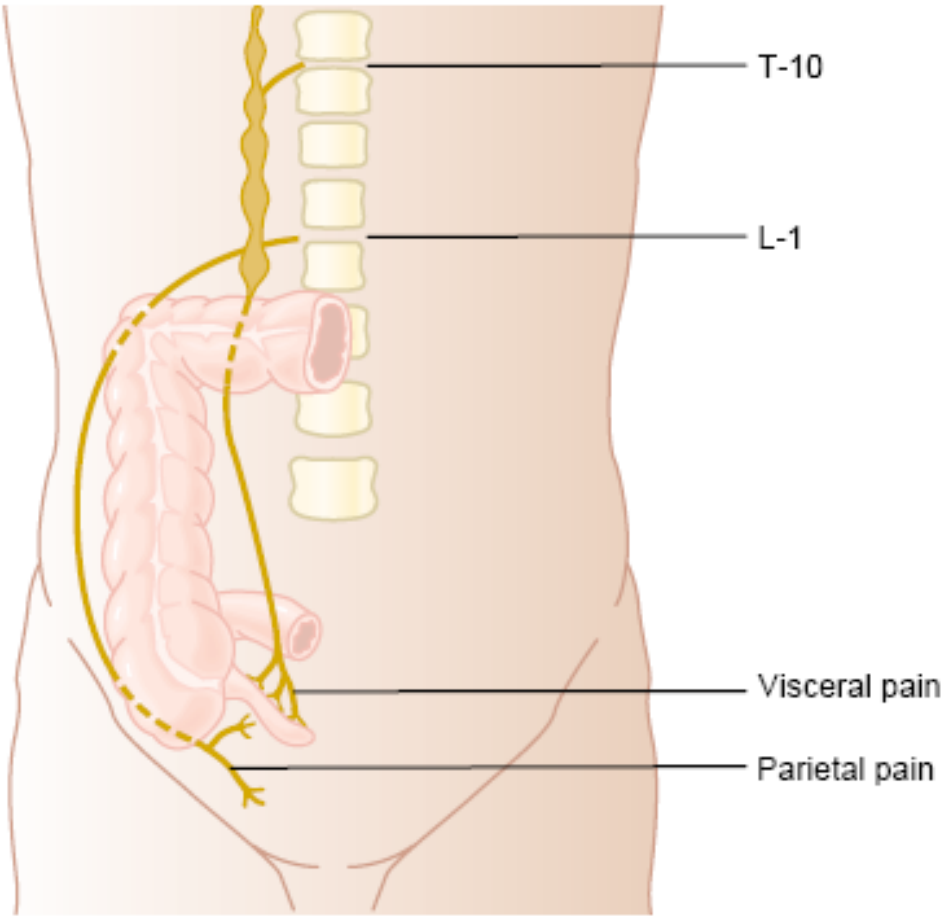
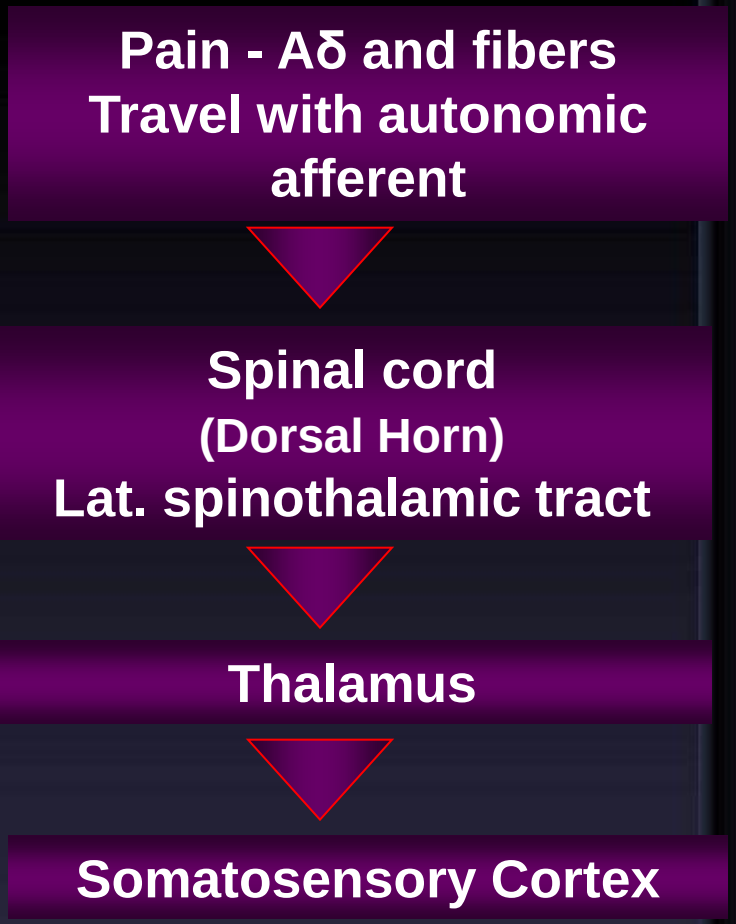


Figure 48–7

Visceral and parietal transmission of pain signals from the appendix.

CHARACTERSITICS OF VISCERAL PAIN

- Poorly localized
- Associated with nausea and autonomic disturbance
- Often referred
- Cutting, crushing are not painful when applied to viscera
- Pain is caused by distension, ischemia and inflammation



The brain tissues themselves are almost totally insensitive to pain.

Tugging on the venous sinuses around the brain, damaging the tentorium, or stretching the dura at the base of the brain can cause intense pain that is recognized as headache. Also, almost any type of traumatizing, crushing, or stretching stimulus to the blood vessels of the meninges can cause headache.

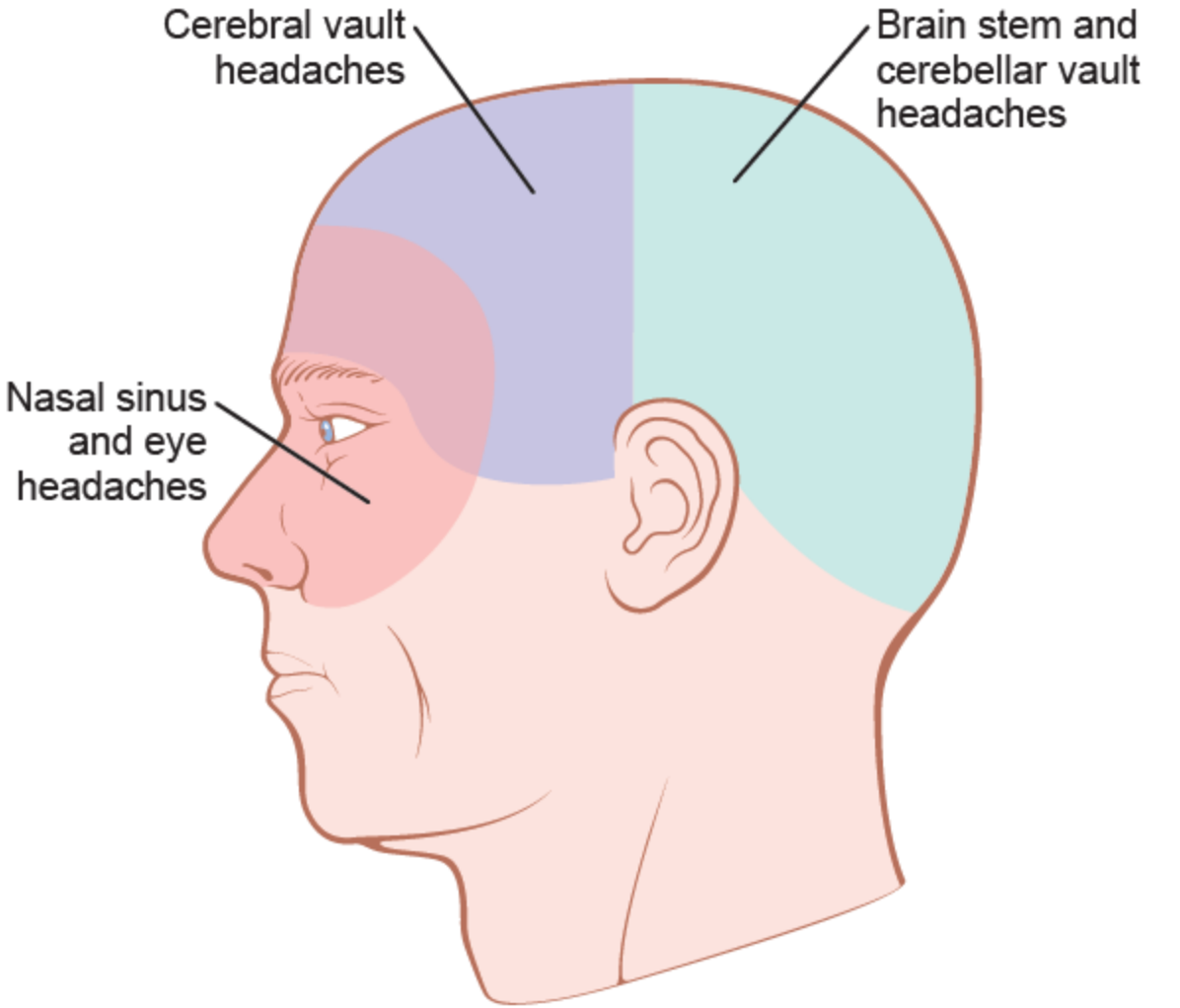
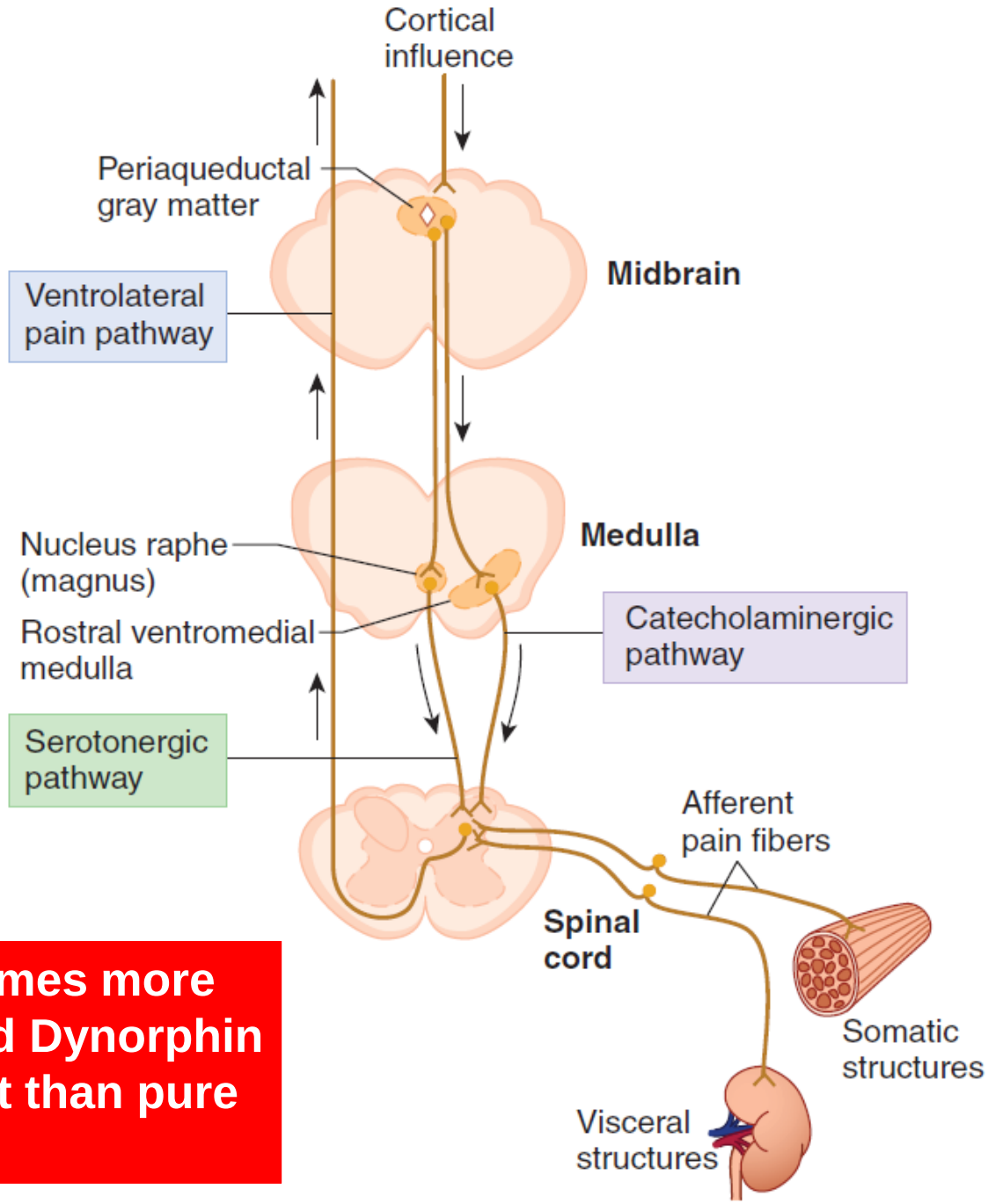


Figure 49-9. Areas of headache resulting from different causes.

Pain Suppression ("Analgesia") System in the Brain and Spinal Cord

Ascending Pain Pathway

Descending Analgesic Pathway



Beta Endorphin is 50 times more potent than morphine and Dynorphin is 200 times more potent than pure morphine

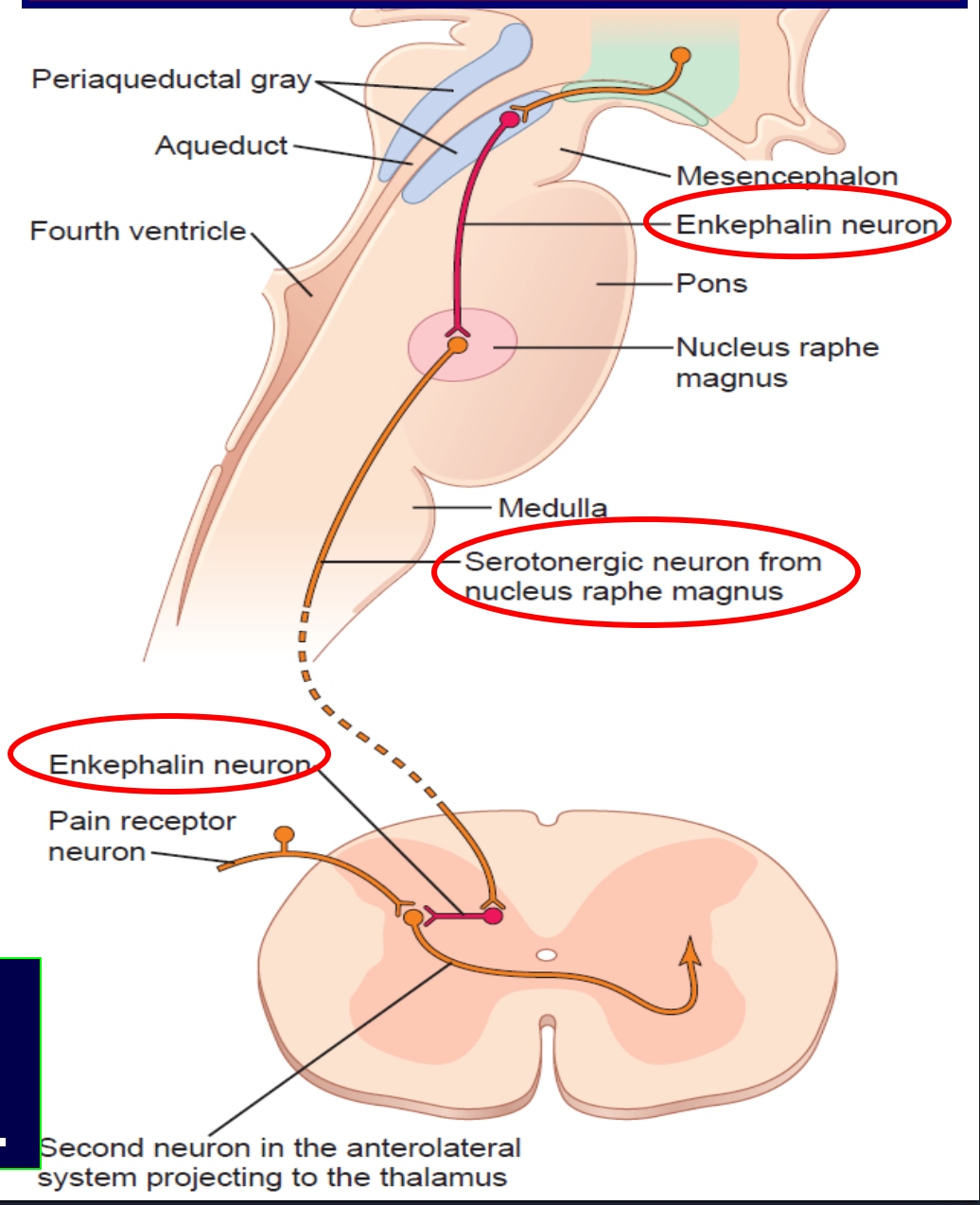
(1) Enkephalin Neurons from periaqueductal gray and periventricular areas of the mesencephalon and upper pons send signals to

(2) Raphe magnus nucleus, in the lower pons and upper medulla From these nuclei, second-order N go down the dorsolateral columns in the spinal cord & secrete Serotonin which act on local neurons to secrete Enkephalin

(3) a pain inhibitory complex in the dorsal of spinal cord

At this point, the analgesia signals can block the pain before it is relayed to the brain.

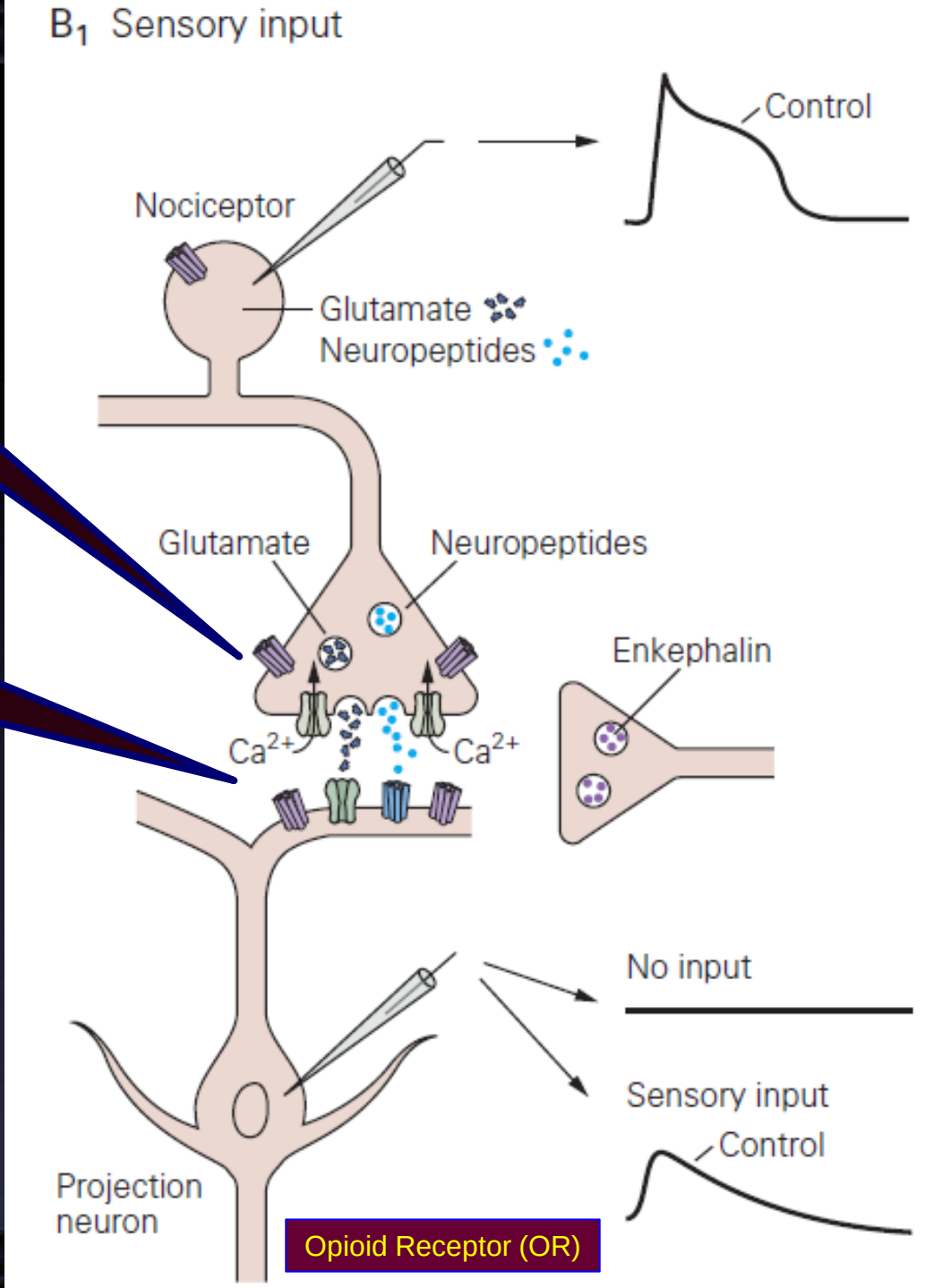
Pain Suppression ("Analgesia") System in the Brain and Spinal Cord

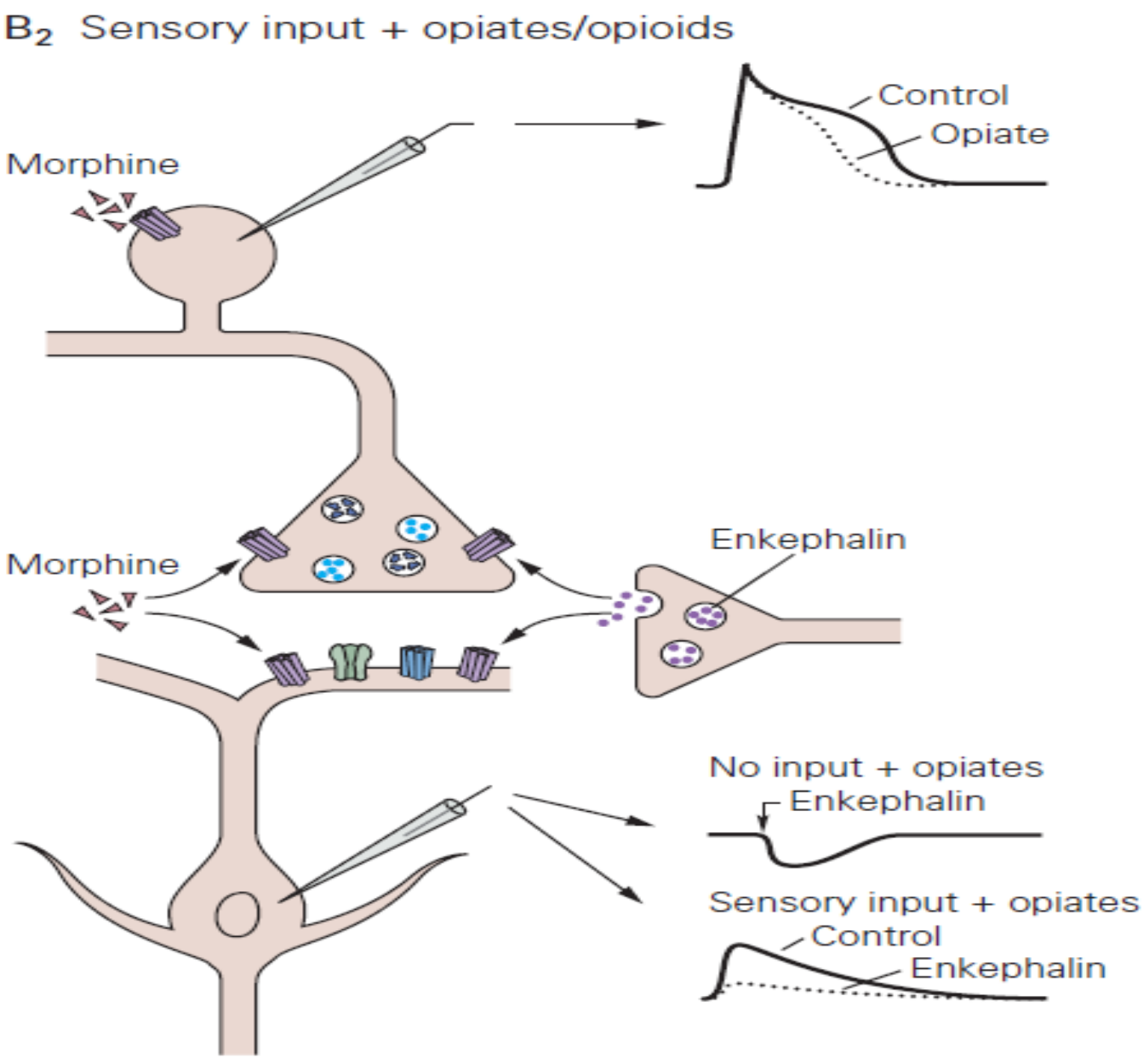


Activation of the presynaptic OR leads to a decrease in Ca^{++} influx, resulting in a decrease in release of glutamate and substance P.

Activation of the postsynaptic OR hyperpolarizes the dorsal horn interneuron by causing an increase in K^{+} conductance.

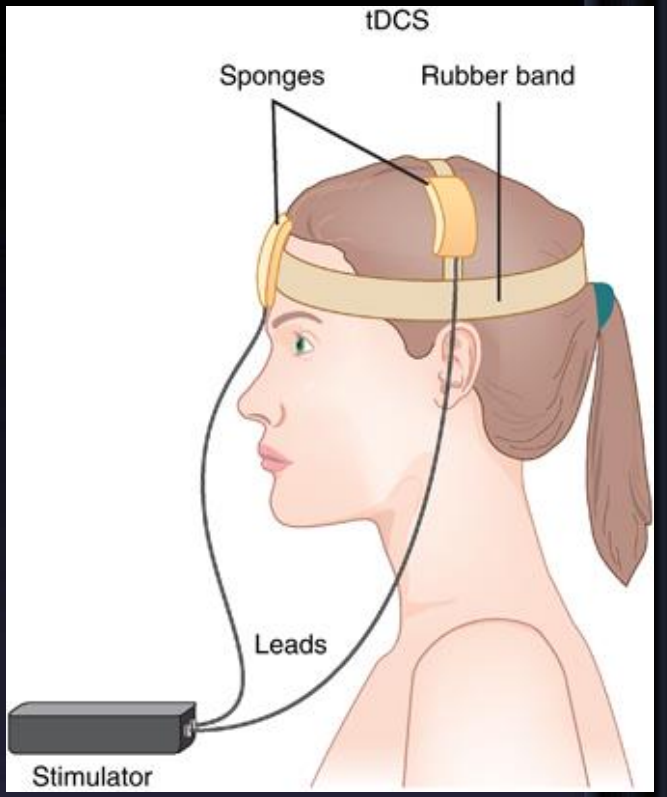
- ↓ duration of the EPSP in the dorsal horn neuron.
- Activation of OR on dorsal root ganglia cell bodies also contributes to reduced transmission from nociceptive afferents.




B2 Sensory input + opiates/opioids
Control
Opiate
Morphine
Morphine
Enkephalin
No input + opiates
Enkephalin
Sensory input + opiates
Control
Enkephalin

TRANSCRANIAL DIRECT CURRENT STIMULATION (TDCS)

- It is a non-invasive procedure in which a device sends a small Direct Current (DC) across electrodes in the areas of interest on the scalp to modulate brain function.
- This current flow can increases or decreases the neuronal excitability in the specific area being stimulated, based on which type of stimulation.
- When the current passes from the anode to the cathode, it may increase the activity of the brain at the anode site and decrease the activity of the brain near the cathode site.

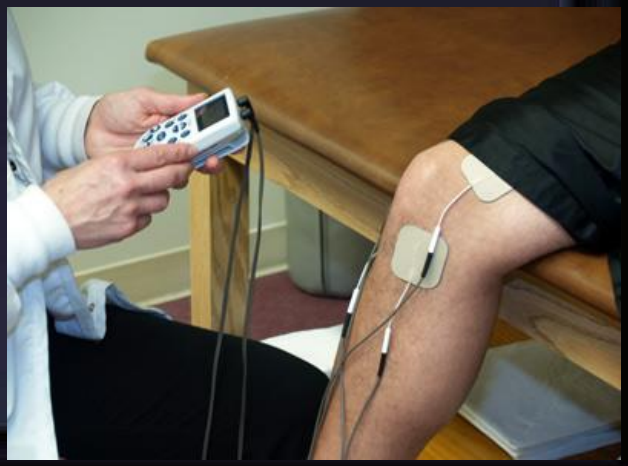


TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION (TENS)

- The gate-control mechanism of pain modulation and serves as the rationale behind the use of transcutaneous electrical nerve stimulation (TENS) for pain relief.
- TENS uses electrodes to activate Aα and Aβ fibers in the vicinity of the injury. TENS stimulates sensory nerves to block pain signals, stimulate endorphin production to help normalize sympathetic function.

INTERFERENTIAL STIMULATION

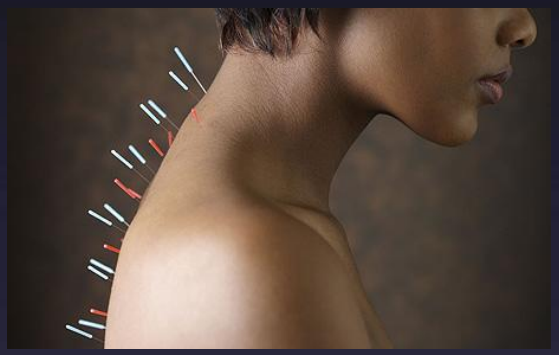
Interferential Stimulation differs from TENS because it allows a deeper penetration by using two frequencies of the tissue with more comfort (compliance) and increased circulation.
Stimulate parasympathetic nerve fibers for increased blood flow.

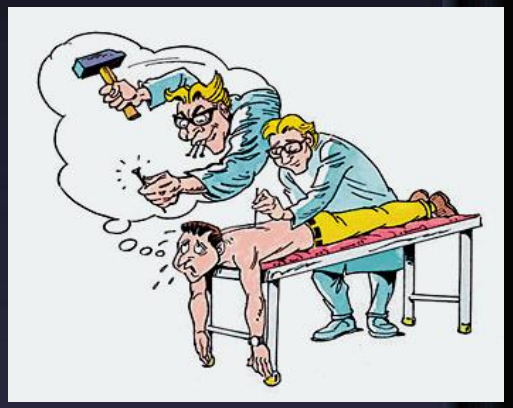


Inhibition of Pain Transmission by Tactile Sensory Signals

- Stimulation of large type Aβ sensory fibers from peripheral tactile receptors depress transmission of pain signals from the same body area by lateral inhibition in the spinal cord
- The simultaneous physical and psychogenic excitation of the central analgesia system is the basis of pain relief by ***ACUPUNCTURE.***

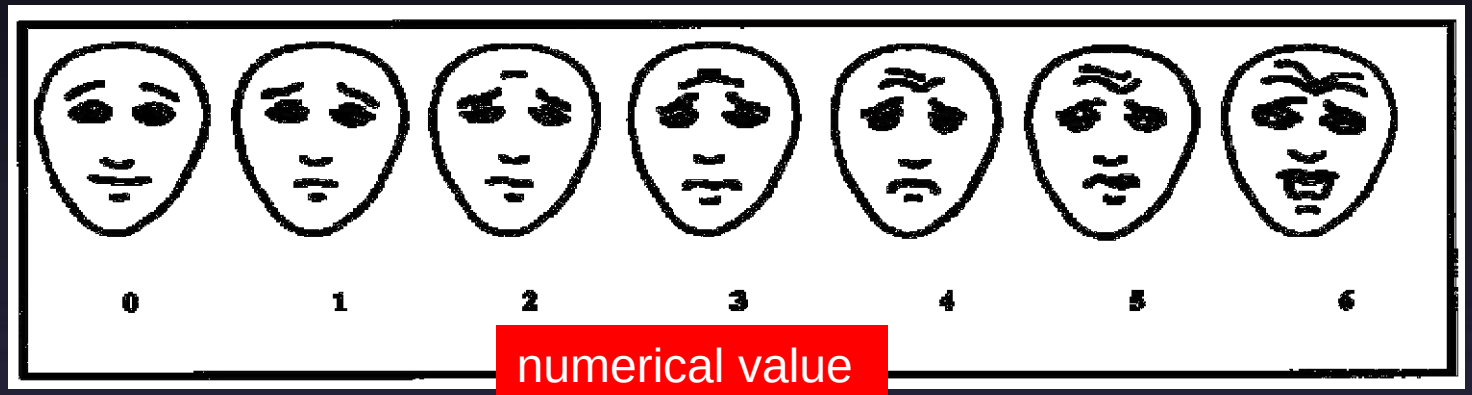
The analgesic effect of electroacupuncture may involve the release of endogenous opioids and activation of descending pain modulatory pathway.





PAIN SCALES

- Visual Analog Scale
- Locate area of pain on a picture
- McGill pain questionnaire
  - Evaluate sensory, evaluative, & affective components of pain
    - 20 subcategories, 78 words



Mc Gill-Melzack
PAIN QUESTIONNAIRE

Patient's name _____ Age _____
File No. _____ Date _____
Clinical category (e.g. cardiac, neurological, etc.):

Diagnosis: _____
_____
_____

Analgesic (if already administered):
1. Type _____
2. Dosage _____
3. Time given in relation to this test _____

Patient's intelligence: circle number that represents best estimate
1 (low) 2 3 4 5 high

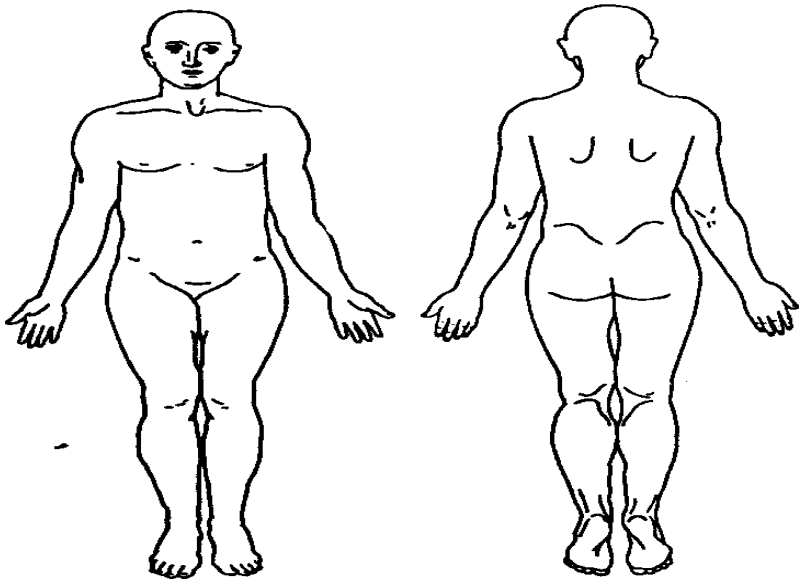
****

This questionnaire has been designed to tell us more about your pain. Four major questions we ask are:
1. Where is your pain?
2. What does it feel like?
3. How does it change with time?
4. How strong is it?

It is important that you tell us how your pain feels now. Please follow the instructions at the beginning of each part.

Part 1. Where is your Pain?

Please mark, on the drawings below, the areas where you feel pain. Put E if external, or I if internal, near the areas which you mark. Put EI if both external and internal.



Part 2. What Does Your Pain Feel Like?

Some of the words below describe your present pain. Circle ONLY those words that best describe it. Leave out any category that is not suitable. Use only a single word in each appropriate category–the one that applies best.

1	2	3	4
Flickering	Jumping	Pricking	Sharp
Quivering	Flashing	Boring	Cutting
Pulsing	Shooting	Drilling	Lacerating
Throbbing		Stabbing	
Beating		Lancinating	
Pounding			
5	**6**	**7**	**8**
Pinching	Tugging	Hot	Tingling
Pressing	Pulling	Burning	Itchy
Gnawing	Wrenching	Scalding	Smarting
Cramping		Searing	Stinging
Crushing			
9	**10**	**11**	**12**
Dull	Tender	Tiring	Sickening
Sore	Taut	Exhausting	Suffocating
Hurting	Rasping		
Aching	Splitting		
Heavy			
13	**14**	**15**	**16**
Fearful	Punishing	Wretched	Annoying
Frightful	Cruel	Blinding	Troublesome
Terrifying	Vicious		Miserable
	Killing		Intense
			Unbearable
17	**18**	**19**	**20**
Spreading	Tight	Cool	Nagging
Radiating	Numb	Cold	Nauseating
Penetrating	Drawing	Freezing	Agonizing
Piercing	Squeezing		Dreadful
	Tearing		Torturing

Part 3. How Does Your Pain Change With Time?

1. Which word or words would you use to describe the pattern of your pain?

1	2	3
Continuous	Rhythmic	Brief
Steady	Periodic	Momentary
Constant	Intermittent	Transient

2. What kind of things relieve your pain?

3. What kind of things increase your pain?

Part 4. How Strong Is Your Pain?

People agree that the following 5 word represent pain in increasing intensity. They are:

1	2	3	4	5
Mild	Discomforting	Distressing	Horrible	Excruciating

To answer each question below, write the number of the most appropriate word in the space beside the question.

1. Which word describes your pain right now? _____
2. Which word describes it at its worst? _____
3. Which word describes it when it is least? _____
4. Which word describes the worst toothache you ever had? _____
5. Which word describes the worst headache you ever had? _____
6. Which word describes the worst stomach-ache you ever had? _____

Applied

1. **What will happen if sensory area SI is removed?**

Ans. persons ability to interpret the quality of pain & precise location of pain will be affected.

2. **Why patient with chronic pain syndrome have difficulty in sleeping?**

Ans. Paleospinothalamic pathway sends information to reticular formation and thalamic nuclei which are part of brain activating / alerting system, therefore chronic pain syndrome causes difficulty in sleep.

Placebo Effect

- **Placebo** stems from the Latin word for **"I shall please"**
  - Used to describe pain reduction obtained from a mechanism other than those related to the physiological effects of the tx.
  - Linked to psychological mechanisms
- All Treatments ™ have some degree of placebo effect
  - Most studies involving TM involving the use of a sham TM (ultrasound set at the intensity of 0) and an actual treatment have shown ↓ levels of pain in each group.

Congenital Analgesia

Congenital insensitivity to pain (CIP), also known as congenital analgesia, is one or more rare conditions in which a person cannot feel (and has never felt) physical pain due to gene mutations

- A well-known case of congenital insensitivity to pain is a girl referred to as **'Miss C'** who was a student at McGill university in Montreal in the 1950s.
- She was normal in every way, except that she could not feel pain. When she was a child she had bitten off the tip of her tongue and had suffered third-degree burns by kneeling on a radiator.
- She did not feel any pain when she was given strong electric shocks or when exposed to very hot and very cold water. When these stimuli were presented to her she showed no change in heart rate, blood pressure or respiration.
- She died at the age of 29 as a result of her condition, because she damaged her knees, hips and spine.

Fibromyalgia: Pain Without Injury

- The occurrence of body-wide pain in the absence of tissue damage, as in fibromyalgia, interferes with all aspects of a person's life and undermines their credibility.
- The problem is that normal activities can be exhausting, sleep is disturbed, the ability to concentrate is impaired, gastrointestinal function is often abnormal, persistent headaches are common, and the unrelenting pain that no one can see is often detrimental to their personal and professional lives--as it creates a "credibility gap."

Phantom limb pain

- Phantom limbs give impression of pressure and pain
- Even if phantom limb is experienced as spatially detached from the body, it is still felt to belong to the patient.
- Paraplegic people experience phantom limbs. They can even experience continually cycling legs.
- It is the emotional and motivational systems that cause the phantom limb experience.

Our brain can reorganize if sensory input is cut off at the ventral posterior thalamic nucleus even after that part is amputated

TERMS FREQUENTLY USED

- **Hyperalgesia:** Increased sensitivity to Pain
- **Allodynia:** A person feels pain from stimuli that don't normally cause pain due to central sensitization. For example, lightly touching your skin or brushing your hair might feel painful.
- clinical feature of many painful conditions, such as neuropathies, complex regional pain syndrome, postherpetic neuralgia, fibromyalgia, and migraine Muscular Pain: Less blood flow in the muscles (ischemia).
- **Stress analgesia:** Mild degree of pain is not felt if the other part of the body has excessive pain.
- **Causalgia:** It is chronic burning pain condition seen after the section (damage, cutting) of a nerve Triggered by a simple stimulus e.g. breeze or vibration.
- **Neuralgia** - sharp pain along a nerve pathway (eg; Trigeminal N)
- **Thalamic Syndrome:** Obstruction of the thalmogeniculate branch of the posterior cerebral artery Affects posterior thalamic nuclei. Patient suffers from prolonged severe pain with variable quality (Dejerine Roussy Syndrome)