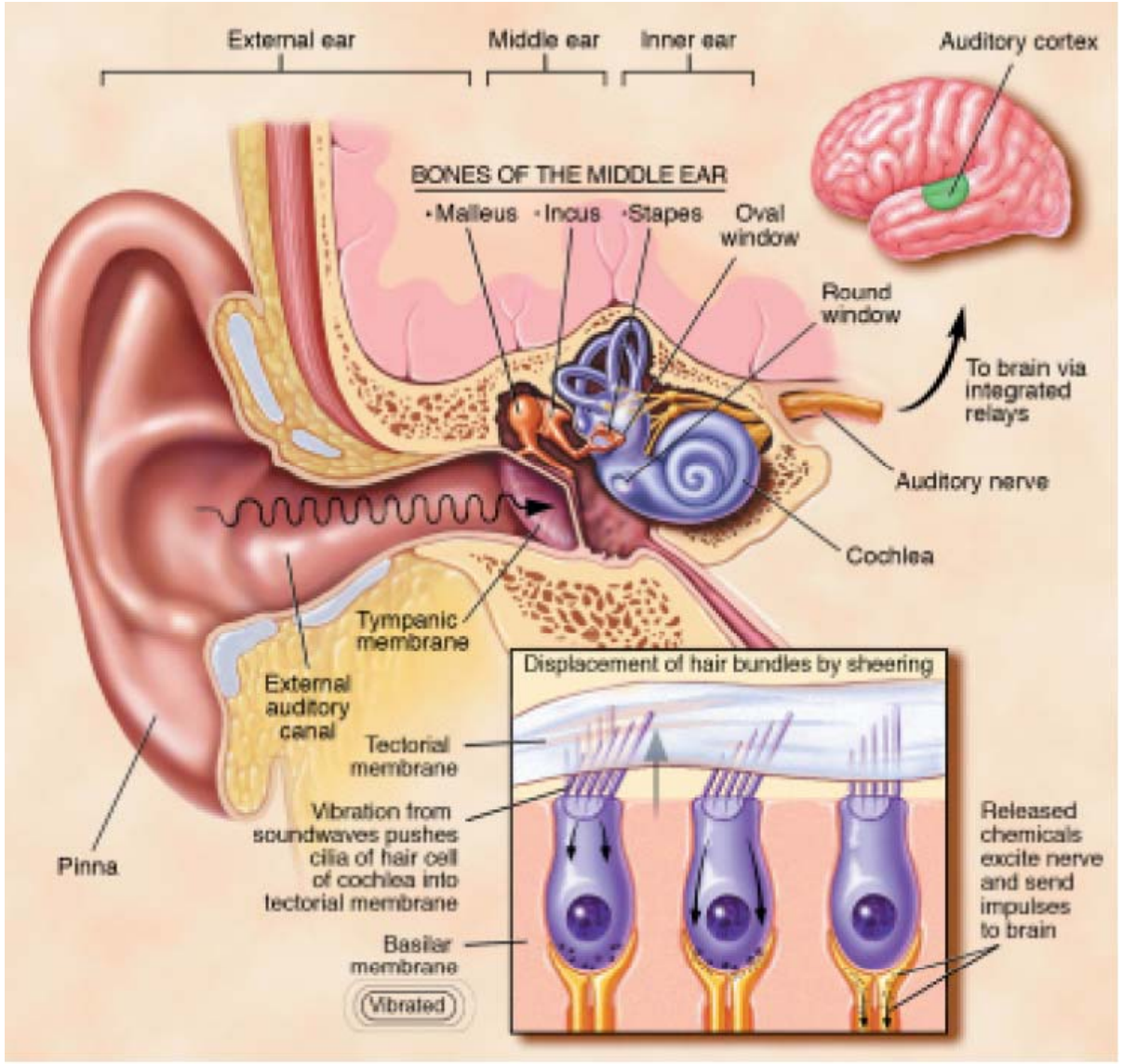
# Hearing


External ear
Middle ear
Inner ear
Auditory cortex
BONES OF THE MIDDLE EAR
Malleus
Incus
Stapes
Oval window
Round window
To brain via integrated relays
Auditory nerve
Cochlea
Tympanic membrane
External auditory canal
Pinna
Displacement of hair bundles by sheering
Tectorial membrane
Vibration from soundwaves pushes cilia of hair cell of cochlea into tectorial membrane
Basilar membrane
Vibrated
Released chemicals excite nerve and send impulses to brain

# The Human Cerebral Cortex

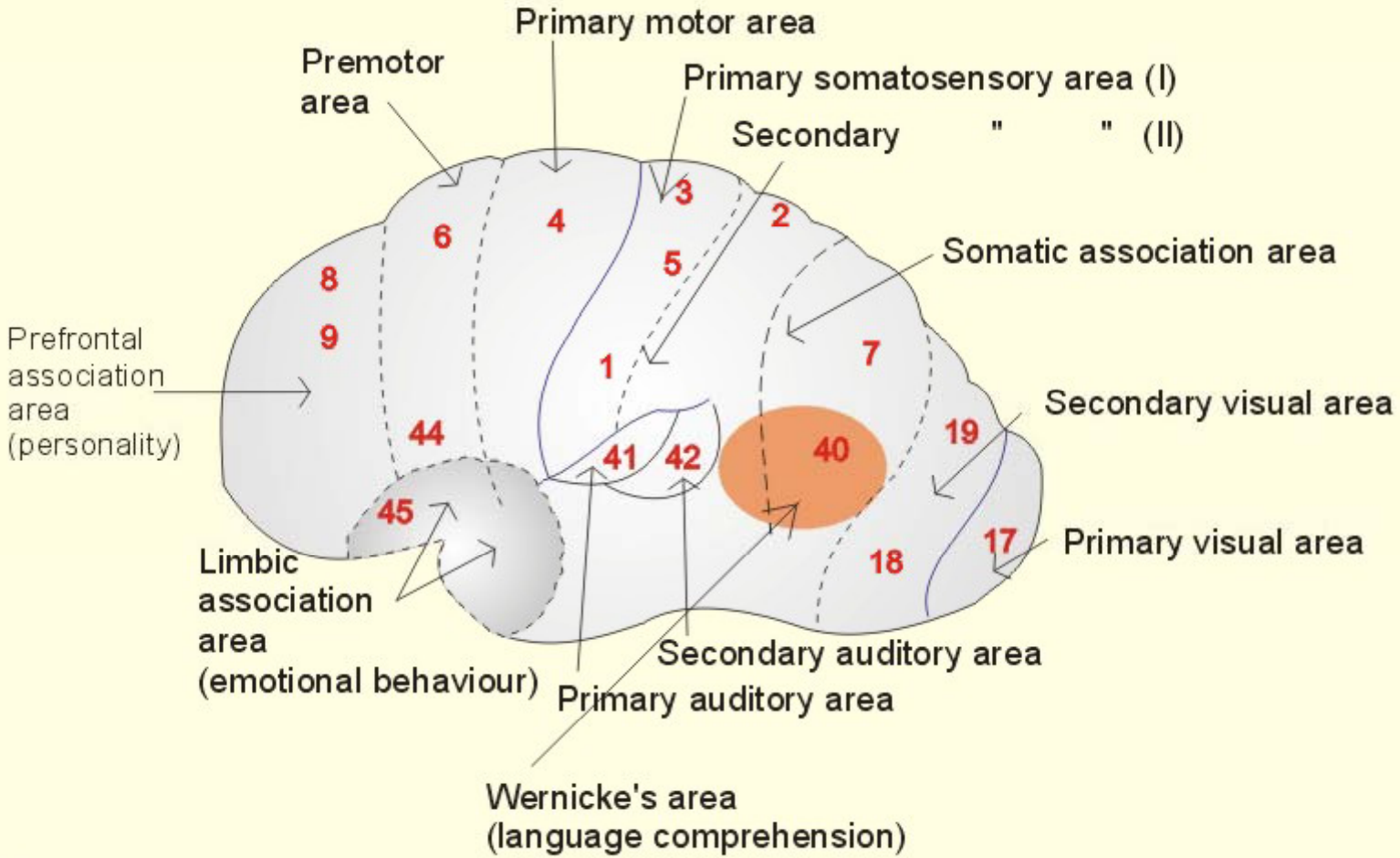



Fig. 4-4

KMc

# Language area in left hemisphere

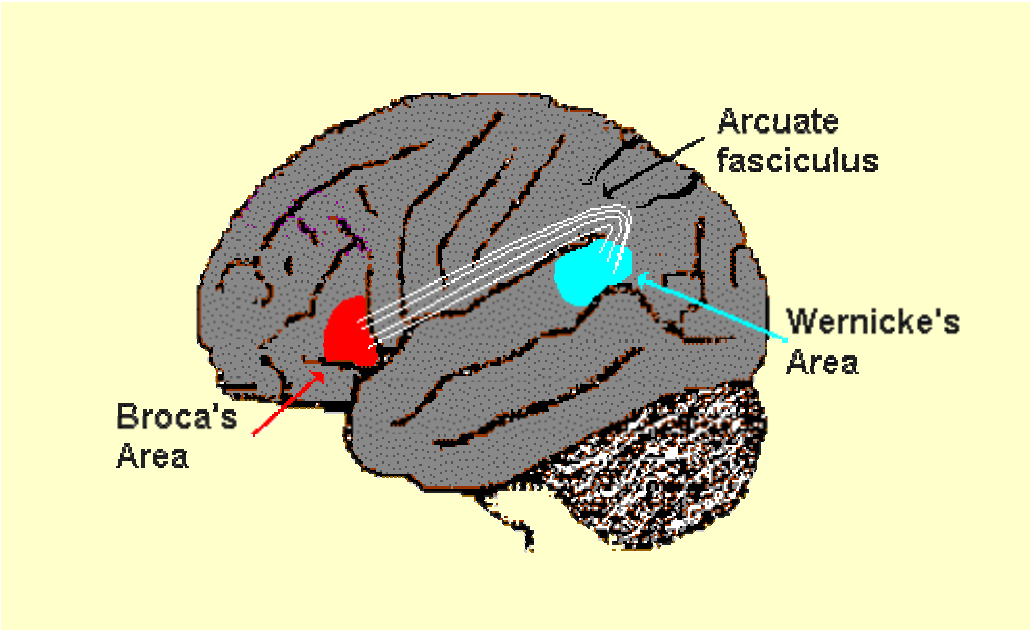
Paul Broca: Broca's area

unable to create grammatically complex sentences

Carl Wernicke: Wernike's area

more pronounced impairment in comprehension

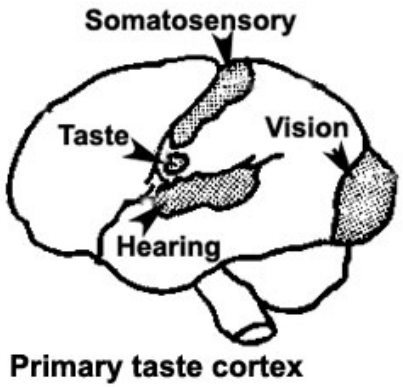
http://mind21.net/13.htm

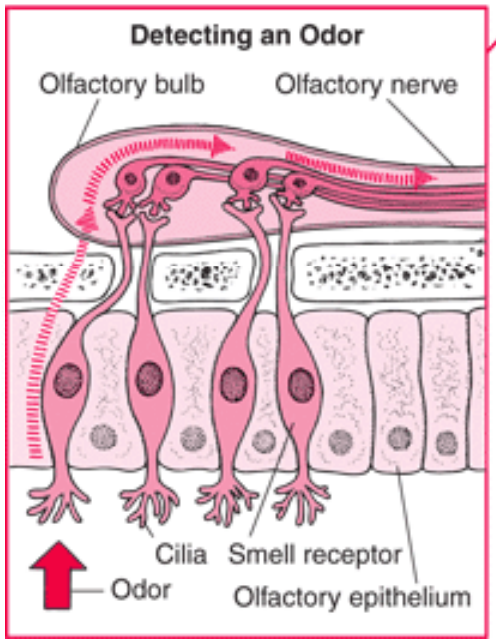


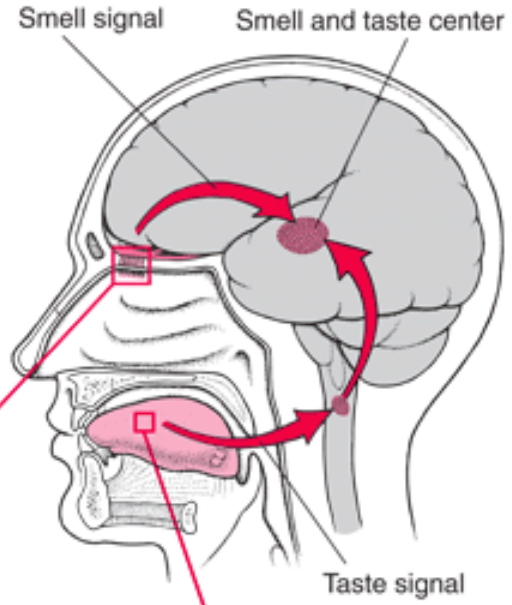
# Taste

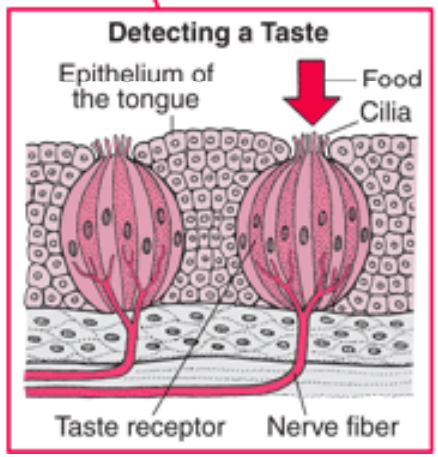
Sensory impulses from taste receptors travel along

- cranial nerves to
- medulla oblongata to
- thalamus to
- gustatory cortex (for interpretation)




http://www.merck.com/mmhe/sec06/ch097/ch097a.html

www.hawkeyecollege.edu/faculty/sdinsmore/A&PI/Export%20Folder10-13/chapter12/PowerPoint/chapter_12_powerpoint_l.ppt

# Chapter 12
# Nervous System III - Senses

## General Senses

- receptors that are widely distributed throughout the body
- skin, various organs and joints

## Special Senses

- specialized receptors confied to structures in the head
- eyes and ears

# Senses

## Sensory Receptors

- specialized cells or multicellular structures that collect information from the environment
- stimulate neurons to send impulses along sensory fibers to the brain

## Sensation

- a feeling that occurs when brain becomes aware of sensory impulse

## Perception

- a person's view of the stimulus; the way the brain interprets the information

# Pathways From Sensation to Perception (Example of an Apple)



TABLE 12.1 Information Flow from the Environment Through the Nervous System

| Information Flow | Smell | Taste | Sight | Hearing |
|---|---|---|---|---|
| Sensory receptors | Olfactory cells in nose | Taste bud receptor cells | Rods and cones in retina | Hair cells in cochlea |
| ↓ | ↓ | ↓ | ↓ | ↓ |
| Impulse in sensory fibers | Olfactory nerve fibers | Sensory fibers in various cranial nerves | Optic nerve fibers | Auditory nerve fibers |
| ↓ | ↓ | ↓ | ↓ | ↓ |
| Impulse reaches CNS | Cerebral cortex | Cerebral cortex | Midbrain and cerebral cortex | Midbrain and cerebral cortex |
| ↓ | ↓ | ↓ | ↓ | ↓ |
| Sensation (new experience, recalled memory) | A pleasant smell | A sweet taste | A small, round, red object | A crunching sound |
| ↓ | ↓ | ↓ | ↓ | ↓ |
| Perception | The smell of an apple | The taste of an apple | The sight of an apple | Biting into an apple |

# Receptor Types

Chemoreceptors

- respond to changes in chemical concentrations

Pain receptors (Nociceptors)

- respond to tissue damage

Thermoreceptors

- respond to changes in temperature

Mechanoreceptors

- respond to mechanical forces

Photoreceptors

- respond to light

# Sensory Impulses

- stimulation of receptor causes local change in its receptor potential
- a graded electrical current is generated that reflects intensity of stimulation
- if receptor is part of a neuron, the membrane potential may generate an action potential
- if receptor is not part of a neuron, the receptor potential must be transferred to a neuron to trigger an action potential
- peripheral nerves transmit impulses to CNS where they are analyzed and interpreted in the brain

# Sensations

Projection

process in which the brain projects the sensation back to the apparent source

it allows a person to pinpoint the region of stimulation

# Sensory Adaptation

- ability to ignore unimportant stimuli

- involves a decreased response to a particular stimulus from the receptors (peripheral adaptations) or along the CNS pathways leading to the cerebral cortex (central adaptation)

- sensory impulses become less frequent and may cease

- stronger stimulus is required to trigger impulses

# General Senses

- senses associated with skin, muscles, joints, and viscera
- three groups
  - exteroceptive senses – senses associated with body surface; touch, pressure, temperature, pain
  - viscероceptive senses – senses associated with changes in viscera; blood pressure stretching blood vessels, ingesting a meal
  - proprioceptive senses – senses associated with changes in muscles and tendons

# Touch and Pressure Senses

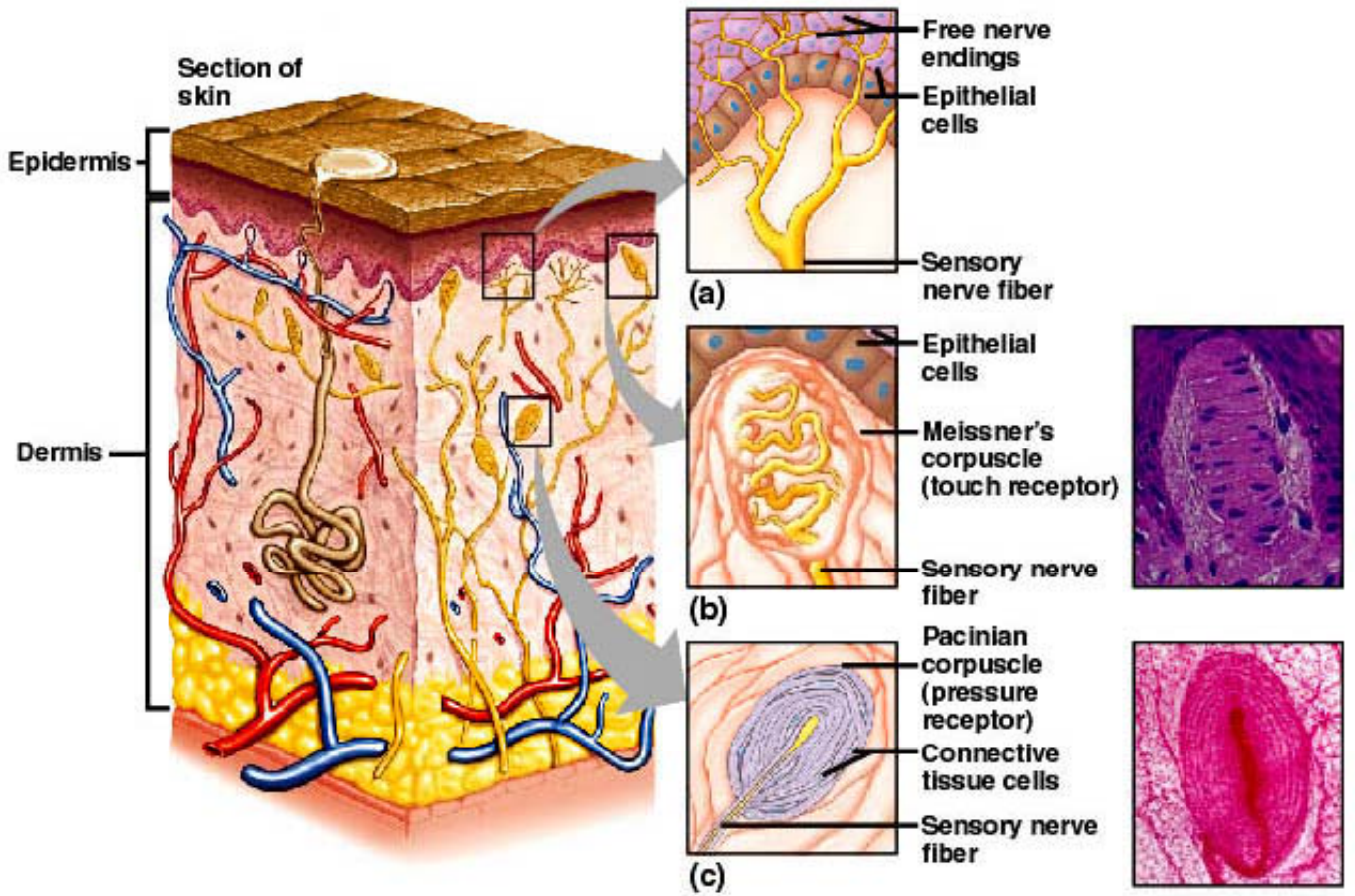
Free nerve endings
- common in epithelial tissues
- simplest receptors
- sense itching

Meissner's corpuscles
- abundant in hairless portions of skin; lips
- detect fine touch; distinguish between two points on the skin

Pacinian corpuscles
- common in deeper subcutaneous tissues, tendons, and ligaments
- detect heavy pressure and vibrations

# Touch and Pressure Receptors





# Temperature Senses

## Warm receptors

- sensitive to temperatures above 25°C (77° F)
- unresponsive to temperature above 45°C (113°F)

## Cold receptors

- sensitive to temperature between 10°C (50°F) and 20°C (68°F)

## Pain receptors

- respond to temperatures below 10°C
- respond to temperatures above 45°C

# Sense of Pain

- free nerve endings
- widely distributed
- nervous tissue of brain lacks pain receptors
- stimulated by tissue damage, chemical, mechanical forces, or extremes in temperature
- adapt very little, if at all

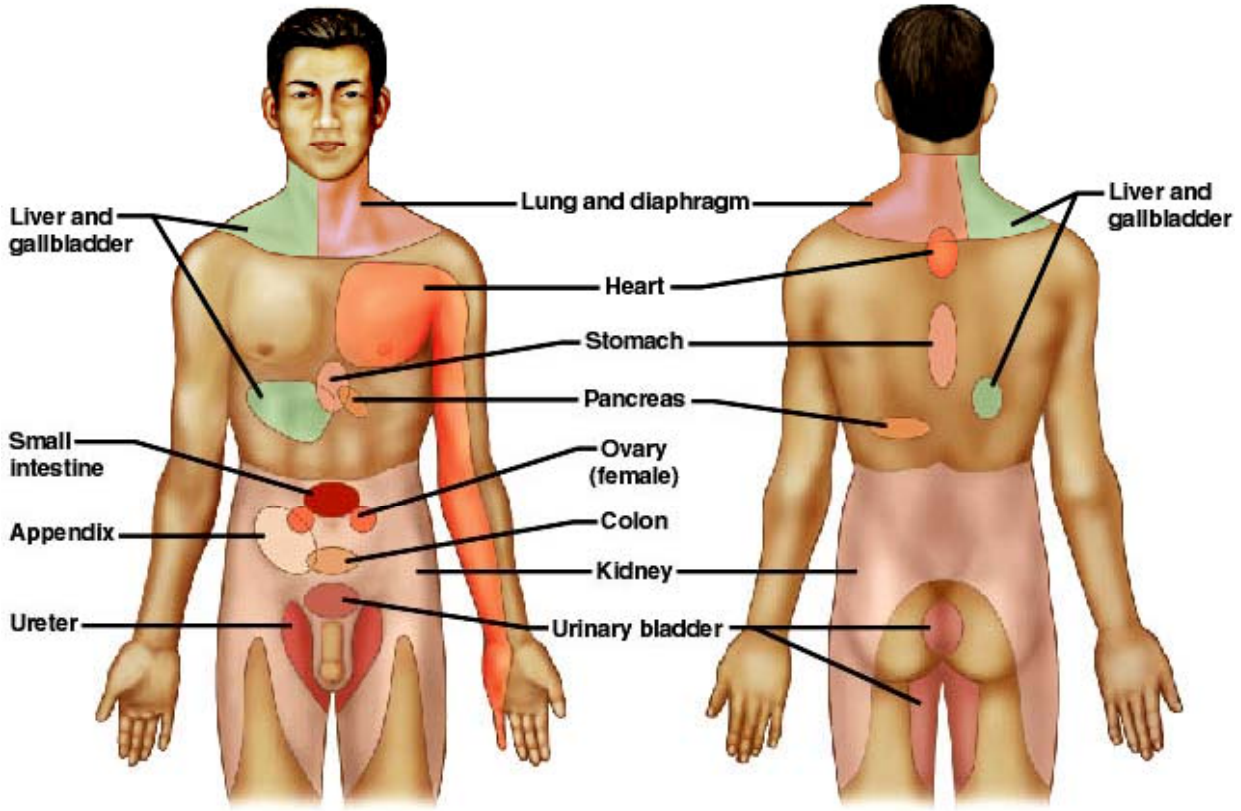
# Visceral Pain

- pain receptors are the only receptors in viscera whose stimulation produces sensations
- pain receptors respond differently to stimulation
- not well localized
- may feel as if coming from some other part of the body
  - known as referred pain

# Referred Pain

• may occur due to sensory impulses from two regions following a common nerve pathway to brain





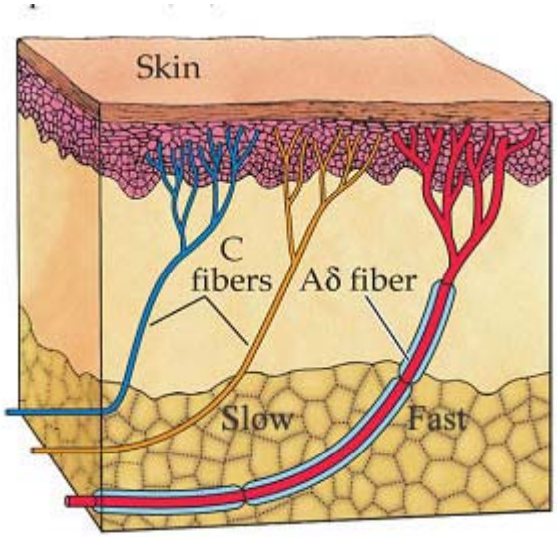
# Pain Nerve Pathways

## Acute pain fibers

- A-delta fibers
- thin, myelinated
- conduct impulses rapidly
- associated with sharp pain
- well localized

## Chronic pain fibers

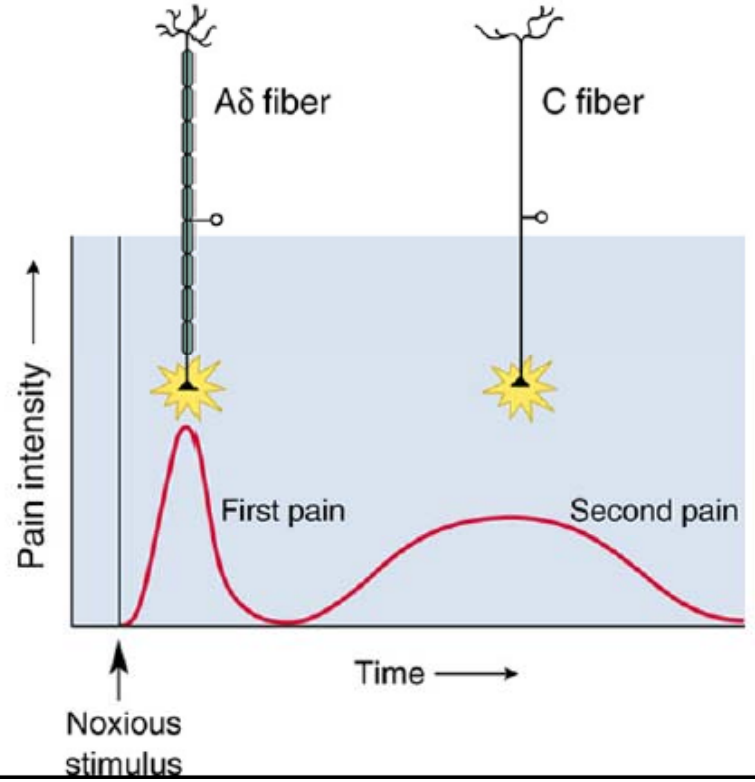
- C fibers
- thin, unmyelinated
- conduct impulses more slowly
- associated with dull, aching pain
- difficult to pinpoint



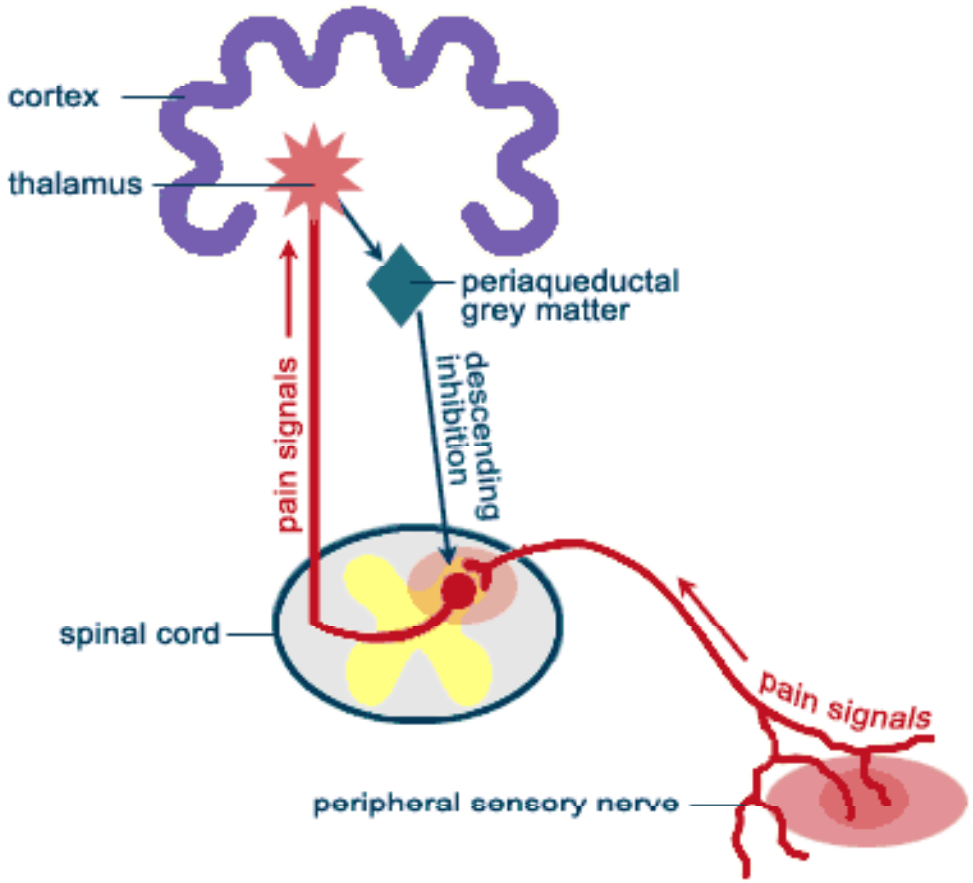

BIOLOGICAL PSYCHOLOGY, Fourth Edition, Figure 8.23 © 2004 Sinauer Associates, Inc.

# Pain

- Primary Afferents
  - First pain and second pain



Neural Pain Pathways




http://www.ccac.ca/en/CCAC_Programs/ETCC/Module10/07.html

# Regulation of Pain Impulses

Thalamus

- allows person to be aware of pain

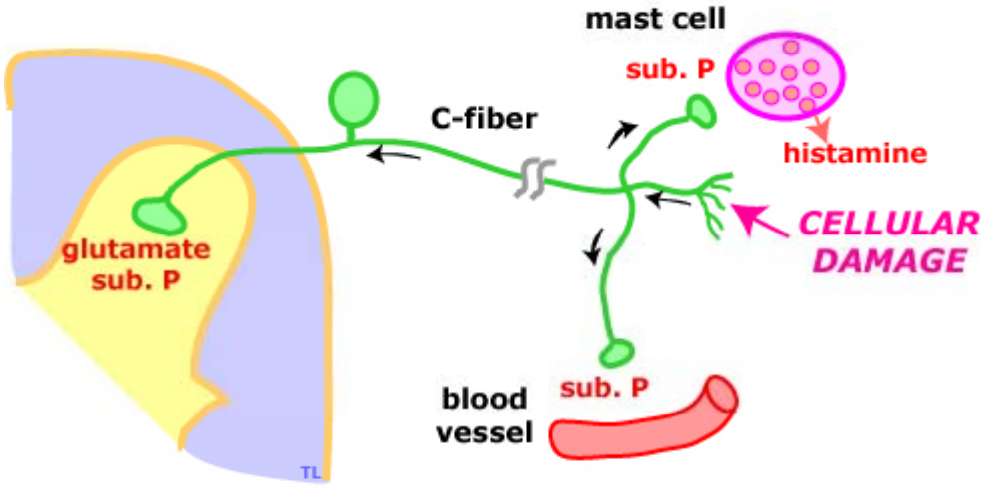
Cerebral Cortex

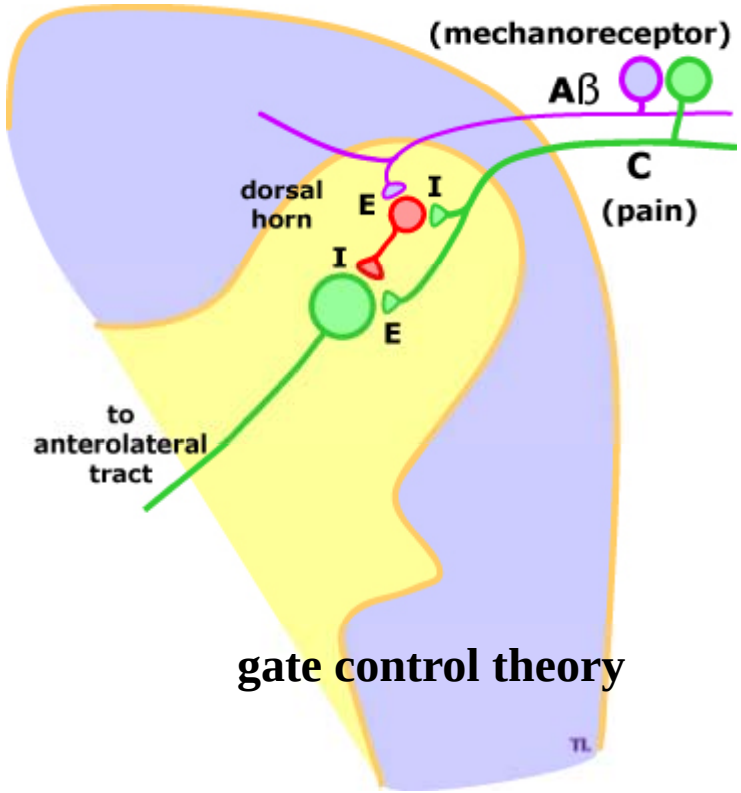
- judges intensity of pain
- locates source of pain
- produces emotional and motor responses to pain

Pain Inhibiting Substances

- enkephalins
- serotonin
- endorphins

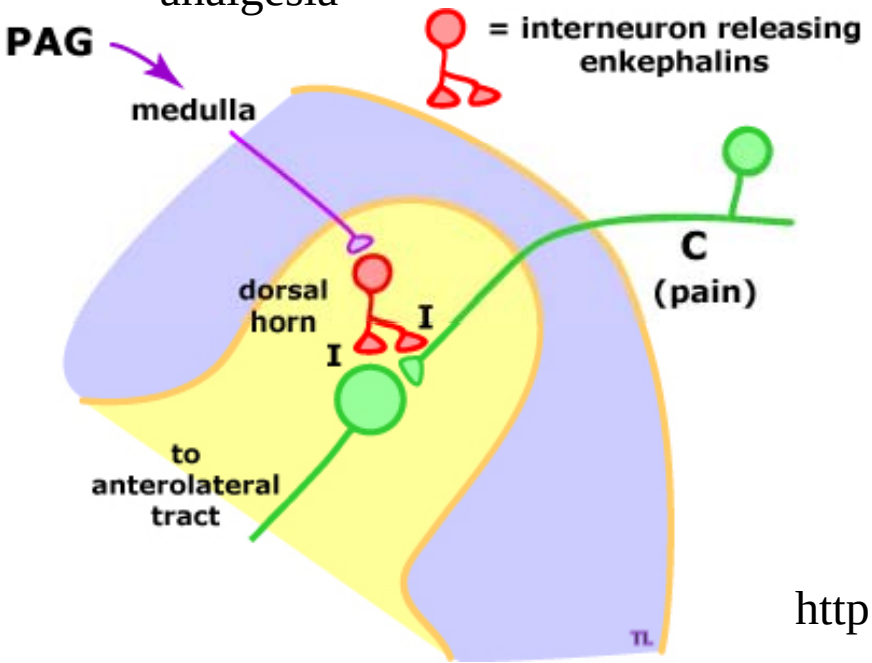
Reduction in the Perception of Pain




**gate control theory**

analgesia

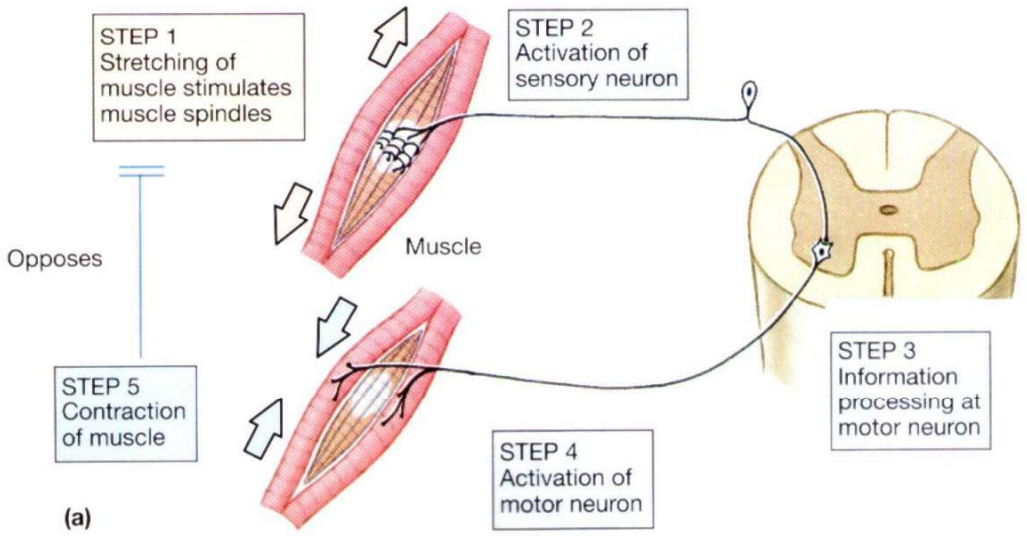



http://courses.washington.edu/conj/sensory/pain.htm

# Proprioceptors

- mechanoreceptors
- send information to spinal cord and CNS about body position and length and tension of muscles
- Main kinds of proprioreceptors
    - Pacinian corpuscles – in joints
    - muscle spindles – in skeletal muscles*
    - Golgi tendon organs – in tendons*

*stretch receptors



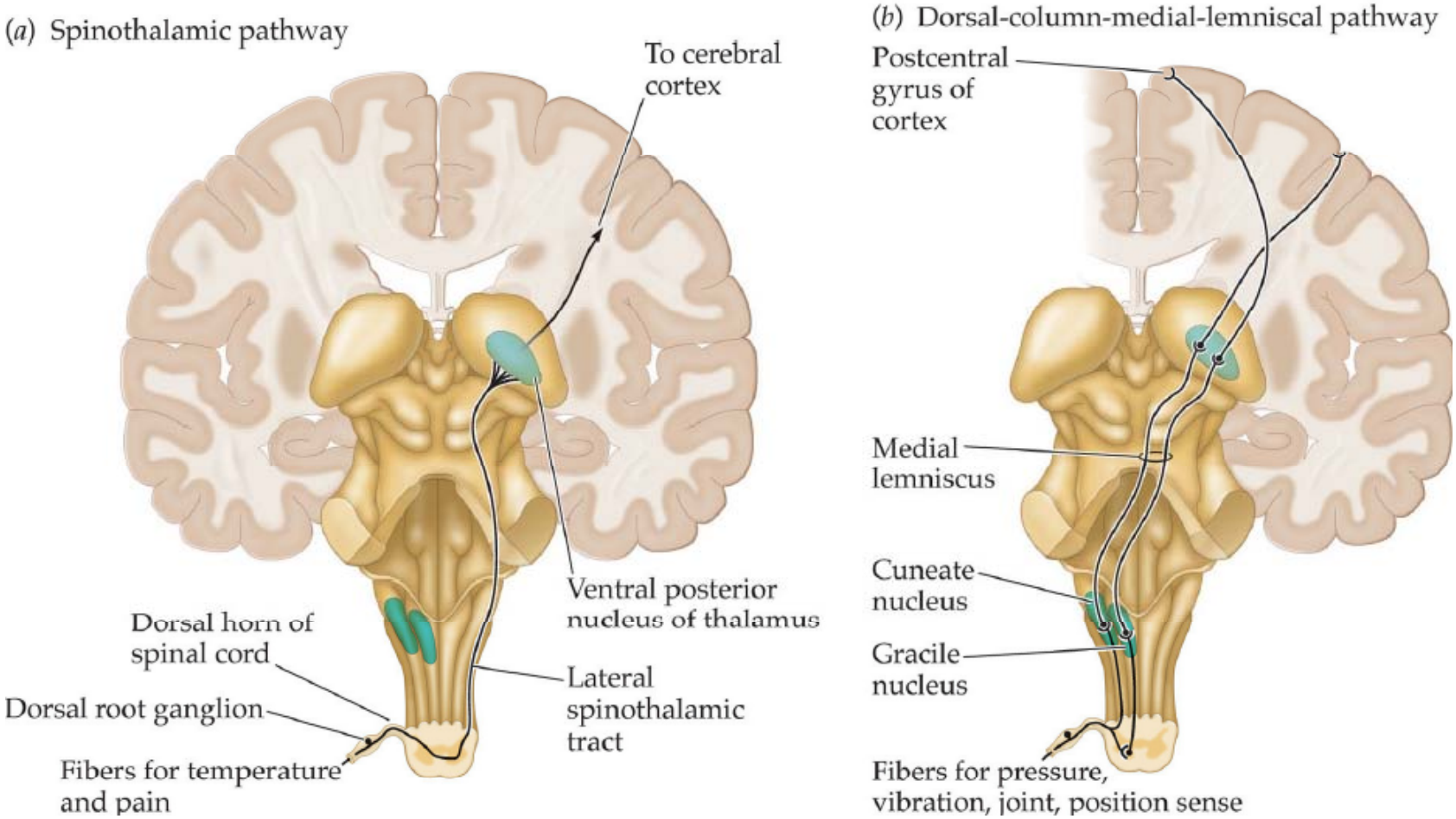
# Summary of Receptors of the General Senses



TABLE 12.2 Receptors Associated with General Senses

| Type | Function | Sensation |
|---|---|---|
| Free nerve endings (mechanoreceptors) | Detect changes in pressure | Touch, pressure |
| Tactile corpuscles (mechanoreceptors) | Detect objects moving over the skin | Touch, texture |
| Lamellated corpuscles (mechanoreceptors) | Detect changes in pressure | Deep pressure, vibrations, fullness in viscera |
| Free nerve endings (thermoreceptors) | Detect changes in temperature | Heat, cold |
| Free nerve endings (pain receptors) | Detect tissue damage | Pain |
| Free nerve endings (mechanoreceptors) | Detect stretching of tissues, tissue spasms | Visceral pain |
| Muscle spindles (mechanoreceptors) | Detect changes in muscle length | None |
| Golgi tendon organs (mechanoreceptors) | Detect changes in muscle tension | None |

# *Pathways from Skin to Cortex*



# *Pathways from Skin to Cortex*