Pain & Acupuncture

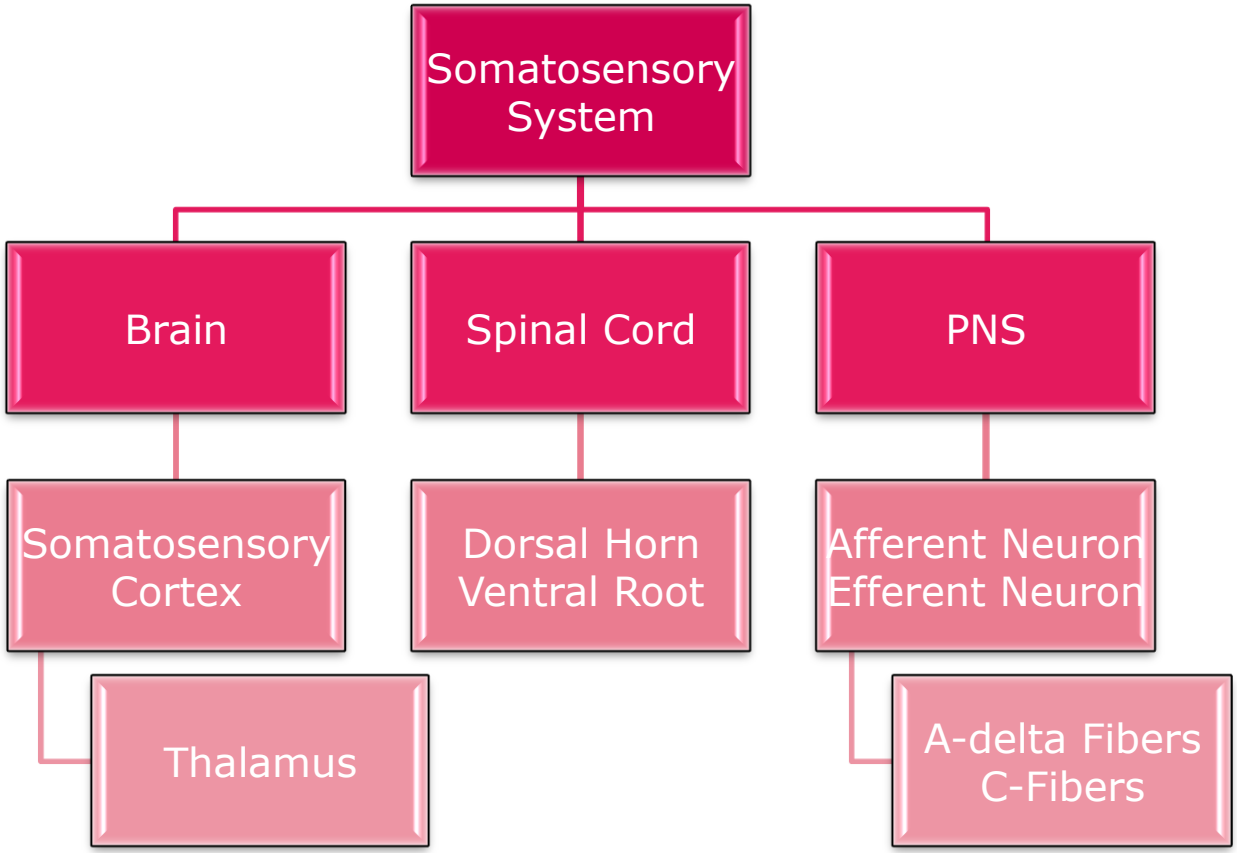
What is Pain?

- **An unpleasant sensory and emotional experience associated with actual or potential tissue damage.**
  - NOCICEPTION（"the neural processes of encoding and processing noxious stimuli.）
  - PAINFUL
  - SUFFERING
  - PAIN BEHAVIOR
- **Pain is always subjective**

What is Pain?

- One of the body's defense mechanisms - warns the brain that its tissues may be in jeopardy
- **May be triggered without any physical damage to tissues.**
- Acute pain is the primary reason people seek medical attention and the major complaint that they describe on initial evaluation
- Chronic pain can be so emotionally and physically debilitating that it is a leading cause of suicide.

The Nervous System and Pain

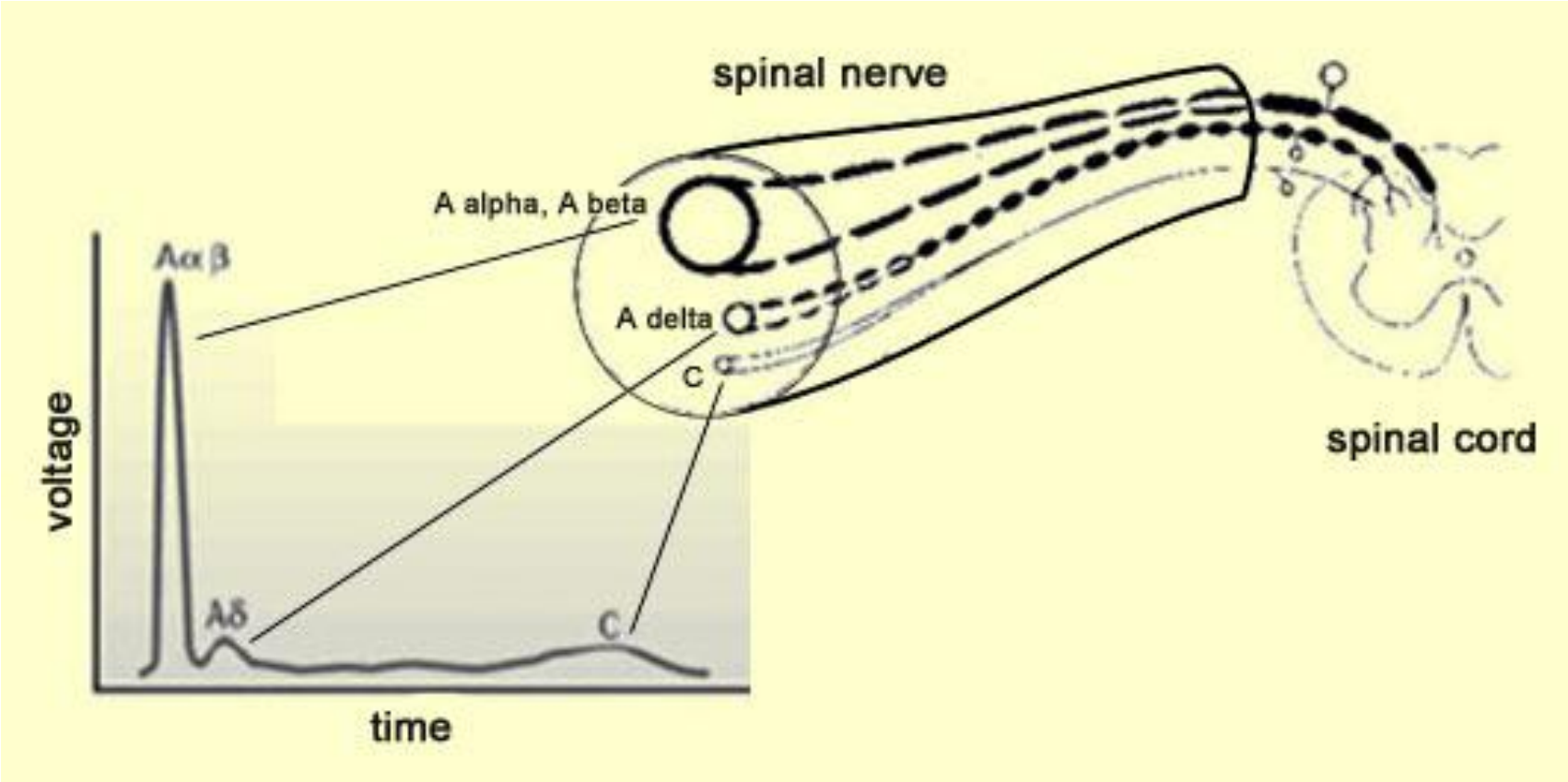


PNS – Nerve Fiber Types

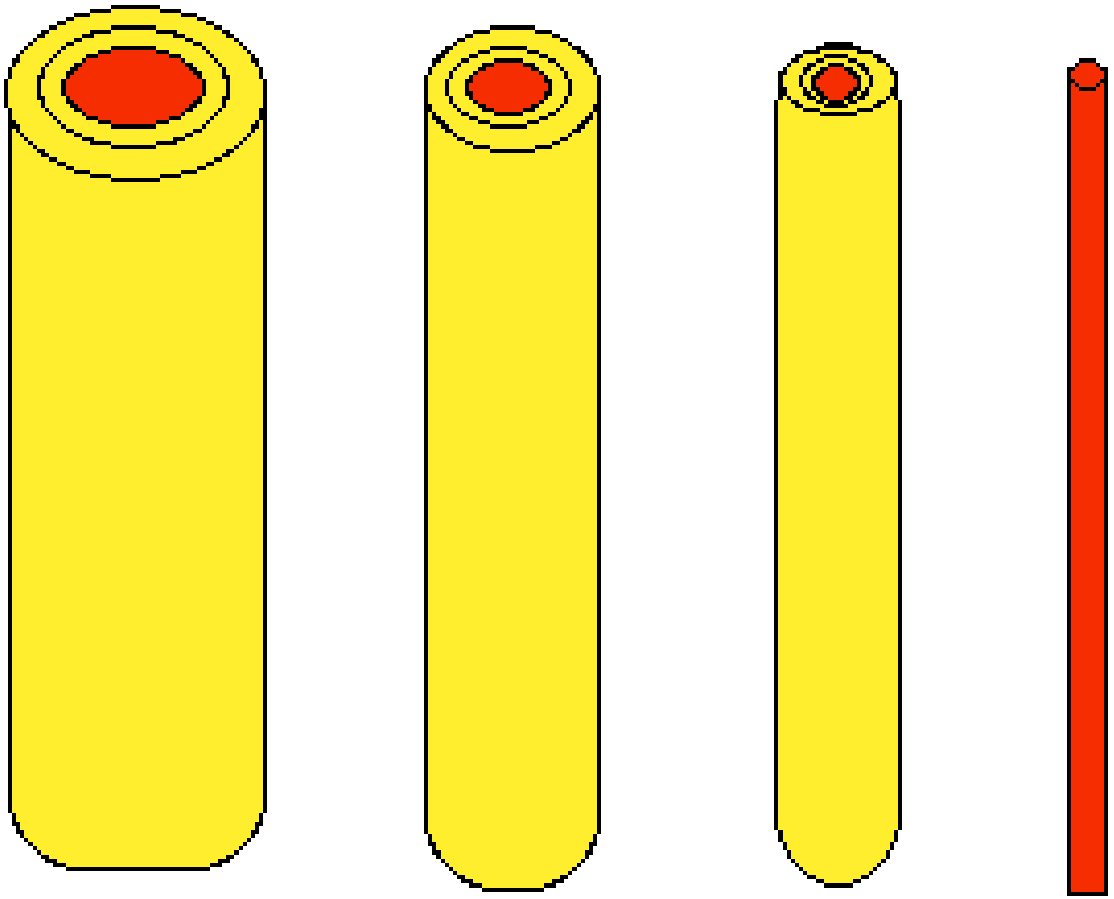
- **Afferent** – Sensory Neurons
  - Three Types Are Important to Understand Pain
    - **A-delta fibers** – smaller, **fast transmitting**, myelinated fibers that **transmit sharp pain**
      - Mechanoreceptors – Triggered by strong mechanical pressure and intense temperature
    - **C-fibers** – smallest, **slow transmitting**, unmyelinated nerve fibers that **transmit dull or aching pain**.
      - Mechanoreceptors – Mechanical & Thermal
      - Chemoreceptors – Triggered by chemicals released during inflammation
    - **A-beta fibers** – large diameter, **fast transmitting**, myelinated sensory fibers

- **Efferent** – Motor neurons

Nerve Fiber Types



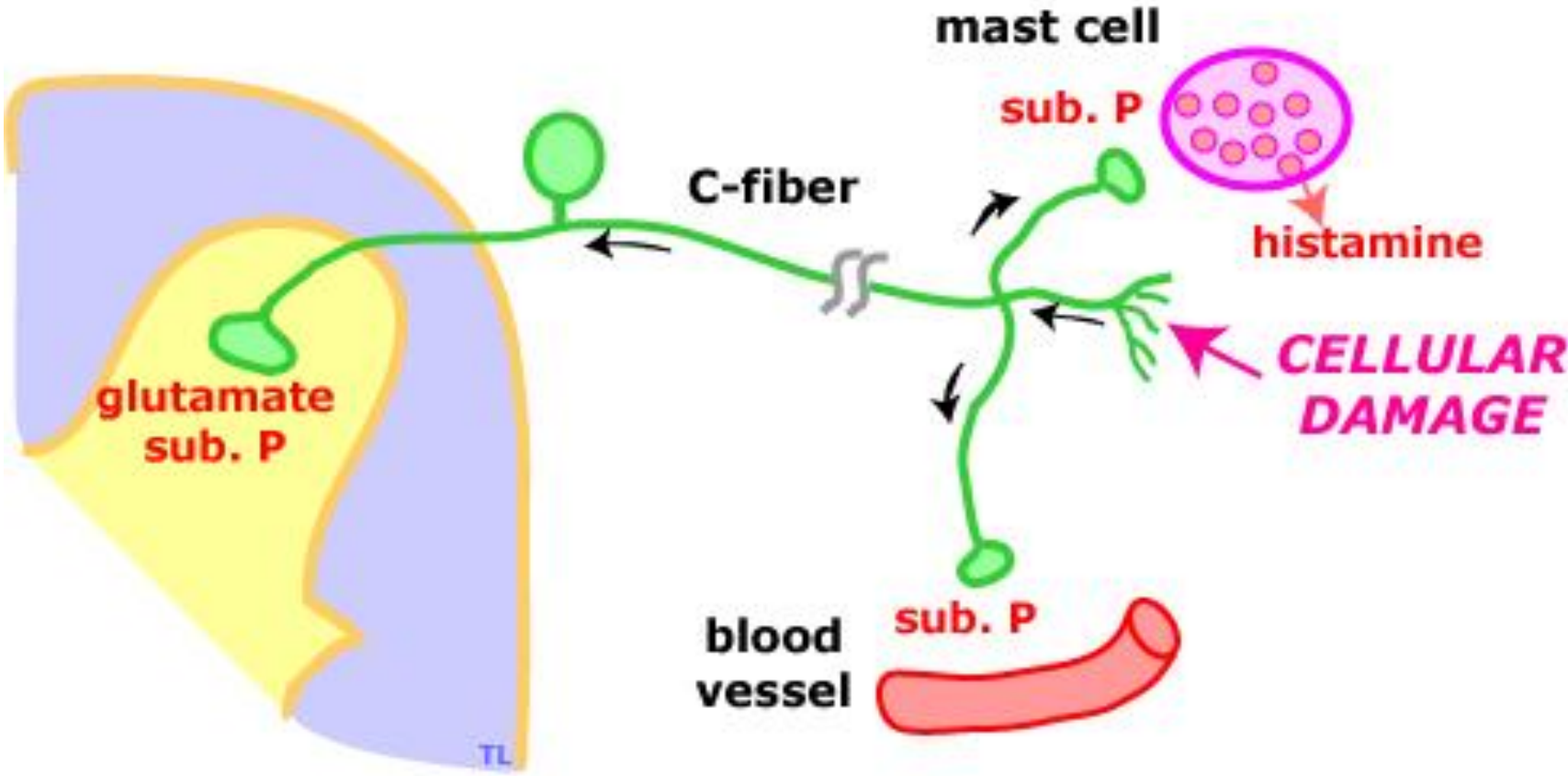
Primary Afferent Axons

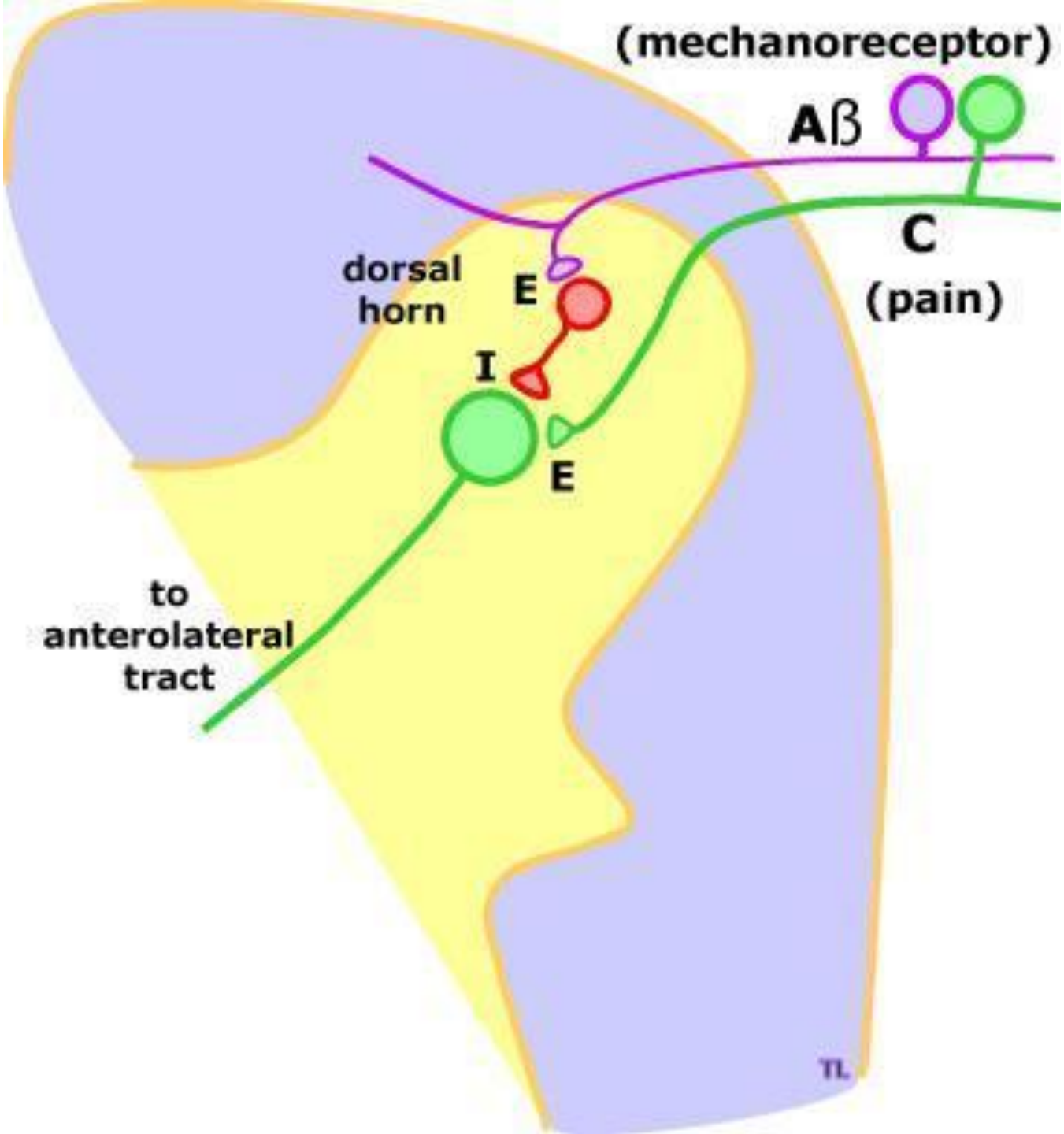


Axon Type	Aα	Aβ	Aδ	C
Diameter (μm)	13-20	6-12	1-5	.2-1.5
Speed (m/s)	80-120	35-75	5-35	.5-2.0

Nerve Fiber Types

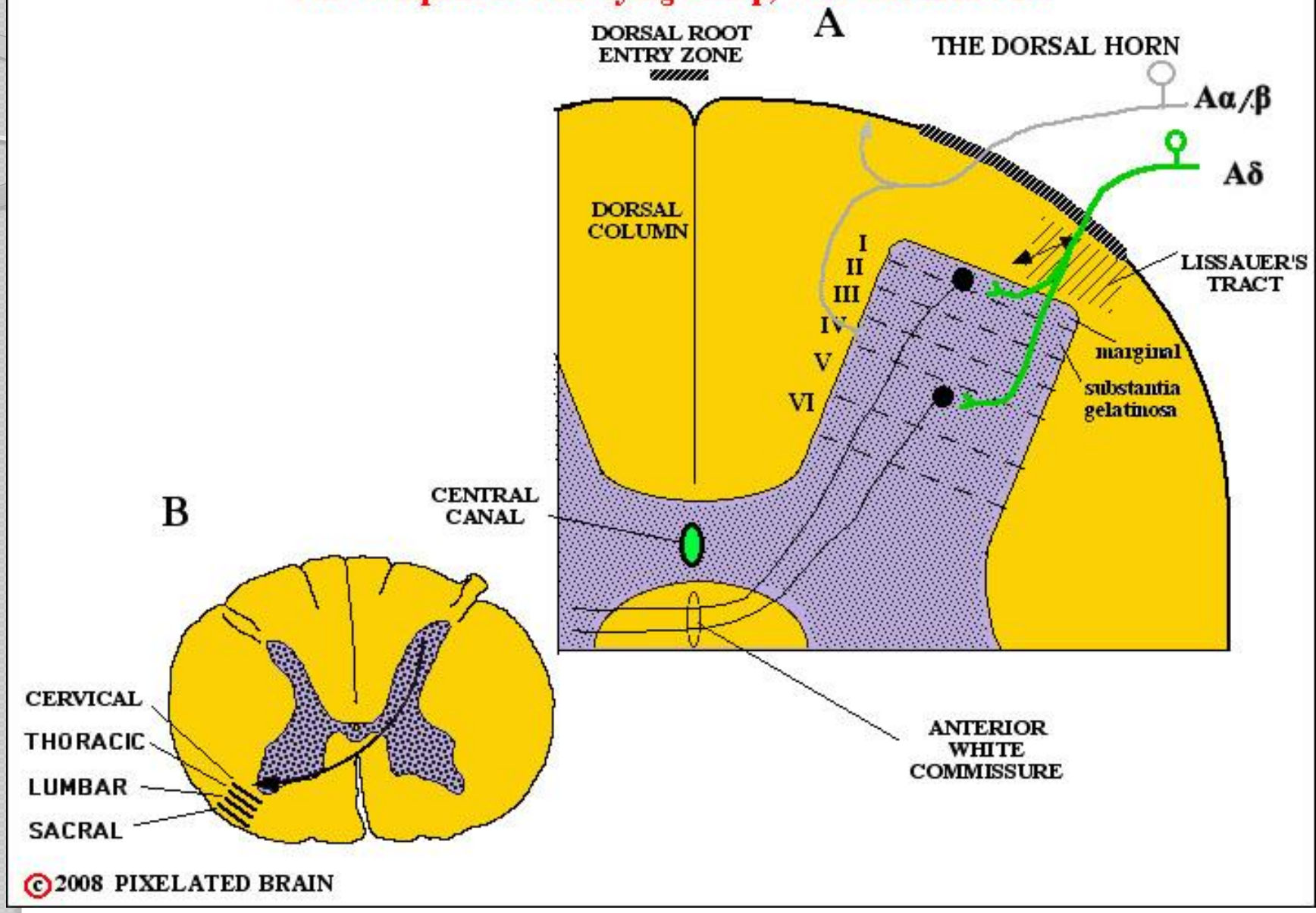
Type of Nerve Fibre	Information Carried	Myelin Sheath?	Diameter (micrometers)	Conduction Speed (m/s)
A-alpha	proprioception	myelinated	13 - 20	80 - 120 
A-beta	touch	myelinated	6 - 12	35 – 90 
A-delta	pain (mechanical and thermal)	myelinated	1 - 5	5 – 40 
C	pain (mechanical, thermal, and chemical)	non-myelinated	0.2 - 1.5	0.5 - 2 

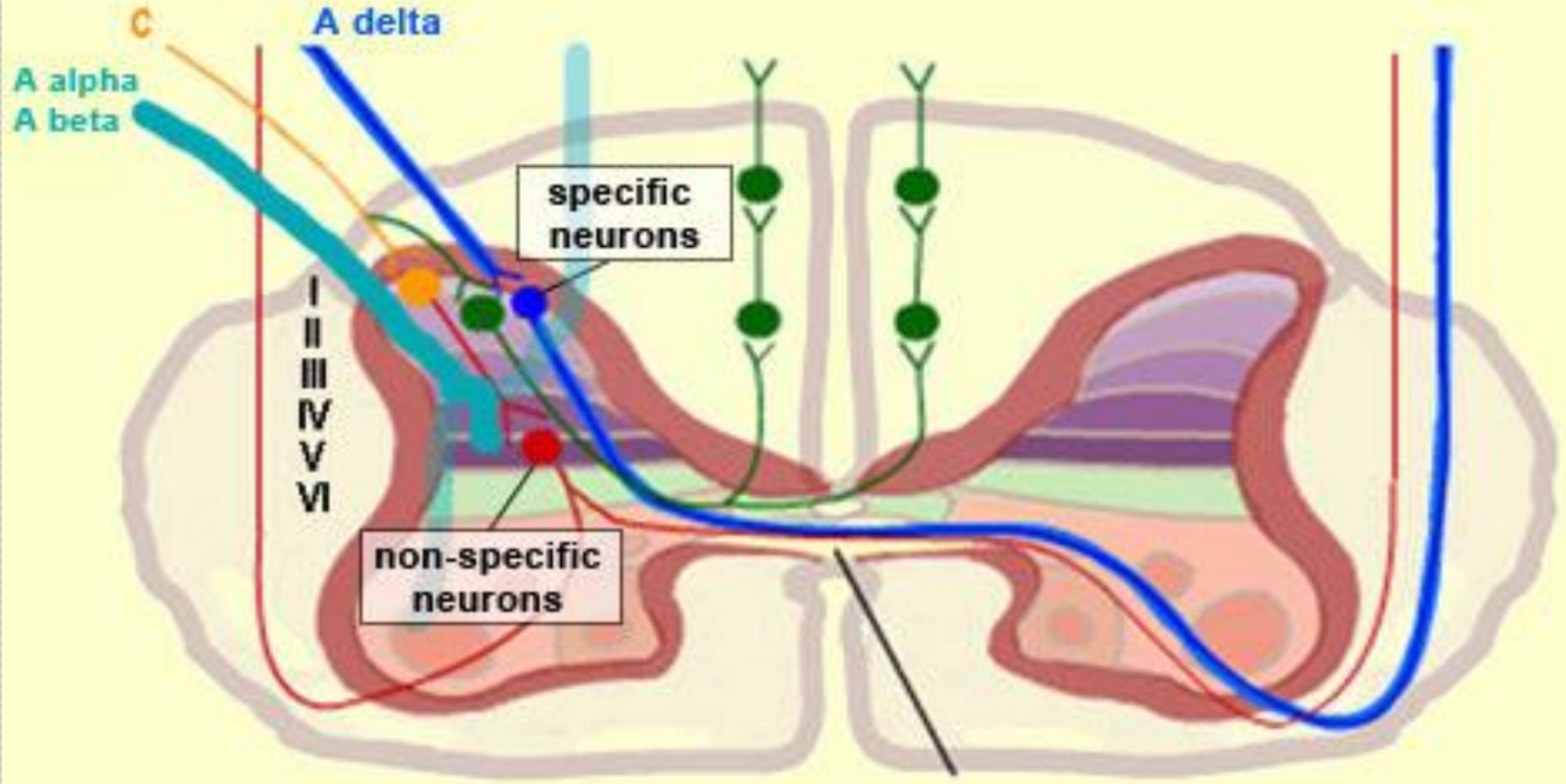

mast cell
sub. P
C-fiber
histamine
CELLULAR
DAMAGE
glutamate
sub. P
blood
vessel
sub. P
TL


(mechanoreceptor)
Aβ
C
(pain)
dorsal
horn
E
I
E
to
anterolateral
tract

THE DIRECT (NEO) SPINOTHALAMIC PATHWAY

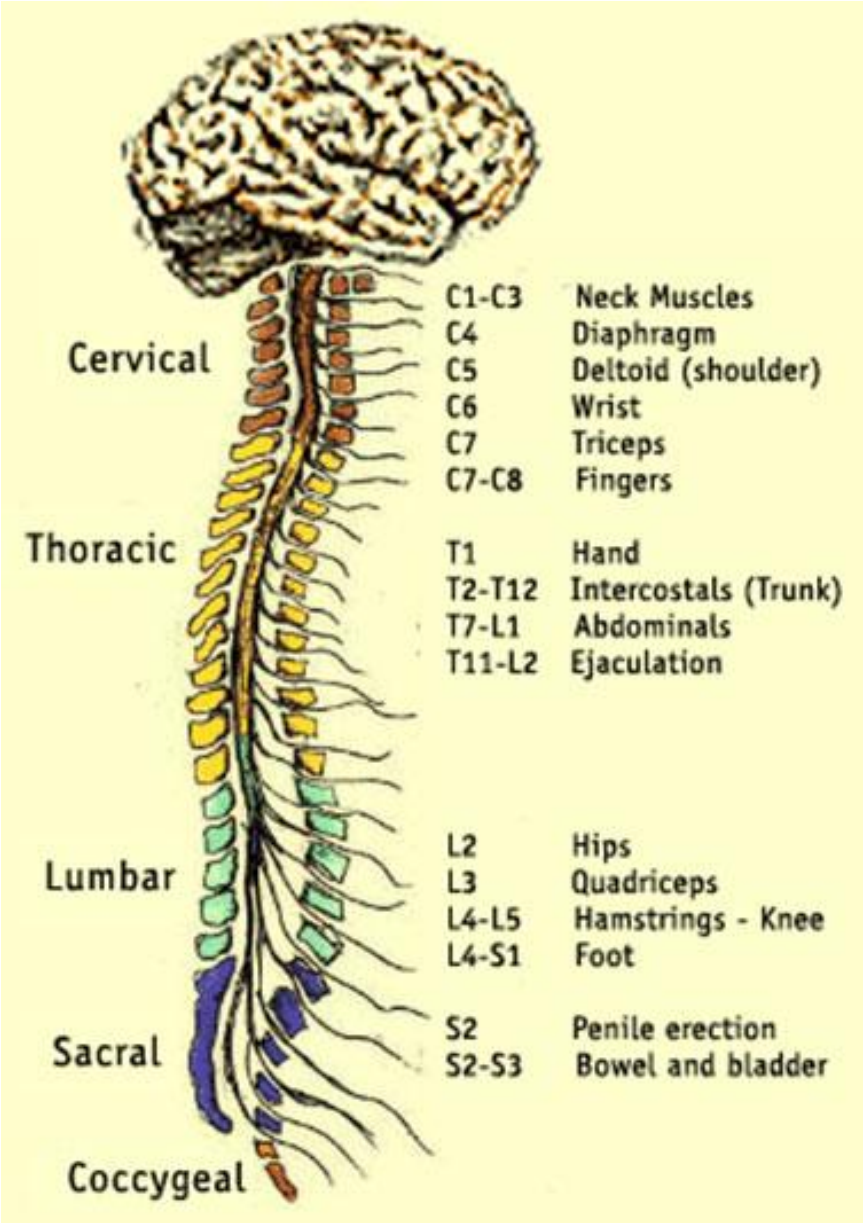
The Component Conveying Sharp, Well-localized Pain




C
A delta
A alpha
A beta
specific neurons
I
II
III
IV
V
VI
non-specific neurons

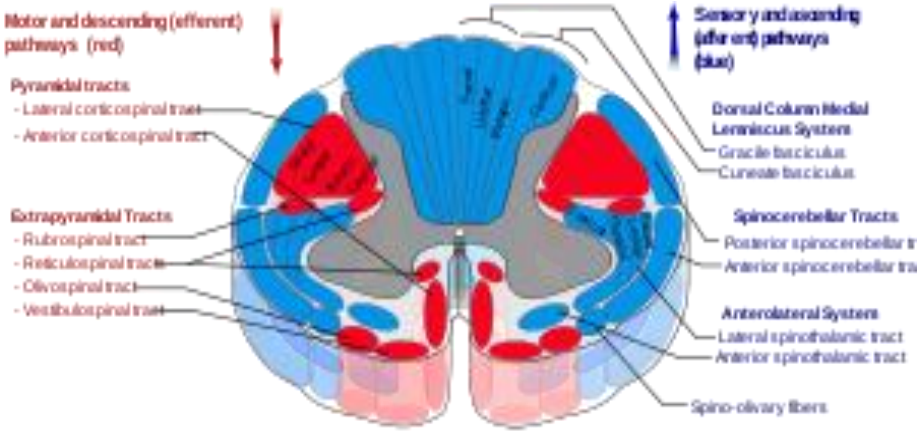
Spinal Cord

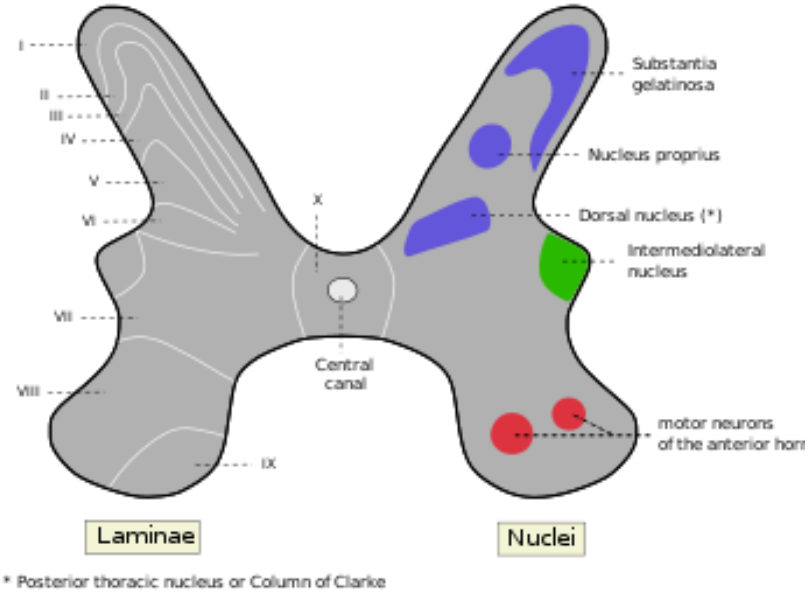
- Multiple ascending and descending tracts of interneurons (connect afferent & efferent)
- Afferent Neurons – Enter to dorsal (back) side
- Efferent Neurons – Exit the ventral (front) side

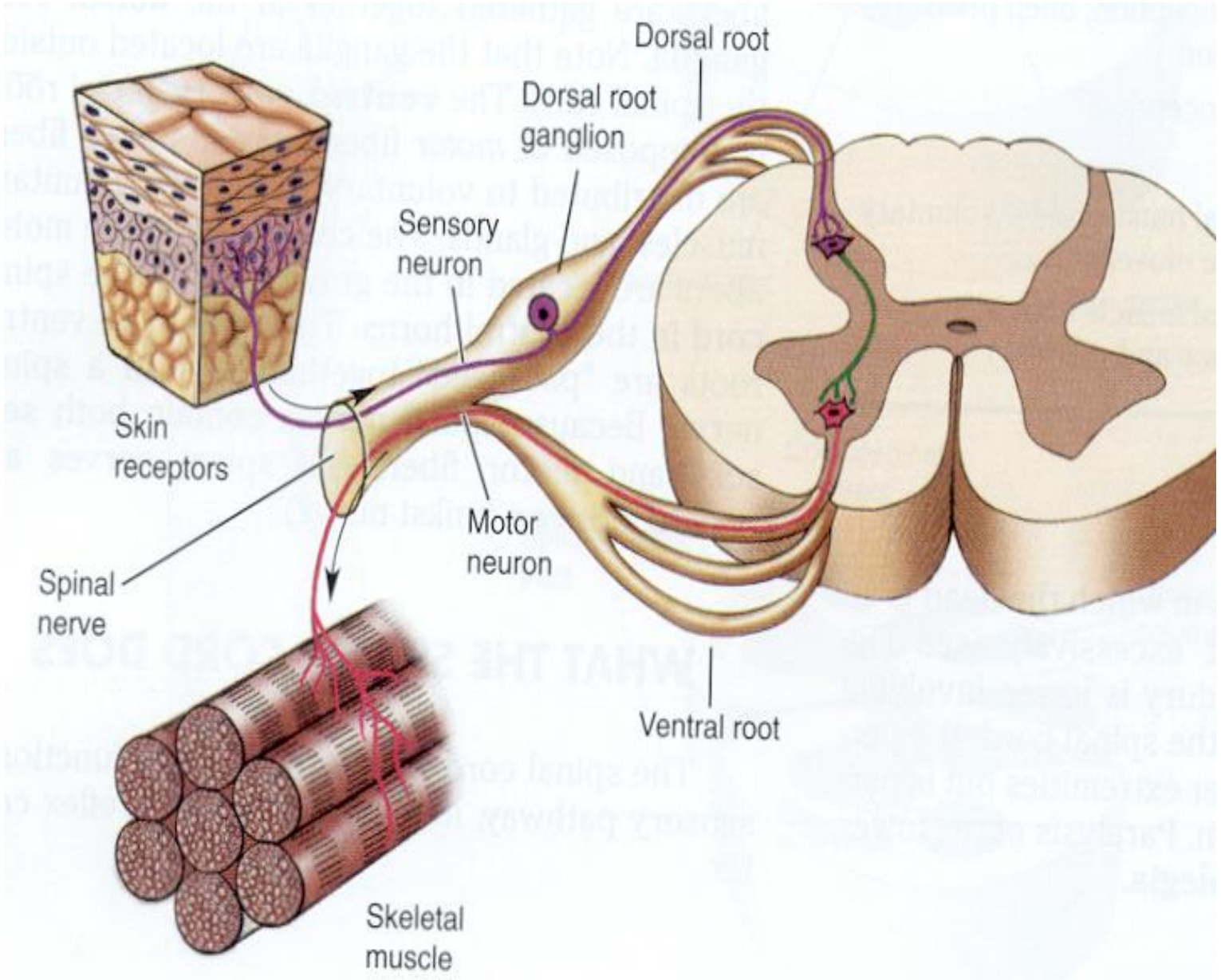


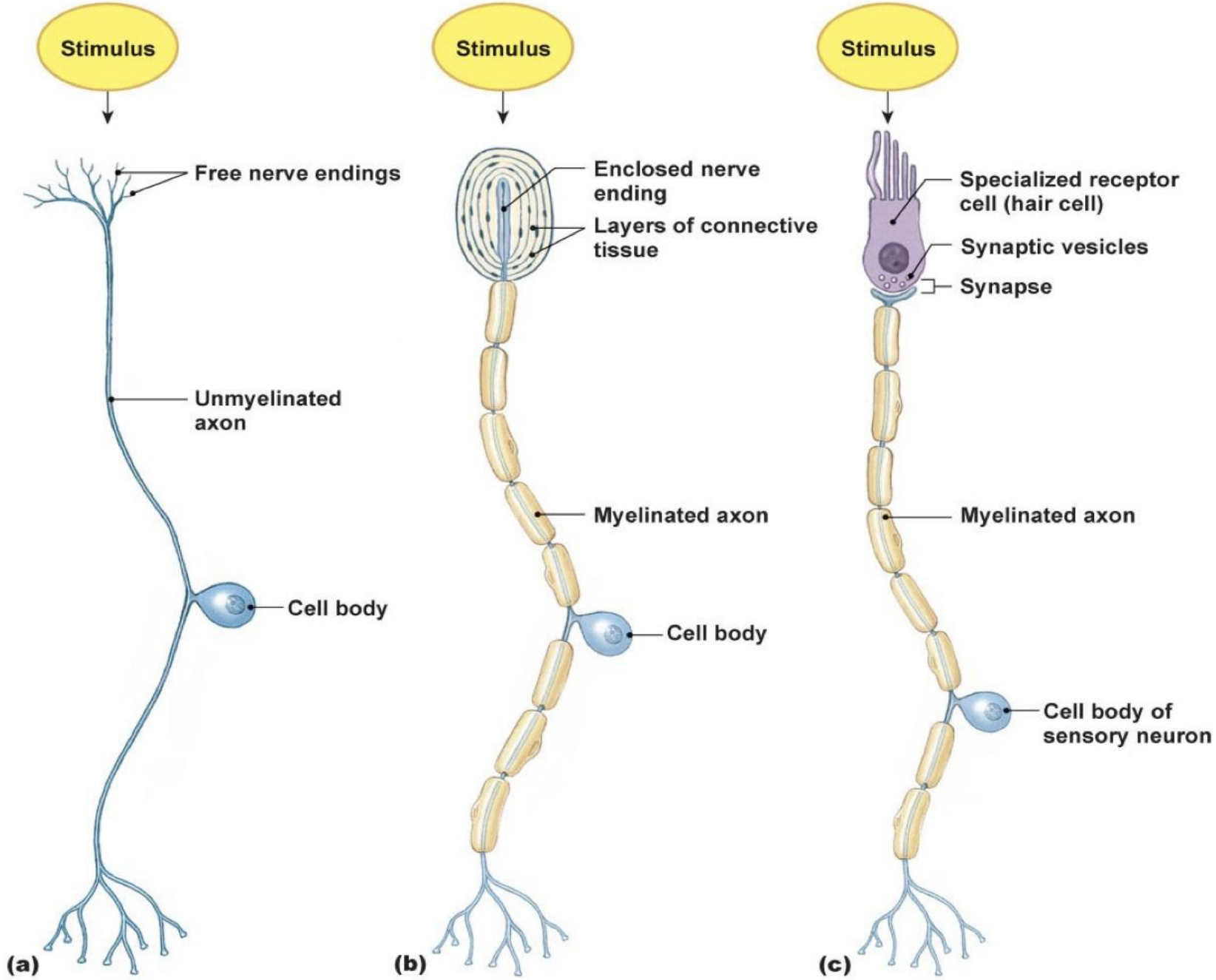
Spinal Cord

- Spinal Layers
  - Spinal grey matters divided into 10 layers
- Substantia Gelatinosa
  - Composed of a layer of cell bodies running up and down the dorsal horns of the spinal cord
  - Receive input from A and C-fibers
  - Activity in SG inhibits pain transmission



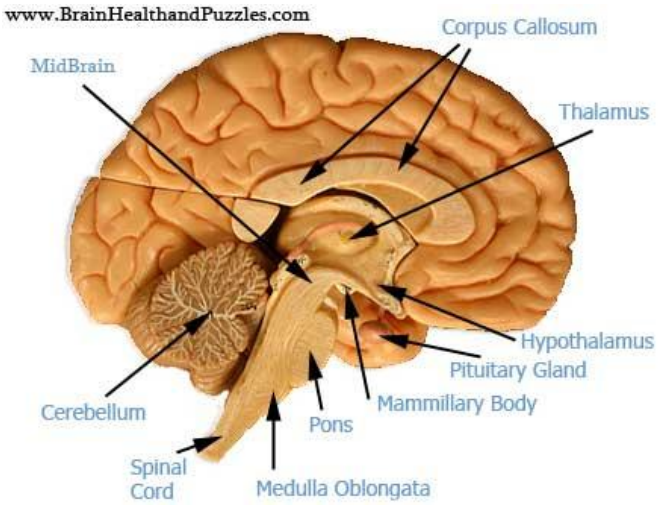



Dorsal root
Dorsal root ganglion
Sensory neuron
Skin receptors
Spinal nerve
Motor neuron
Ventral root
Skeletal muscle

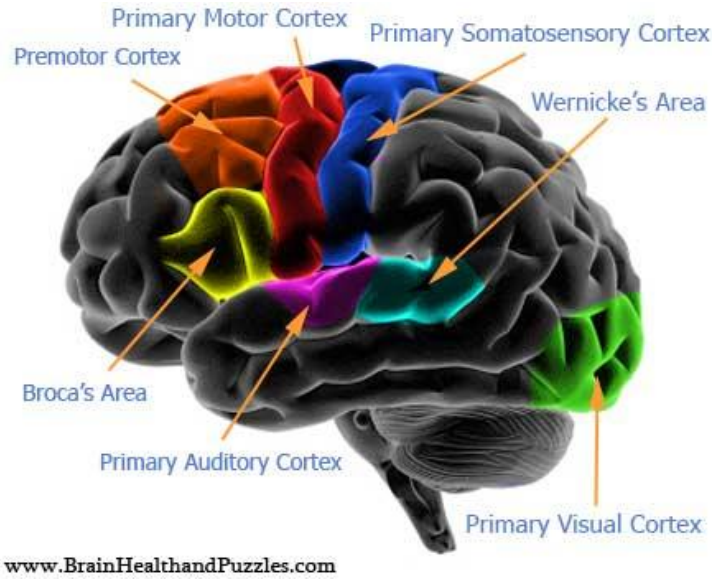


The Brain

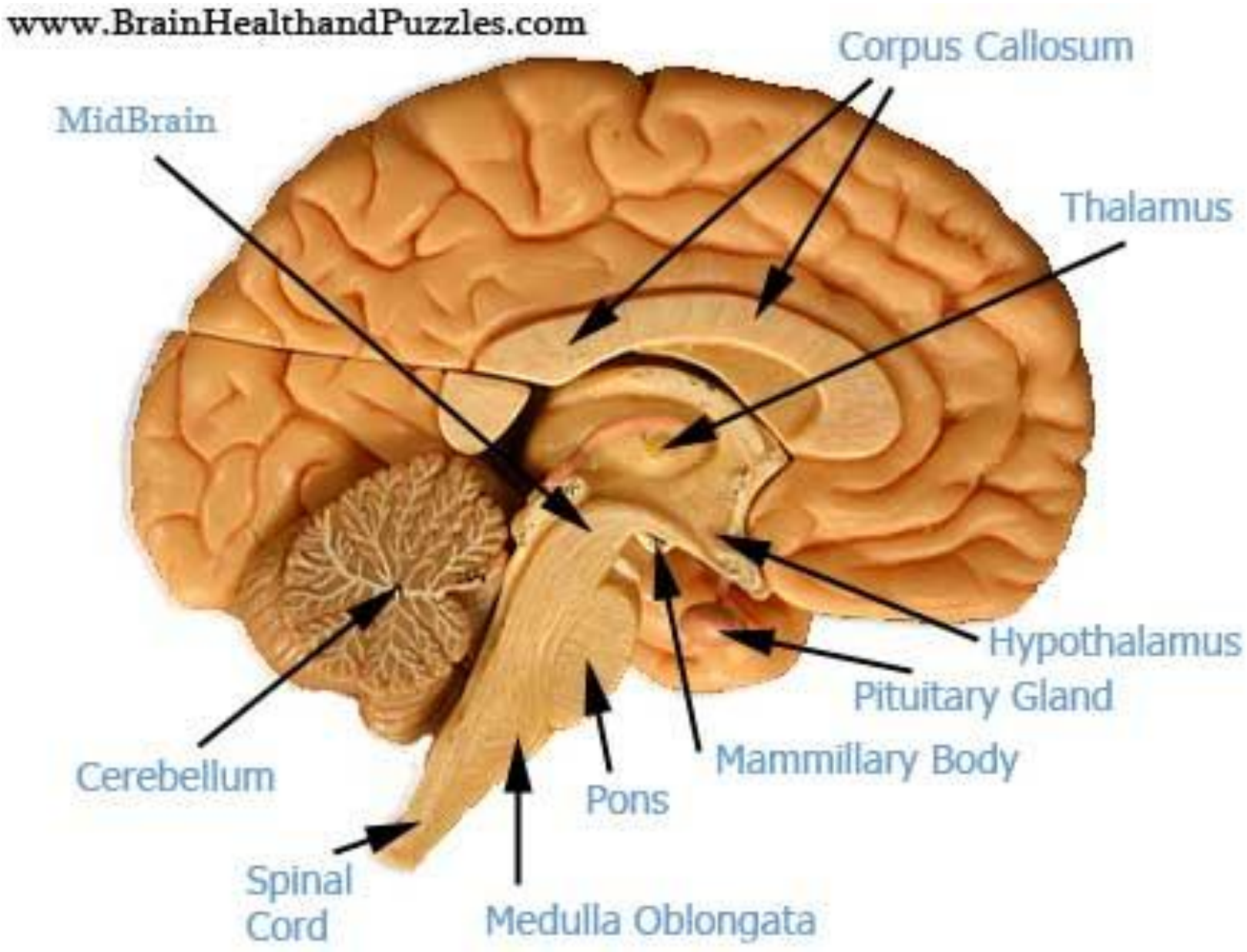
- Thalamus



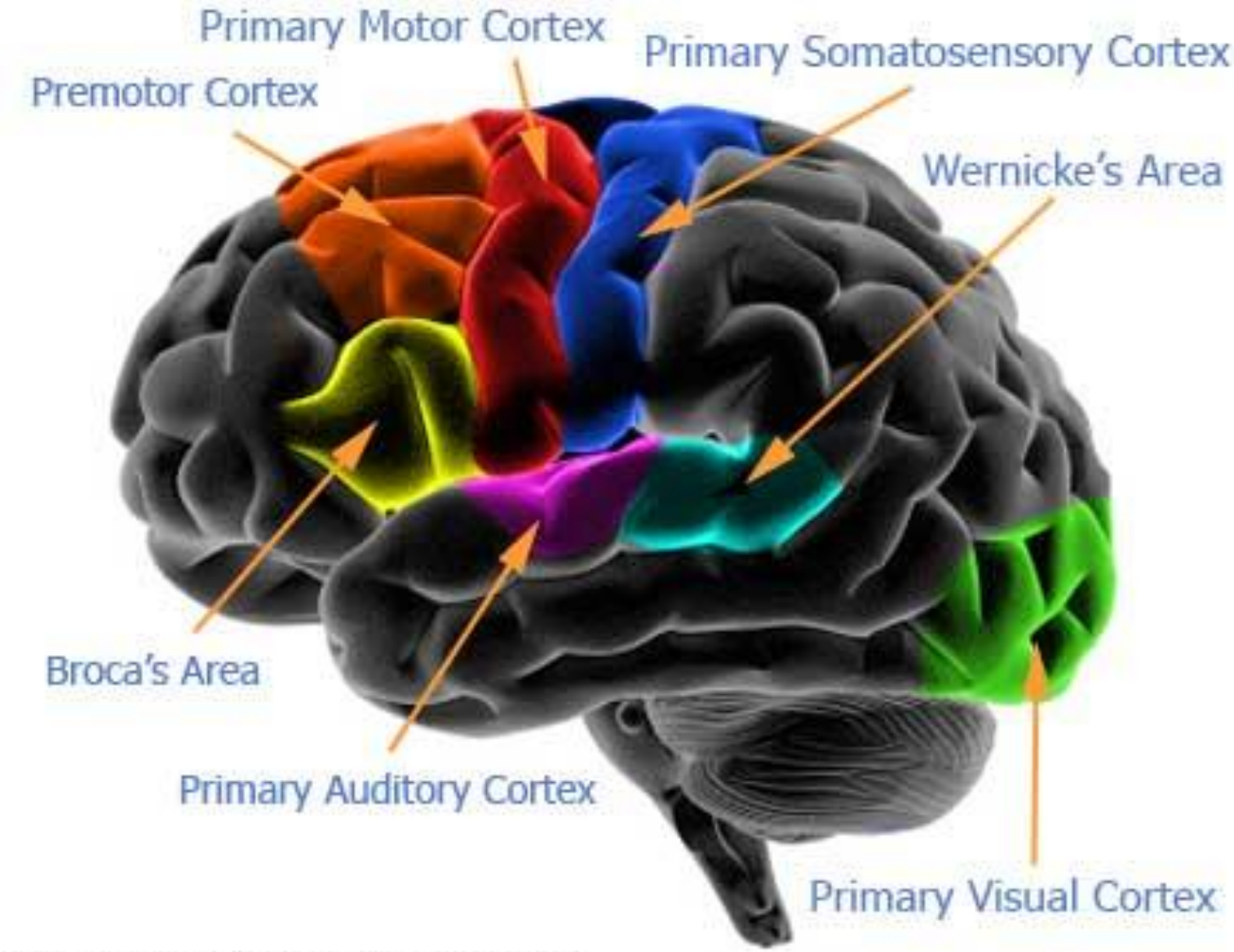
- Somatosensory Cortex



Thalamus


www.BrainHealthandPuzzles.com
Corpus Callosum
MidBrain
Thalamus
Hypothalamus
Pituitary Gland
Mammillary Body
Cerebellum
Pons
Spinal Cord
Medulla Oblongata

Somatosensory Cortex



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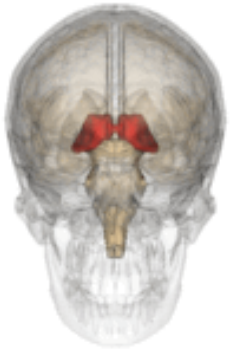
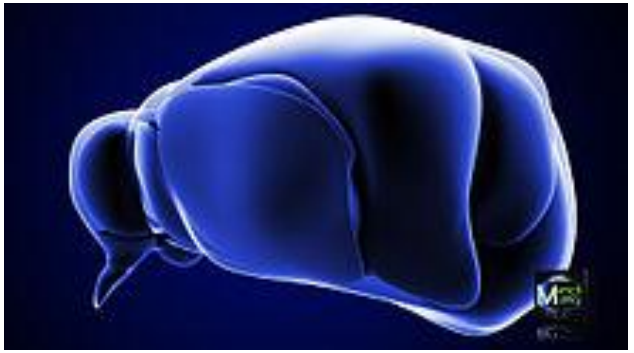
Thalamus

- The sensory switchboard of the brain



- Located in the middle of the brain

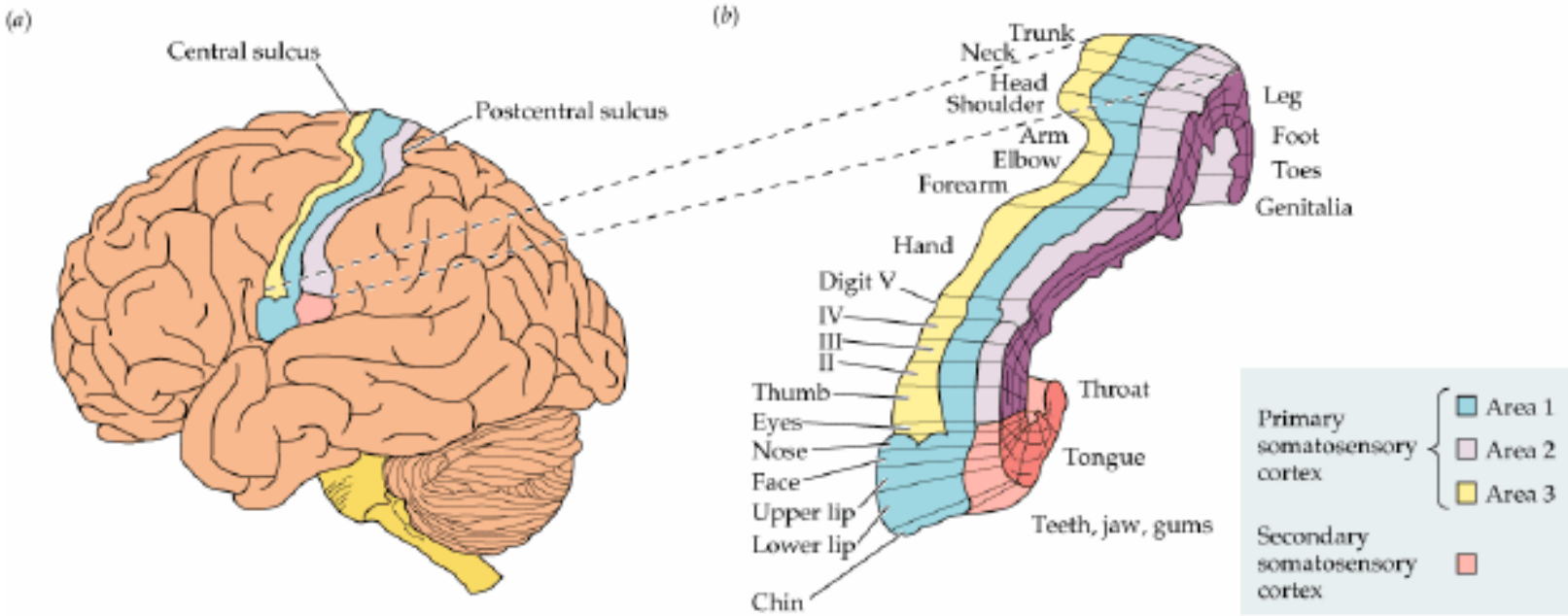


Somatosensory Cortex

•Area of cerebral cortex located in the parietal lobe right behind the frontal lobe

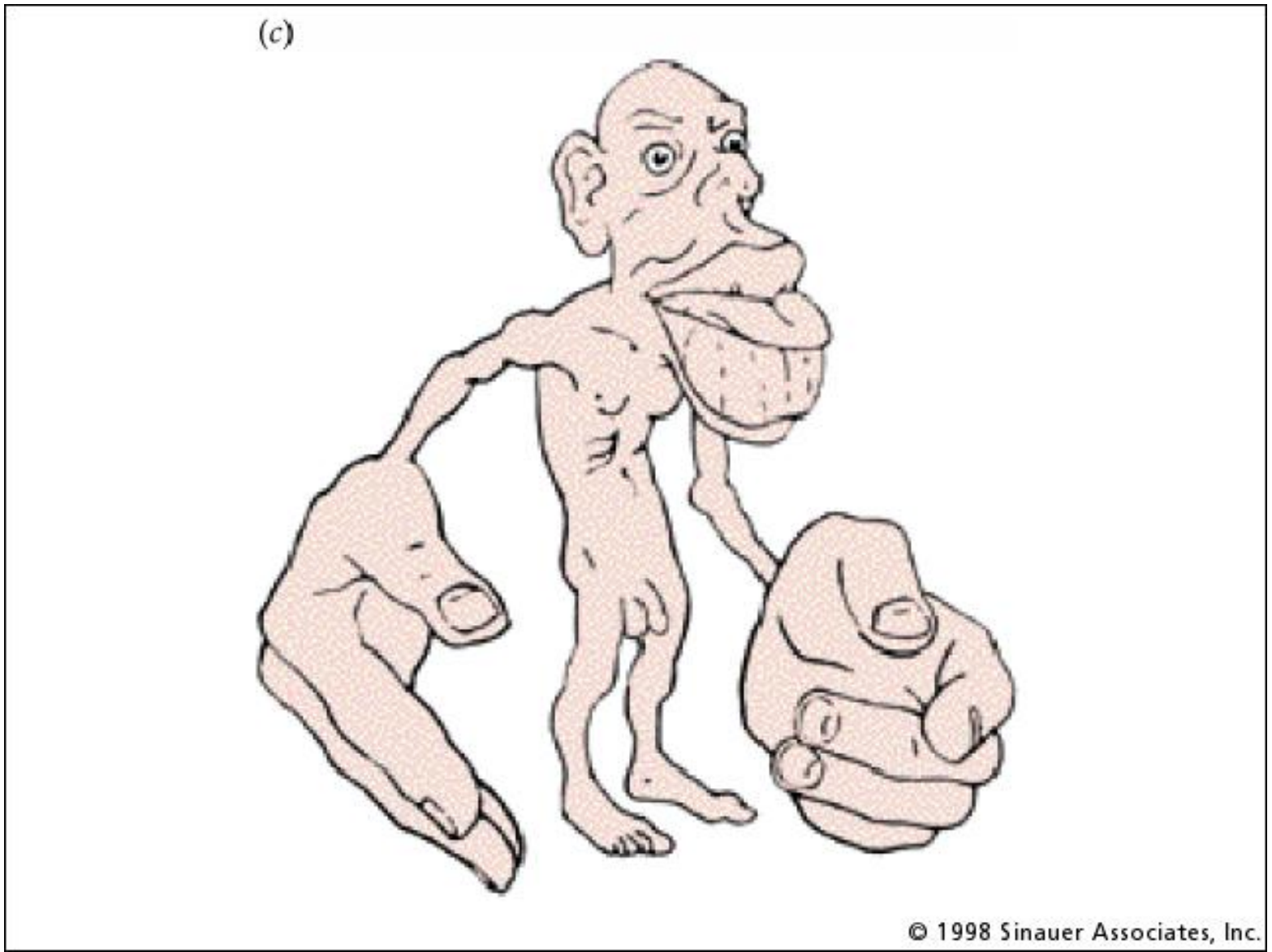
•Receives all info on touch and pain.

Somatosensory Cortex



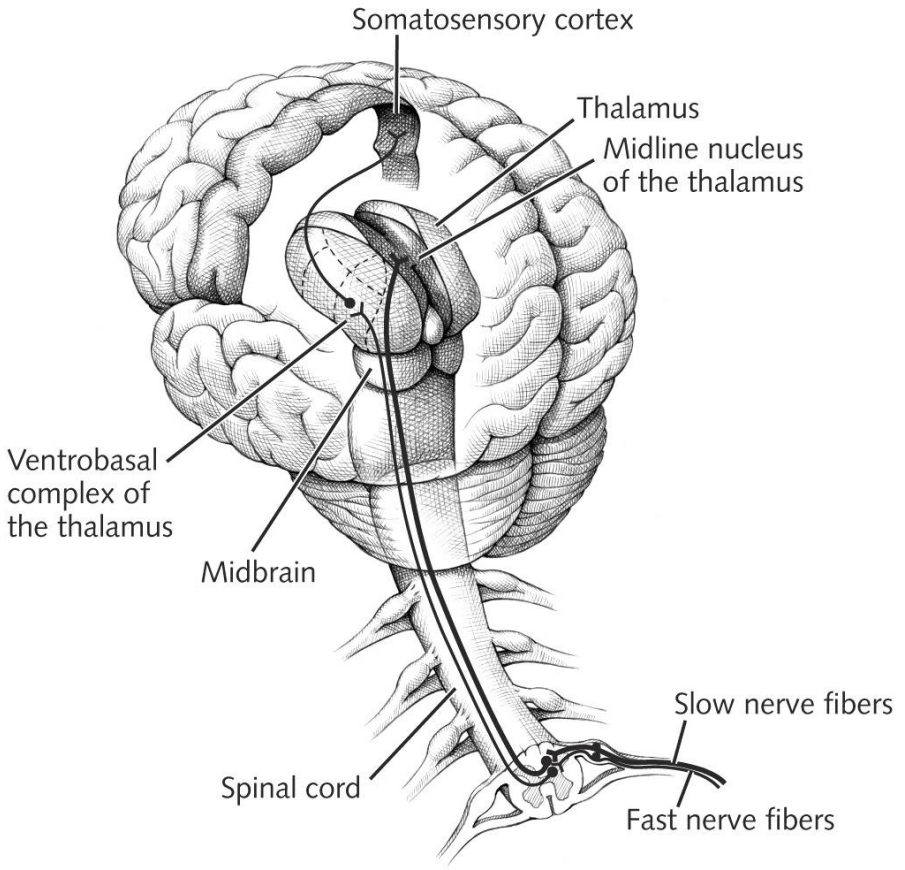
Somatosensory Cortex

•Somatotopically organized



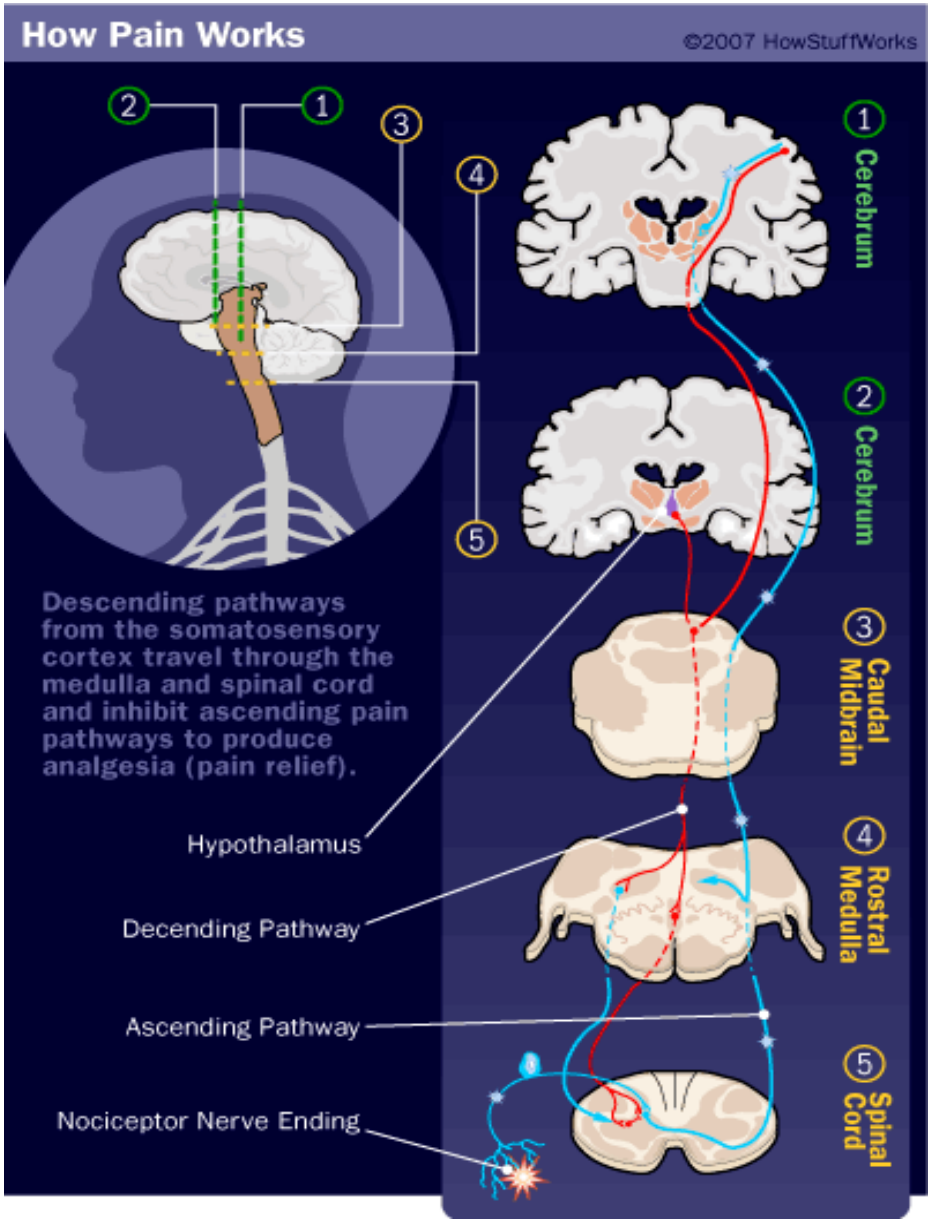
Pain Pathways – Going Up

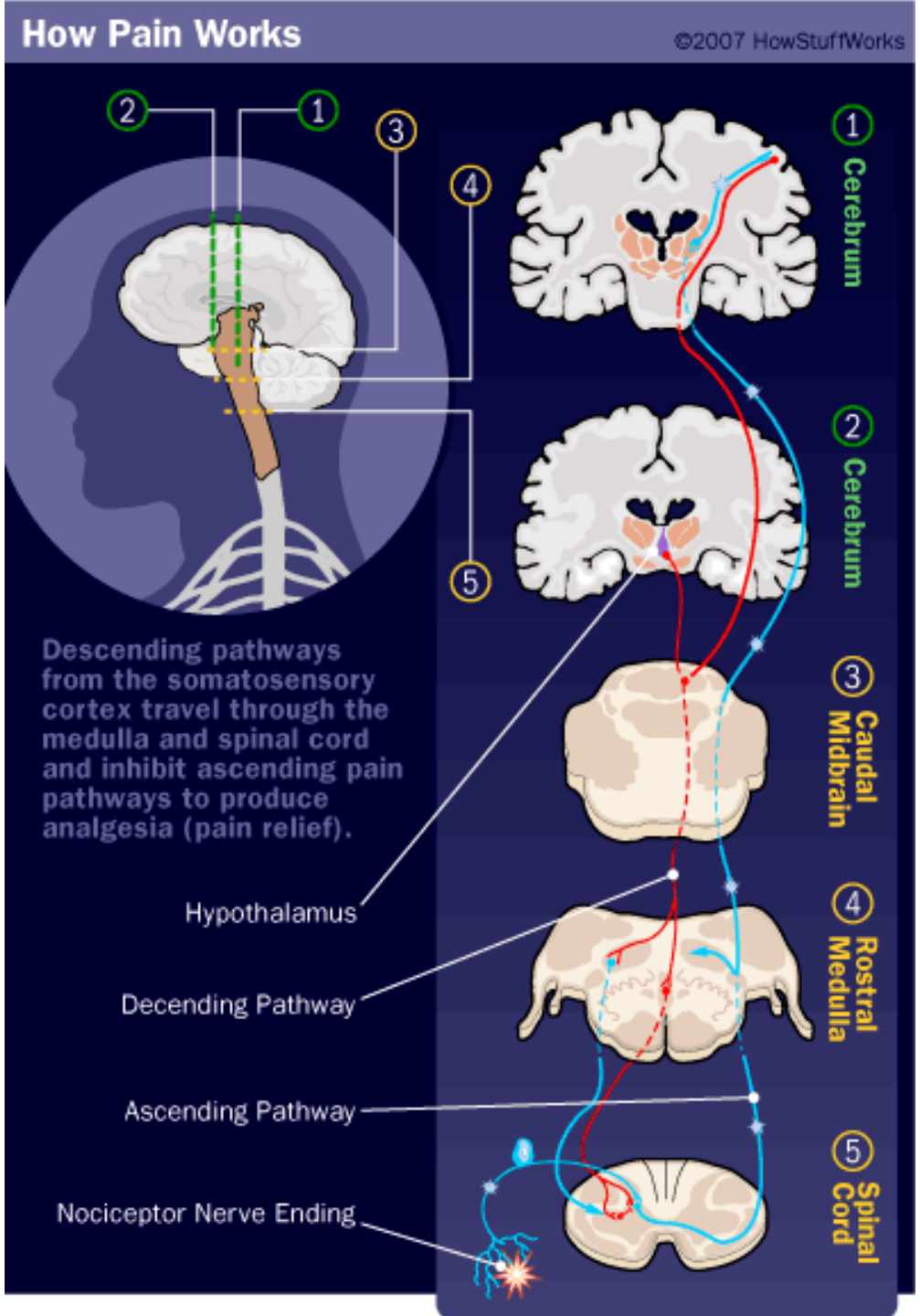
- Pain information travels up the spinal cord through the spino-thalamic track (2 parts)
  - PSTT
    - Immediate warning of the presence, location, and intensity of an injury
  - NSTT
    - Slow, aching reminder that tissue damage has occurred



Pain Pathways – Going Down

- Descending pain pathway responsible for pain inhibition




How Pain Works
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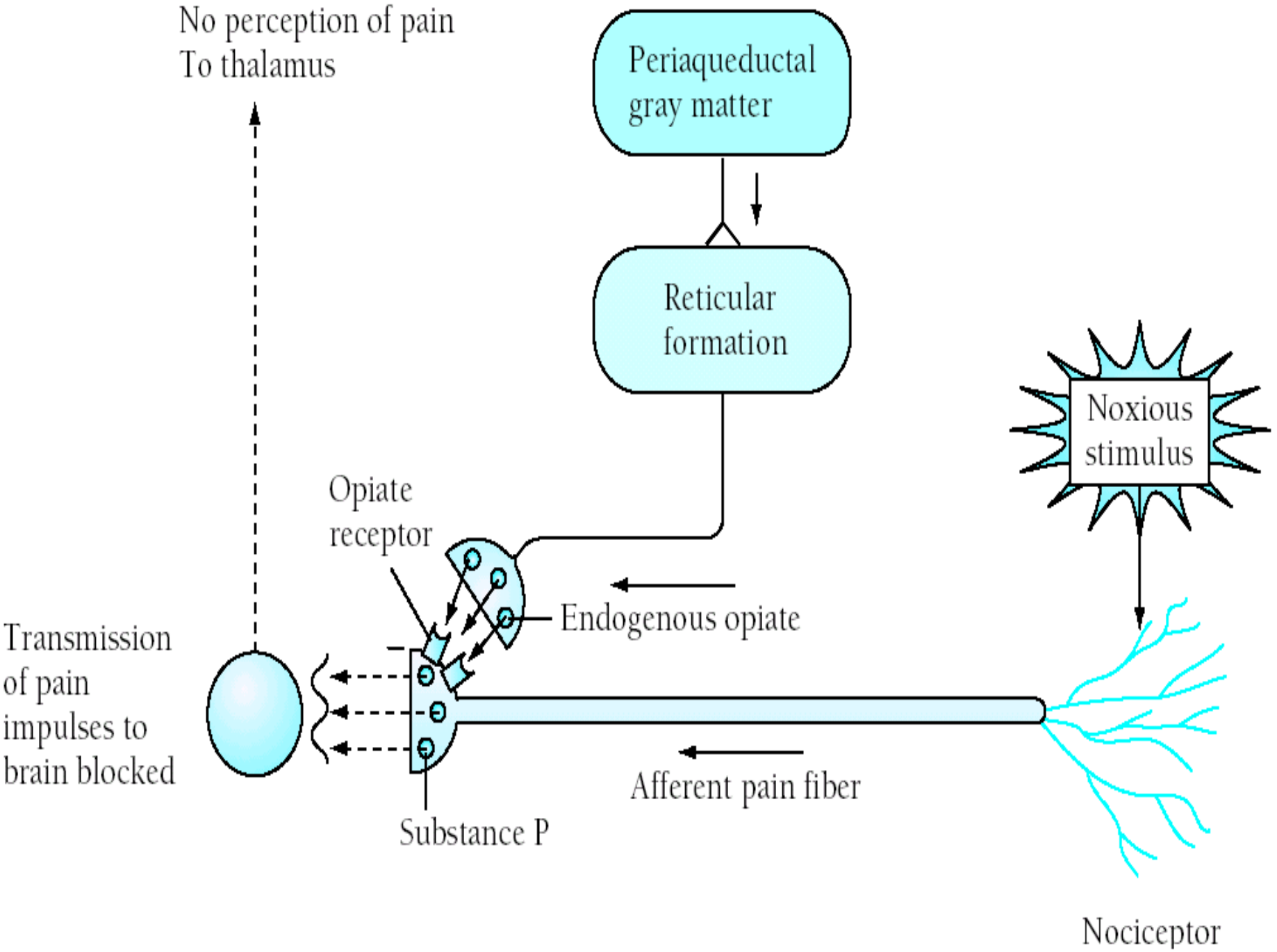
2
1
3
4
5
Descending pathways from the somatosensory cortex travel through the medulla and spinal cord and inhibit ascending pain pathways to produce analgesia (pain relief).
1 Cerebrum
2 Cerebrum
3 Caudal Midbrain
4 Rostral Medulla
5 Spinal Cord
Hypothalamus
Decending Pathway
Ascending Pathway
Nociceptor Nerve Ending

The Neurochemicals of Pain

- Pain Initiators
  - Glutamate - Central
  - Substance P - Central
  - Brandykinin - Peripheral
  - Prostaglandins - Peripheral
- Pain Inhibitors
  - Serotonin
  - Endorphins
  - Enkephalins
  - Dynorphin


No perception of pain
To thalamus
Periaqueductal gray matter
Reticular formation
Noxious stimulus
Opiate receptor
Endogenous opiate
Transmission of pain impulses to brain blocked
Afferent pain fiber
Substance P
Nociceptor

Theories of Pain

- Specificity Theory
  - Began with Aristotle
  - Pain is hardwired
    - Specific "pain" fibers bring info to a "pain center"
  - Refuted in 1965

- **Gate Control Theory**

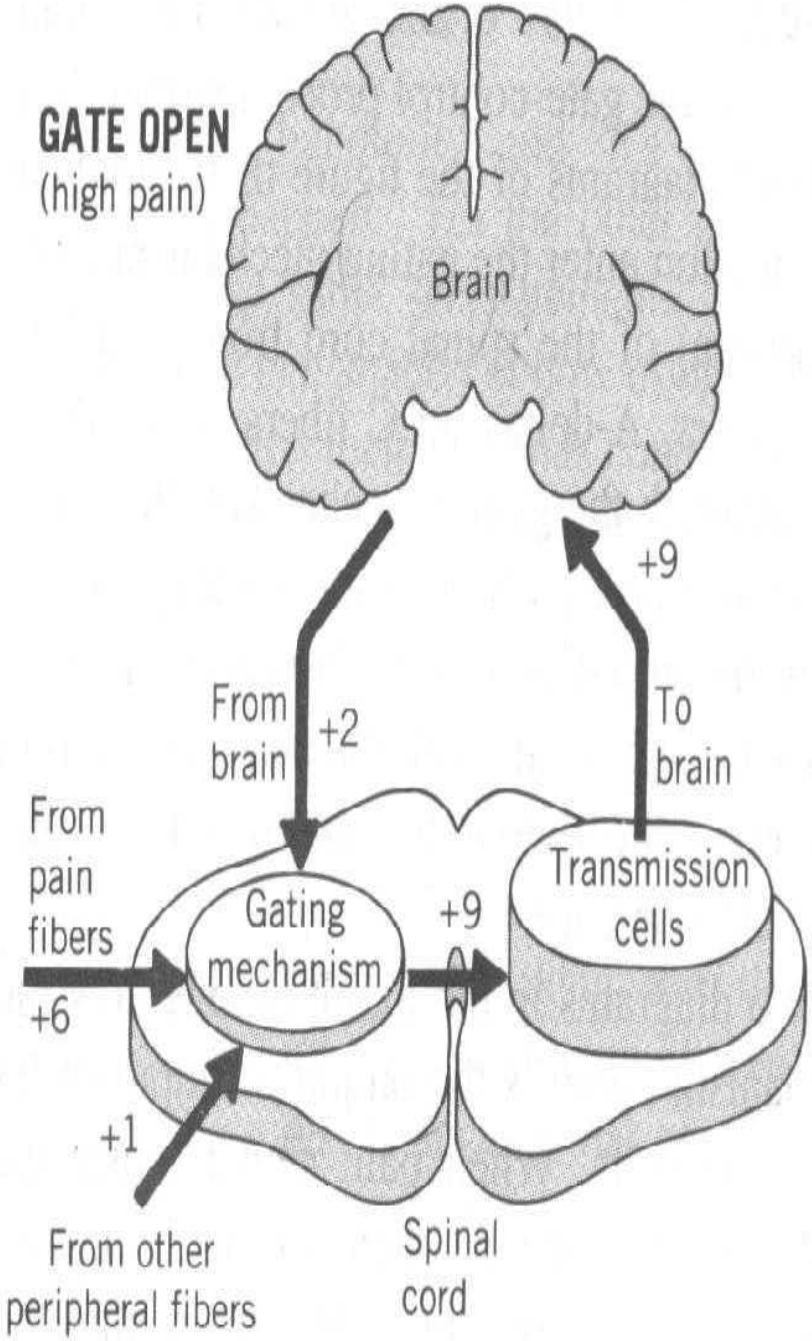
Gate-Control Theory – Ronald Melzack (1960s)

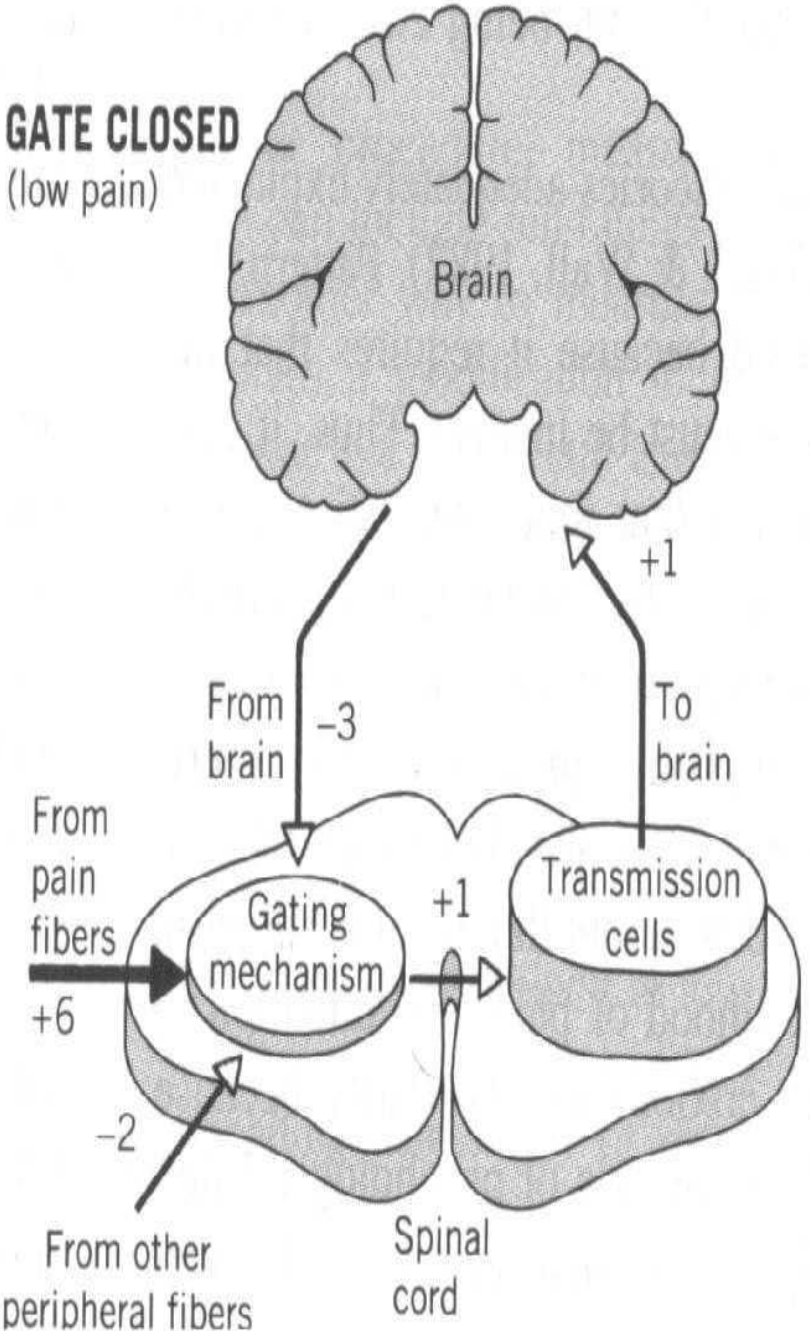
- Described physiological mechanism by which psychological factors can affect the experience of pain.
- **Neural gate can open and close thereby modulating pain.**
- **Gate is located in the spinal cord**.
  - It is the SG

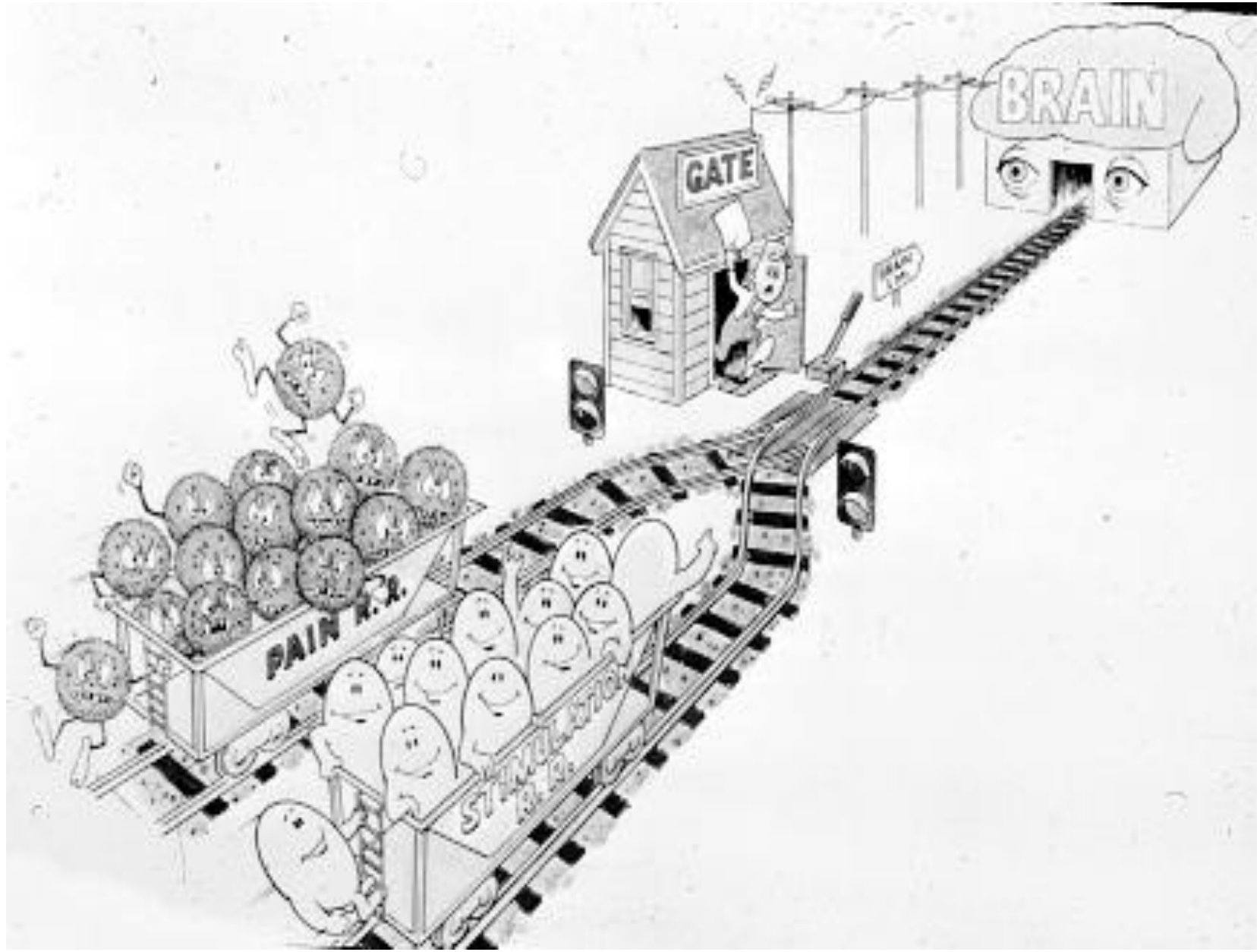
Opening and Closing the Gate

- When the gate is closed signals from small diameter pain fibres do not excite the dorsal horn transmission neurons.

- When the gate is open, pain signals excite dorsal horn transmission cells


GATE OPEN
(high pain)
Brain
+9
From brain
+2
To brain
From pain fibers
+6
Gating mechanism
+9
Transmission cells
+1
From other peripheral fibers
Spinal cord


GATE CLOSED
(low pain)
Brain
+1
From brain
−3
To brain
From pain fibers
+6
Gating mechanism
+1
Transmission cells
−2
From other peripheral fibers
Spinal cord


BRAIN
GATE
PAIN R.A.

Three Factors Involved in Opening and Closing the Gate

- The amount of activity in the pain fibers.
- The amount of activity in other peripheral fibers.
- Messages that descend from the brain.

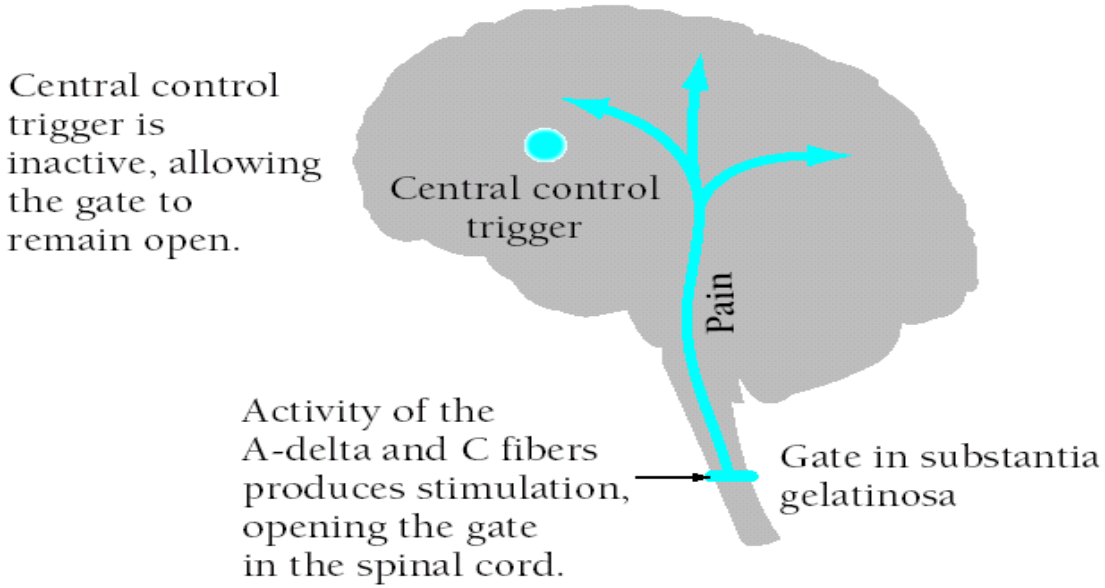
Conditions that Open the Gate

- Physical conditions
  - Extent of injury
  - Inappropriate activity level
- Emotional conditions
  - Anxiety or worry
  - Tension
  - Depression
- Mental Conditions
  - Focusing on pain
  - Boredom

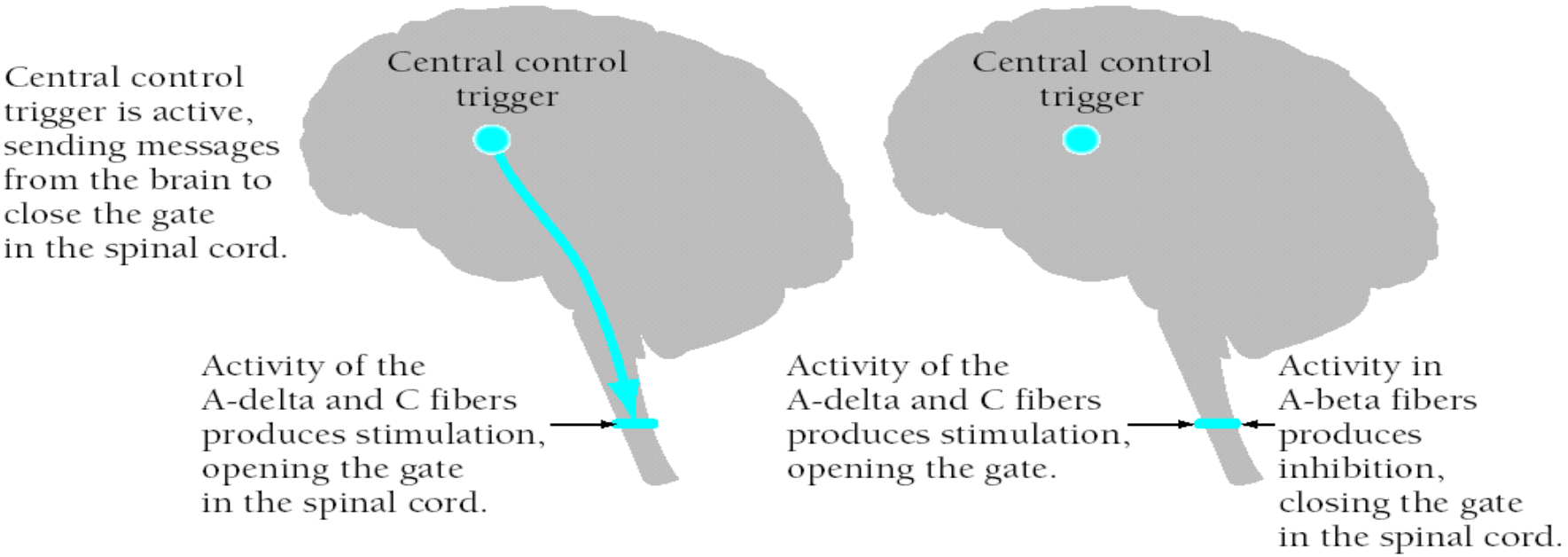
Conditions That Close the Gate

- Physical conditions
  - Medications
  - Counter stimulation (e.g., heat, massage)
- Emotional conditions
  - Positive emotions
  - Relaxation, Rest
- Mental conditions
  - Intense concentration or distraction
  - Involvement and interest in life activities

Open gate = Pain



Closed gate = Decreased pain



Categories of Pain

- Pain can be categorized according to its origin:
  - **Cutaneous** – Skin, tendons, ligaments
  - **Deep somatic** - Bone, muscle connective tissue
  - **Visceral** – Organs, cavity linings
  - **Neuropathic** – Nerve pain
- By certain qualities
  - Radiating
  - Referred
  - Intractable

Phantom Limb Pain

- Pain in a absent body part
- Very common in amputees
- Ranges from tingling top sensation to pain

Acute Pain

- ACUTE – Pain lasting for less than 6 months
  - Highly correlated to damage
  - Anxiety abates w/treatment
  - De-activation often helpful

Chronic Pain

- Pain lasting > 6 months
  - Not correlated to tissue damage
  - Learned/Reinforced
  - Often associated w/psychopathology or coping problems
  - More likely to abuse alcohol and drugs
  - Leads to shutting down
  - Typically does not respond to drugs very well
  - Activity is the best medicine

Measuring Pain

- Physiological
  - Unreliable

- Self-report
  - Behavioral observations
  - Rankings
  - Pain questionnaires
  - Psych tests

Use a standard scale to track the course of pain