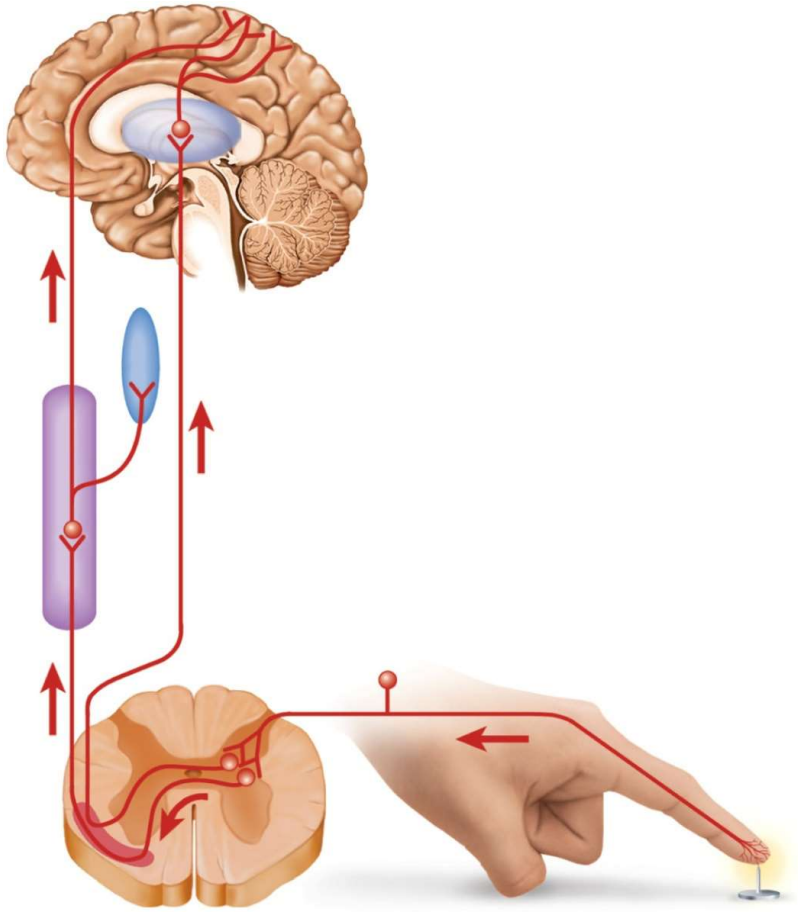
Chapter 16

Sense of Pain



Pain

- Discomfort caused by tissue injury or noxious stimulation that typically leads to evasive action
  - important /// helps to protect us
  - lost of pain in diabetes mellitus = **diabetic neuropathy**
  - If you loose sense of pain then you can not detect tissue damage (e.g. Leprosy)
- **Nociceptors = pain receptors**
  - two types providing different pain sensations
  - **fast pain (alpha)** travels in myelinated fibers at 12 - 30 m/sec /// sharp, localized, stabbing pain perceived with injury
  - **slow pain (delta)** travels unmyelinated fibers at 0.5 - 2 m/sec /// longer-lasting, dull, diffuse feeling
  - Both type in skin // damage skin first detect the alpha fibers followed by delta fibers

Pain

- **somatic pain** - from skin, muscles and joints
- **visceral pain** - from the viscera - stretch, chemical irritants or ischemia of viscera (poorly localized)

- injured tissues release chemicals that stimulate pain fibers
  - **bradykinin** - most potent pain stimulus known
  - makes us aware of injury and activates cascade or reactions that promote healing
  - *histamine, prostaglandin & serotonin* also stimulate nociceptors

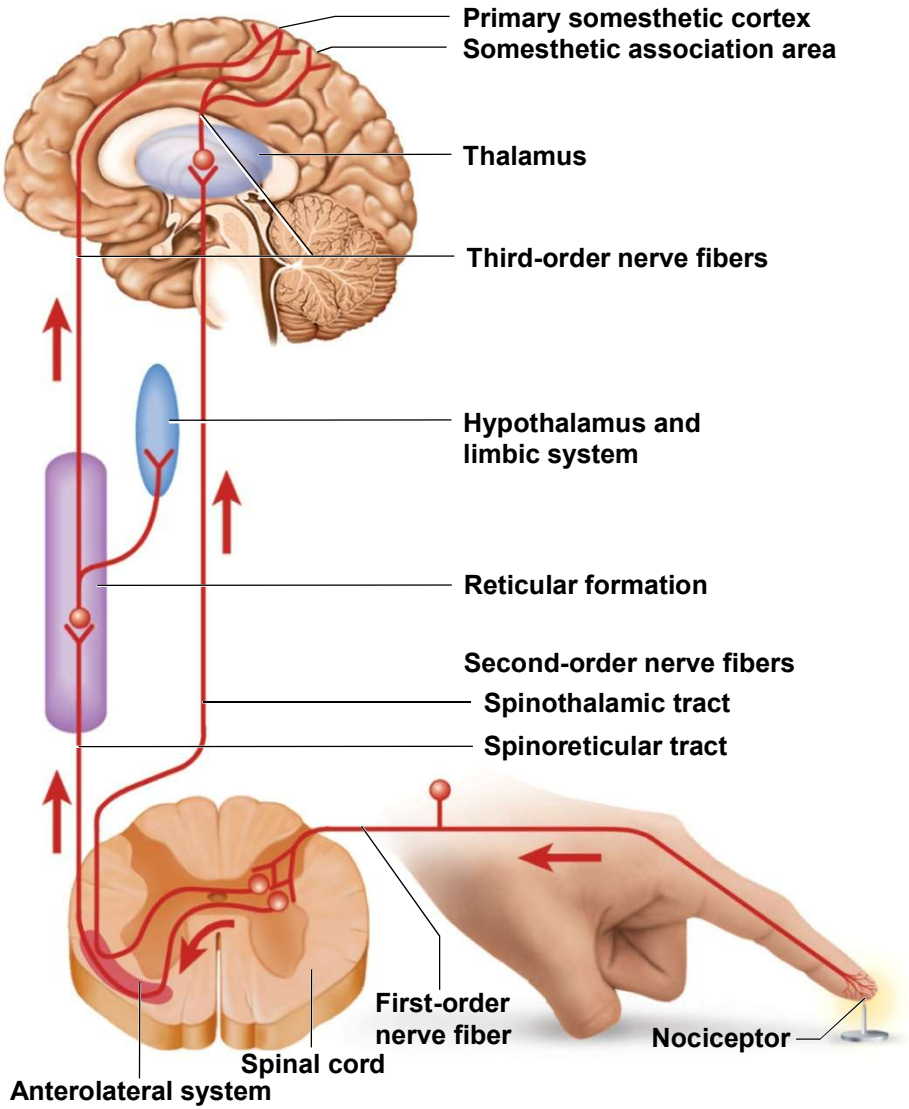
Projection Pathway for Pain

- Ascending and descending tracts (plus multiple sub-routes)
  - Neurons in pain ascending route to somatic sensory gyrus:
    - **first-order neuron** cell bodies in dorsal root ganglion of spinal nerves or cranial nerves V, VII, IX, and X
    - **second-order neurons** decussate and send fibers up spinothalamic tract (somatic pain) or through medulla to thalamus /// 2nd order gracile fasciculus carries visceral pain signals
    - **third-order neurons** from thalamus reach postcentral gyrus of cerebrum (somatic sensory gyrus)

Projection Pathway for Pain

- Pain signals travel by way of four ascending tracts:
  - **spinothalamic tract** – most significant pain pathway /// carries most somatic pain signals
  - **spinoreticular tract** – carries pain signals to reticular formation /// activate visceral, emotional and behavioral reactions to pain
  - **gracile fasciculus** – carries signals to the thalamus for visceral pain -- lower extremities
  - **cuniate fasiculus** – carries signals to the thalamus for visceral pain -- upper extremities

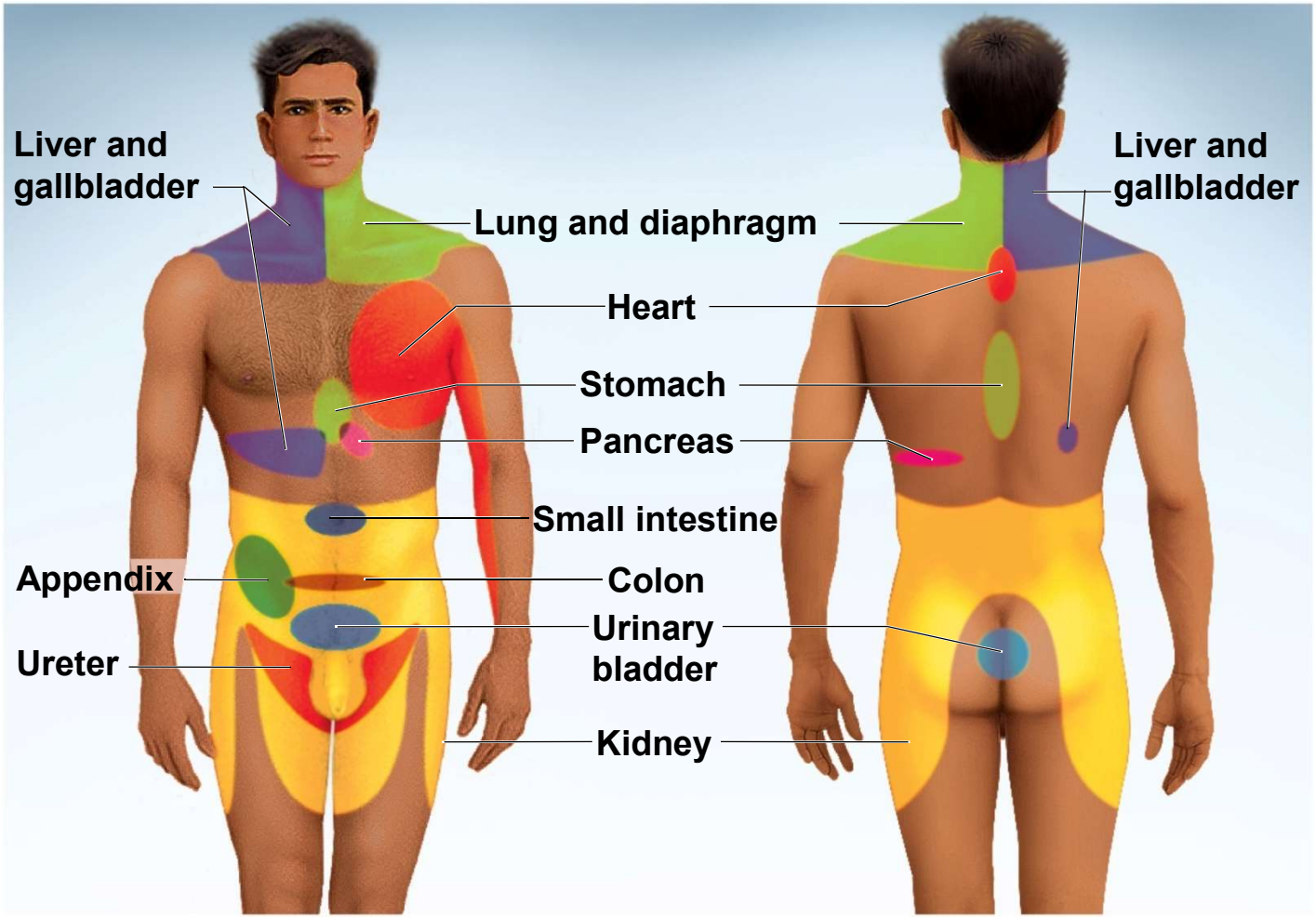
Pain Signal Destinations



Referred Pain

- Pain in viscera often mistakenly thought to come from the skin or other superficial site
  - results from convergence of neural pathways in CNS
  - brain “assumes” visceral pain is coming from skin /// brain can not distinguish source
  - heart pain felt in shoulder or arm because both send pain input to spinal cord segments T1 to T5

Referred Pain



CNS Modulation of Pain

- analgesic (pain-relieving) mechanisms of CNS /// just beginning to be understood
  - tied to receptor sites for opium, morphine & heroin located in the brain
  - enkephalins - two analgesic oligopeptides with 200 times the potency of morphine
    - endorphins
    - dynorphins
    - (larger analgesic neuropeptides discovered later)

CNS Modulation of Pain

- endogenous opioids /// internally produced opium-like substances
  - enkephalins, endorphins, and dynorphins
  - secreted by the CNS, pituitary gland, digestive tract, and other organs
- neuromodulators
  - enkephalins can block the transmission of pain signals
  - produce feelings of pleasure and euphoria

Spinal Gating

- Stops pain signals at the posterior horn of the spinal cord
  - descending analgesic fibers arise in brain stem
  - travel down the spinal cord in the reticulospinal tract
  - block pain signals from traveling up the cord to the brain

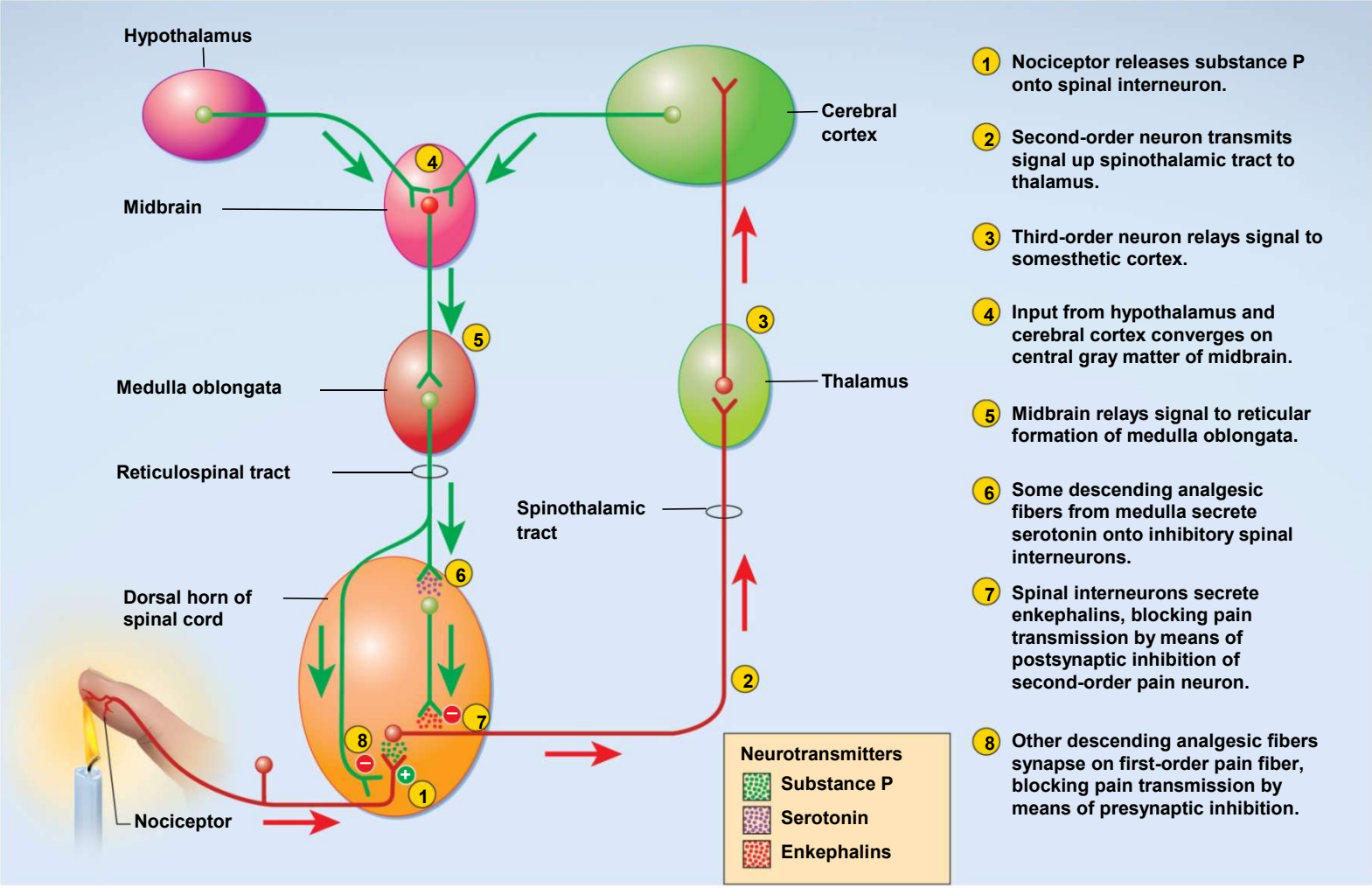
Spinal Gating

- Normal pain pathway (ascending)
  - **nociceptor** stimulates second-order nerve fiber
  - **substance P** is neurotransmitter at this synapse
  - second-order fiber transmits signal up the **spinothalamic tract** to the thalamus
  - **thalamus** relays the signals through third order neurons to the cerebral cortex where one becomes conscious of the pain

Spinal Gating: Pathway for Pain Blocking

- signals from the hypothalamus and cerebral cortex feed into the central gray matter of the midbrain // allows both autonomic and conscious influences on pain perception
- midbrain relays signals to certain nuclei in the reticular formation of the medulla oblongata
- medulla issues descending, serotonin-secreting analgesic fibers to the spinal cord // terminate in the posterior horn at all levels of the spinal cord
- in posterior horn, descending analgesic fibers synapse on short spinal interneurons (i.e. local circuit neurons)
- the interneurons synapse on the second-order pain fiber // secrete enkephalins to inhibit the second-order neuron
- some fibers from the medulla also exert presynaptic inhibition by synapsing on the axons of nociceptors and blocking the release of substance P

Spinal Gating of Pain Signals



Spinal Gating

- Rubbing or massaging injury
  - another pathway of spinal gating
  - pain-inhibiting neurons of the posterior horn receive input from mechanoreceptors in the skin and deeper tissues
  - rubbing stimulates mechanoreceptors which stimulates spinal interneurons to secrete enkephalins that inhibit second-order pain neurons