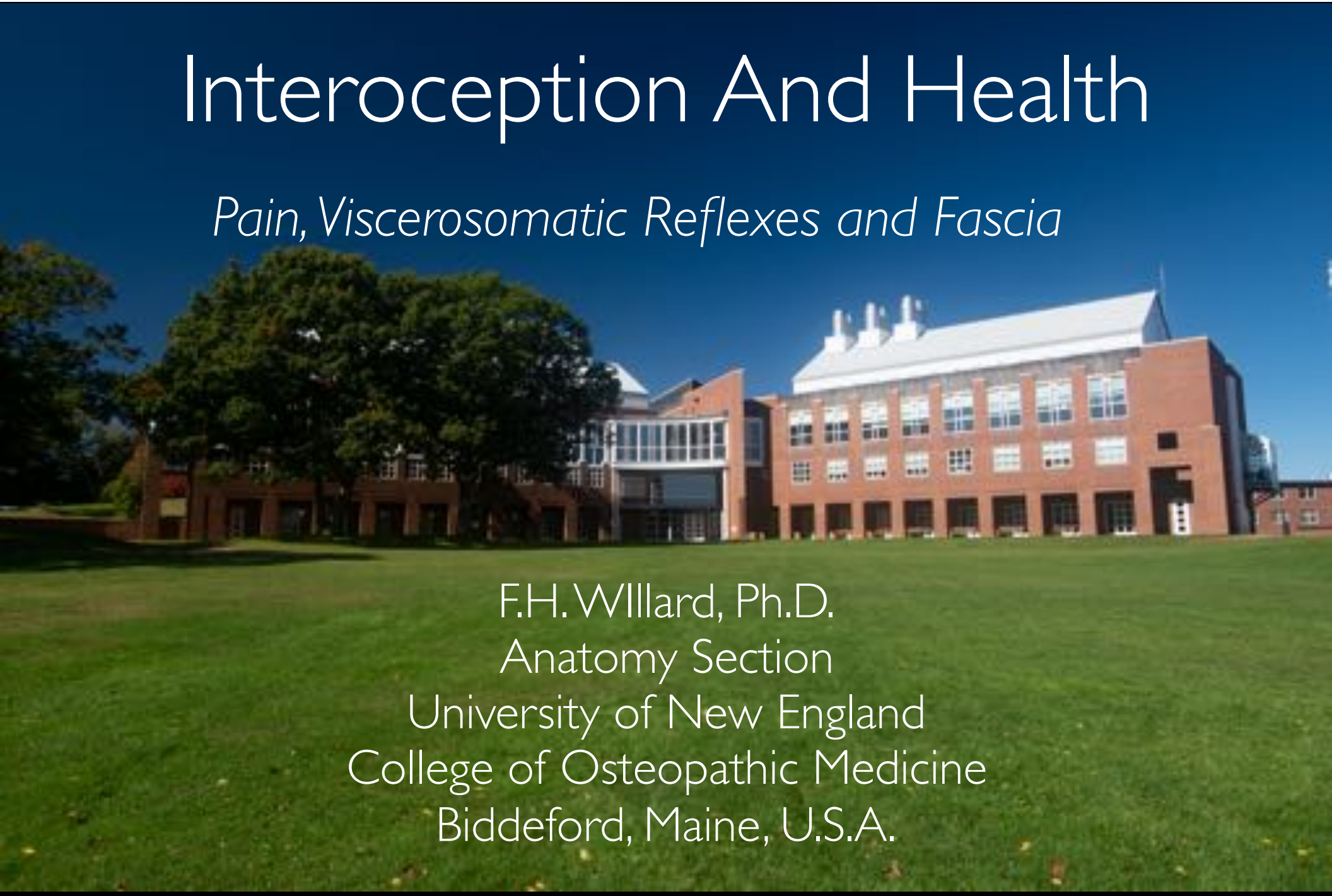
Interoception And Health

Pain, Viscerosomatic Reflexes and Fascia



F.H. WIllard, Ph.D.
Anatomy Section
University of New England
College of Osteopathic Medicine
Biddeford, Maine, U.S.A.

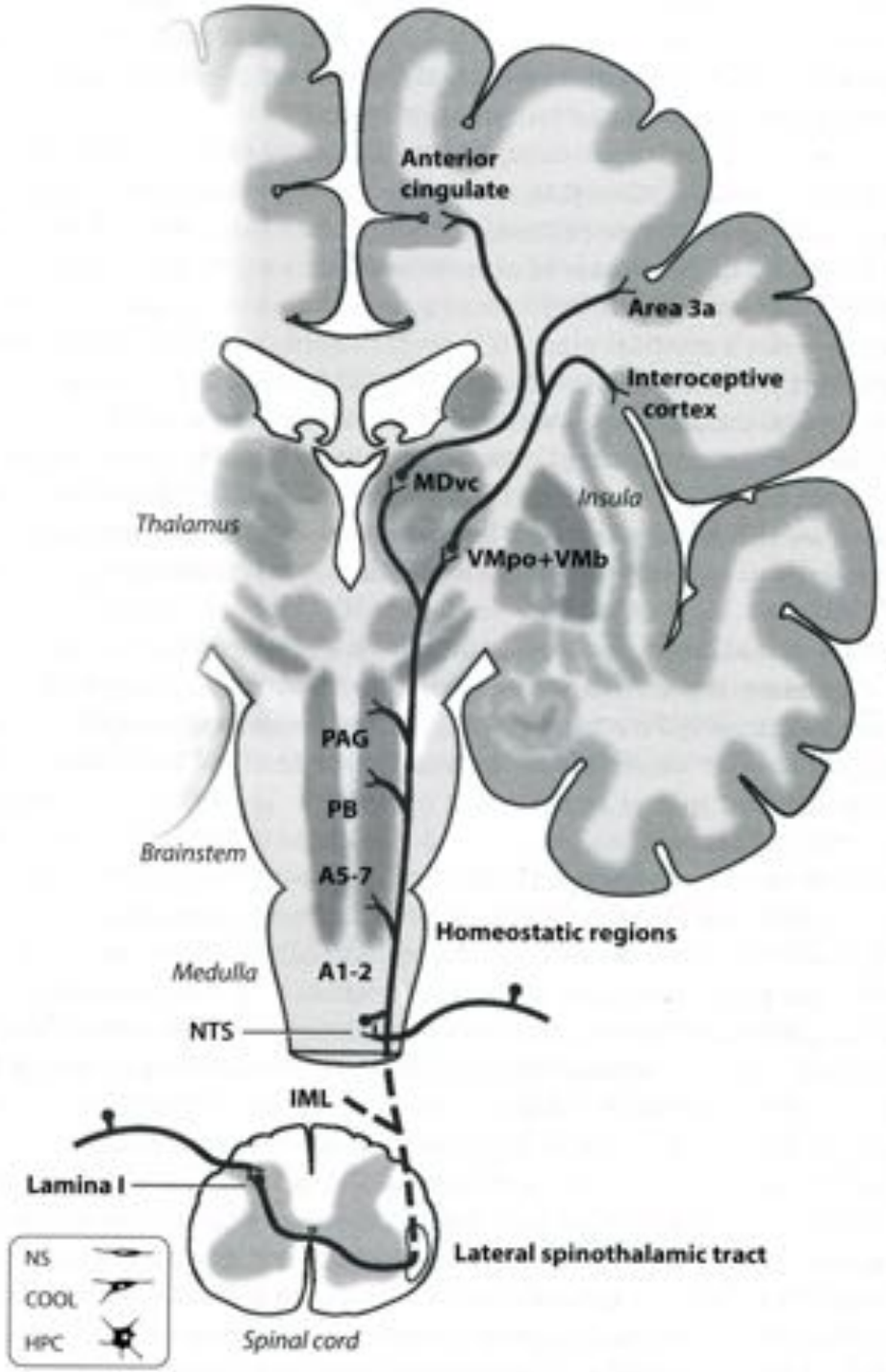
Sherrington Model

- Proprioception - Position sense
- Teloreception - Hearing & vision
- Extroception - Outside mechanical input
- Chemoreception - Taste & smell
- Thermoreception - Temperature
- Interoception - Viscera sense

Craig Concept Modification

- Interoception:
  - Small-caliber fibers from visceral, deep somatic tissue and skin
  - Processed in the dorsal horn
  - Carried in the Spinothalamic Tract
  - Processed in "Interoceptive Cortex"

The Interoceptive System



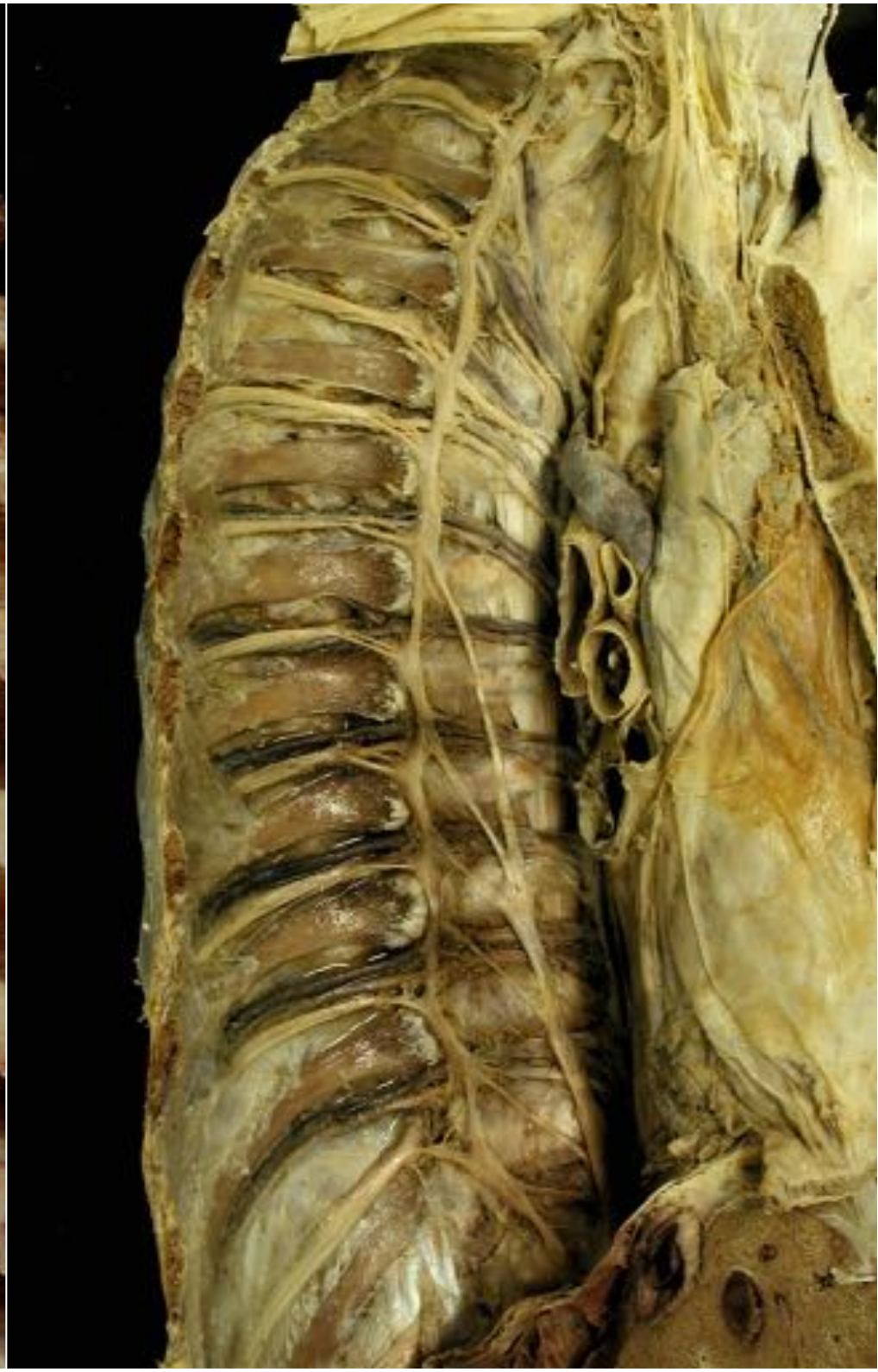
Craig, A.D. 2015. How Do You Feel? An Interoceptive Moment with Your Neurobiological Self. Princeton University Press, Princeton.

What is Interoception

- Small-caliber fiber system
  - Responsive to touch
  - Responsive to noxious stimuli
  - Responsive to tissue chemistry
  - Responsive to immunochemistry

Interoceptive systems of the Body

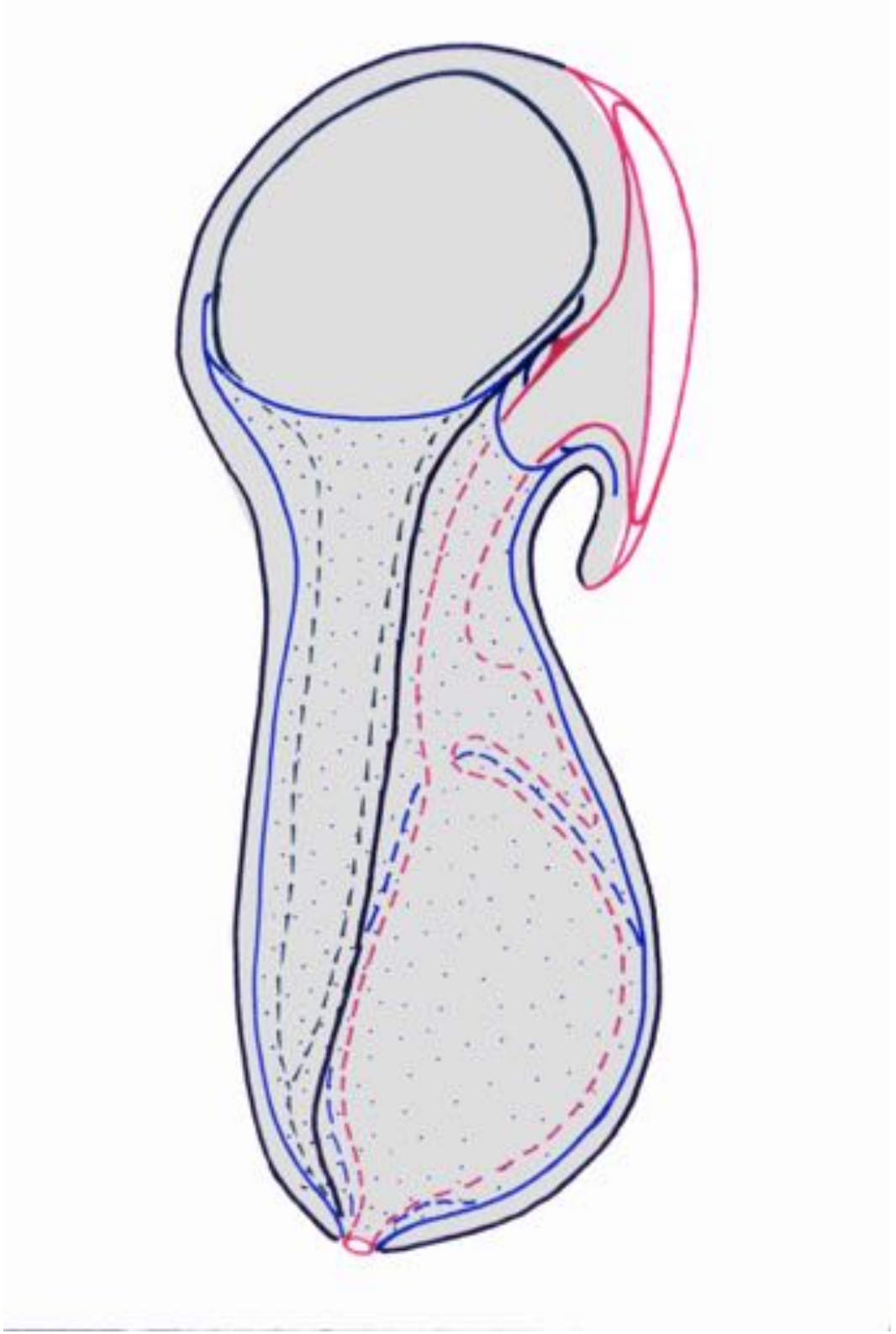
- Somatic small-caliber fiber system
  - Body wall & viscera
- Visceral small-caliber fiber system
  - Organs & visceral fascia



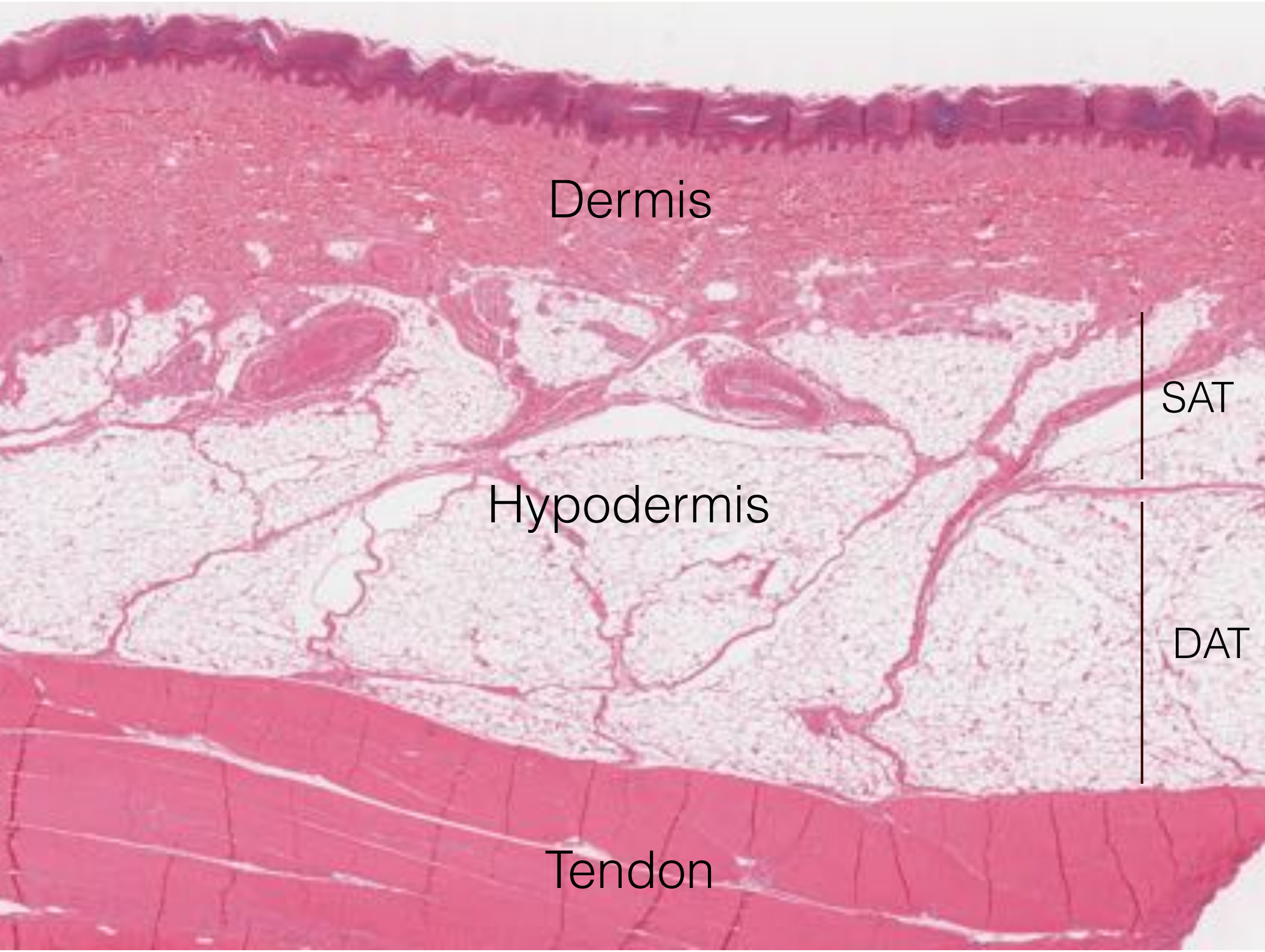
UNE UNIVERSITY OF NEW ENGLAND
College of Osteopathic Medicine
Department of Anatomy

The Fascial System

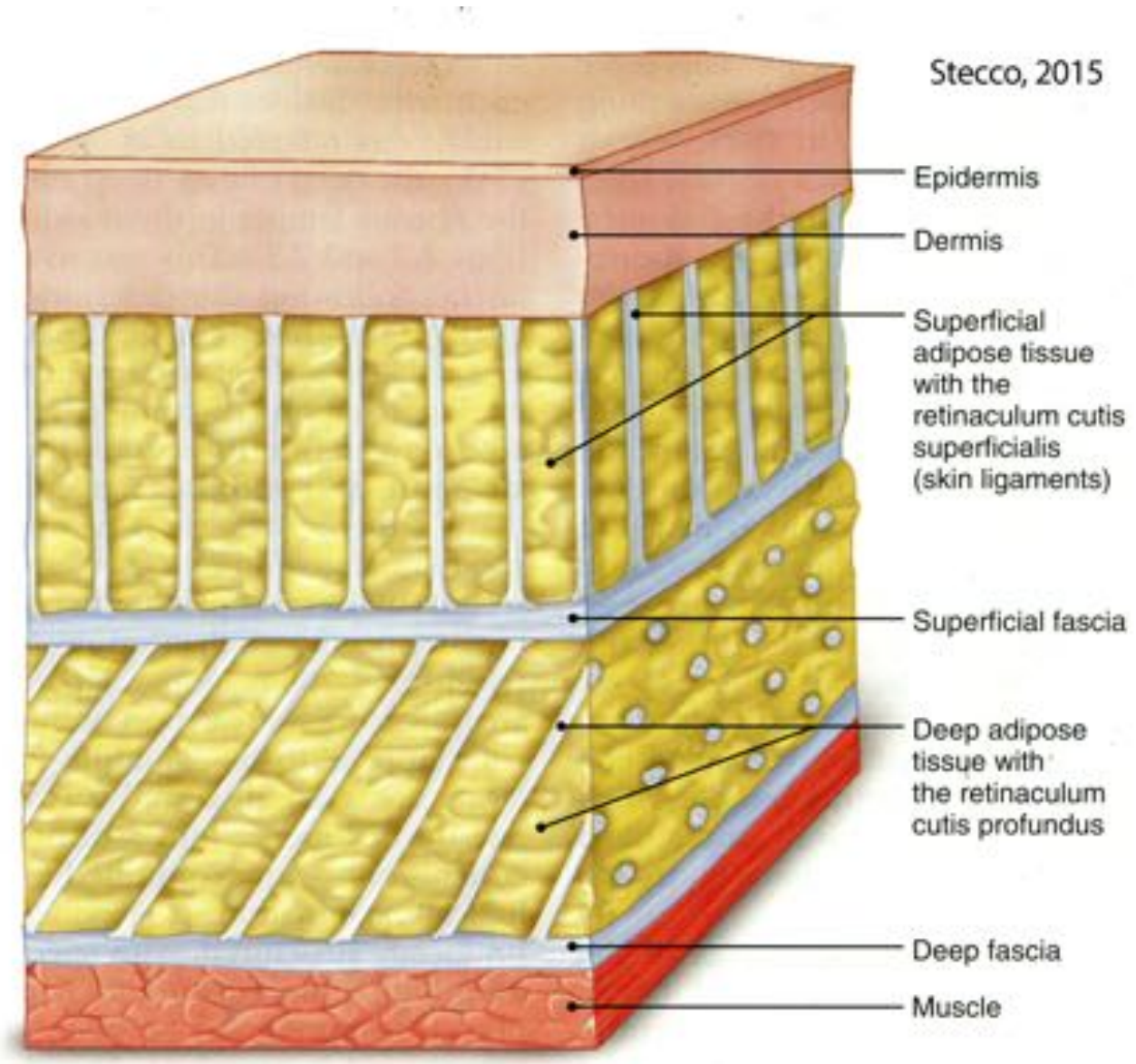
Pannicular Layer





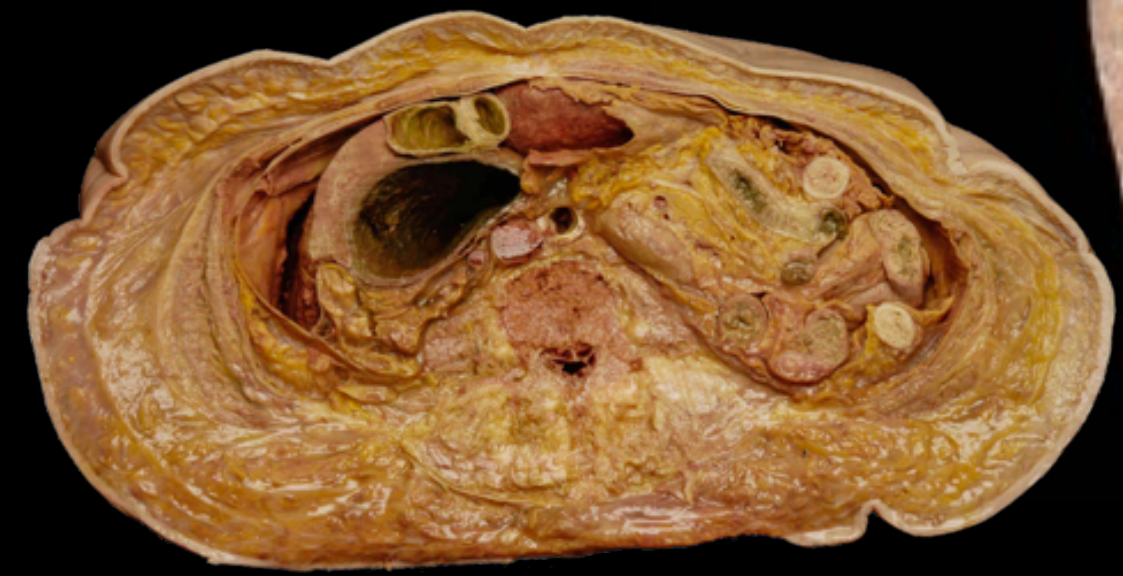

Dermis
SAT
Hypodermis
DAT
Tendon

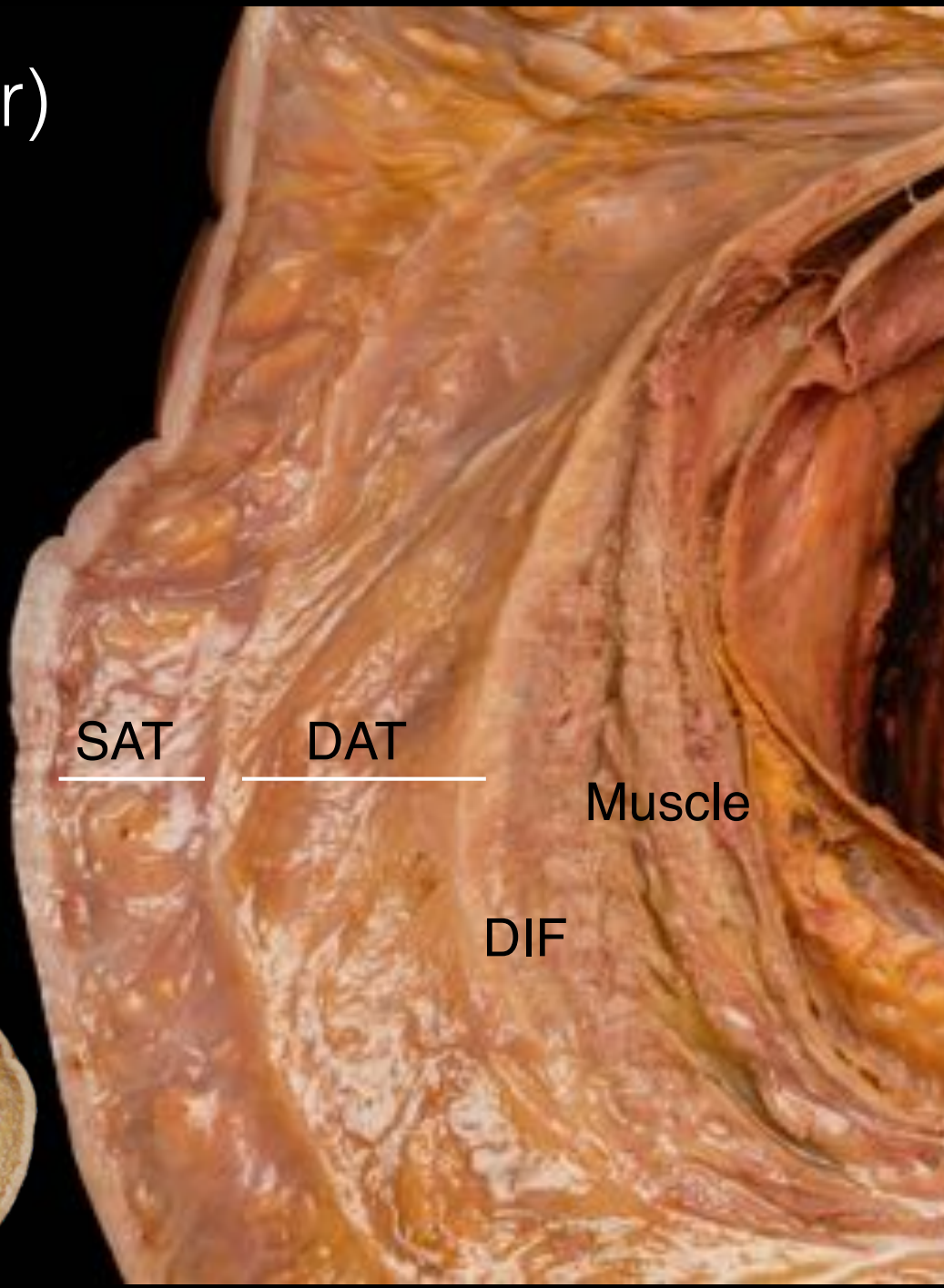
Biodynamic Matrix



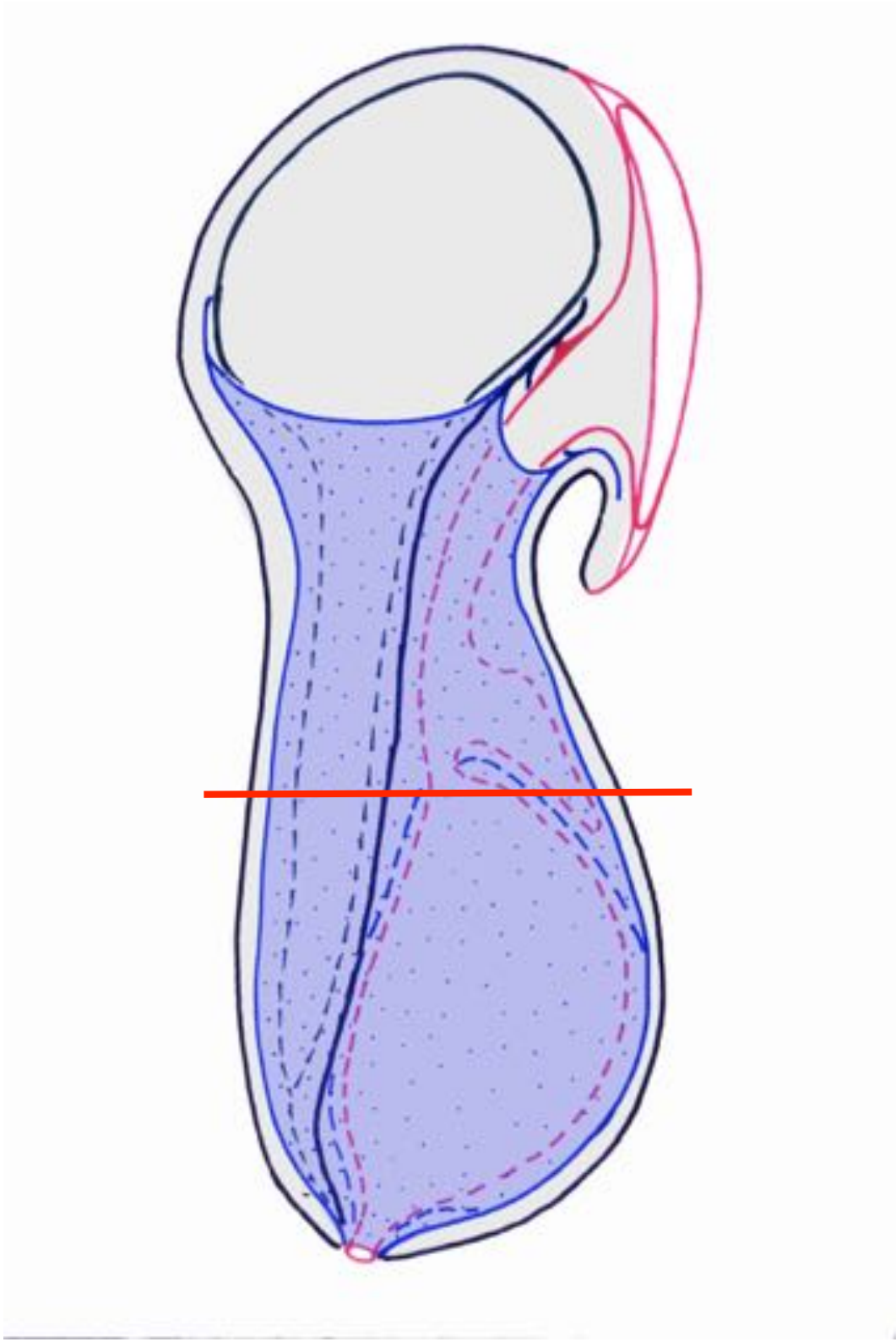
Superficial (Pannicular) Layer

Superficial Adipose Tissue (SAT)
Membranous layer
Deep Adipose Tissue (DAT)



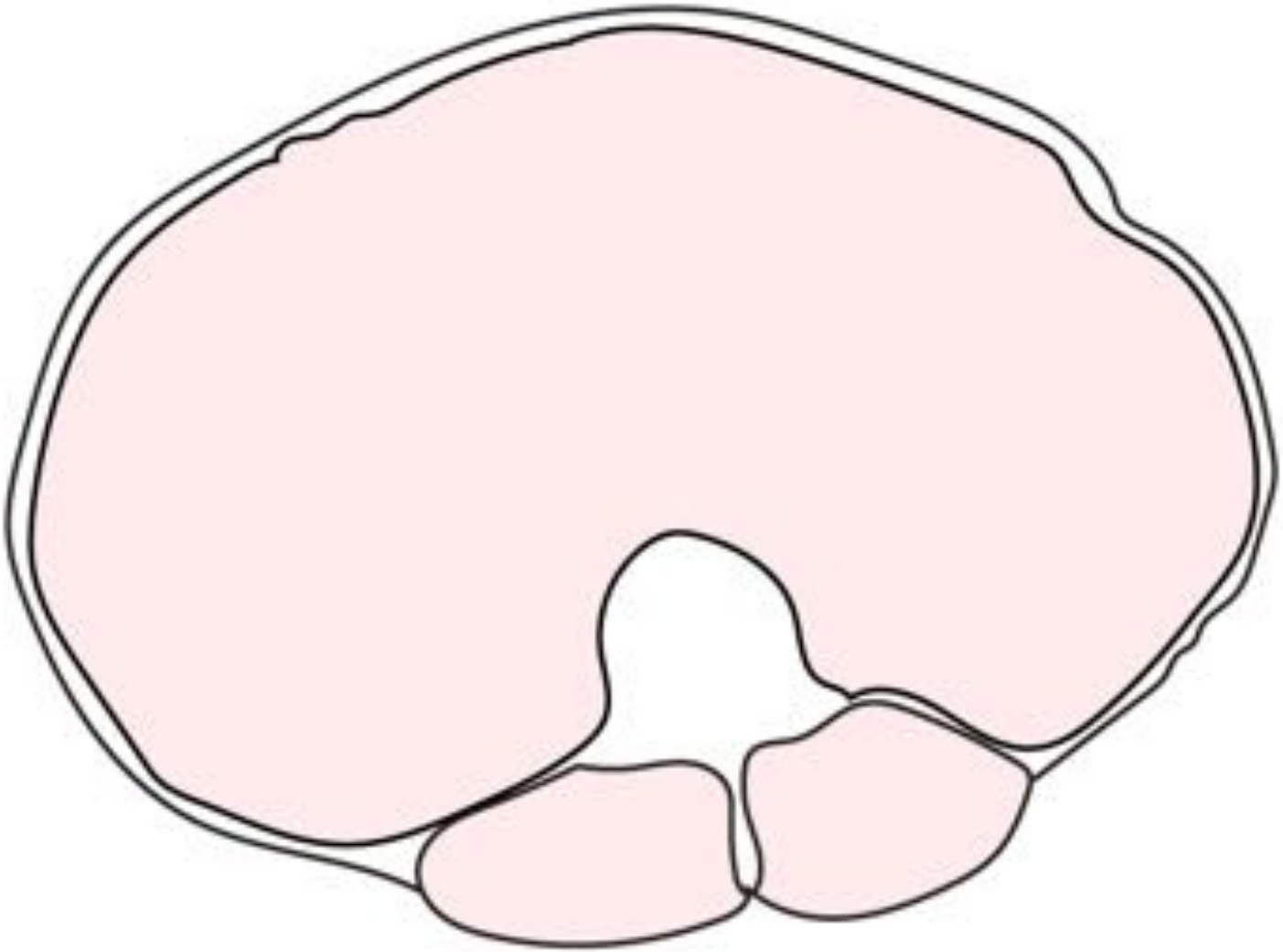


Axial
Layer

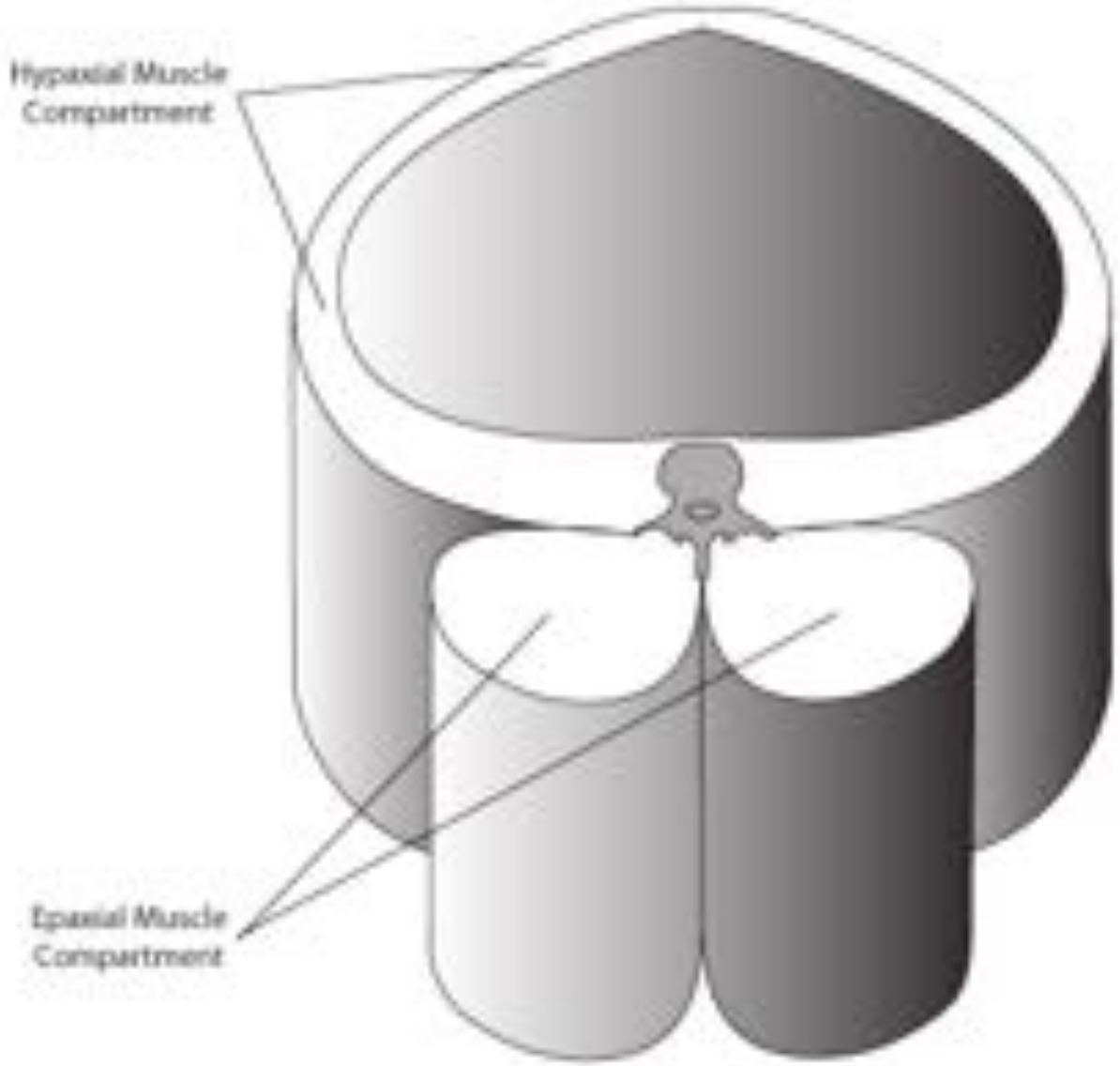



Fascial Cylinders
1742BI

Fascial Cylinders



Axial Fascial Columns



Appendicular Deep Fascia

Deep to the Pannicular Layer

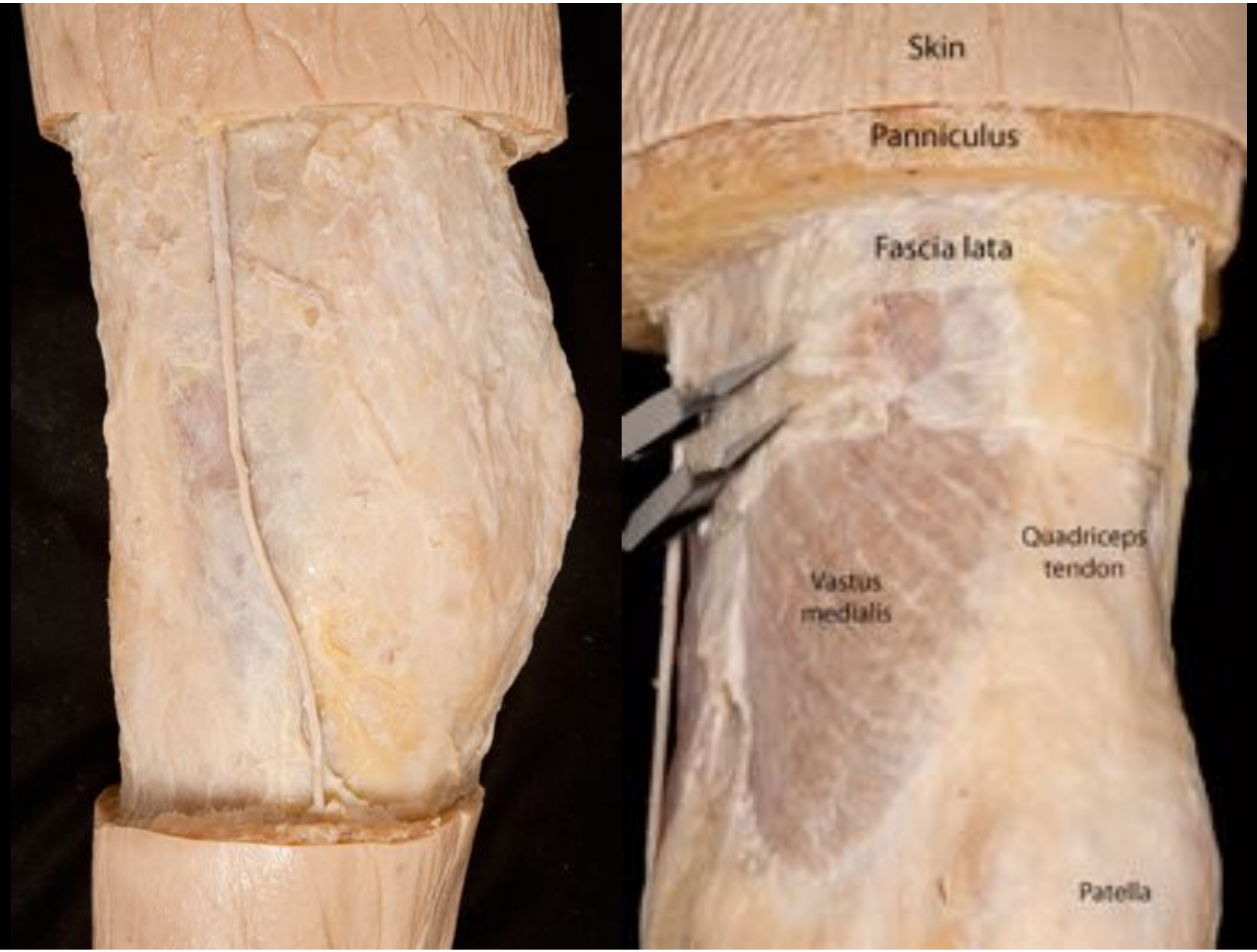
- Aponeurotic (membranous) layer of investing fascia
- Septal bands
- Epimysium, Peritneon & Periosteum

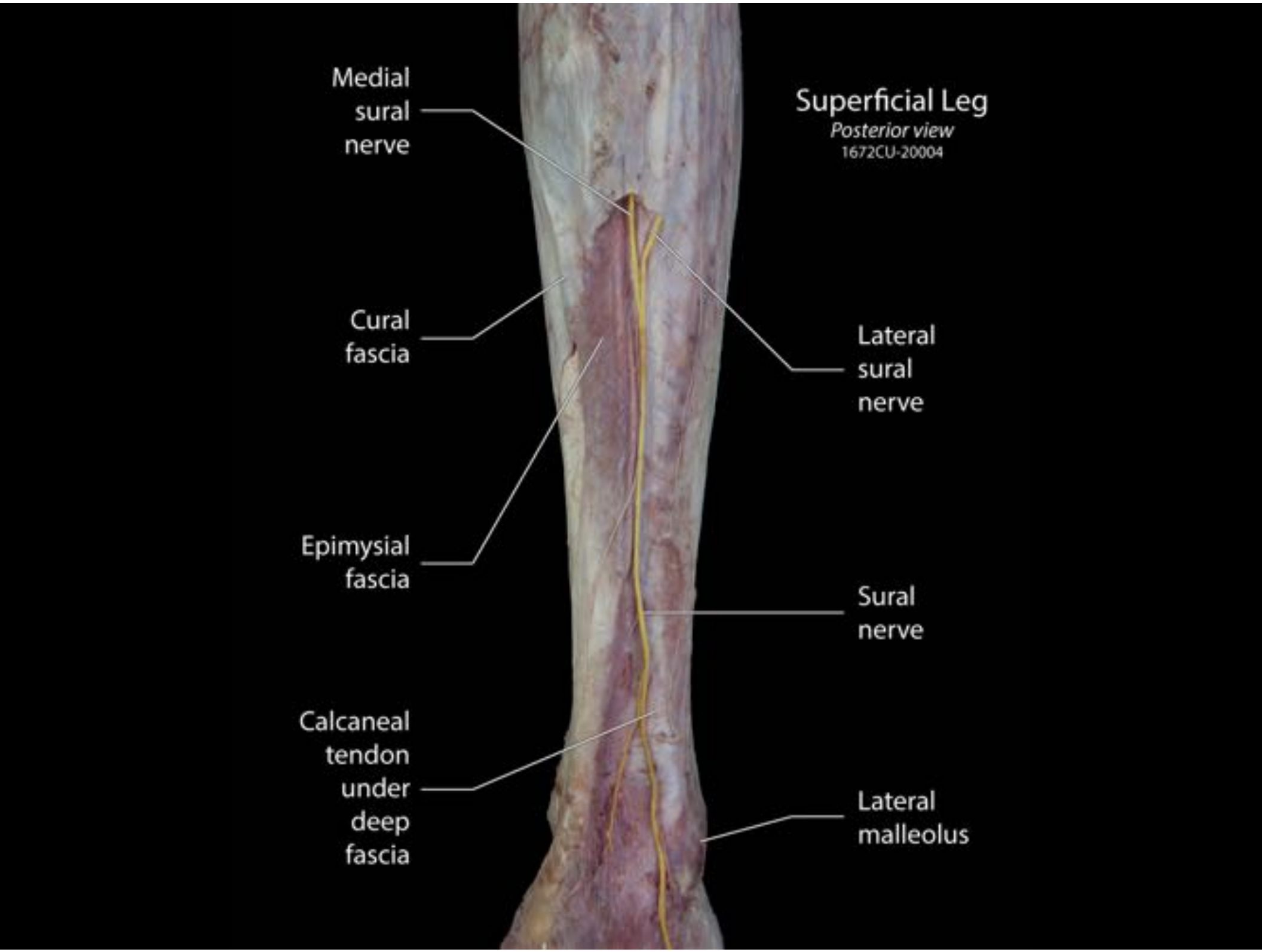
Appendicular Fascia

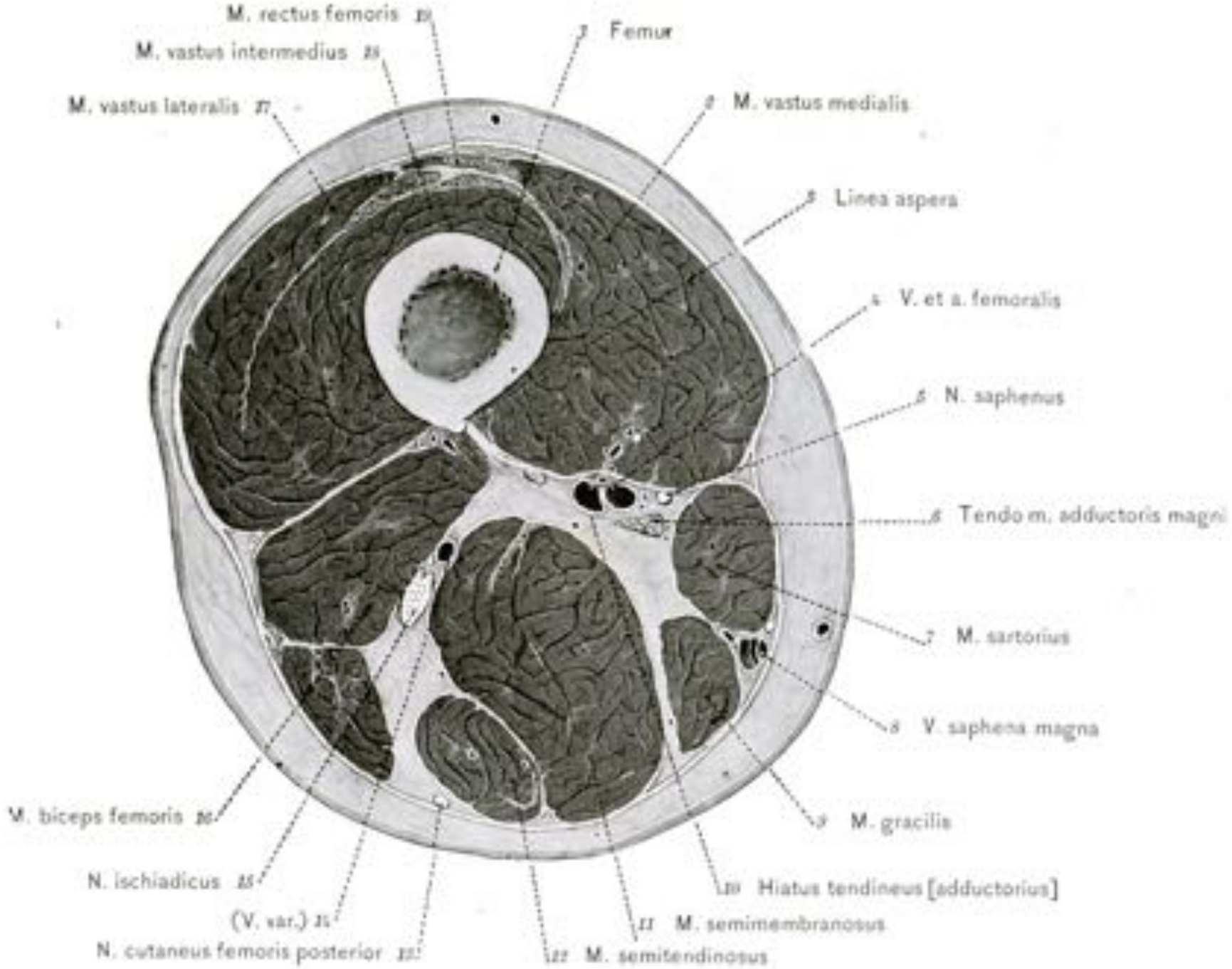
"The Support Stocking"

1672CO-1002

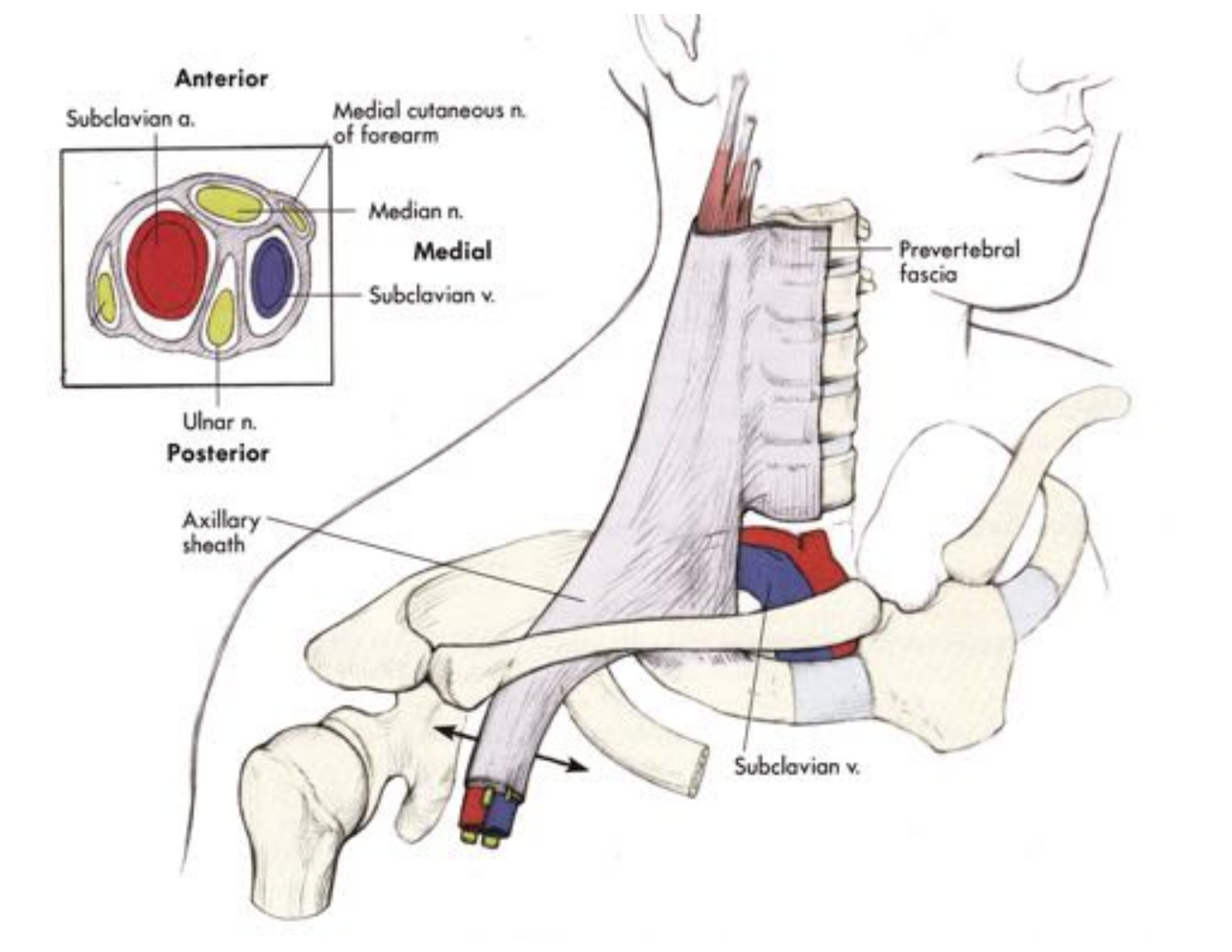

1672PA-1019


Skin
Panniculus
Fascia lata
Quadriceps tendon
Vastus medialis
Patella

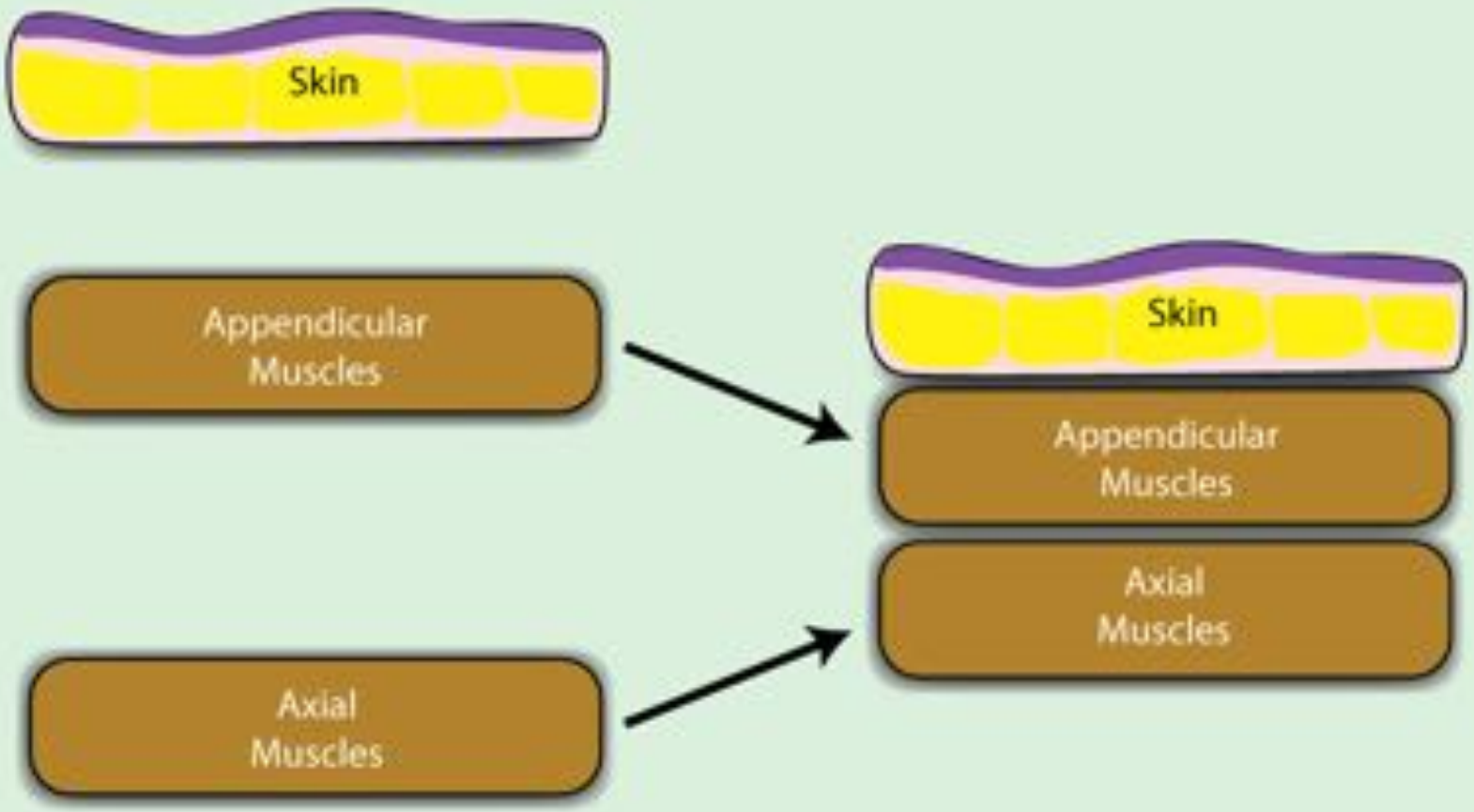

Medial sural nerve
Superficial Leg
Posterior view
1672CU-20004
Cural fascia
Lateral sural nerve
Epimysial fascia
Sural nerve
Calcaneal tendon under deep fascia
Lateral malleolus


M. rectus femoris 21
M. vastus intermedius 28
M. vastus lateralis 27
1 Femur
2 M. vastus medialis
3 Linea aspera
4 V. et a. femoralis
5 N. saphenus
6 Tendo m. adductoris magni
7 M. sartorius
8 V. saphena magna
9 M. gracilis
10 Hiatus tendineus [adductorius]
11 M. semimembranosus
12 M. semitendinosus
M. biceps femoris 26
N. ischiadicus 25
(V. sar.) 24
N. cutaneus femoris posterior 23

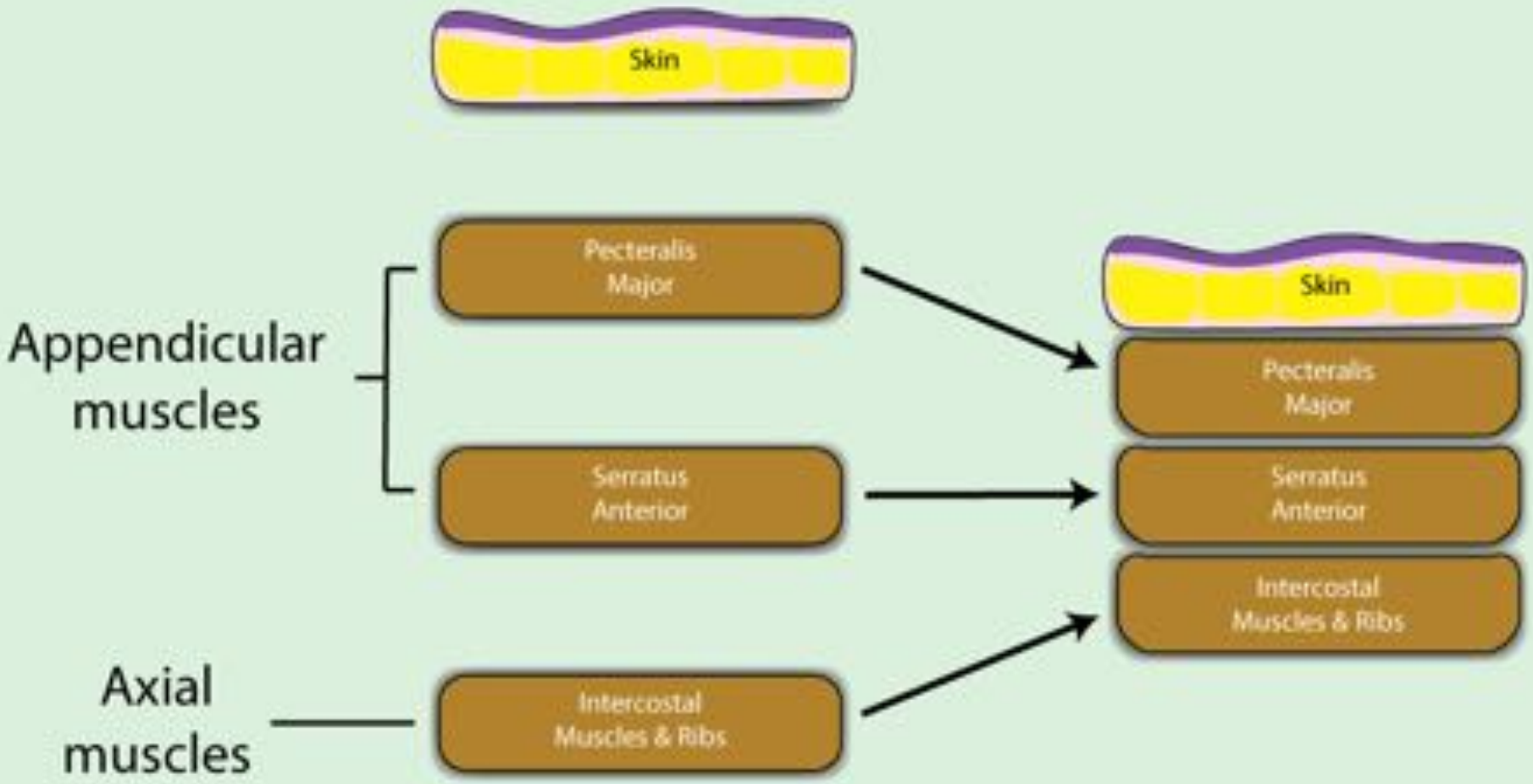
SECTION 85


Anterior
Subclavian a.
Medial cutaneous n. of forearm
Median n.
Medial
Subclavian v.
Ulnar n.
Posterior
Axillary sheath
Prevertebral fascia
Subclavian v.

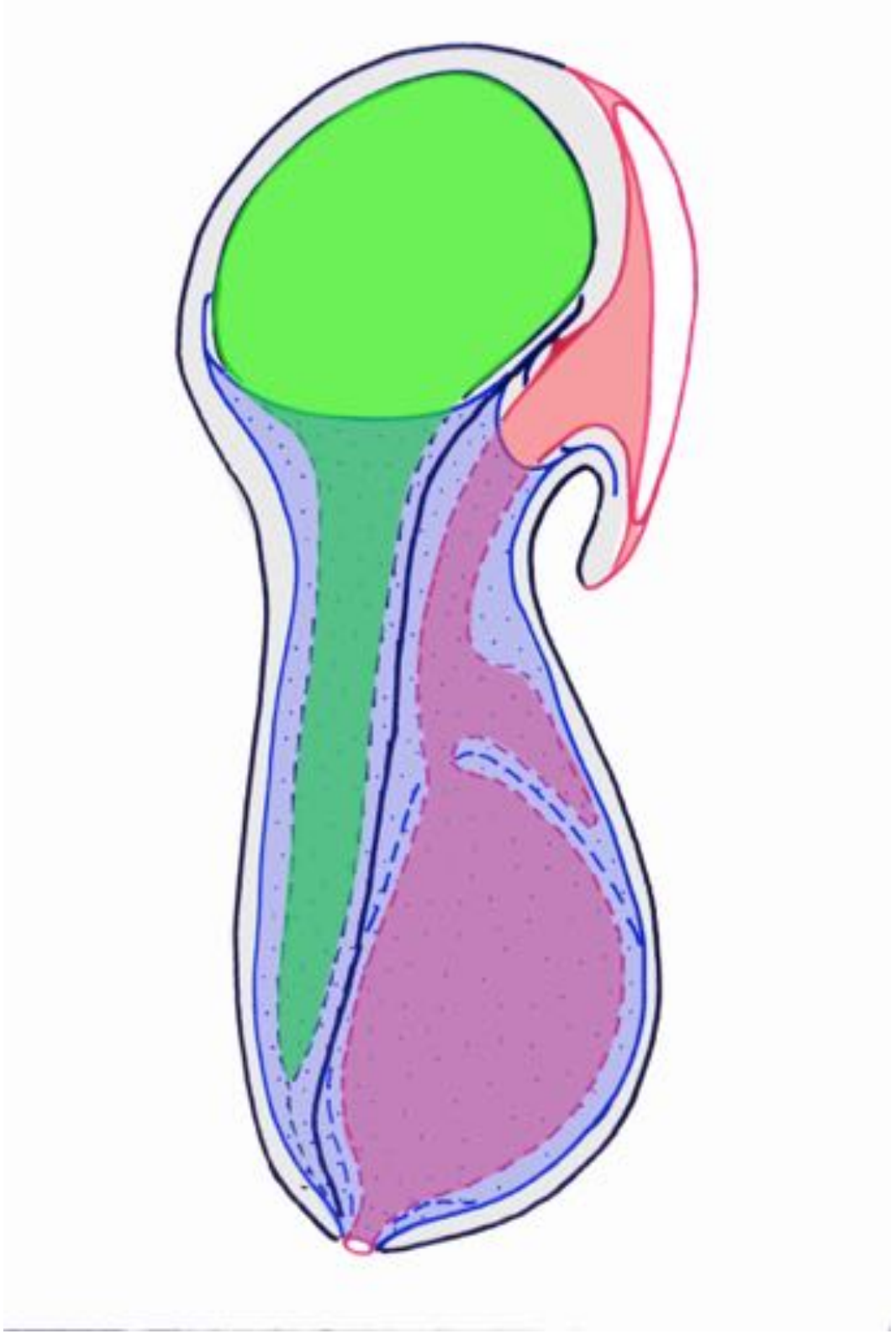
Appendicular-Axial Junctions



Appendicular-Axial Junctions

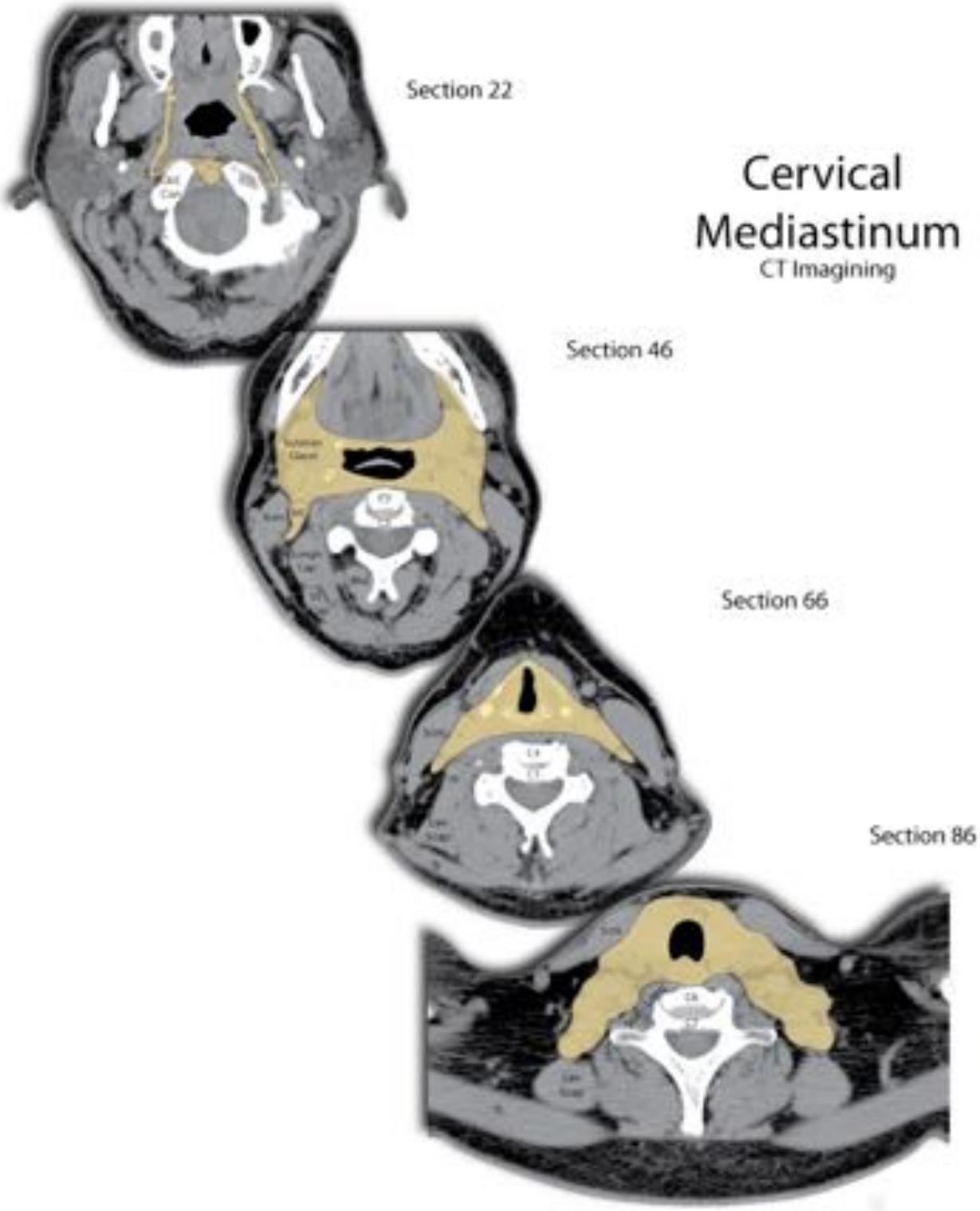


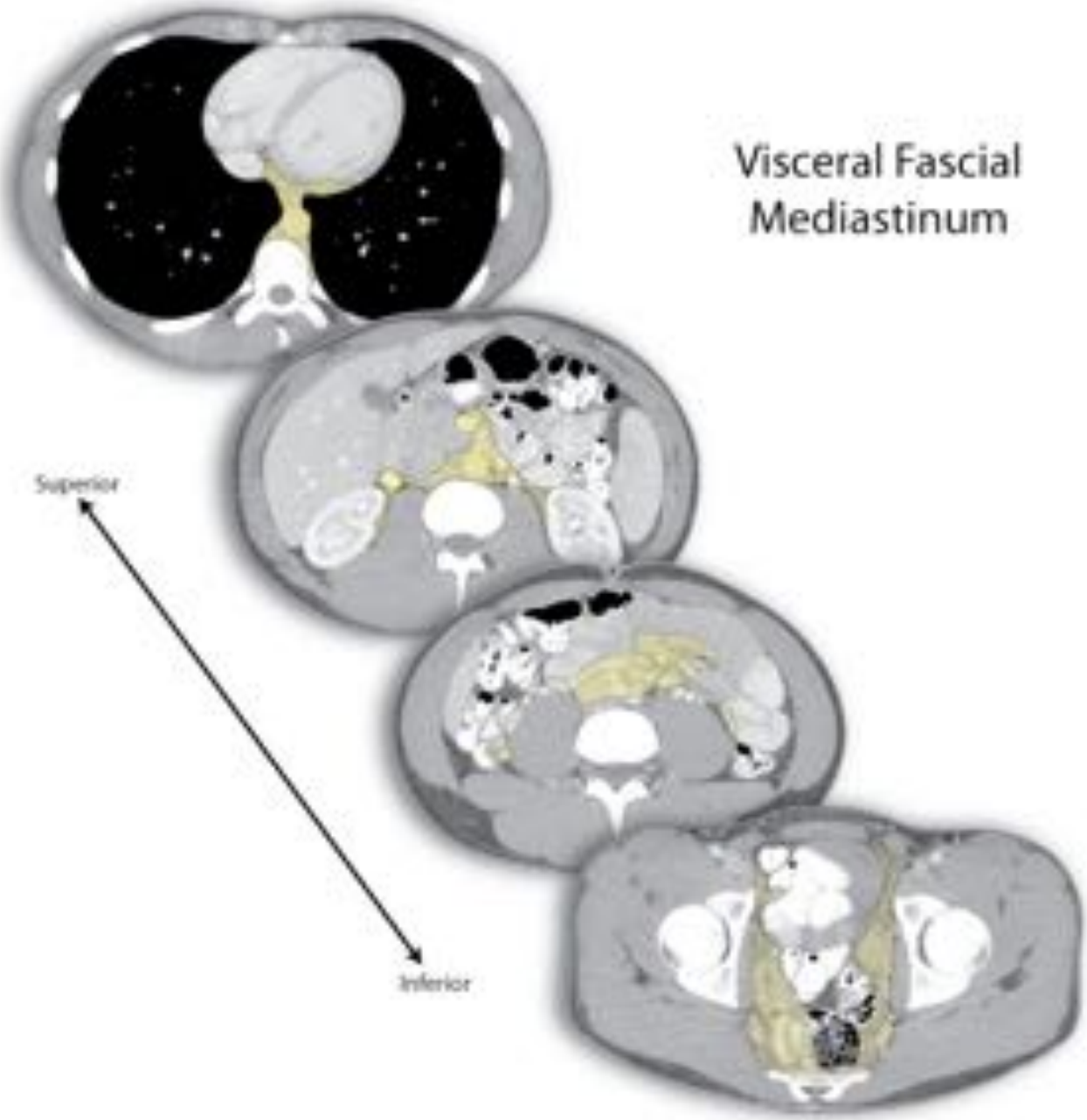
Visceral Layer

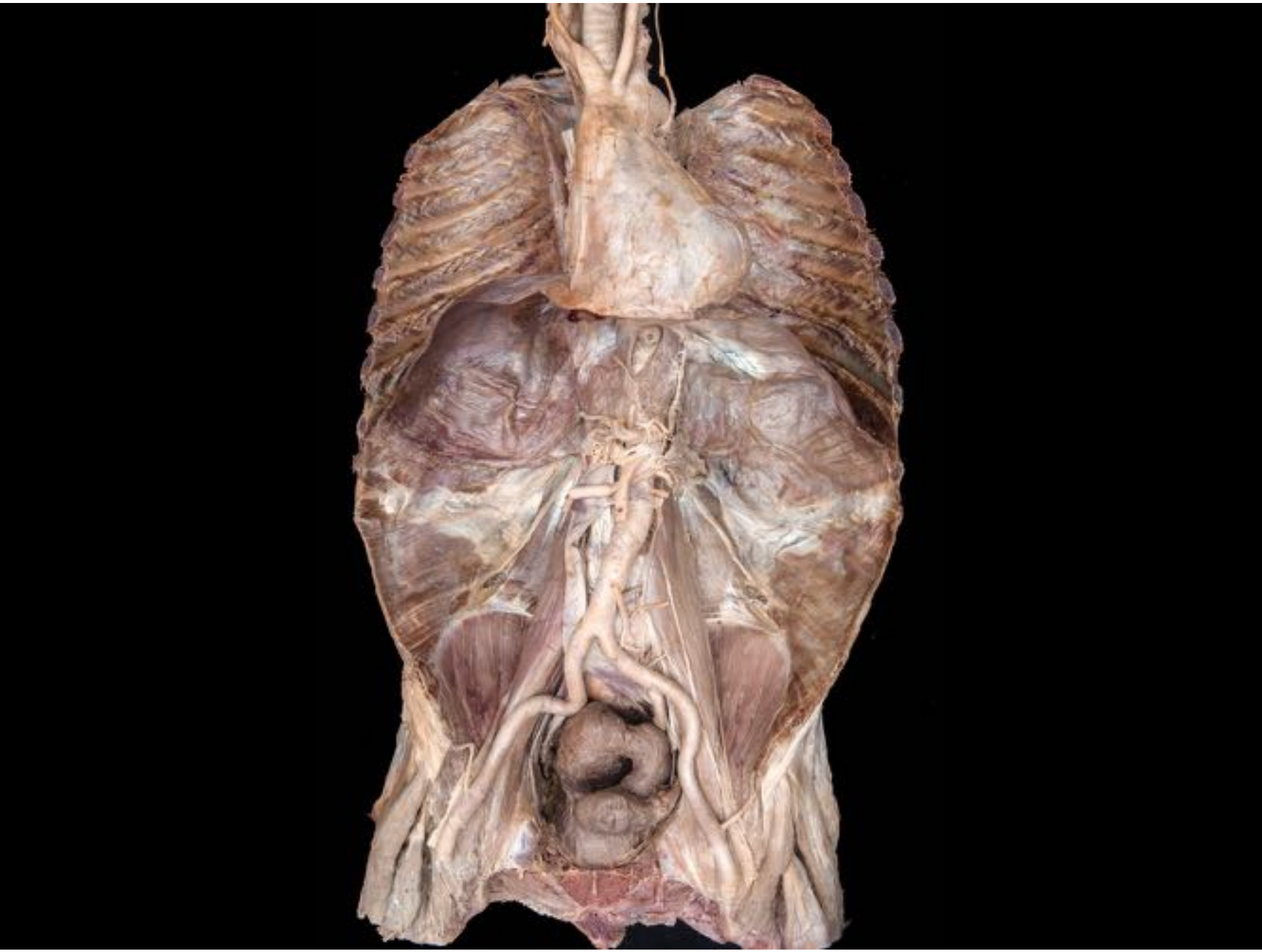


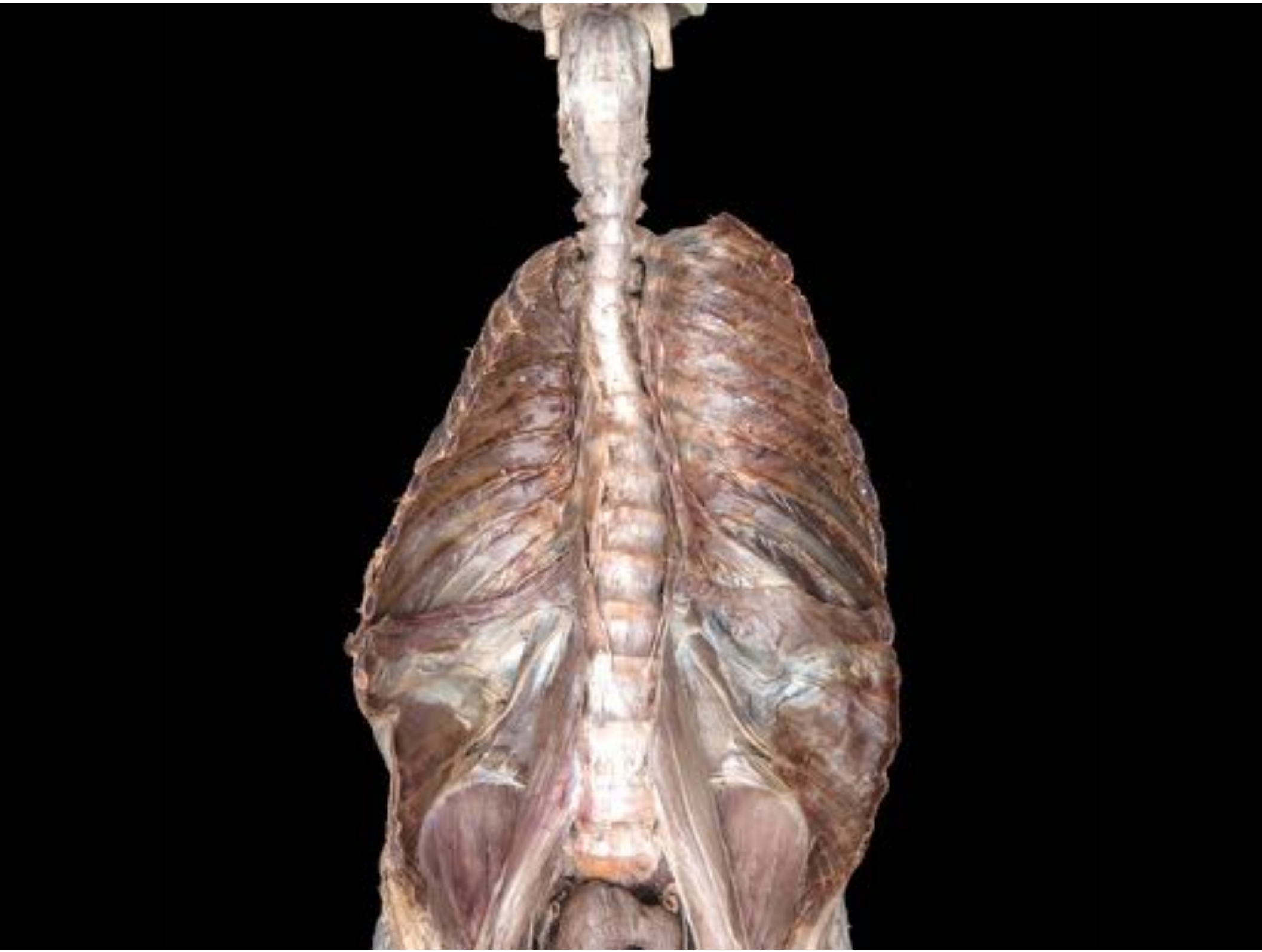
Cervical Mediastinum

CT Imagining




Visceral Fascial
Mediastinum
Superior
Inferior



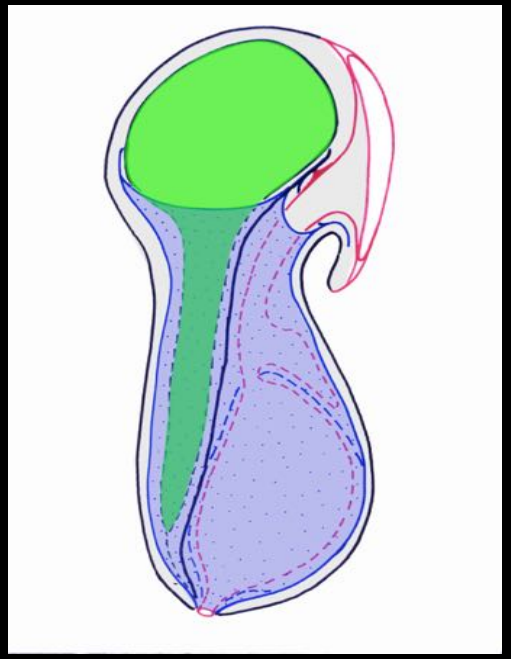


Cervical,
Thoracic, &
Abdominopelvic
Mediastinum

Neurovascular
conduit:
Arteries
Veins
Nerves
Lymphatics

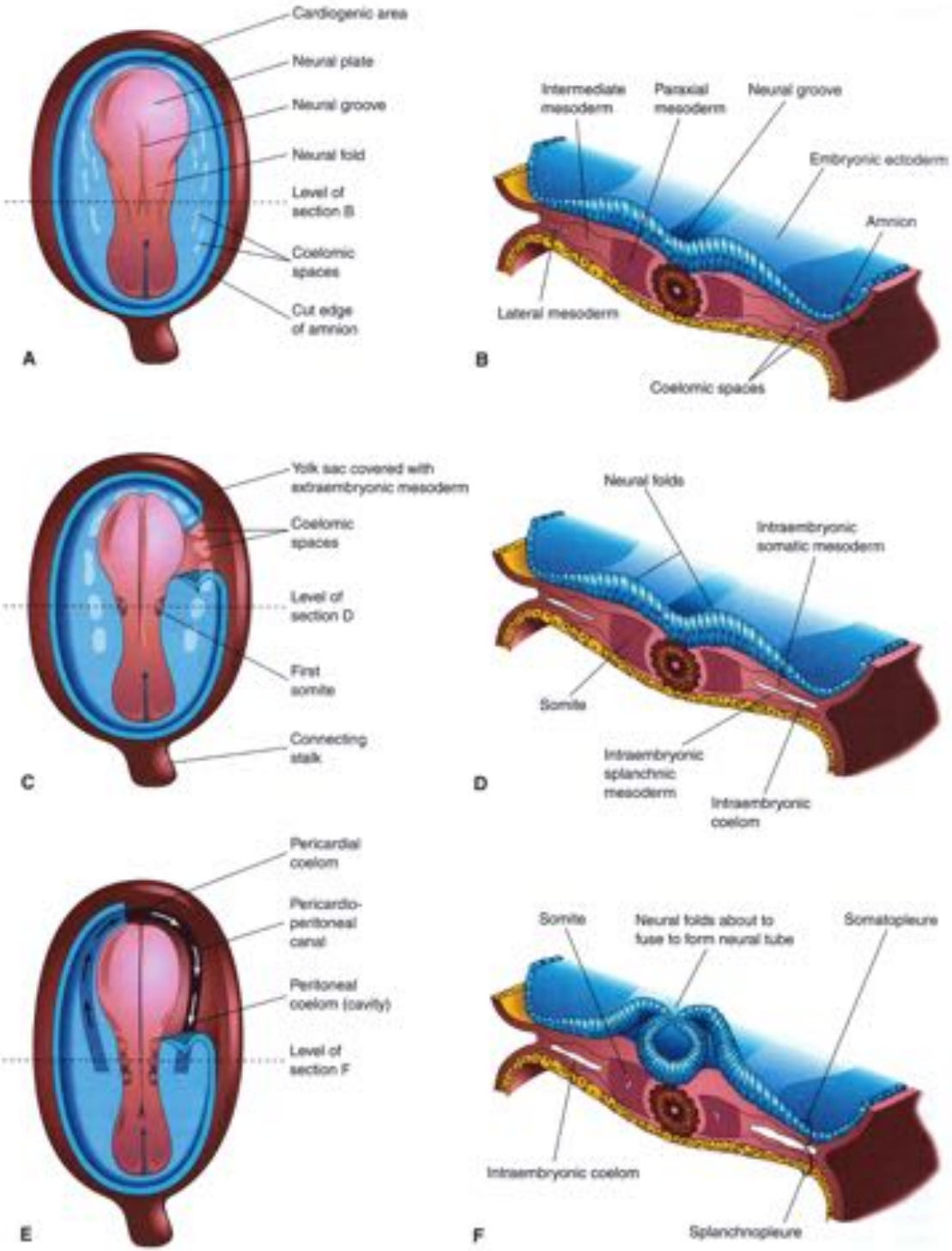
The Fascial System

- Pannicular or superficial fascia
- Investing or deep fascia
- Meningeal fascia
- Visceral fascia

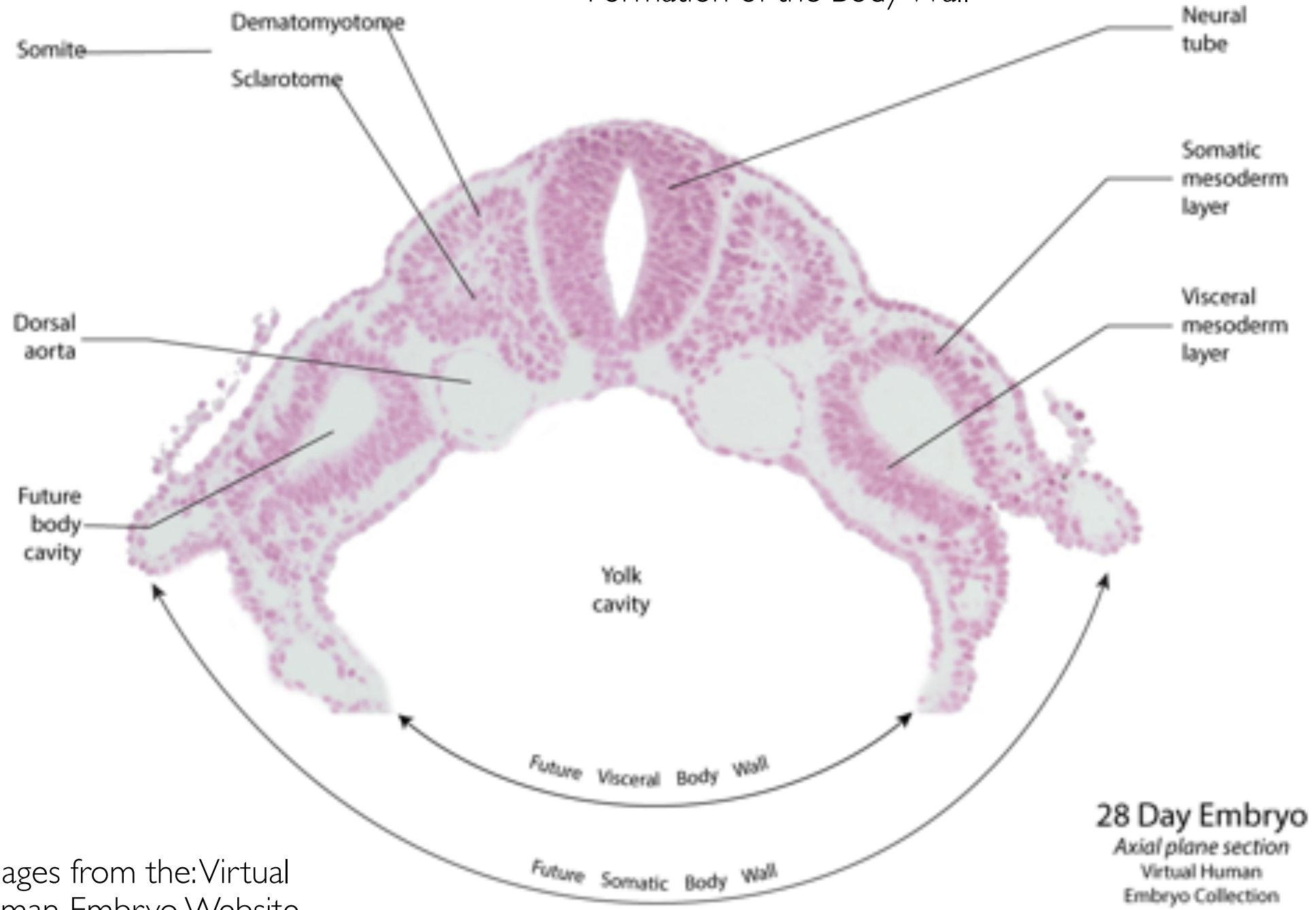


The Development and Innervation of Fascia

Development of the Body Wall



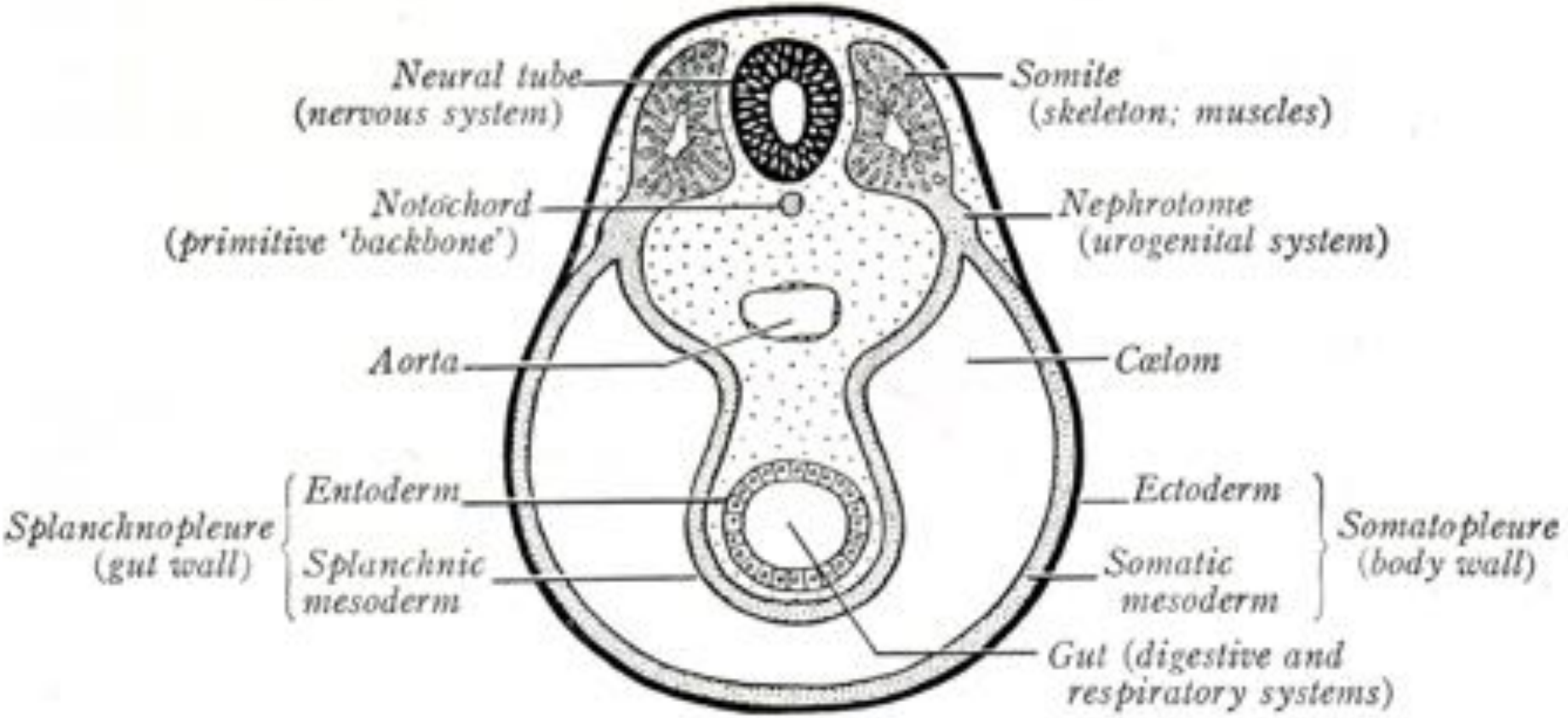
Formation of the Body Wall



Images from the: Virtual Human Embryo Website

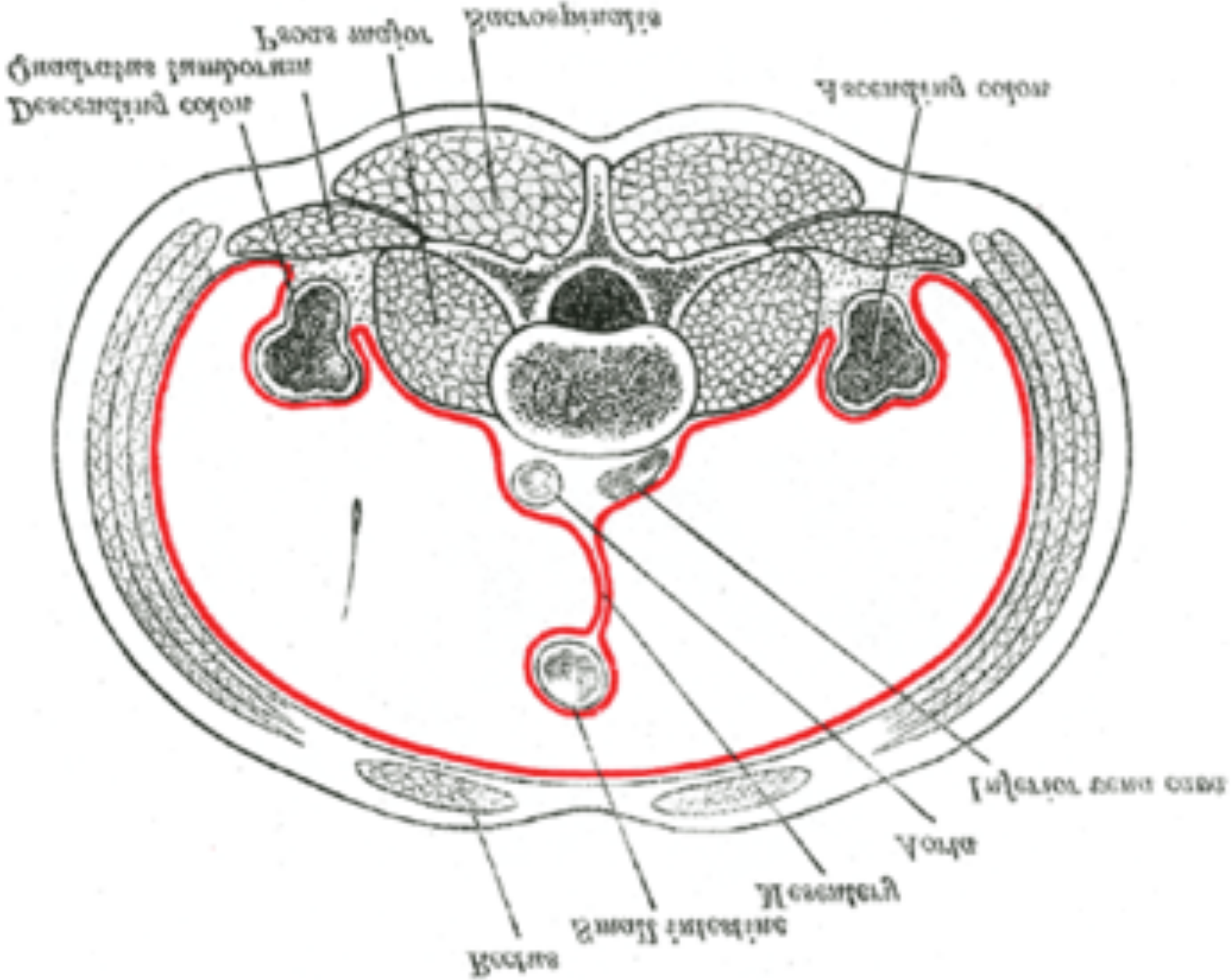
https://www.ehd.org/virtual-human-embryo/

Stylized Body Wall of a Human Embryo



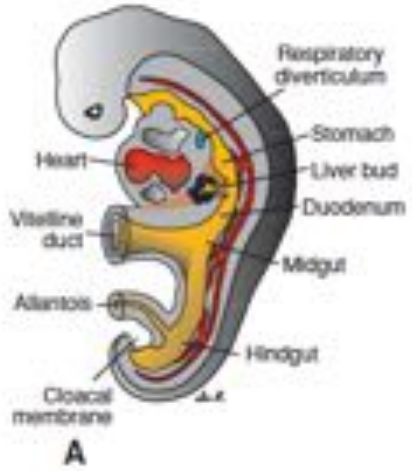
Arey, 1965

Suspensory Ligaments

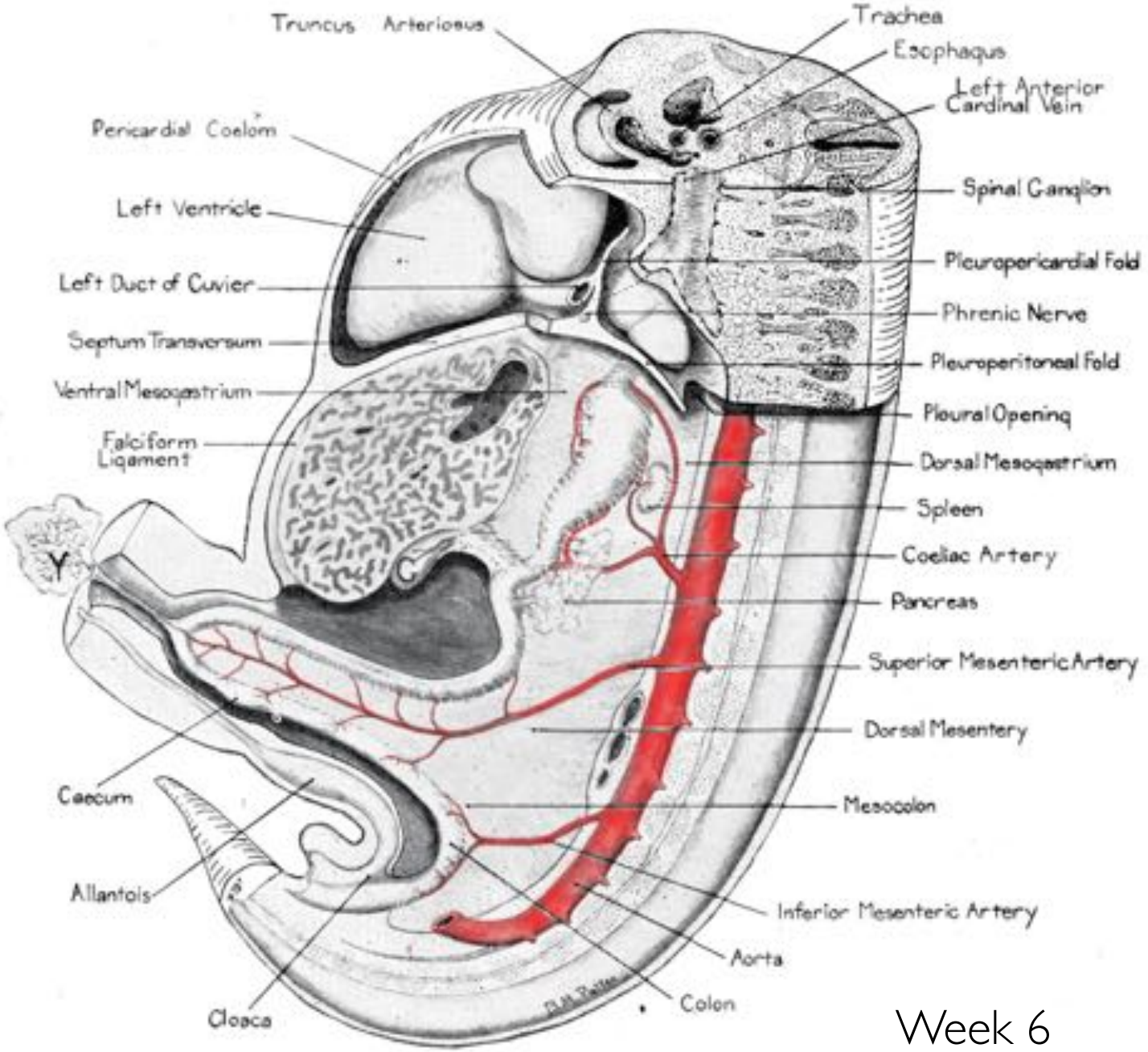


Sagittal View

Innervation of Viscera Established



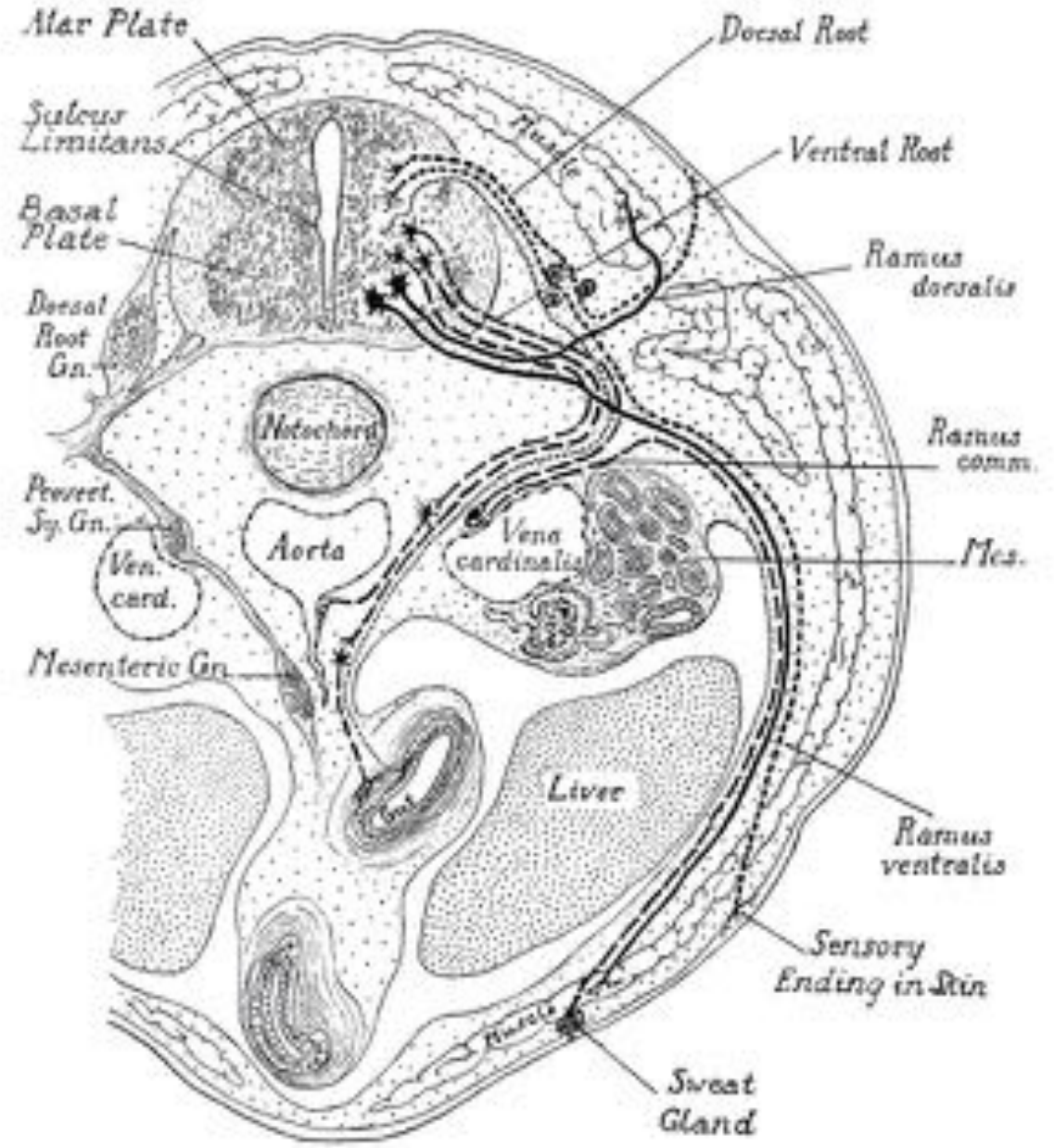
Week 3.5



Week 6

Patten BM. Human Embryology. Philadelphia: The Blakiston Company, 1946.

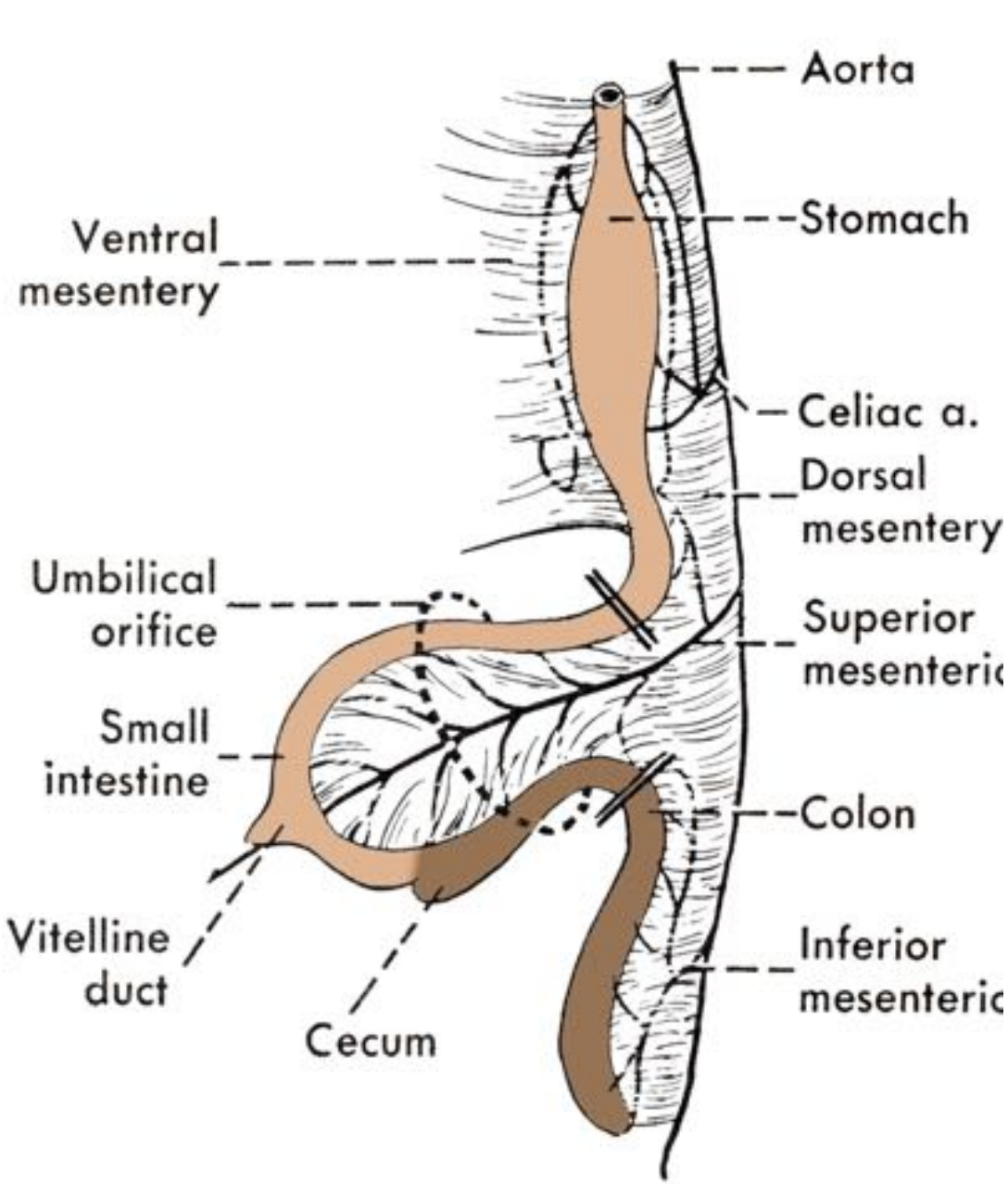
Innervation of the Somite

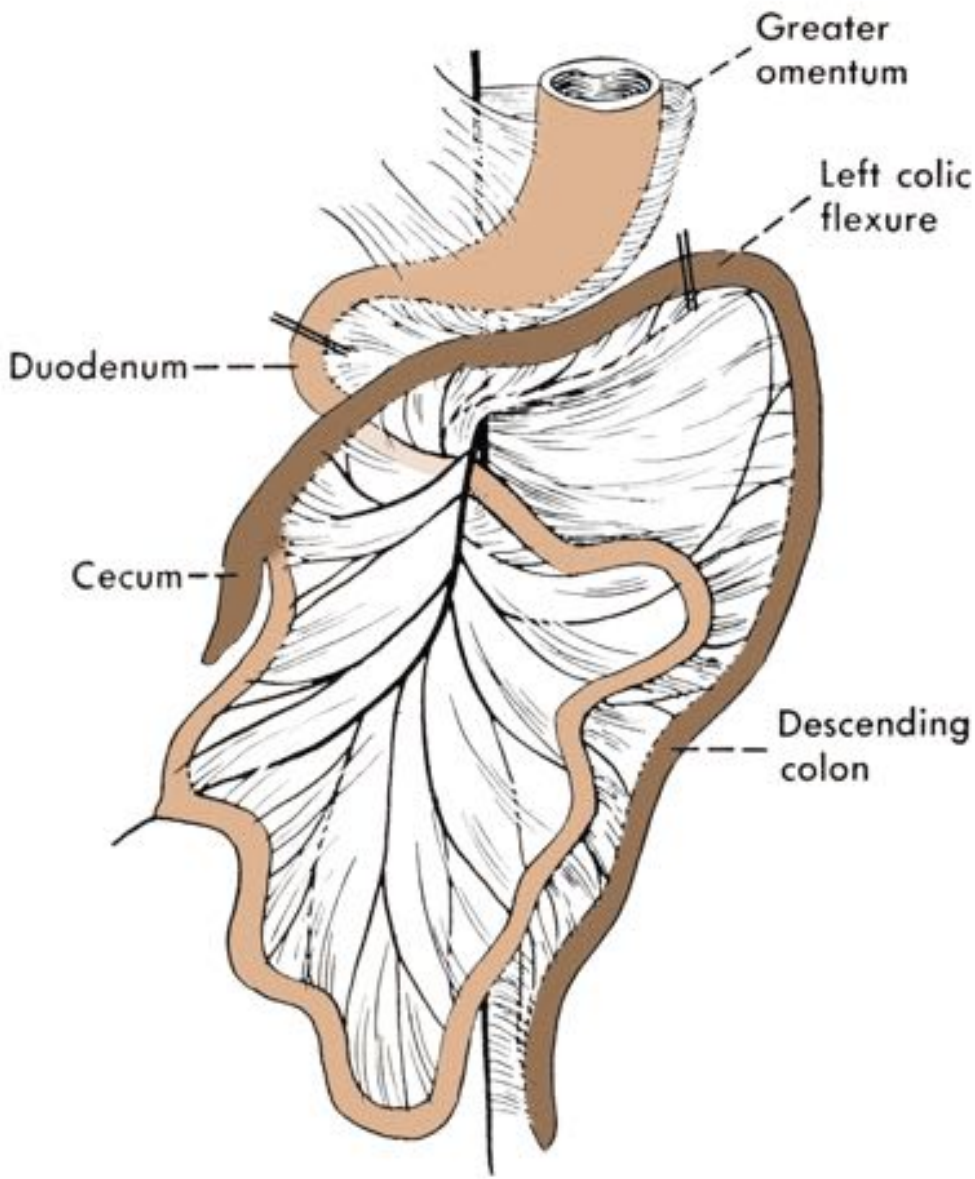


- Dermatome
- Myotome
- Scleratome
- Viscerotome

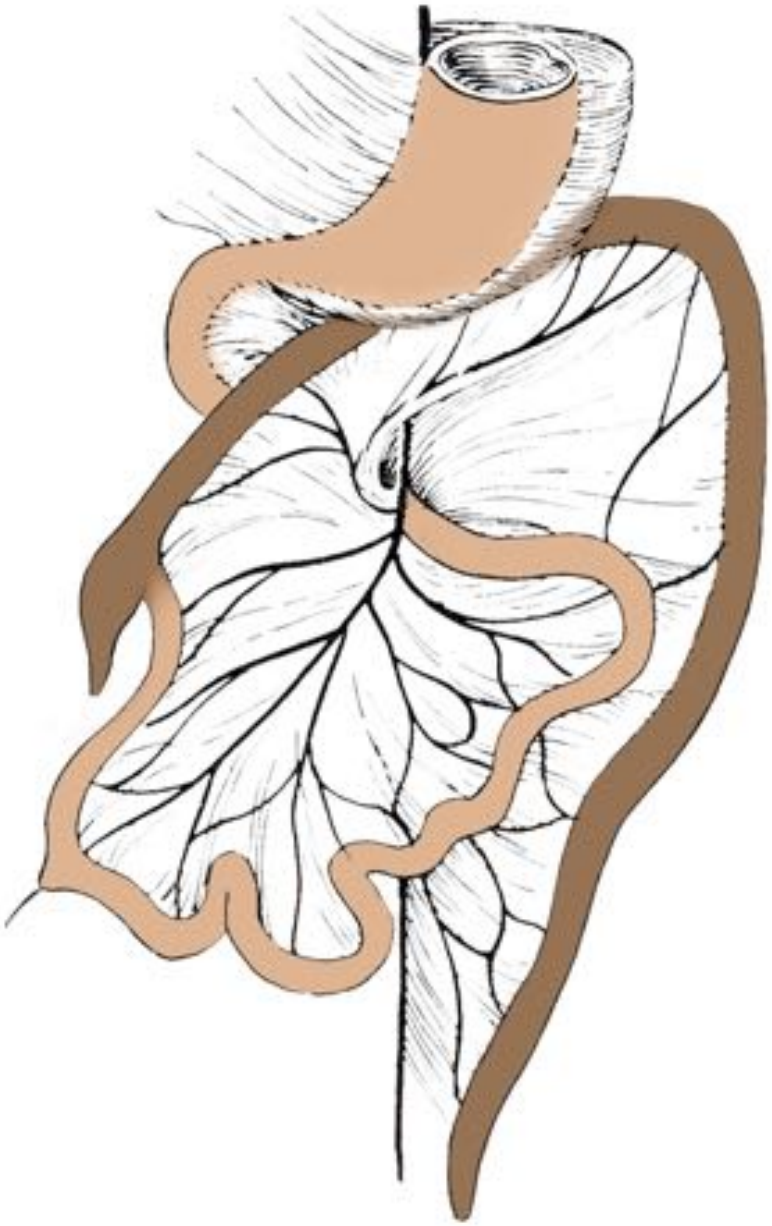
B. M Pattern. *Human Embryology*, Philadelphia:The Blakiston Company, 1946.

Midgut Rotation

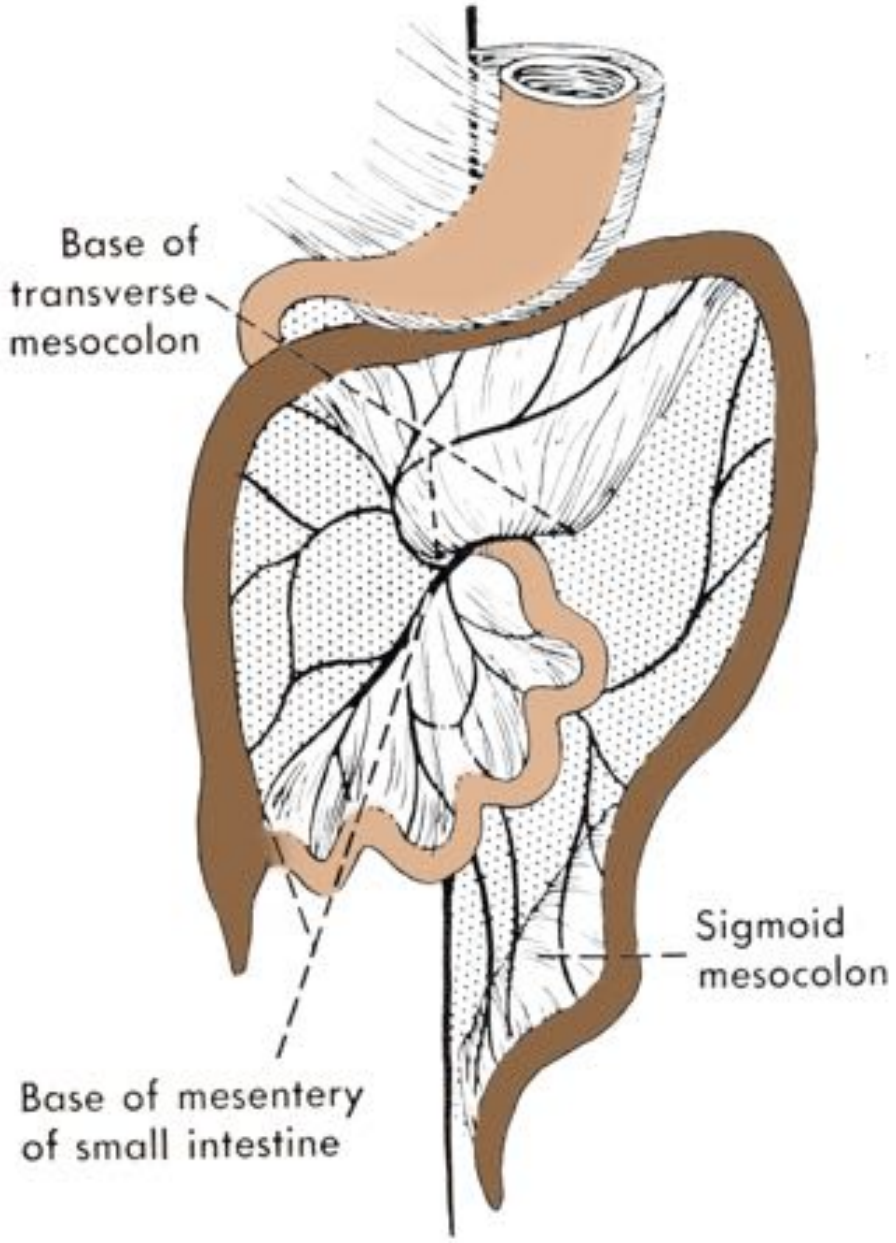




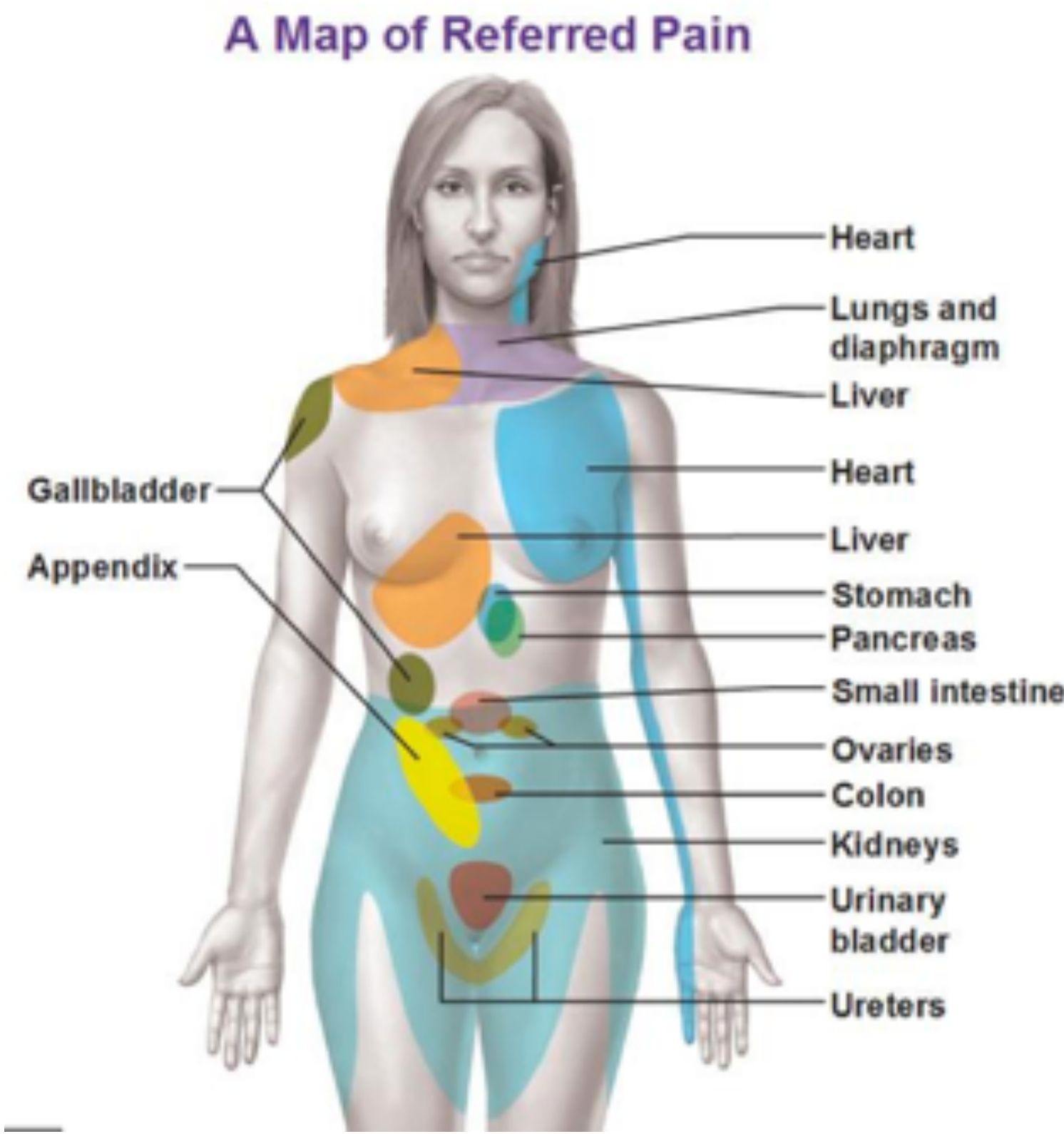
10th Week



11th Week

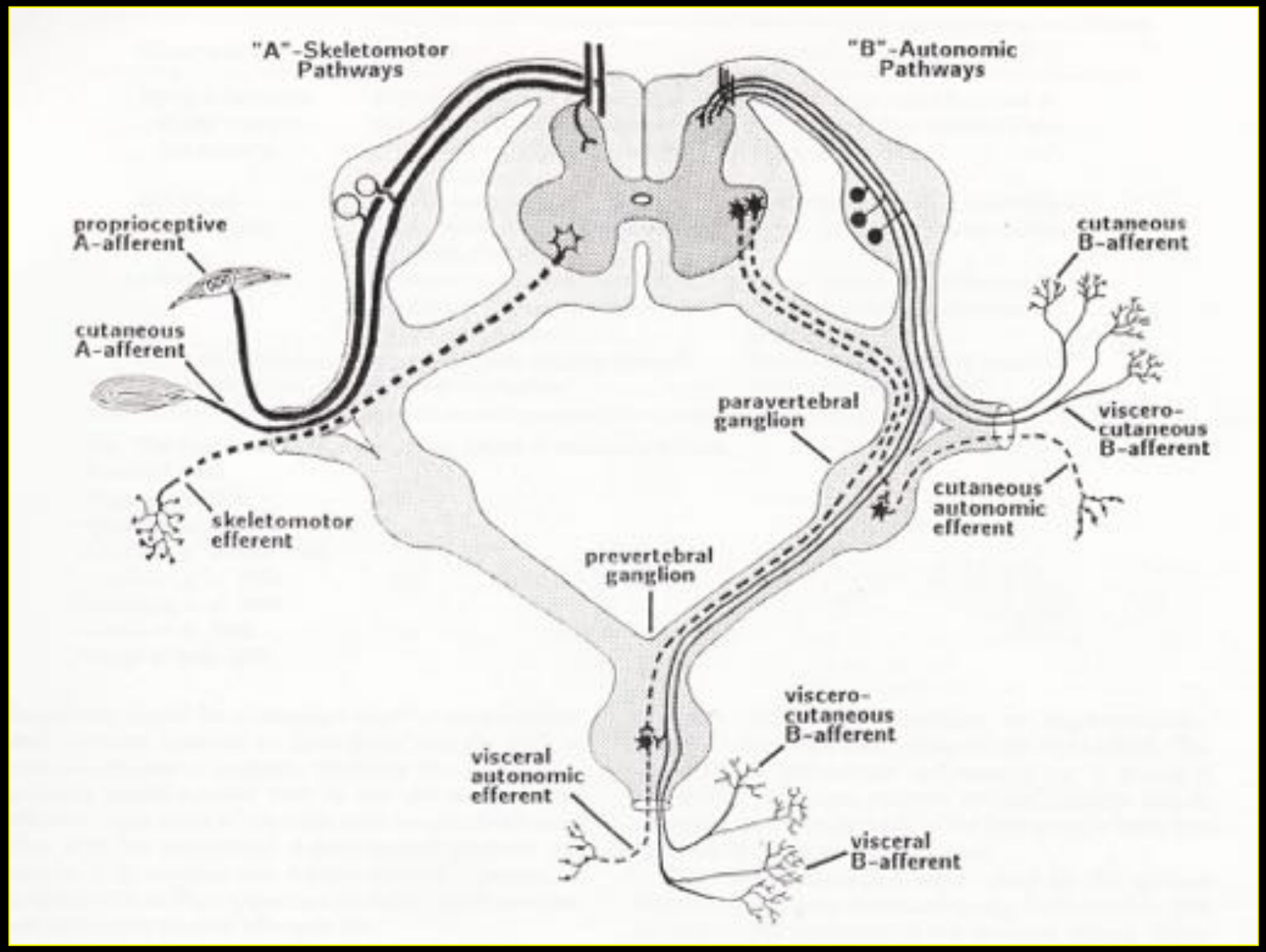


Viscerotopic Body Map



The Innervation of Fascia

Primary Afferent Fibers



Prechtl and Powley, Behav. Brain Sci. 13:289-331, 1990

Muscle

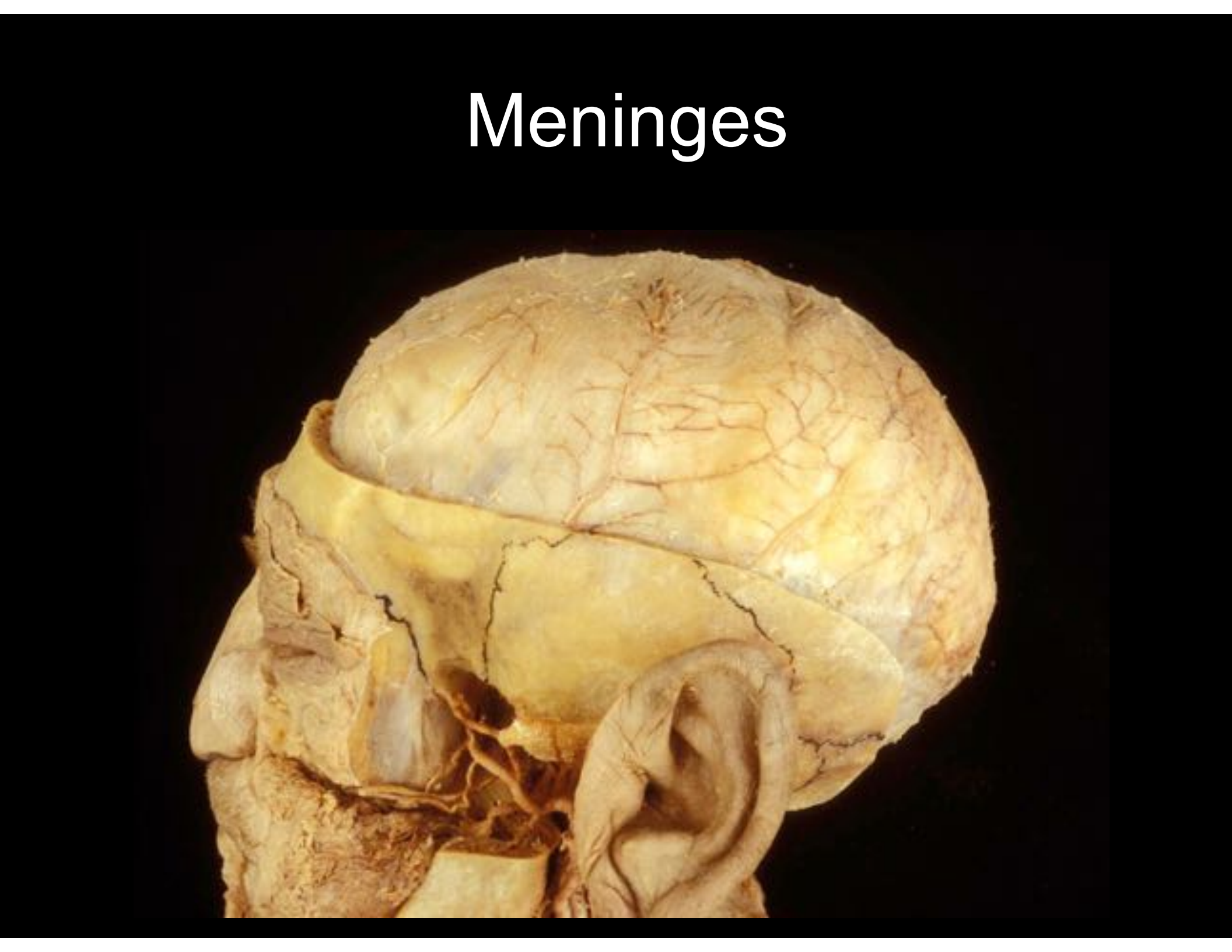
Blood Vessels

Nerves

Joints

Annulus Fibrosis

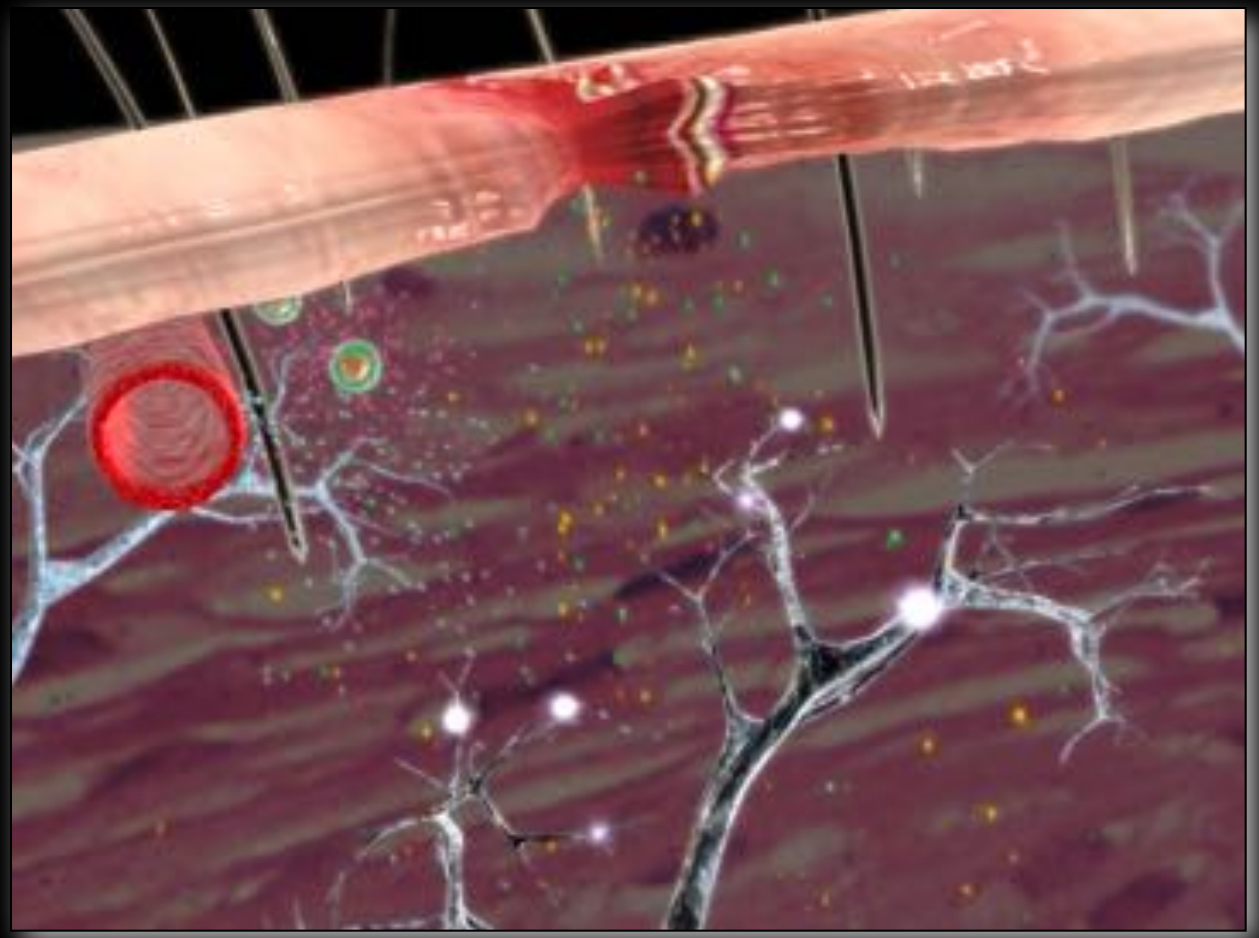
Meninges



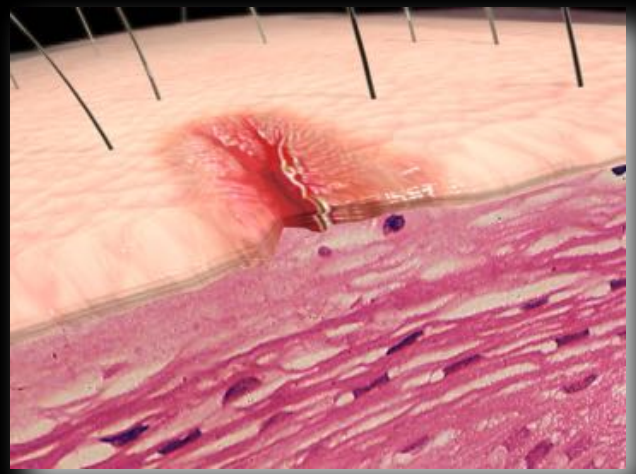
Viscera

Factors Activating PANS

- Bradykinins
- Histamines
- Prostaglandins
- Serotonin
- H^+ and K^+
- Cytokines
- ATP



Neurogenic Inflammatory Cycle



Tissue Inflammation

Histamine

Bradykinin

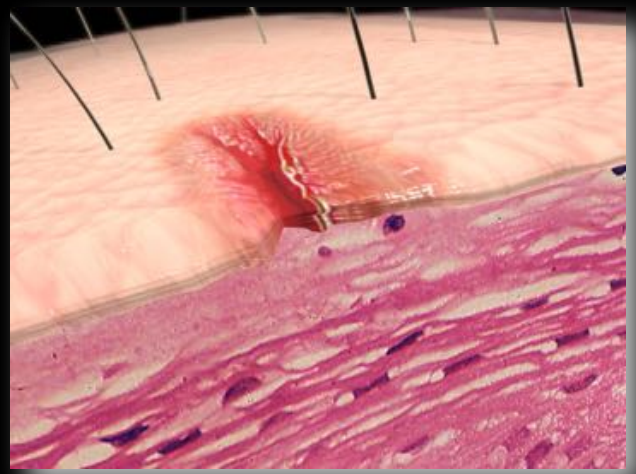
Prostaglandins

Primary Afferent Fibers

Spinal Cord

Neurogenic Inflammatory Cycle

Tissue Inflammation



\+

Neuropeptides

Histamine

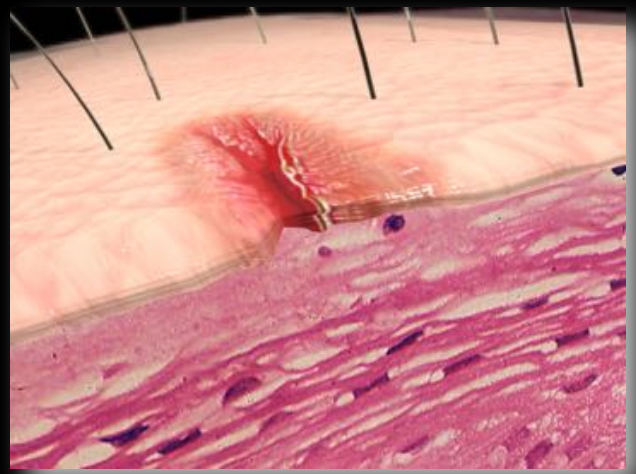
Bradykinin

Prostaglandins

Primary Afferent Fibers

Spinal Cord

Neurogenic Inflammatory Cycle



Tissue Inflammation

\+

Neuropeptides

Histamine

Bradykinin

Prostaglandins

Sensitized Primary Afferent Fibers

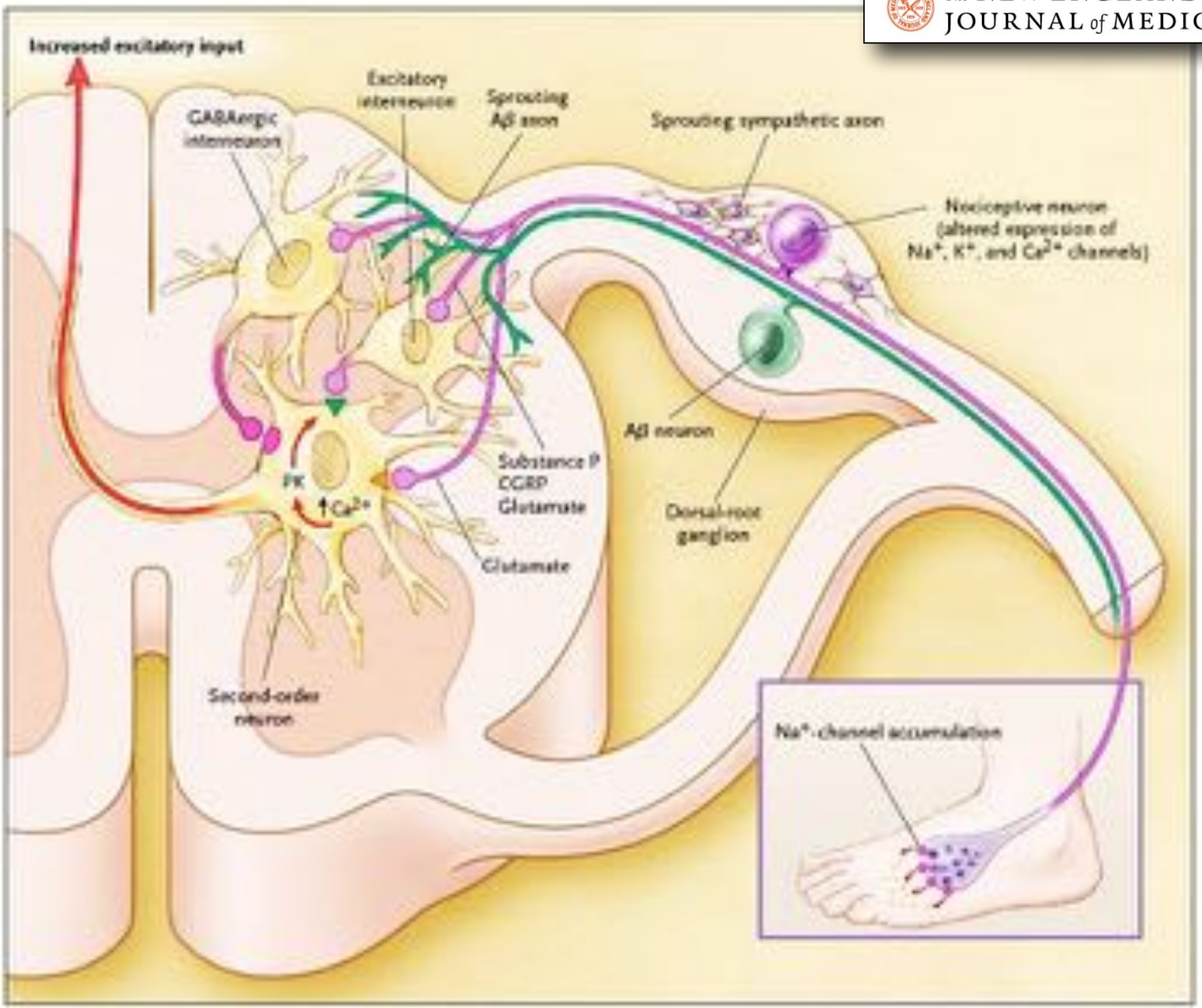
Spinal Cord

Results of PAN Activation

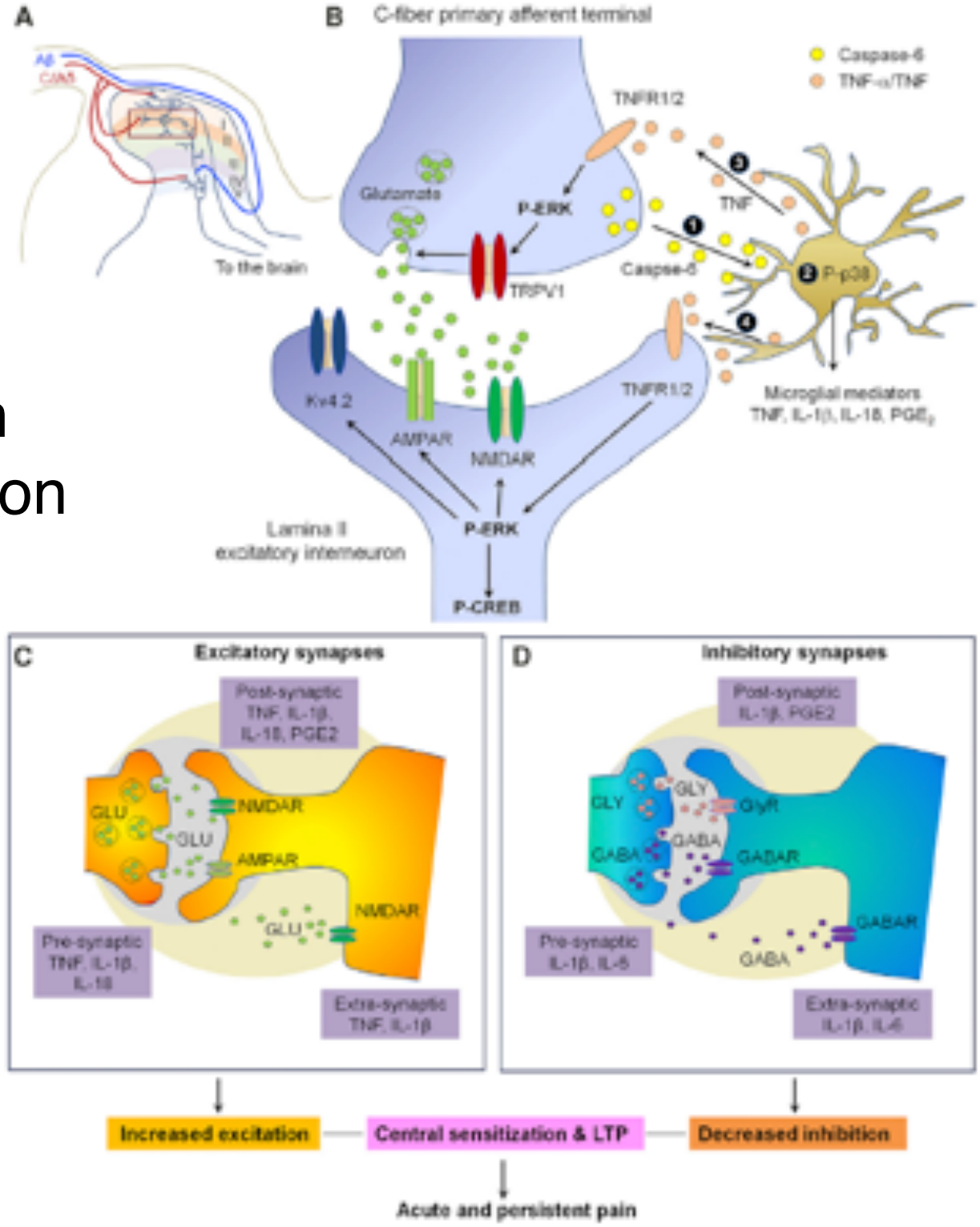
- Lowering of thresholds
- Development of hyperalgesia

"Peripheral Sensitization"

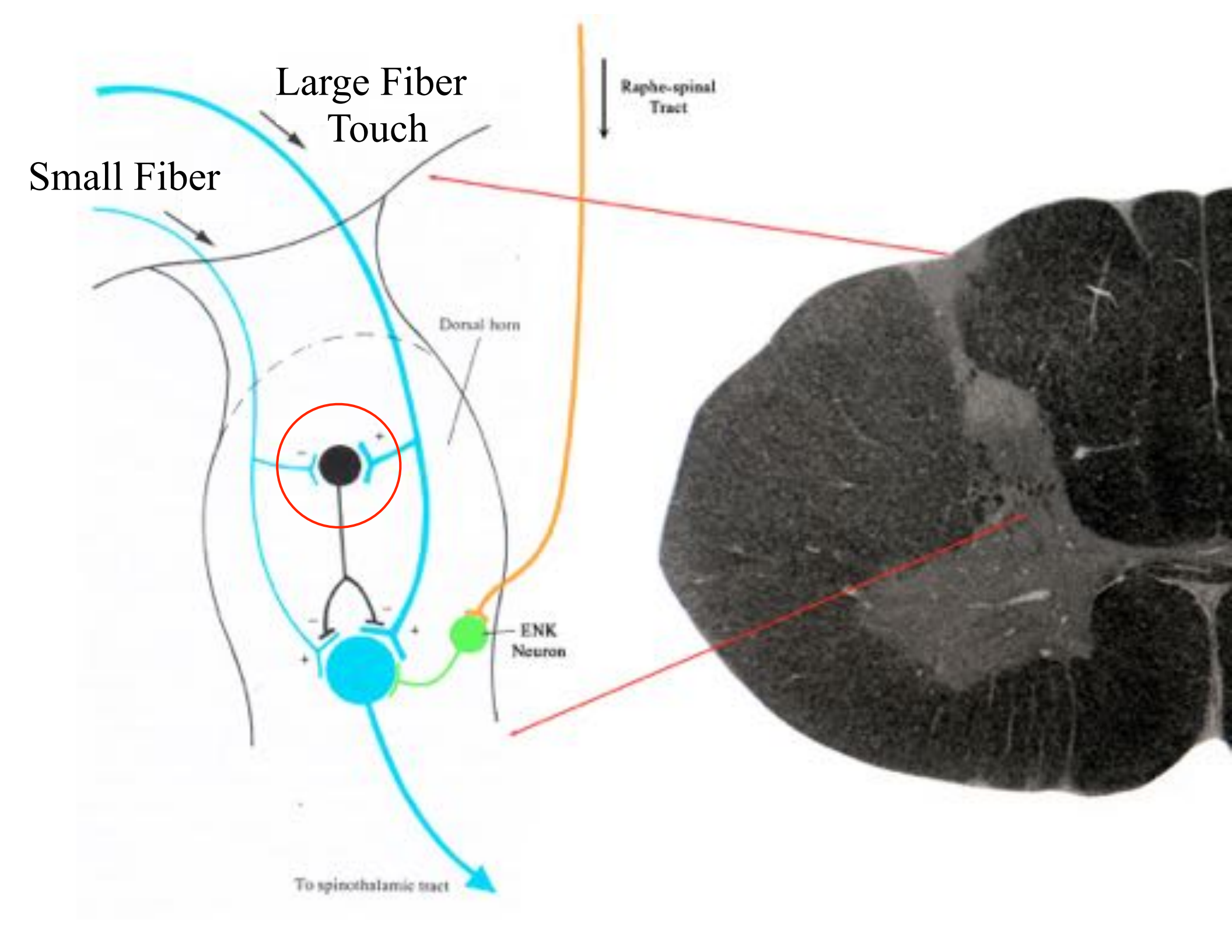
The NEW ENGLAND JOURNAL of MEDICINE

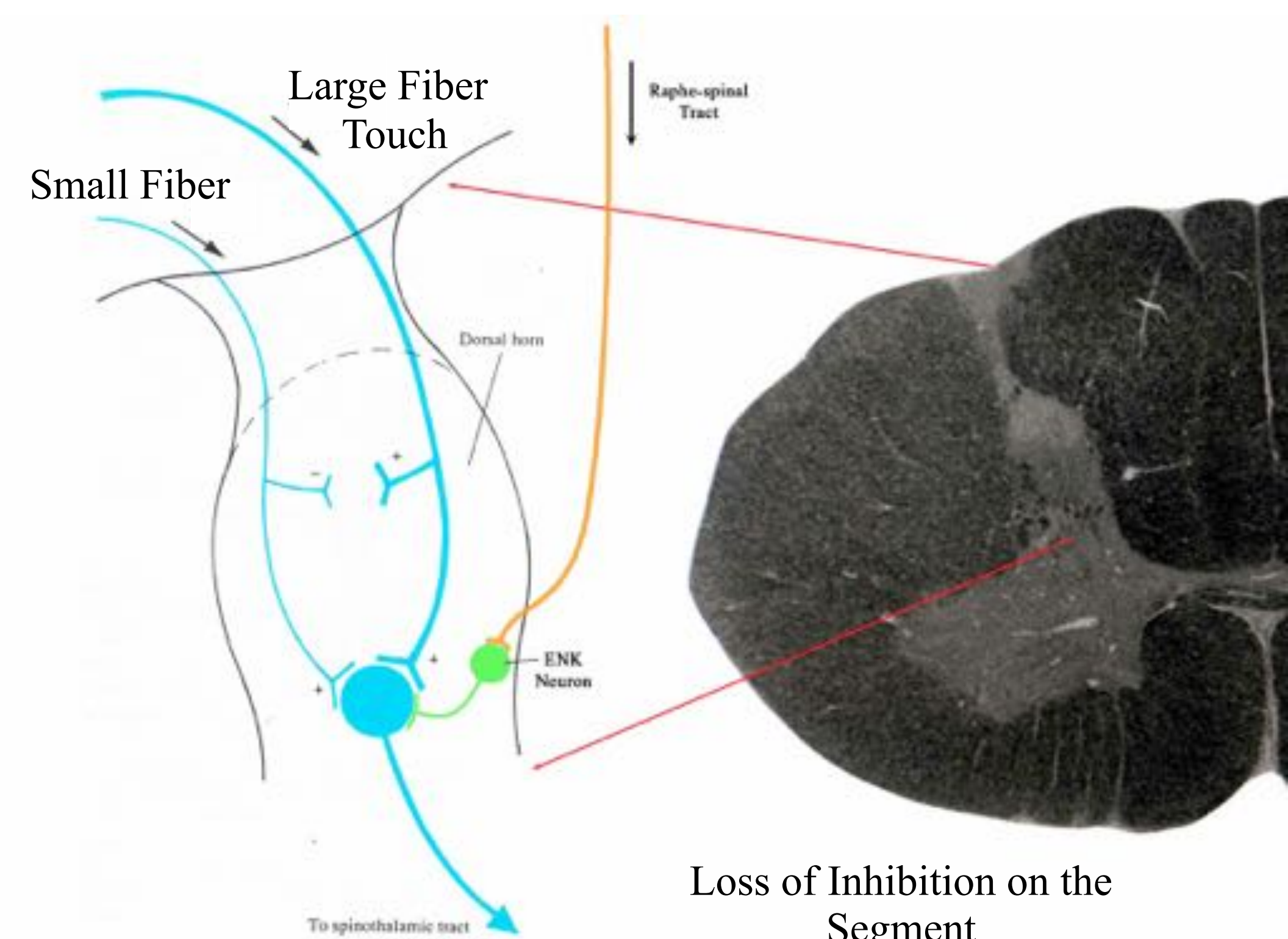


The Role of the Microglial Cell in Central Sensitization



Chen, G., Y.Q. Zhang, Y.J. Qadri, C.N. Serhan, and R.R. Ji. 2018. Microglia in Pain: Detrimental and Protective Roles in Pathogenesis and Resolution of Pain. Neuron. 100:1292-1311.

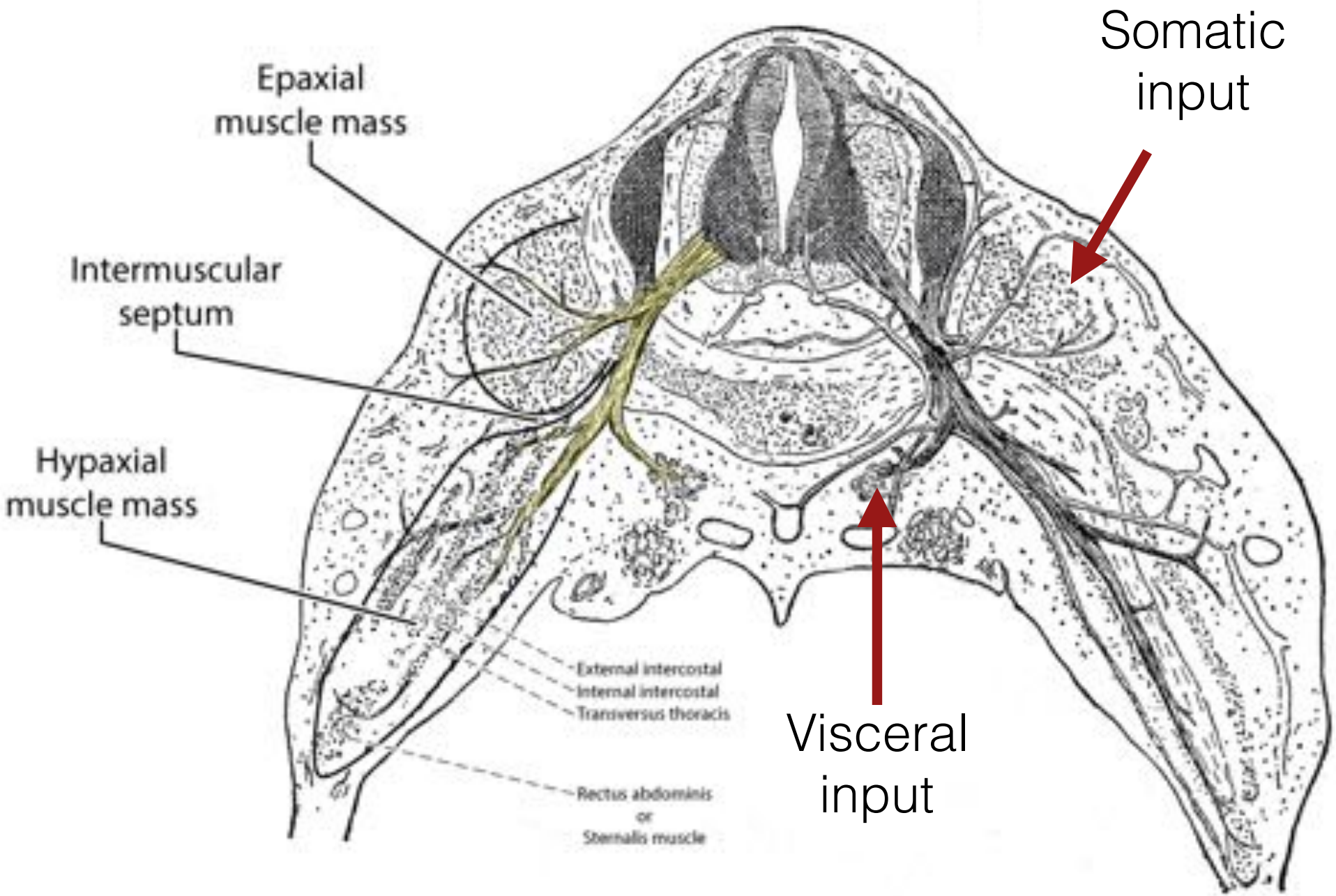

Large Fiber
Touch
Small Fiber
Raphe-spinal
Tract
Dorsal horn
ENK
Neuron
To spinothalamic tract

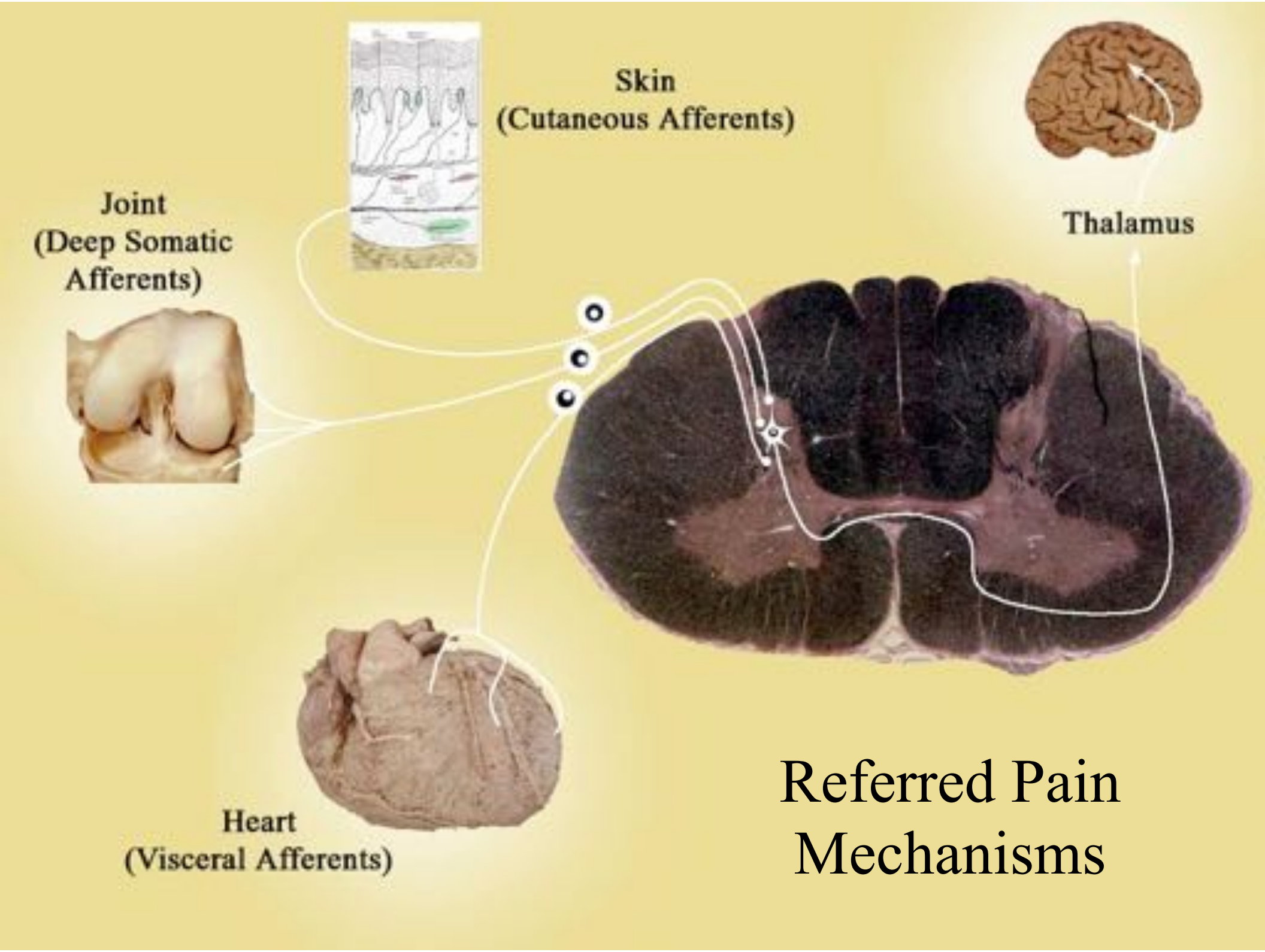


Loss of Inhibition on the Segment

Peripheral & Central Sensitization

Viscerosomatic Integration

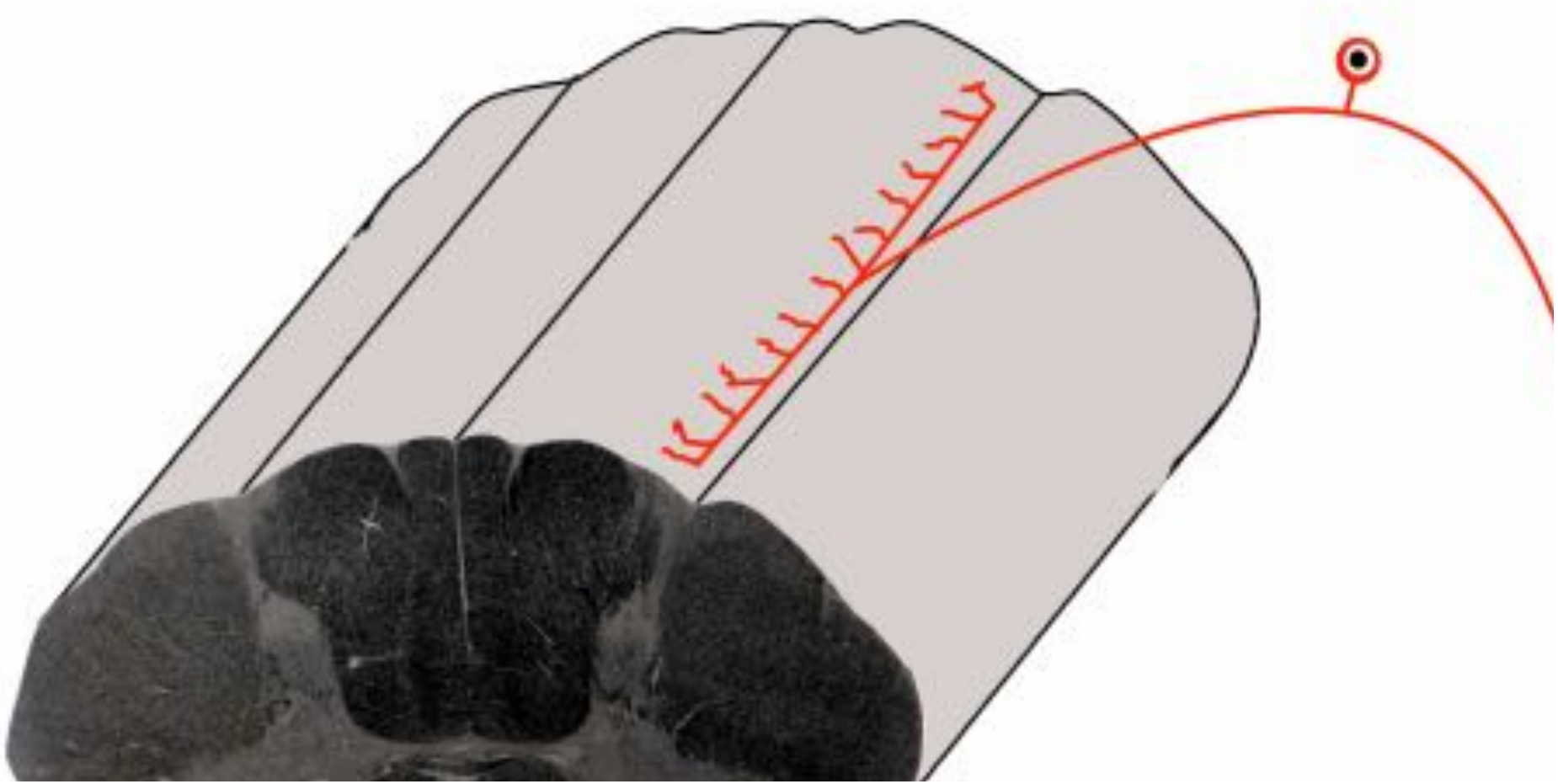




Referred Pain Mechanisms

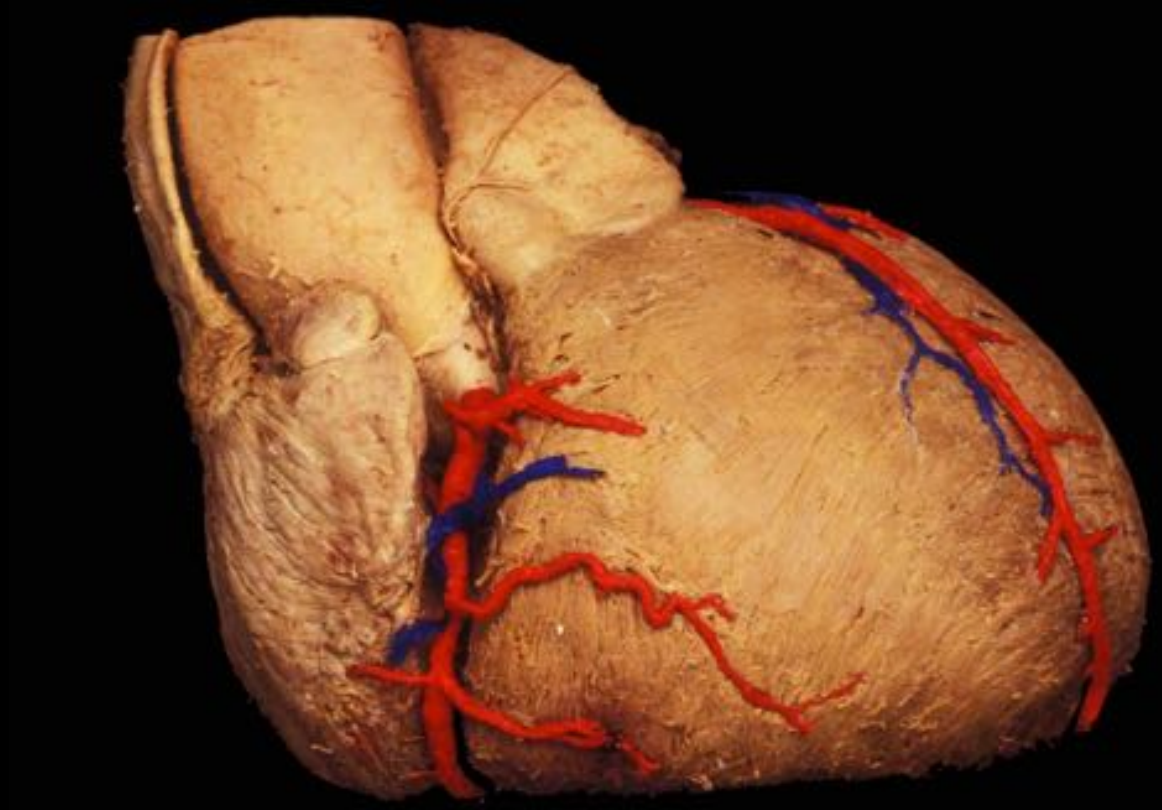
Primary Afferent Fibers

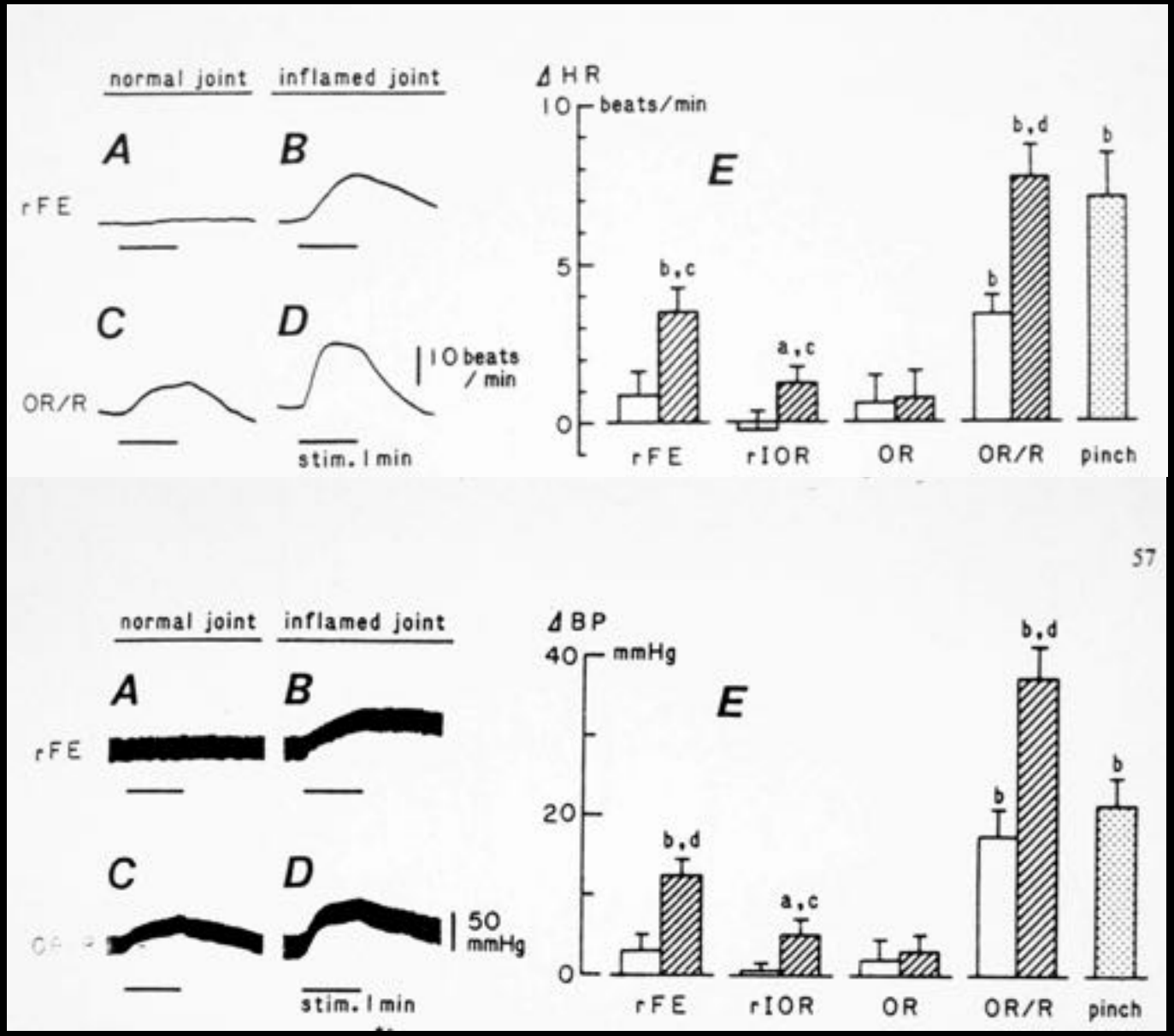
Central Processes



Somatocardiac Reflex

- Nociceptive somatic stimuli
- Elevation of heart rate and blood pressure





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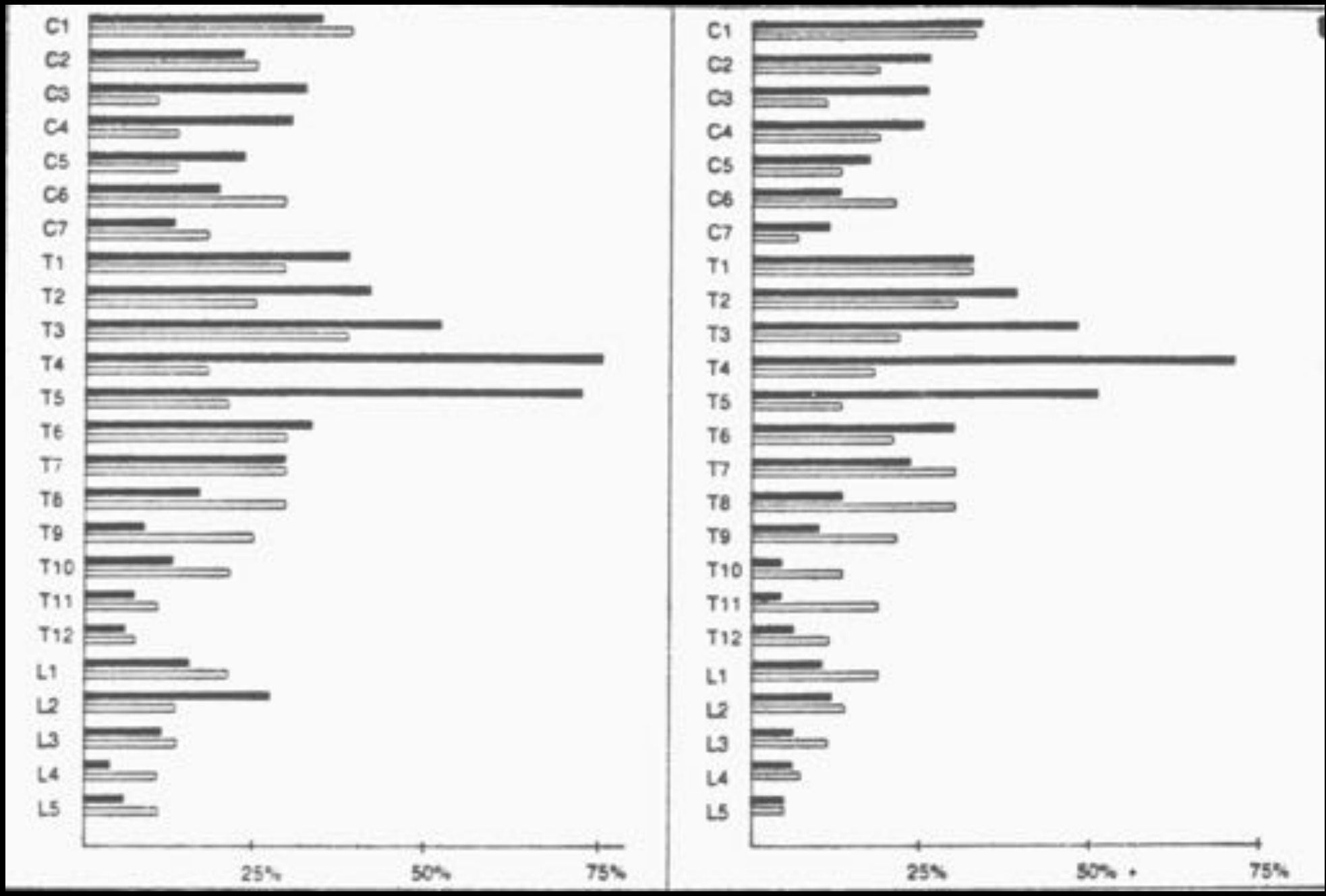
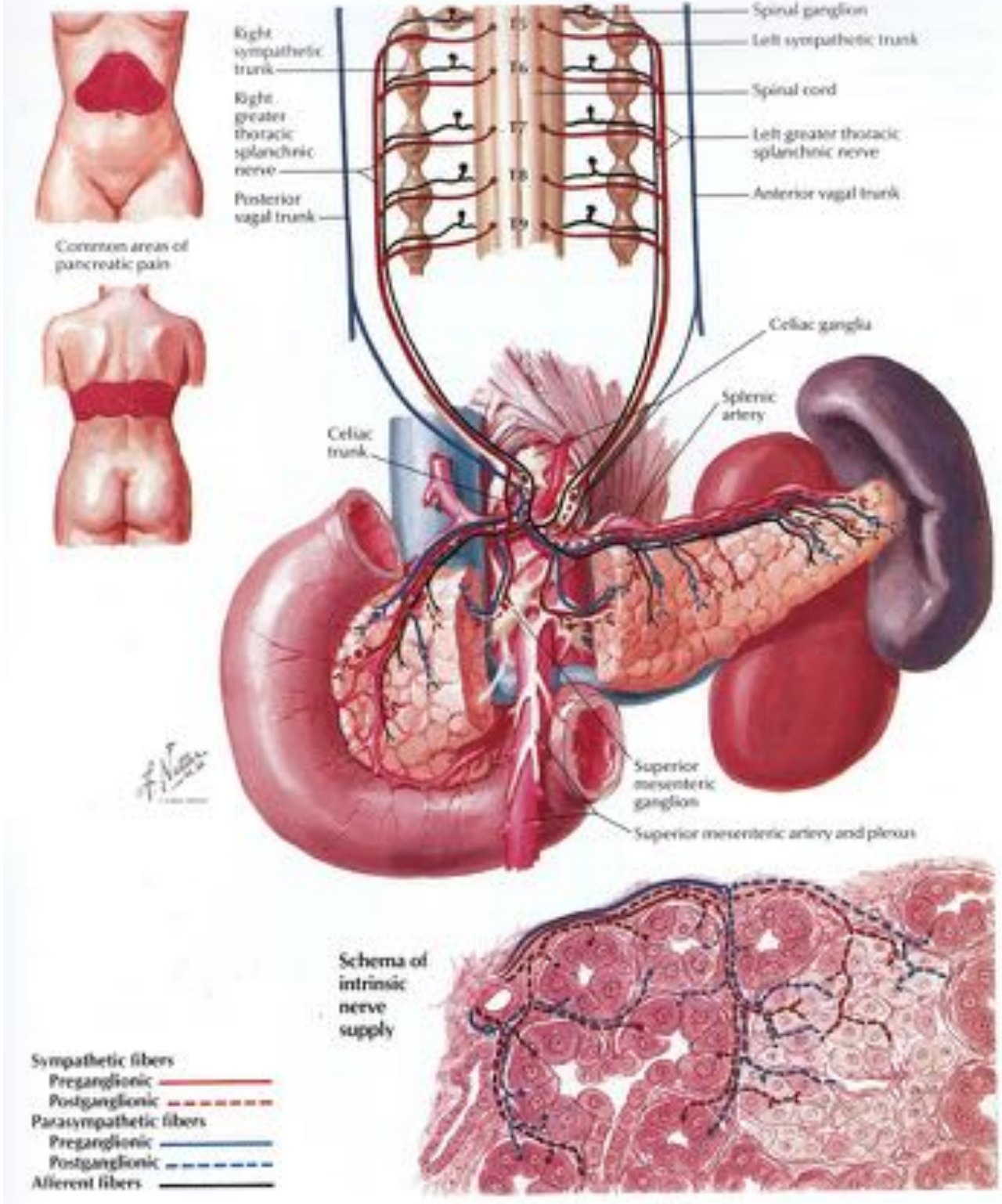
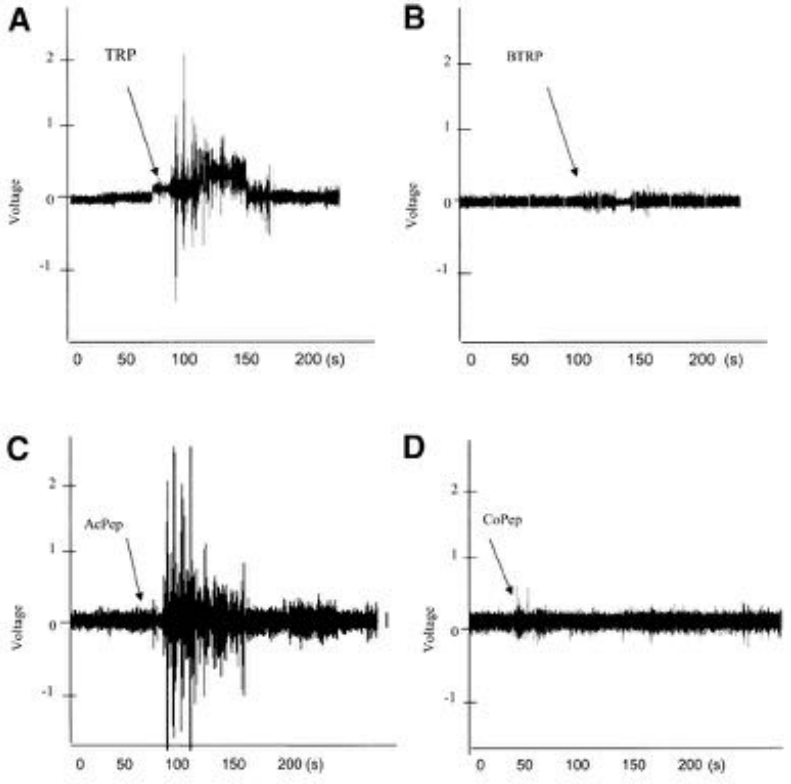


J. M. Cox, S. Gorbis, L. M. Dick, J. C. Rogers, and F. J. Rogers. Palpable musculoskeletal findings in coronary artery disease: results of a double-blind study. *J.A.O.A.* 82:832-836, 1983


Common areas of pancreatic pain
Right sympathetic trunk
Right greater thoracic splanchnic nerve
Posterior vagal trunk
T5
T6
T7
T8
T9
Spinal ganglion
Left sympathetic trunk
Spinal cord
Left greater thoracic splanchnic nerve
Anterior vagal trunk
Celiac ganglia
Splenic artery
Celiac trunk
Superior mesenteric ganglion
Superior mesenteric artery and plexus
Schema of intrinsic nerve supply
Sympathetic fibers
Preganglionic
Postganglionic
Parasympathetic fibers
Preganglionic
Postganglionic
Afferent fibers

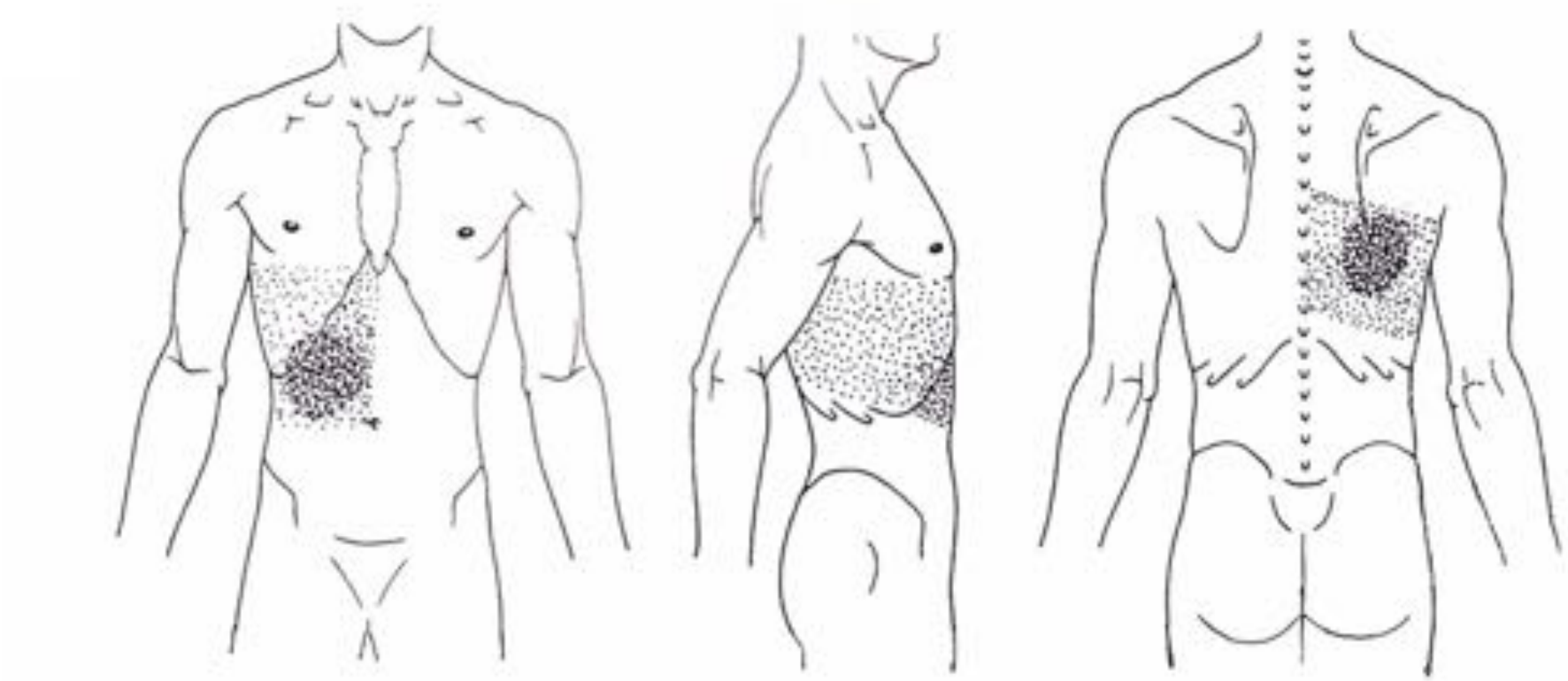
Pancreaticosomatic Reflexes

- Stimulation of the pancreatic duct with trypsin
- Enhance EMG activity in the acromiotrapezius muscle of the back



Hoogerwerf et al,. Trypsin mediates nociception via the proteinase-activated receptor 2: a potentially novel role in pancreatic pain. Gastroenterol. 127 (3):883-891, 2004.

Referred Gall Bladder Pain

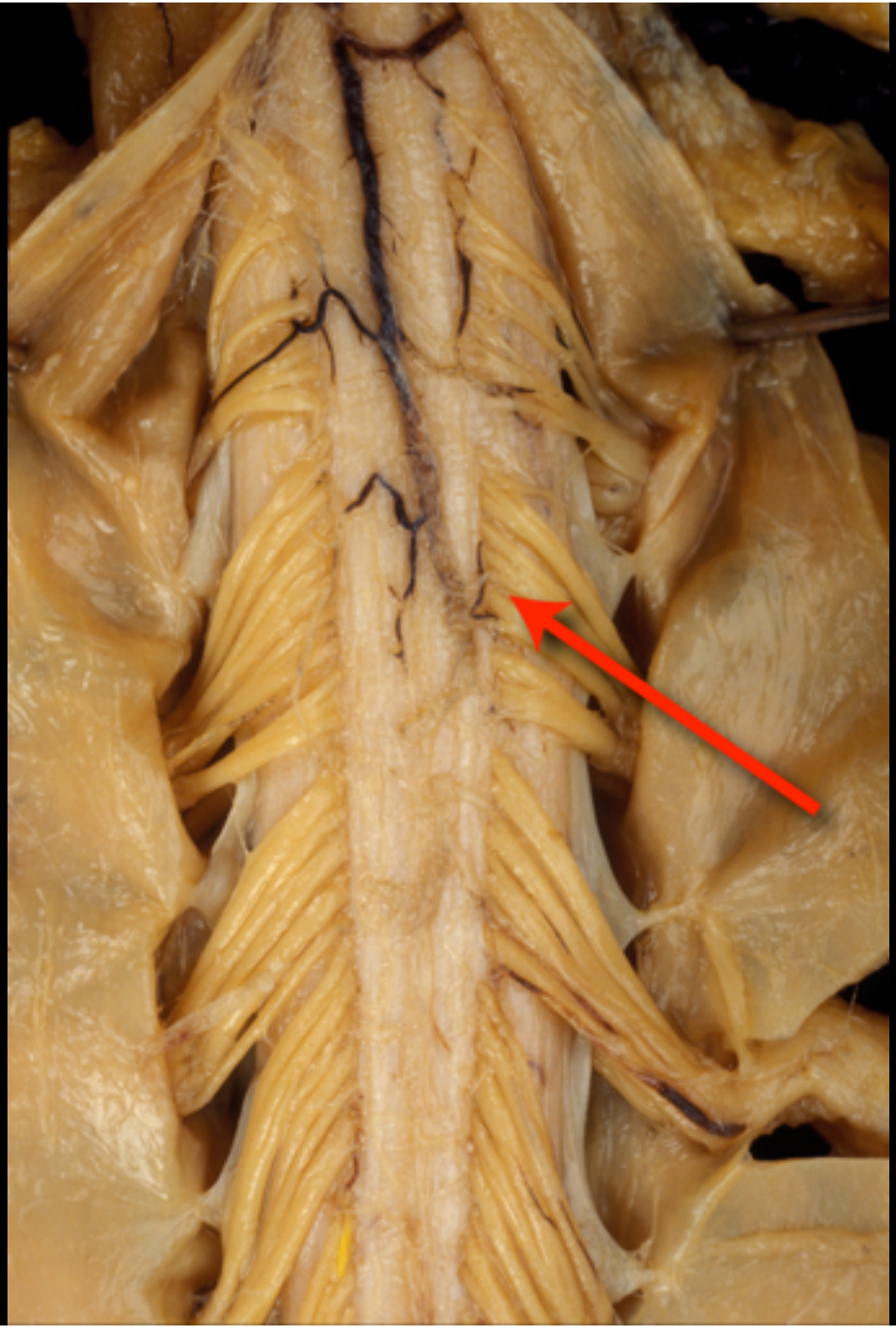


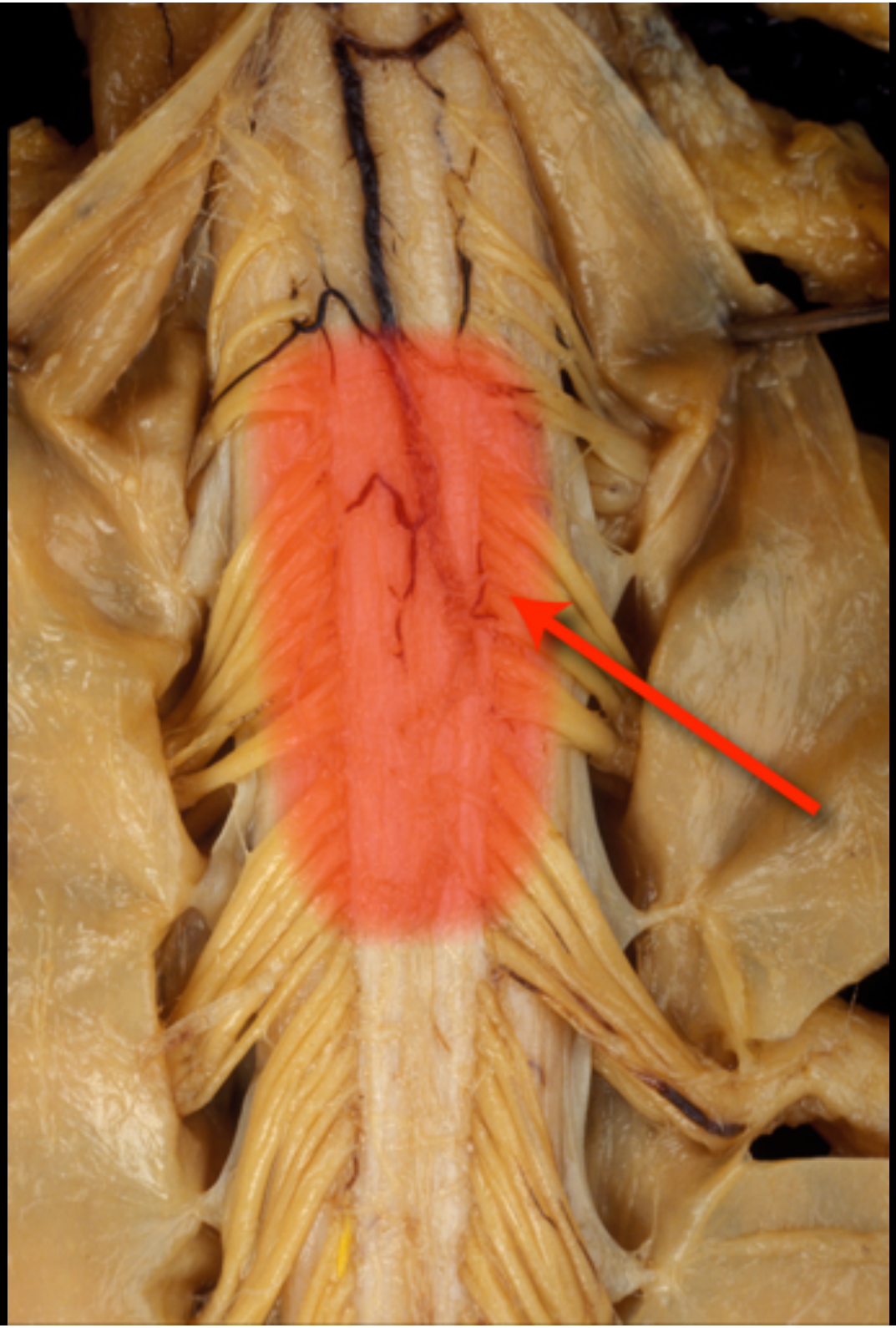
M. A. Giamberardino, G. Affaitati, and R. Costantini. Referred pain from internal organs. *Hdbk Clin.Neurol.* 81 (3rd Series):343-361, 2006

Trophic Changes

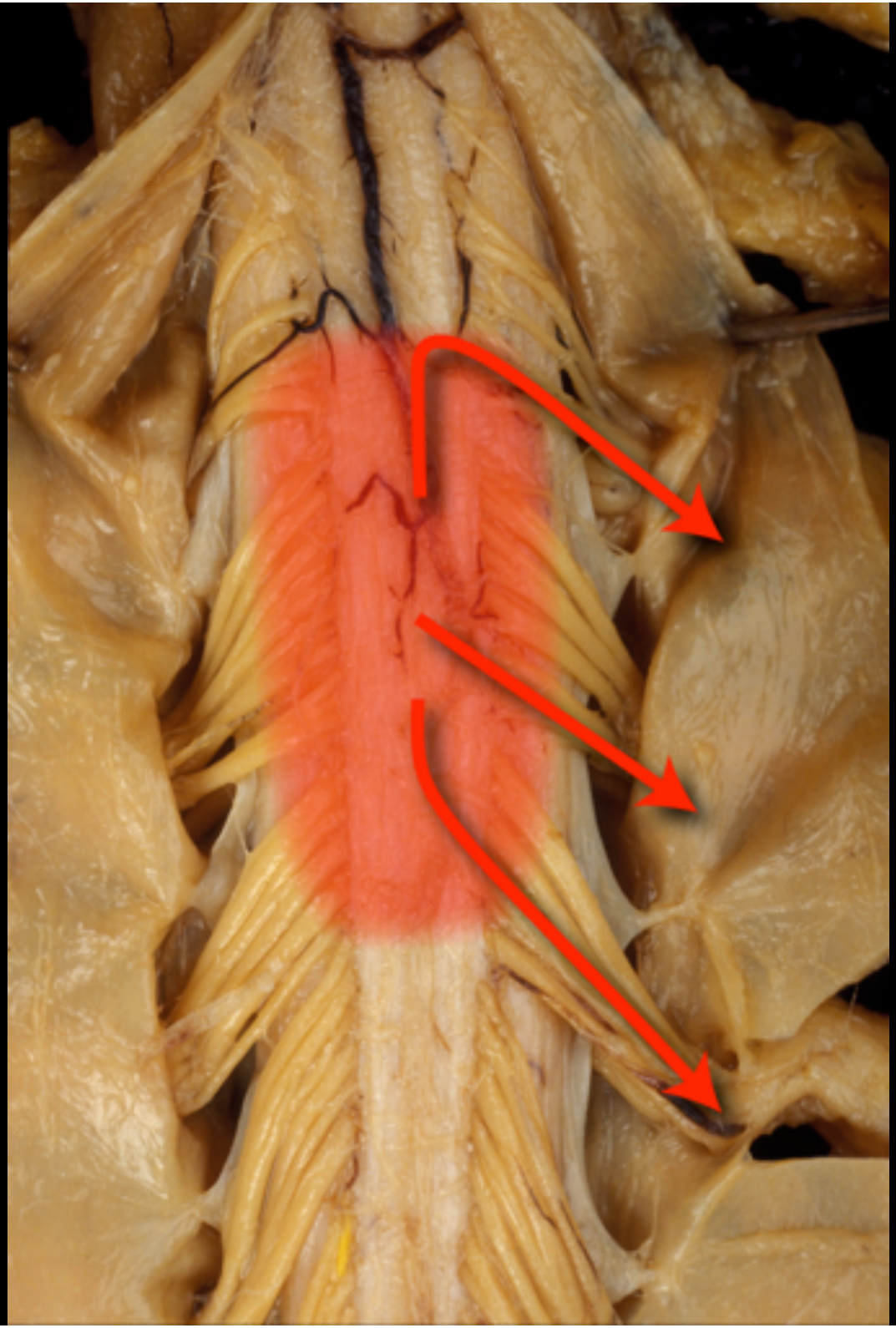
- Increased thickness of the subcutaneous tissue
  - Firmness not related to edema
- Decreased thickness in the associated muscle layers
  - Muscle atrophy
- Degree of change related to duration of painful episodes

M. A. Giamberardino, G. Affaitati, and R. Costantini. Referred pain from internal organs. *Hdbk Clin.Neurol.* 81 (3rd Series):343-361, 2006

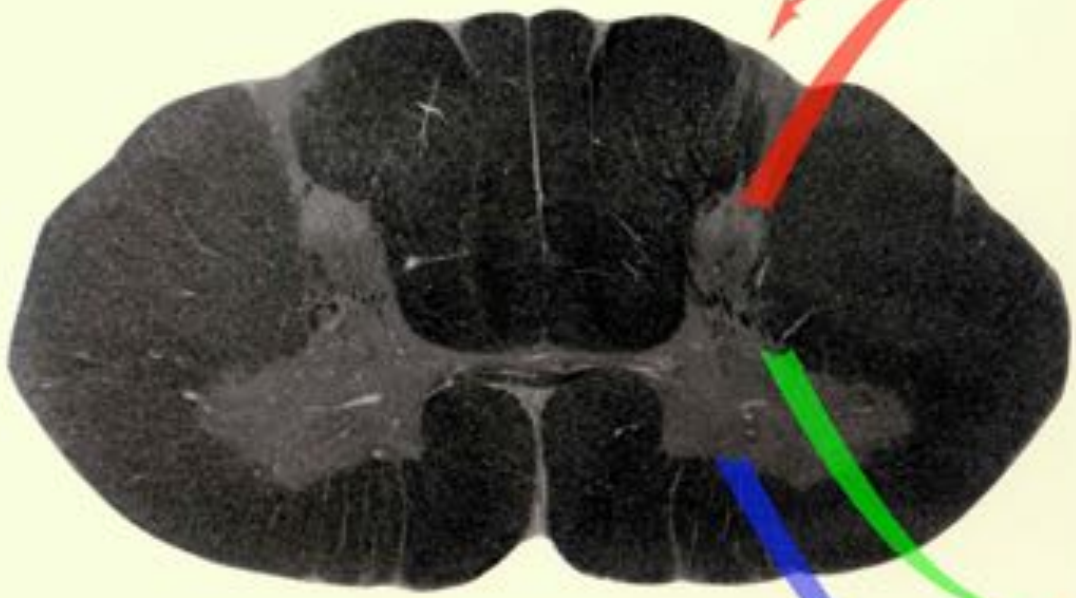




Dorsal Root Reflexes



Spinal Facilitation



Primary Afferernt Nociceptors

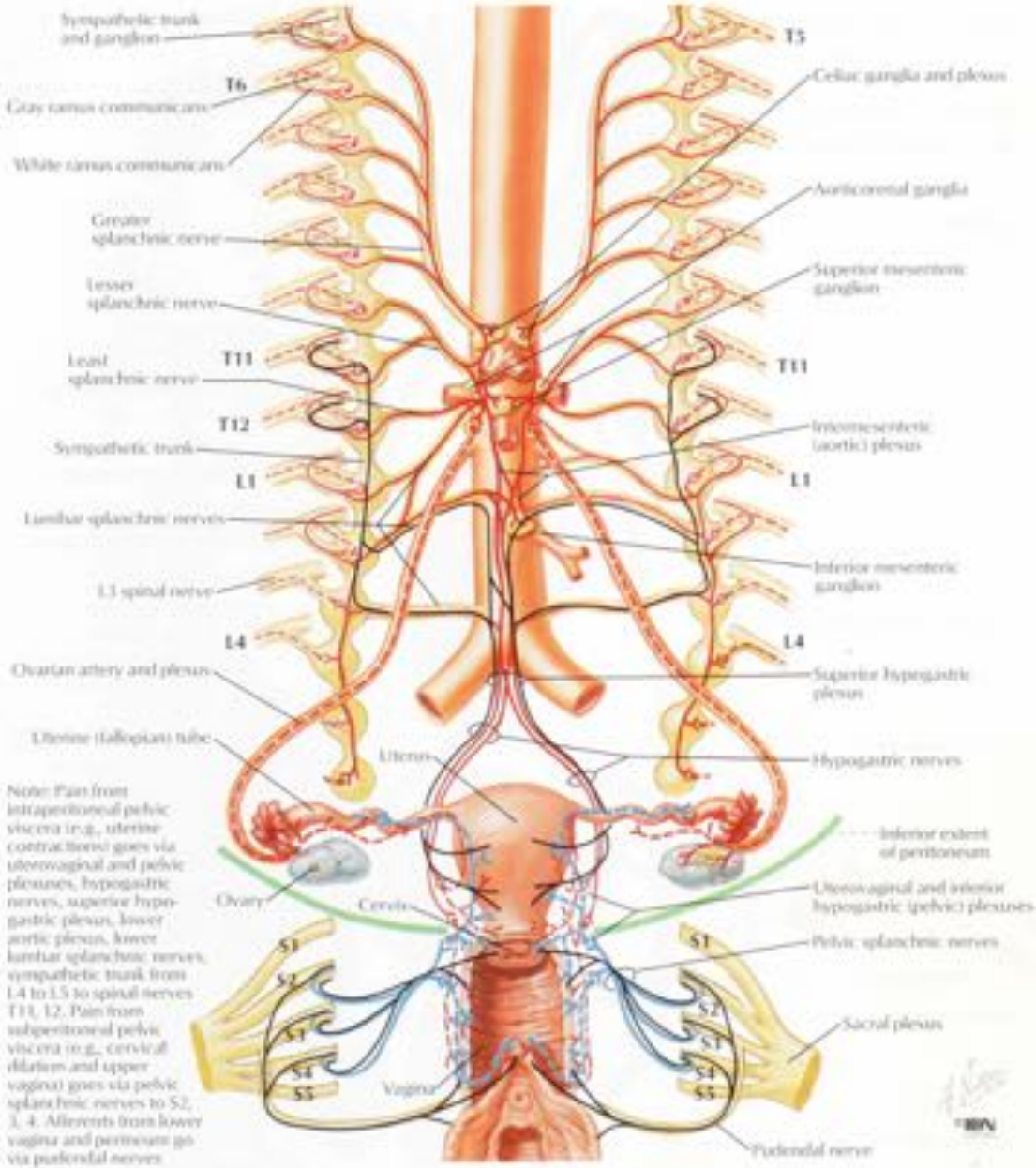
Dorsal Horn Outflow

Lateral Horn Outflow

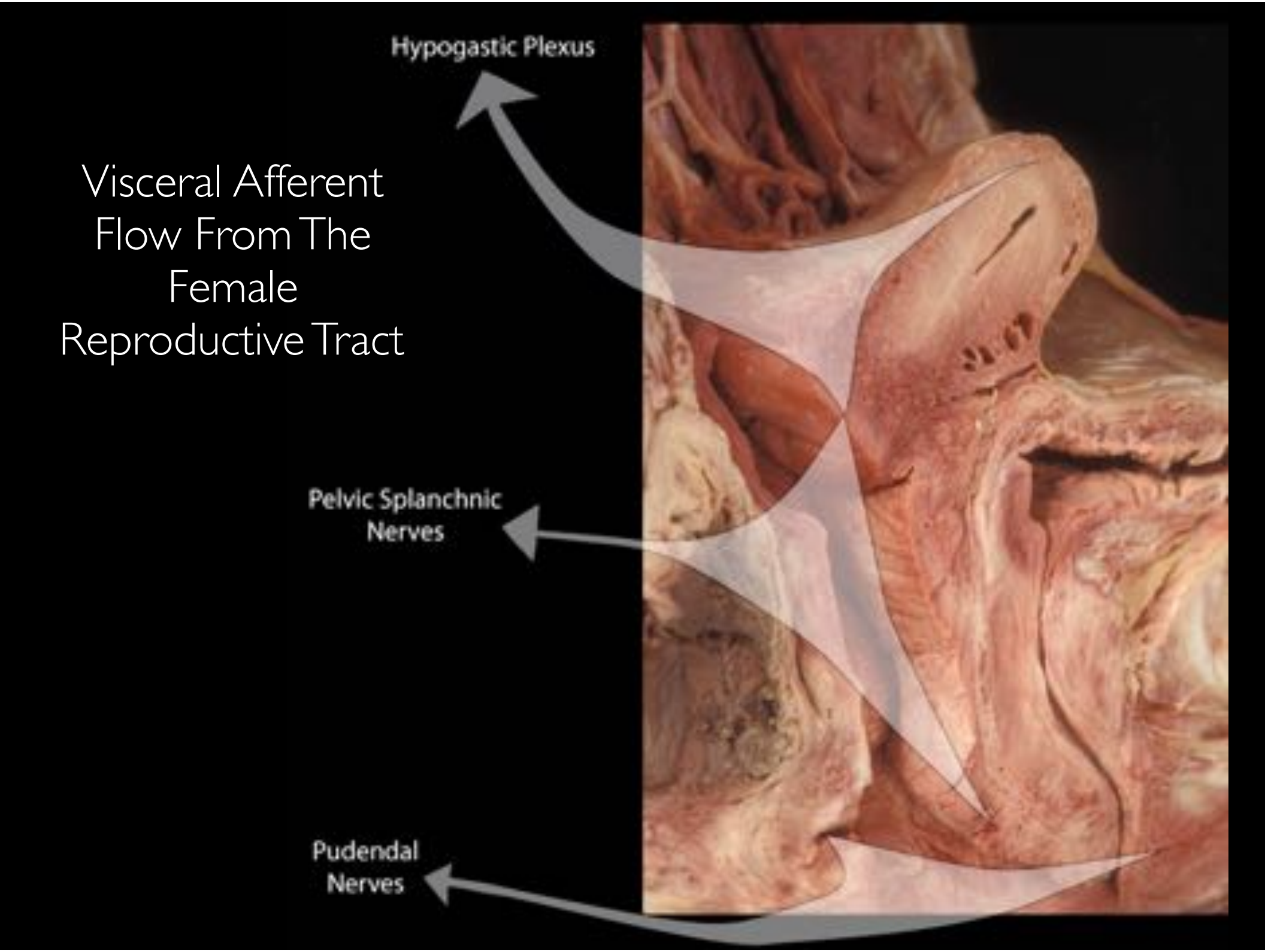
Ventral Horn Outflow

Innervation of Female Reproductive Organs: Schema

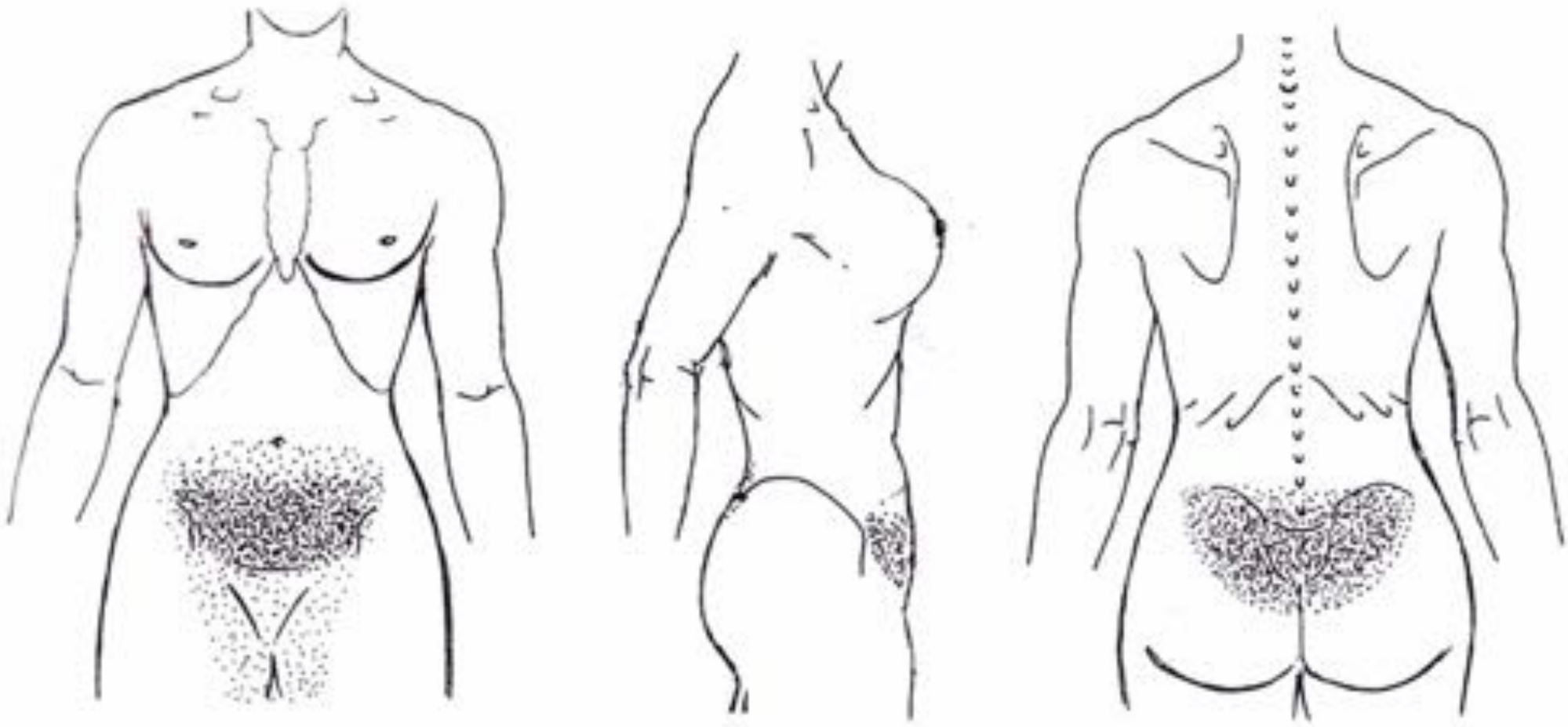
SEE ALSO PLATE 153



Visceral Afferent Flow From The Female Reproductive Tract

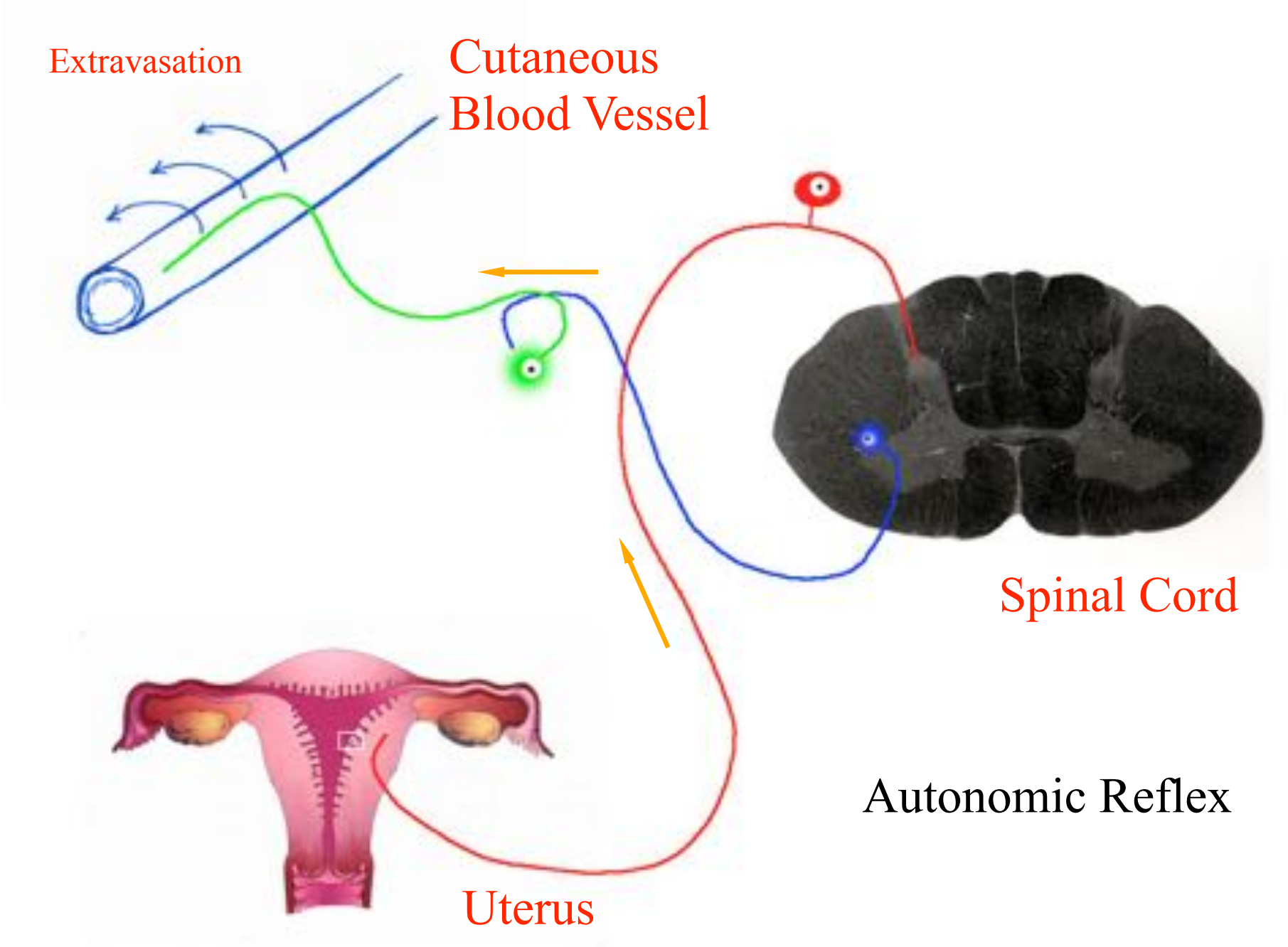


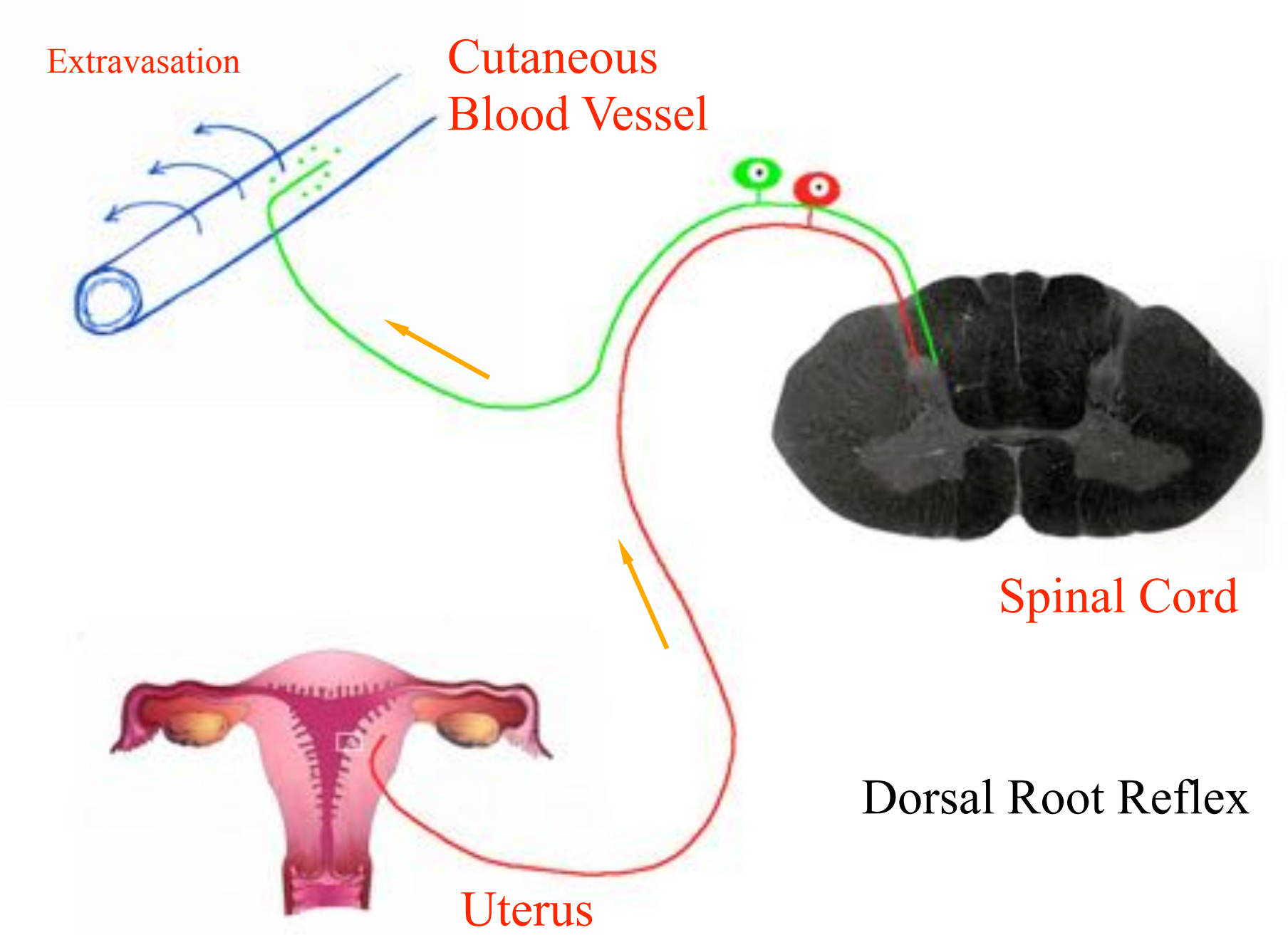
Referred Uterine Pain



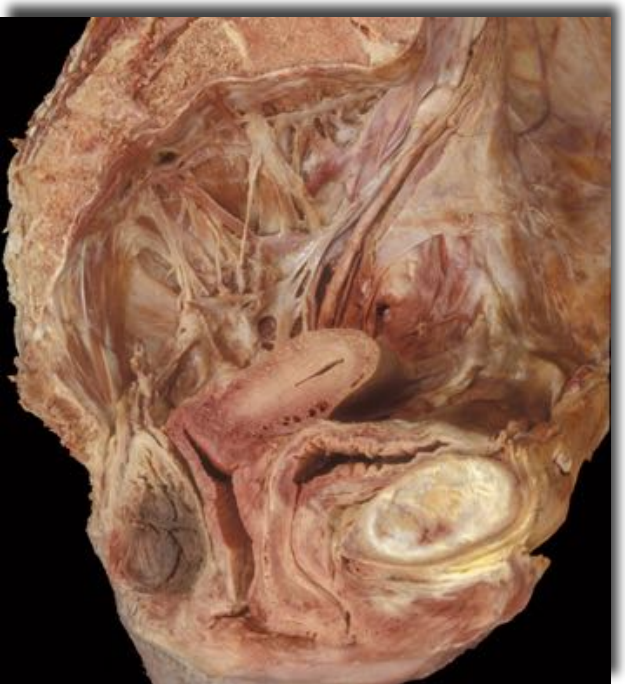
Referred Pain From The Uterus

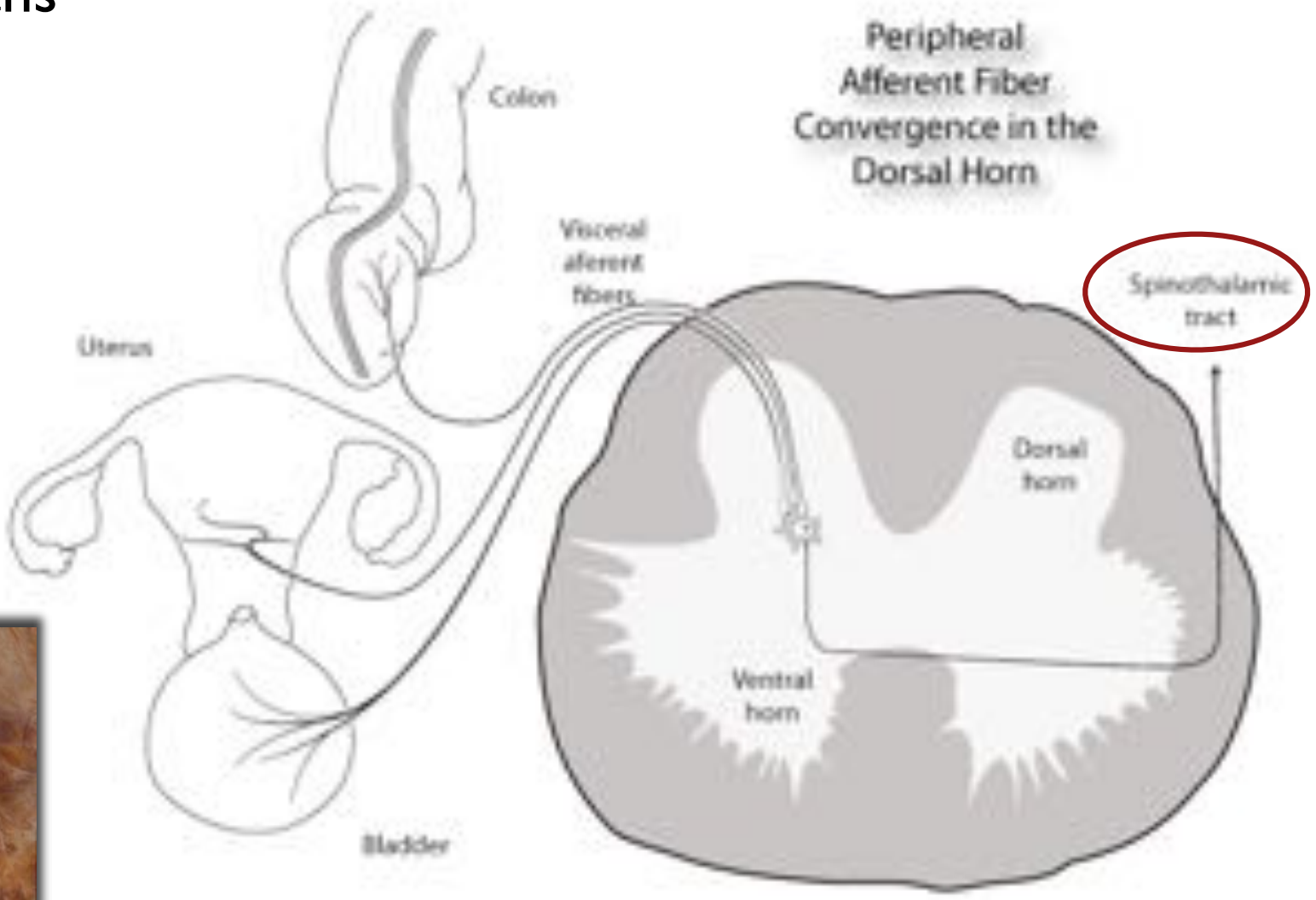
- Rats pretreated with Evans Blue vital dye
- Subjected to noxious uterine stimulation
- Extravasation of dye over the low abdomen and back, sacral and perineal region
    - U. Wesselmann and J. Lai. Mechanisms of referred visceral pain: uterine inflammation in the adult virgin rat results in neurogenic plasma extravasation in the skin. Pain 73 (3):309-317, 1997.


Extravasation
Cutaneous
Blood Vessel
Spinal Cord
Uterus
Autonomic Reflex


Extravasation
Cutaneous
Blood Vessel
Spinal Cord
Uterus
Dorsal Root Reflex

Cross-sensitization of Pelvic Organs





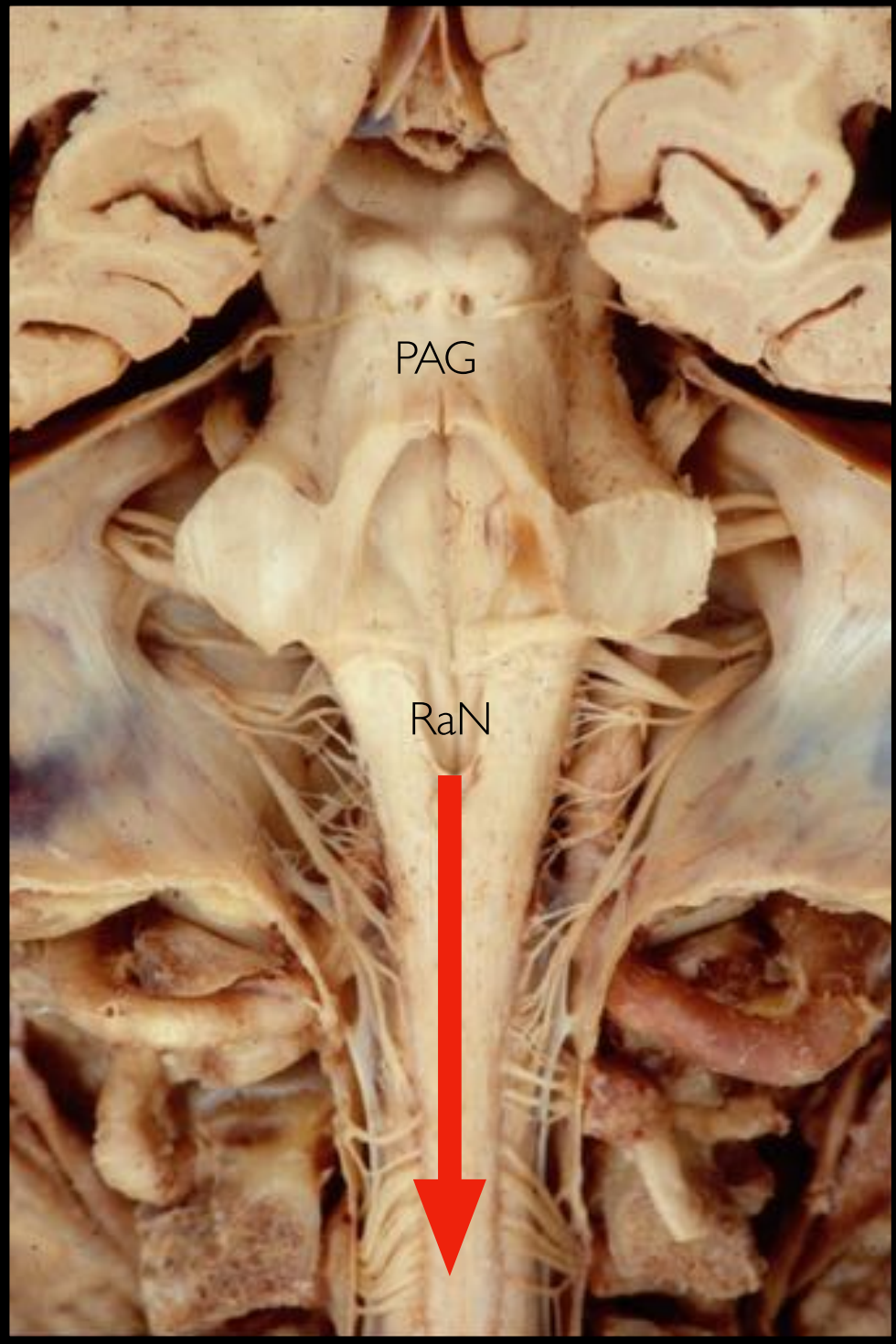
Descending Spinal Control Systems

Endogenous Pain Control

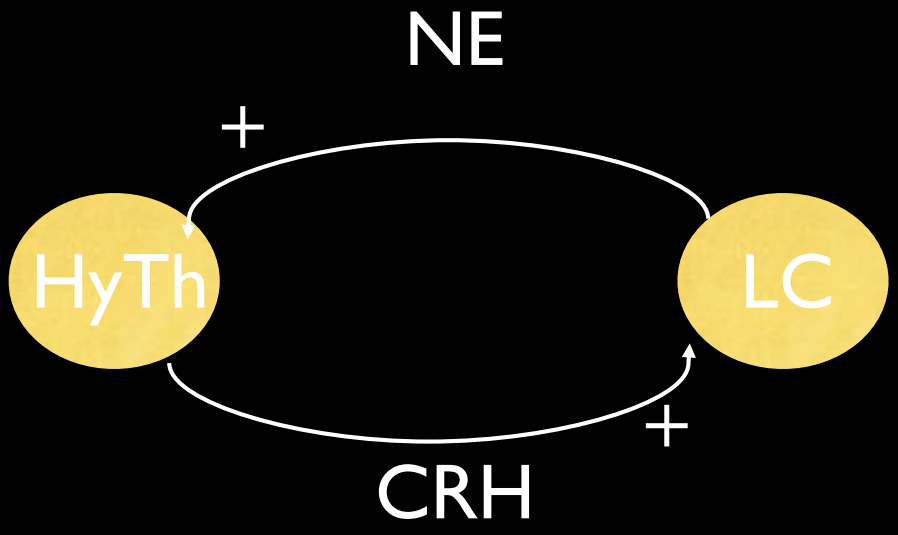
Raphe-spinal system
Noradrenergic-spinal system

Diffuse Noxious Inhibitory Control

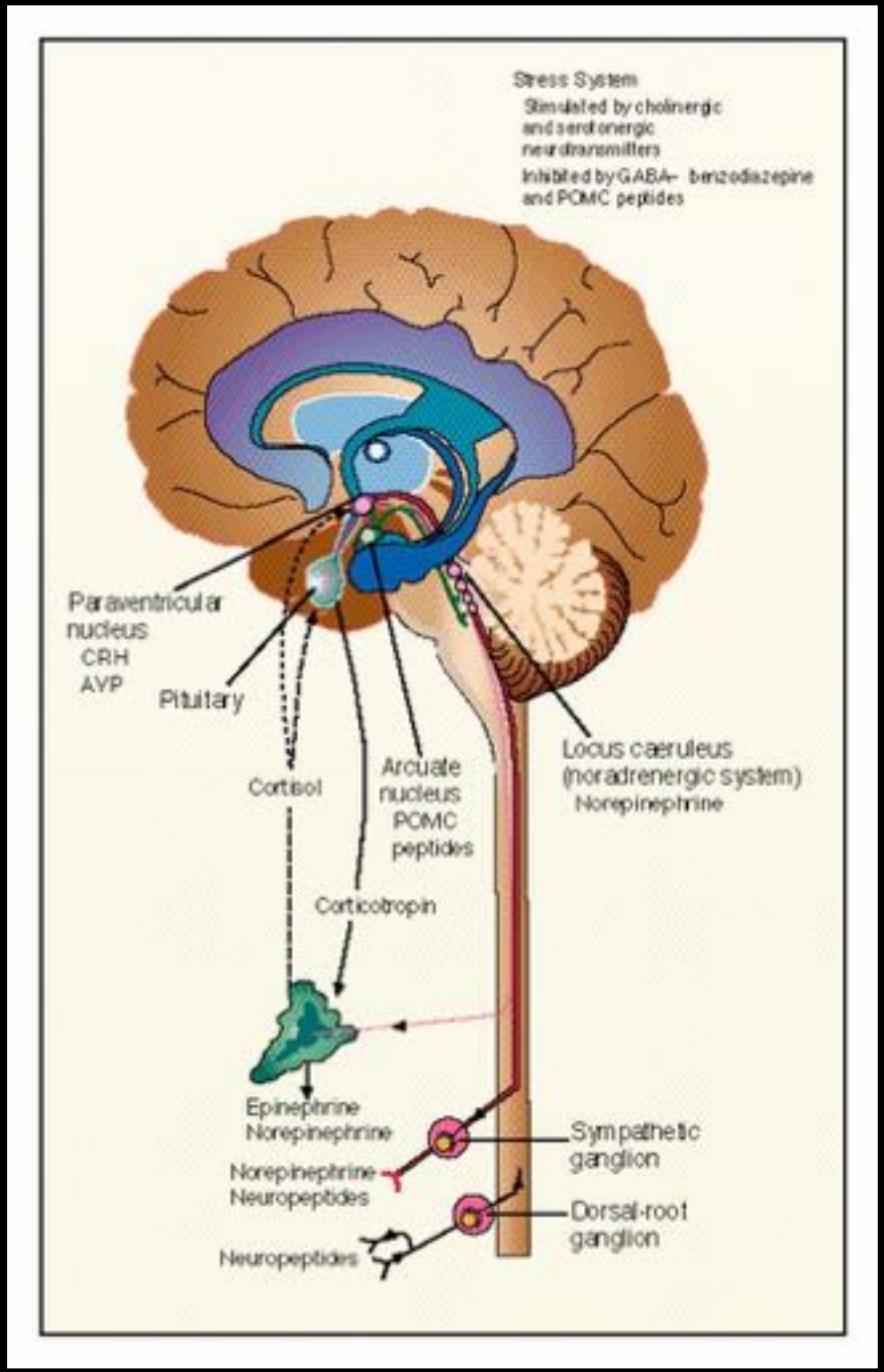
Spino-Reticulospinal Loop



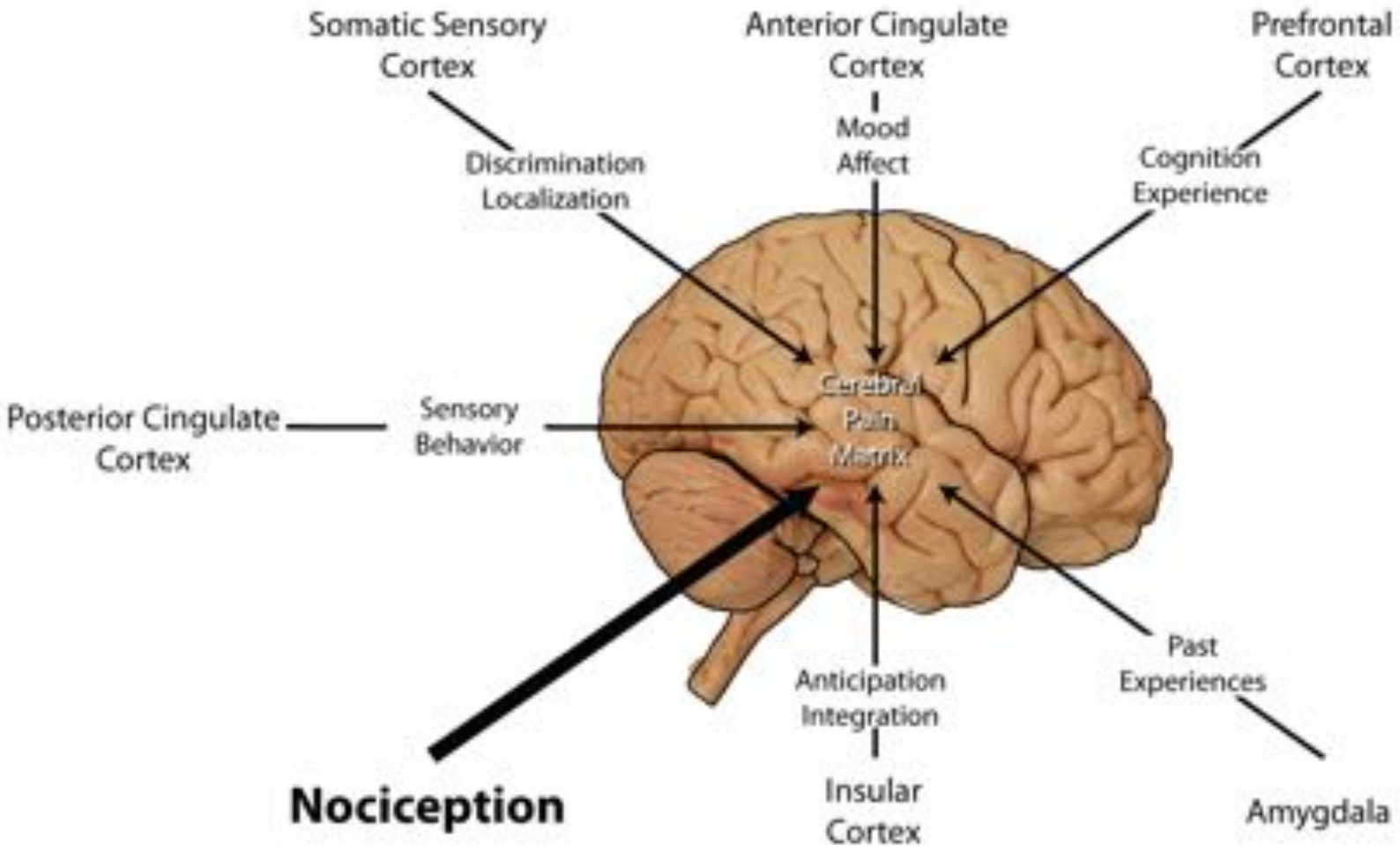
HPA – LC-NE Axis



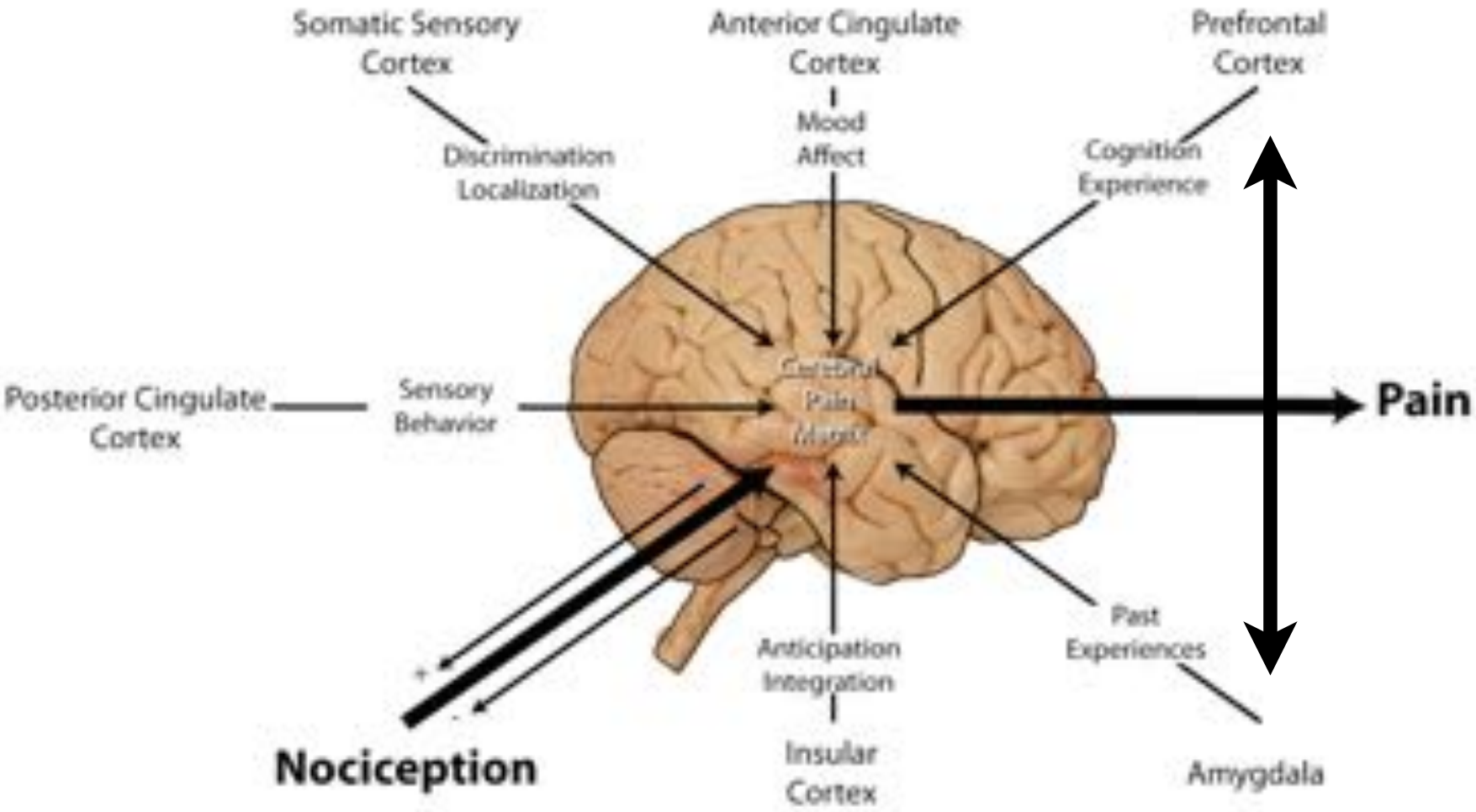
Chrousos, NEJM 332:1351, 1995



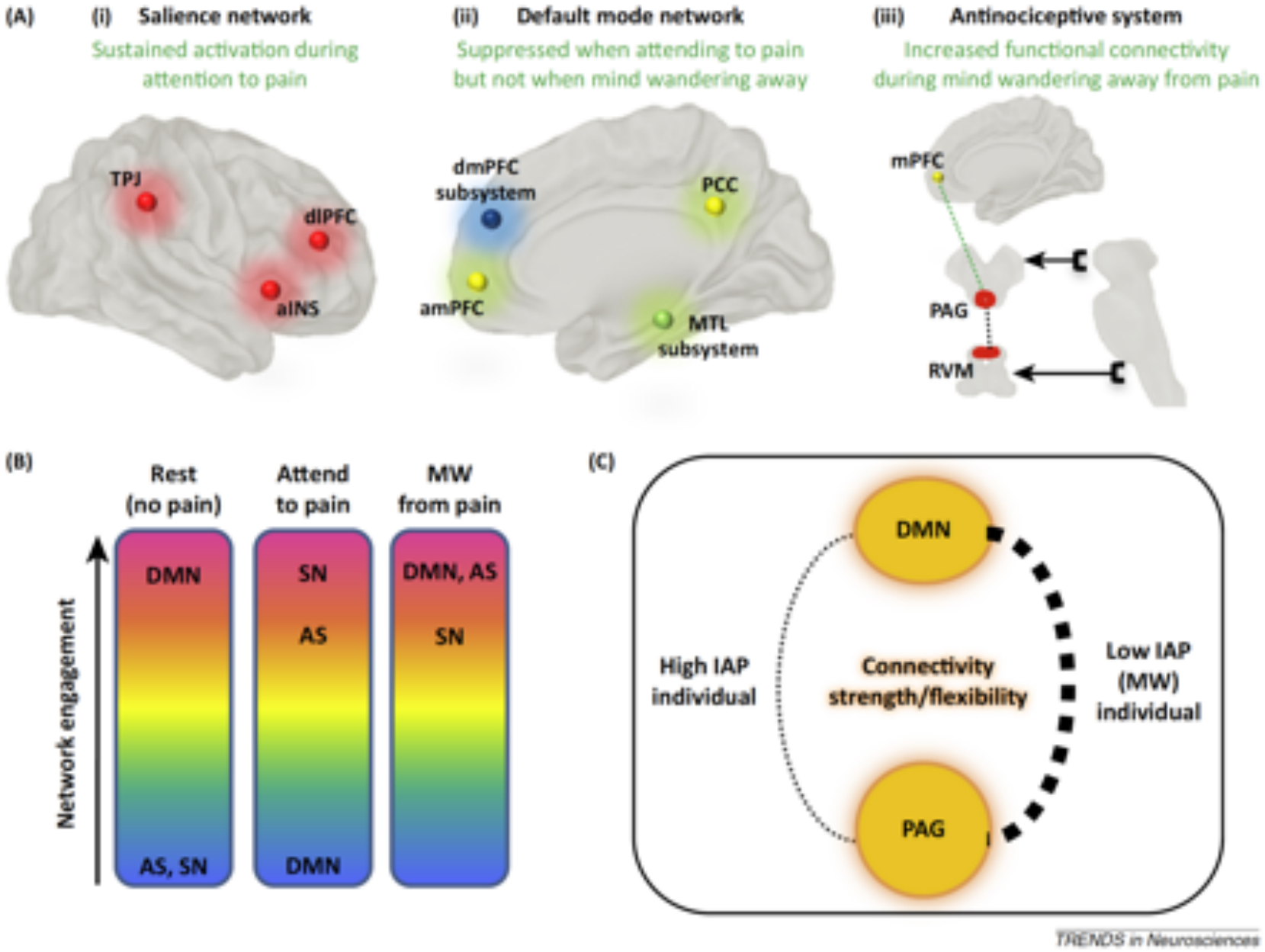
Pain Neuromatrix



Pain Neuromatrix



Pain Connectome

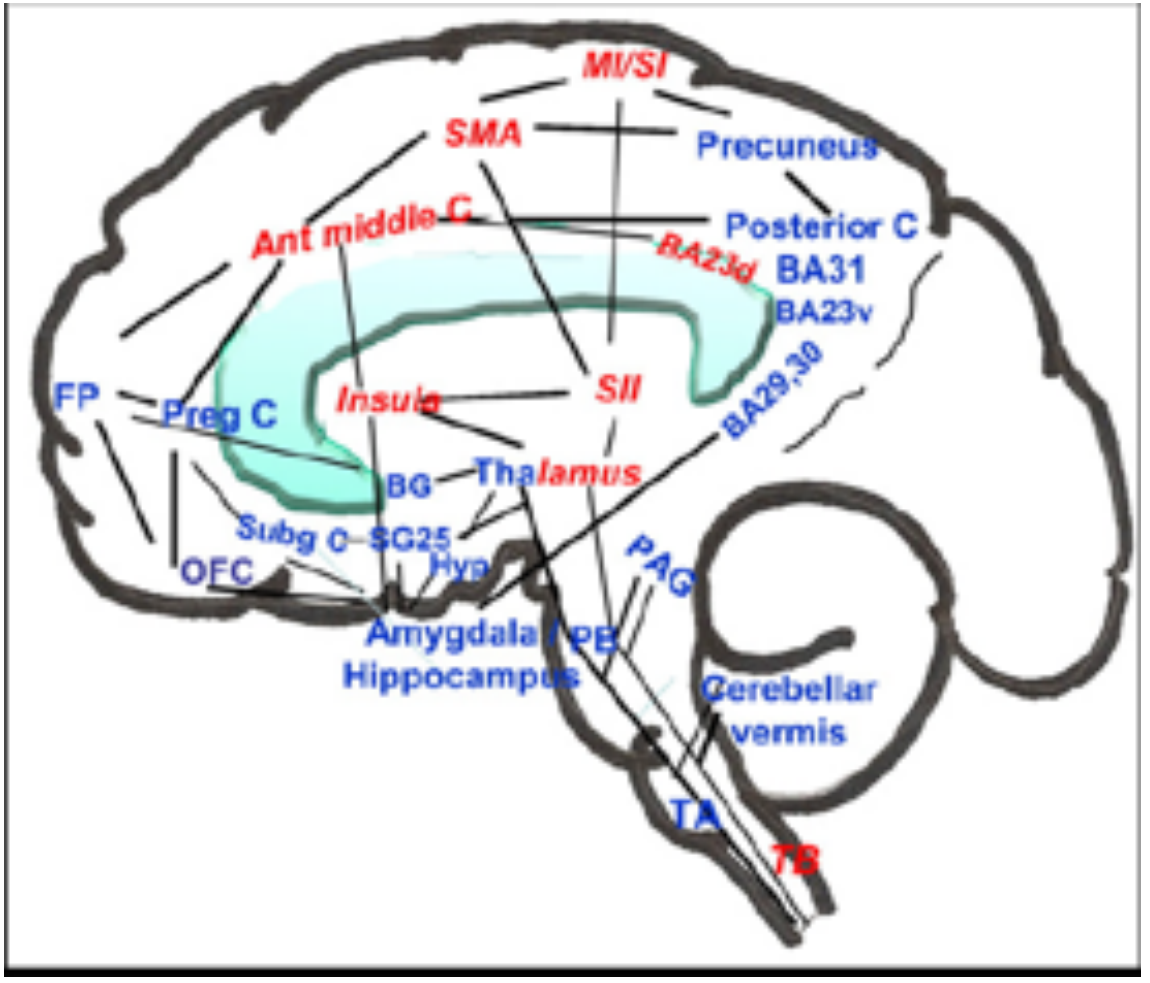


Kucyi A, Davis KD. 2015. The dynamic pain connectome. Trends Neurosci 38: 86-95

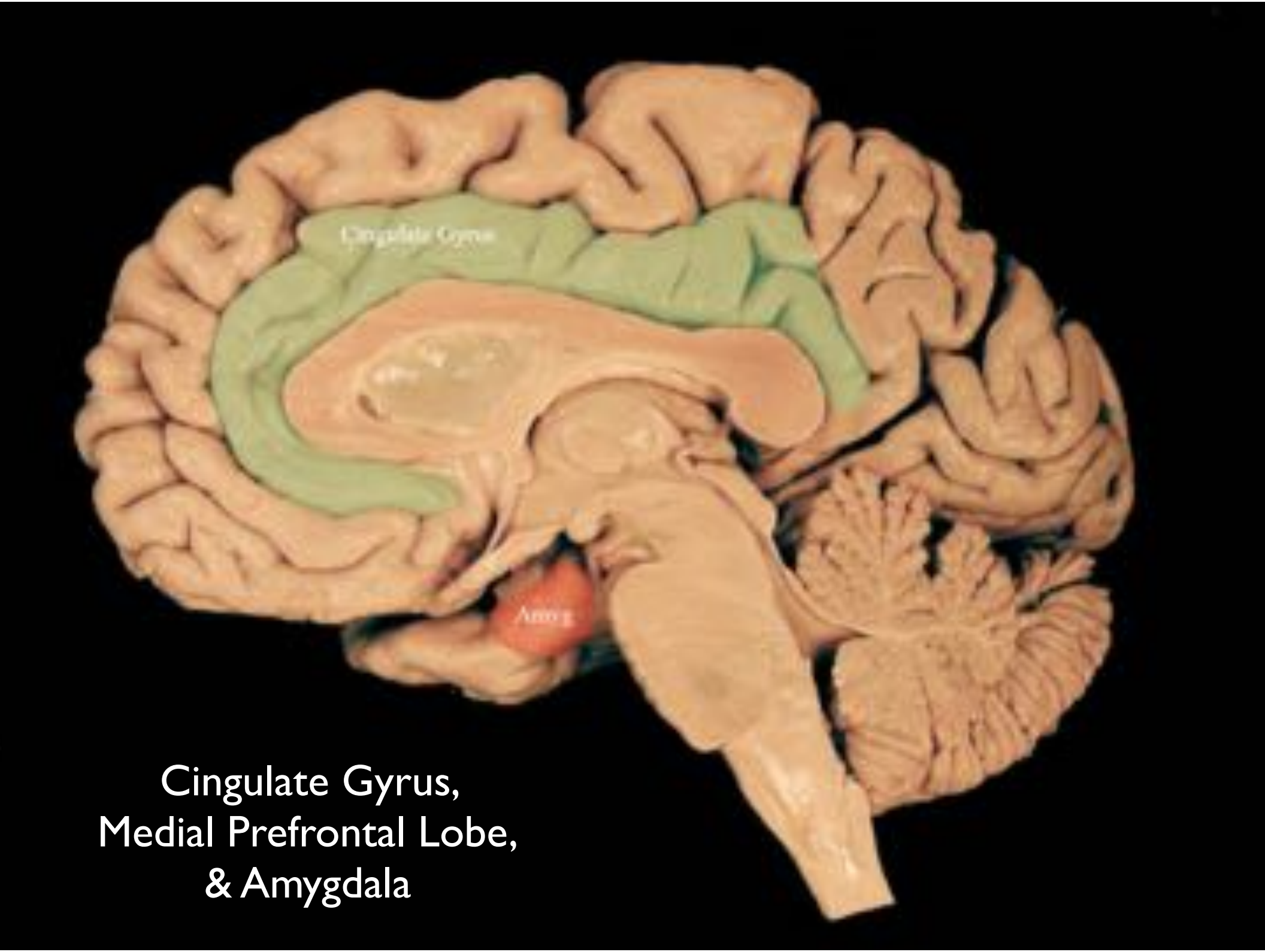
Limbic-Paralimbic-Neocortical-Network

Anti-correlated task-positive network

Negative or deactivation network



Hui KK, Marina O, Liu J, Rosen BR, Kwong KK. 2010. Acupuncture, the limbic system, and the anticorrelated networks of the brain. Auton Neurosci 157: 81-90



Cingulate Gyrus,
Medial Prefrontal Lobe,
& Amygdala

Peripheral & Central Sensitization