Hyperice

IDN

FYZICAL WEBINAR
10/12/2021

Mark Hernandez, PT

- Instructor with Integrative Dry Needling Institute
- Course developer in conjunction with Dr. Frank Gargano for the IDN Course: Advanced Clinical Integration of the Pelvis, Lumbar, Hips, & Abdomen
- At the Integrative Dry Needling Institute, we try to maintain very high standards of evidence based teaching. Our courses draw from instructors who have extensive clinical experience and a data base of over 561scholary articles.
- I have been in a full time fee-for-service private practice since for 1996 and have been practicing since 1994. Currently, I have logged over 40,000 1:1 patient care hours in that time. I am currently licensed in Texas, Colorado, & Arkansas.
- I and IDN are currently coordinating with Hyperice on a vibration/percussion research project with Shani Johnson, PT, DScPT, CMPT *Assistant Professor, Doctor of Physical Therapy Program* Concordia University, St. Paul

Notes for presentation:

Research on vibration has been going on for decades. More research is needed.

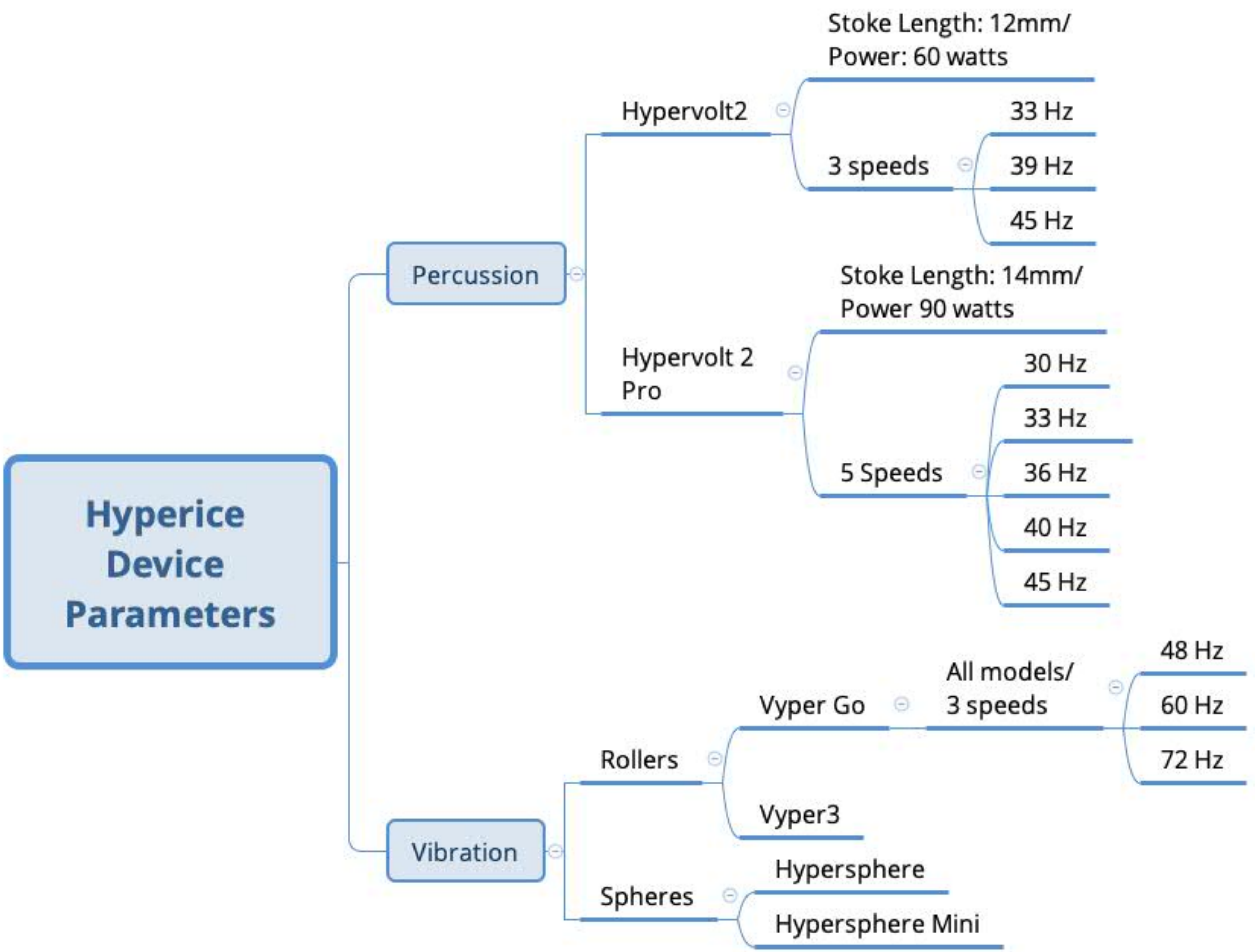
My presentation is base on my clinical experience and extrapolations of current research and past research.

My co-presentor, Brent Brookbush, has and extensive reference library that is easy to reference at https://brookbushinstitute.com

Below is a breakdown of references available at Hyperice and the Brookbush Institute by decade.

I have utilized some of these references and have a few listed at the end of the presentation.

	Vibration	Preventing DOMS	Effect on Muscle Performance	Vibration Foam Roliing	Vibration and Stretching	Additional Research	Hyperice research library
1960-1969	11	0	0	0	0	0	0
1970-1979	13	0	0	0	0	0	0
1980-1989	3	0	1	0	0	0	0
1990-1999	11	1	2	0	0	0	0
2000-2009	7	3	6	0	3	0	0
2010-2019	2	9	4	6	0	4	0
2000-2021							8
	47	**13**	**13**	**6**	**3**	**4**	**8**


Hyperice Device Parameters
Percussion
Hypervolt2
Stoke Length: 12mm/ Power: 60 watts
3 speeds
33 Hz
39 Hz
45 Hz
Hypervolt 2 Pro
Stoke Length: 14mm/ Power 90 watts
5 Speeds
30 Hz
33 Hz
36 Hz
40 Hz
45 Hz
Vibration
Rollers
Vyper Go
All models/ 3 speeds
48 Hz
60 Hz
72 Hz
Vyper3
Spheres
Hypersphere
Hypersphere Mini

Advantages to Hyperice Technologies

- Portability
- Ergonomics
- Various frequencies and Amplitudes
- Various devices for different applications
- Ease of use for many physiologic and mechanical applications
- Very safe

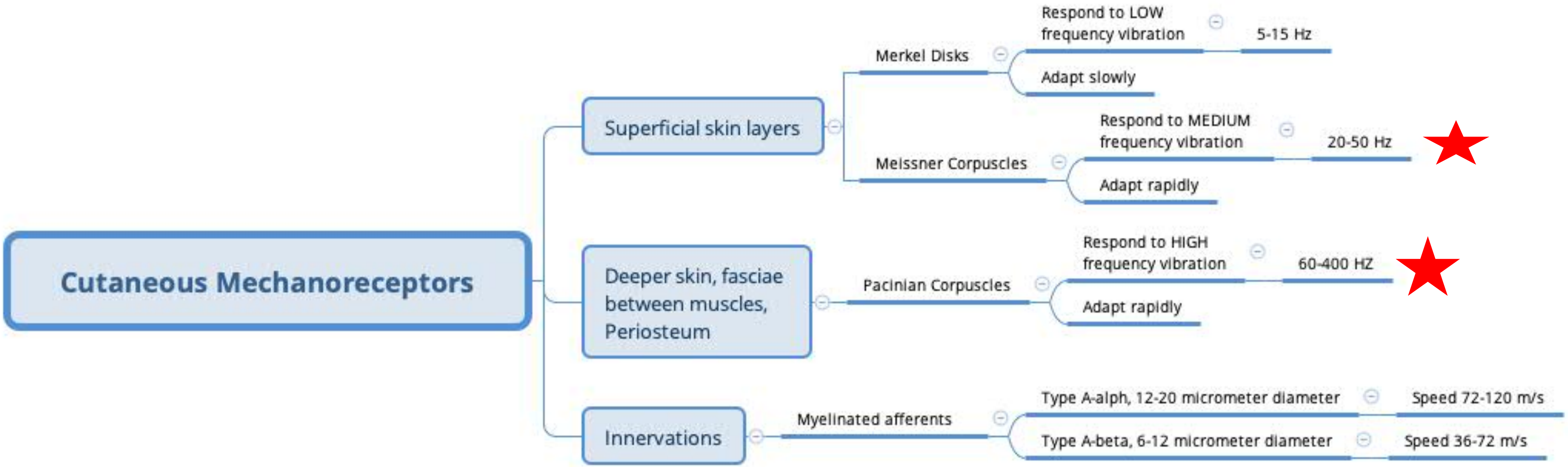
Precautions

- Vibration applied to deep vein thrombosis may displace a thrombus produce an embolus
- Vibration applied to skin with altered elastic properties may produce a friction injury

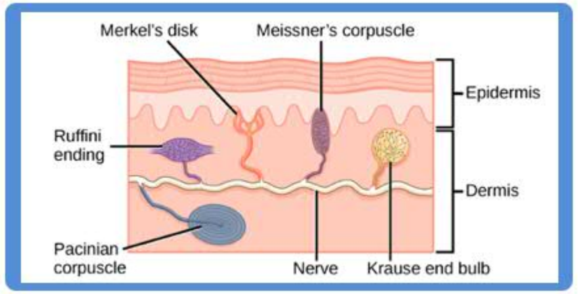
*Not applicable to Hyperice products due to lower frequencies of percussion and vibration.

- *Vibration frequencies above 200 Hz can damage skin
- *Vibration frequencies above 150 Hz may induce pain and discomfort

Cutaneous Mechanoreceptors respond to various frequency and adapt a different rates.



★ HYPERICE FREQUENCY RANGE OF INFLUENCE

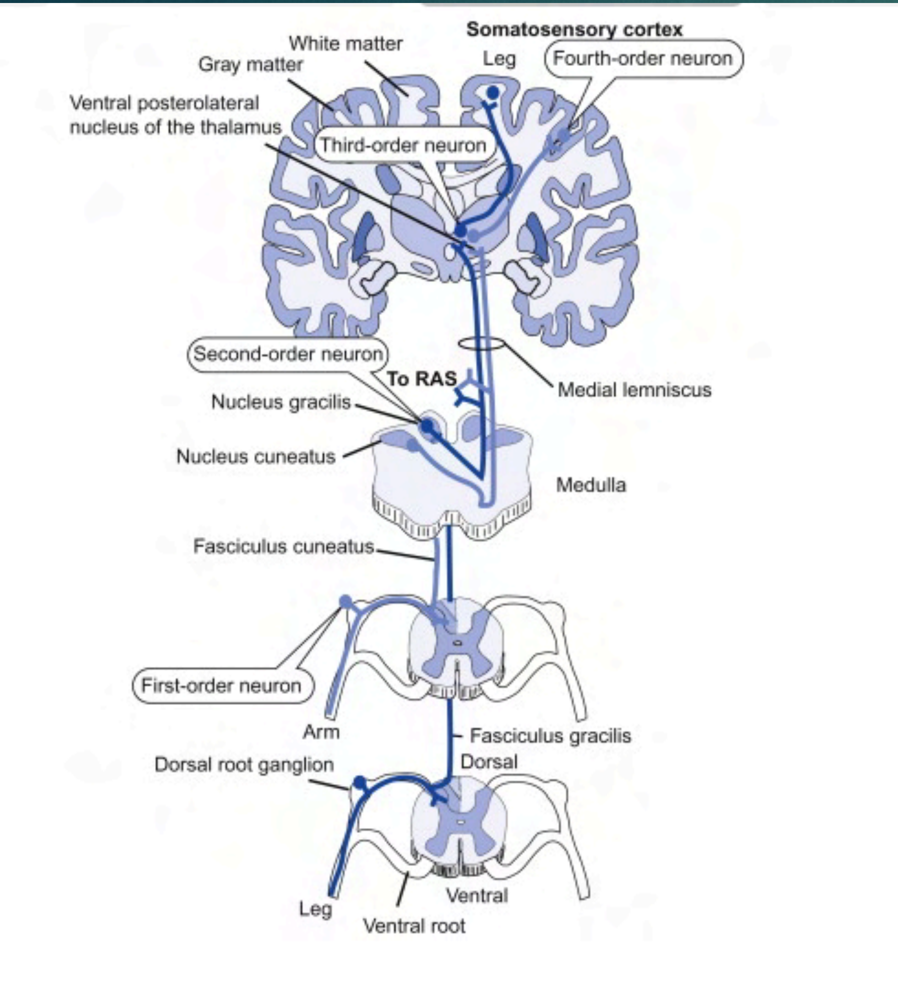


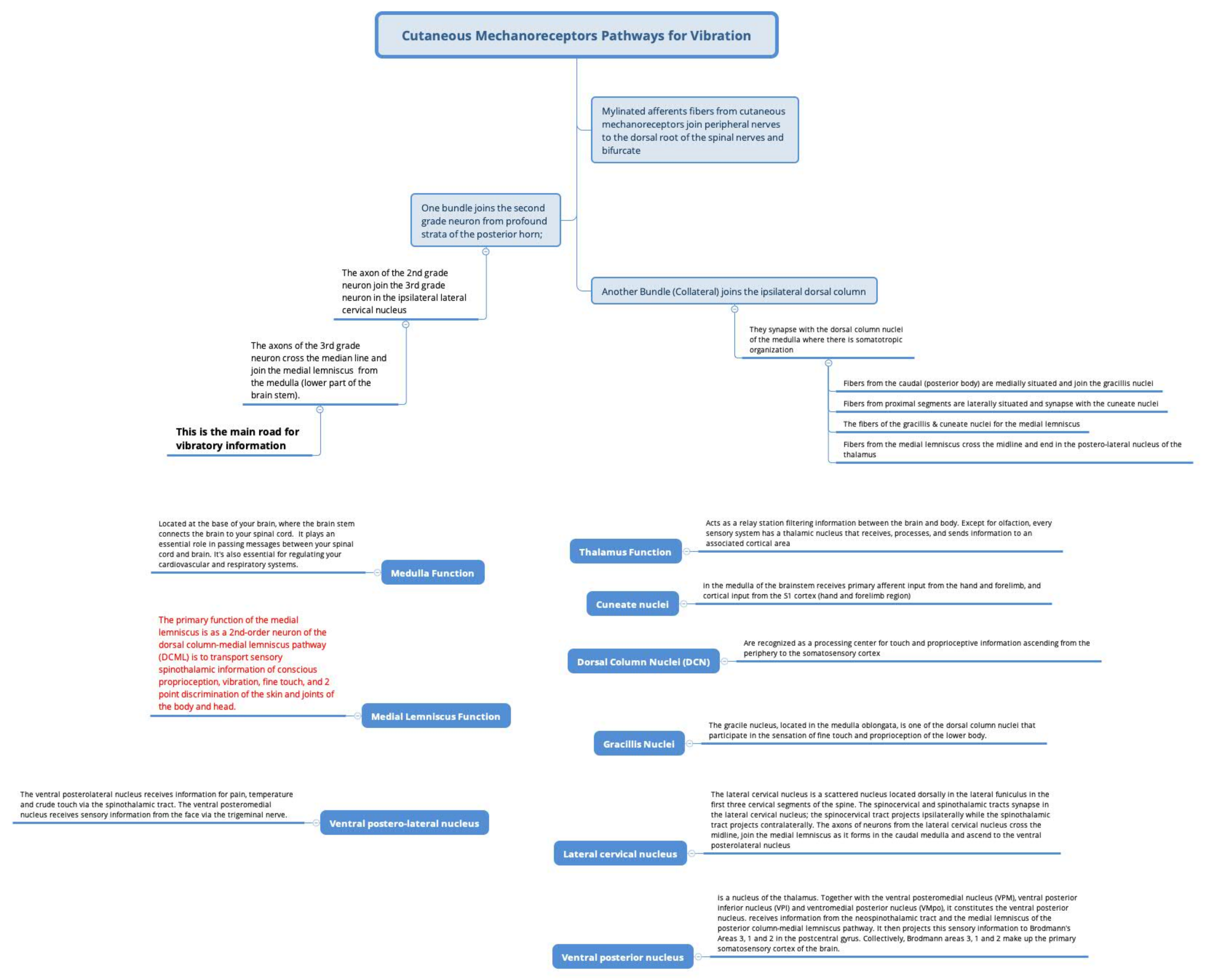
Tactile Skin Mechanoreceptors

- Markel's Disks
  - Slow adapting, unencapsulated nerve endings
  - Respond to and detect light touch
  - Located in upper layers of skin that has hair or is glabrous/hairless
  - Densely distributed in finger tips and lips
  - Receptive fields are small with well defined borders that make them very sensitive to boarders.
- Meissner's Corpuscles
  - Rapidly-adapting, fluid filled encapsulated neurons
  - Respond to and detect fine touch, pressure, and low-frequency vibration ★
  - Located in the upper dermous and project into the epidermis of glabrous skin on finger tips and eyelids
  - Have small well defined boarders which are responsive to fine details
- Ruffini Endings
  - Slow adapting, encapsulated mechanoreceptors
  - Respond to and detect:
    - Skin stretch ★
    - Deformation within joints ★
    - Warmth-due to depth of these receptors, humans perceive cold before warmth
  - Located in the deeper dermis of glabrous and hairy skin
  - Provide valuable feedback for gripping objects and controlling finger position and movement
  - Contribute to proprioception and kinesthesia ★
- Pancinian Corpuscles
  - Rapidly-adapting, deep receptors
  - Respond to compression and detect transient deep pressure and high-frequency vibration ★
  - Located in:
    - The deeper dermis of glabrous and hairy skin
    - Bone periosteum
    - Joint Capsules
    - Pancreas and other viscera
    - Breast
    - Genitals
- Krause end bulbs
  - Respond to and detect cold and temperature change
  - Located in:
    - Conjunctiva of eye
    - Mucous membrane of lips and tongue
    - Epineurium of nerve trunks
    - Penis and clitoris

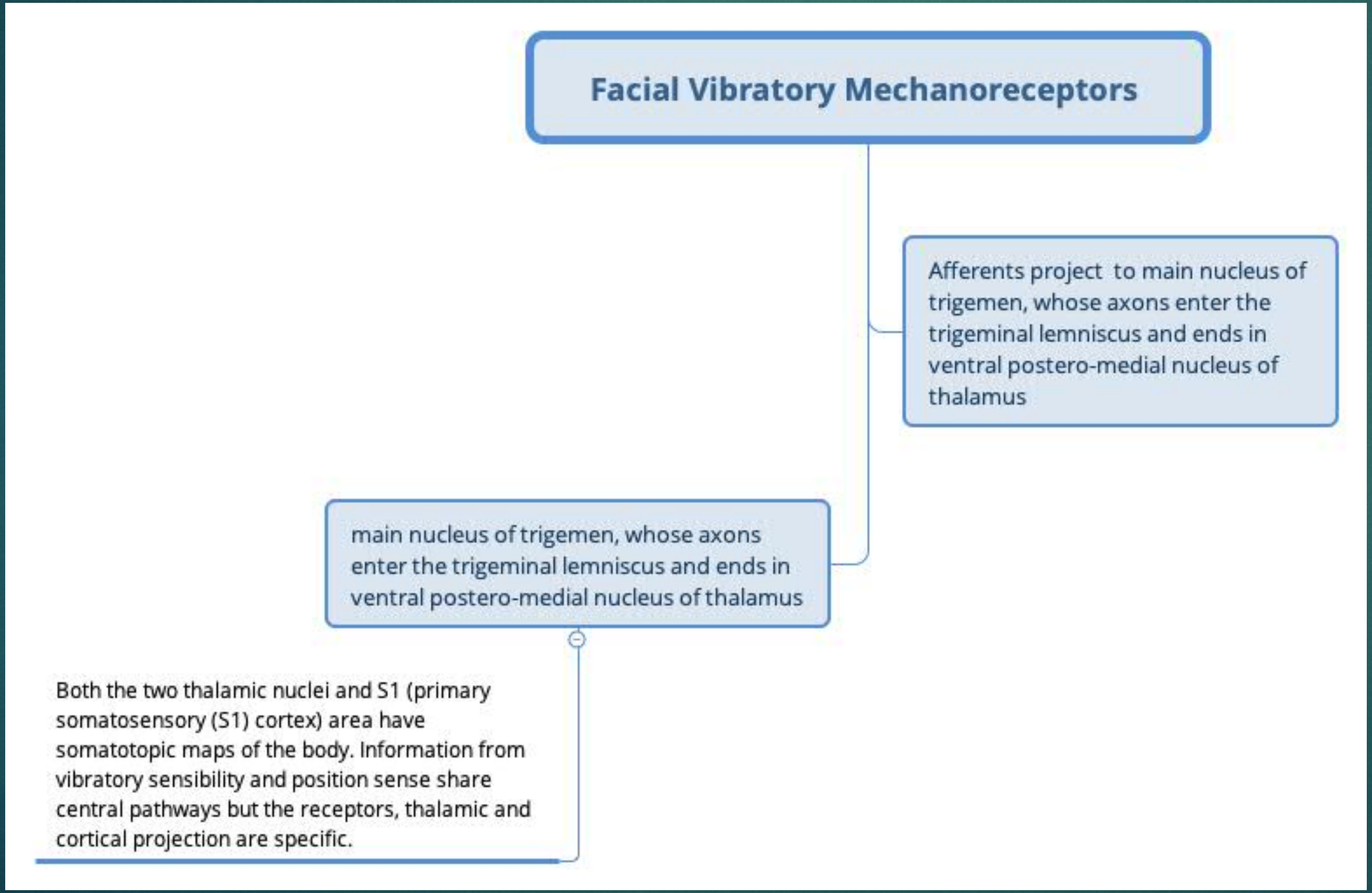
★ Targets of Hyperice vibration and percussion

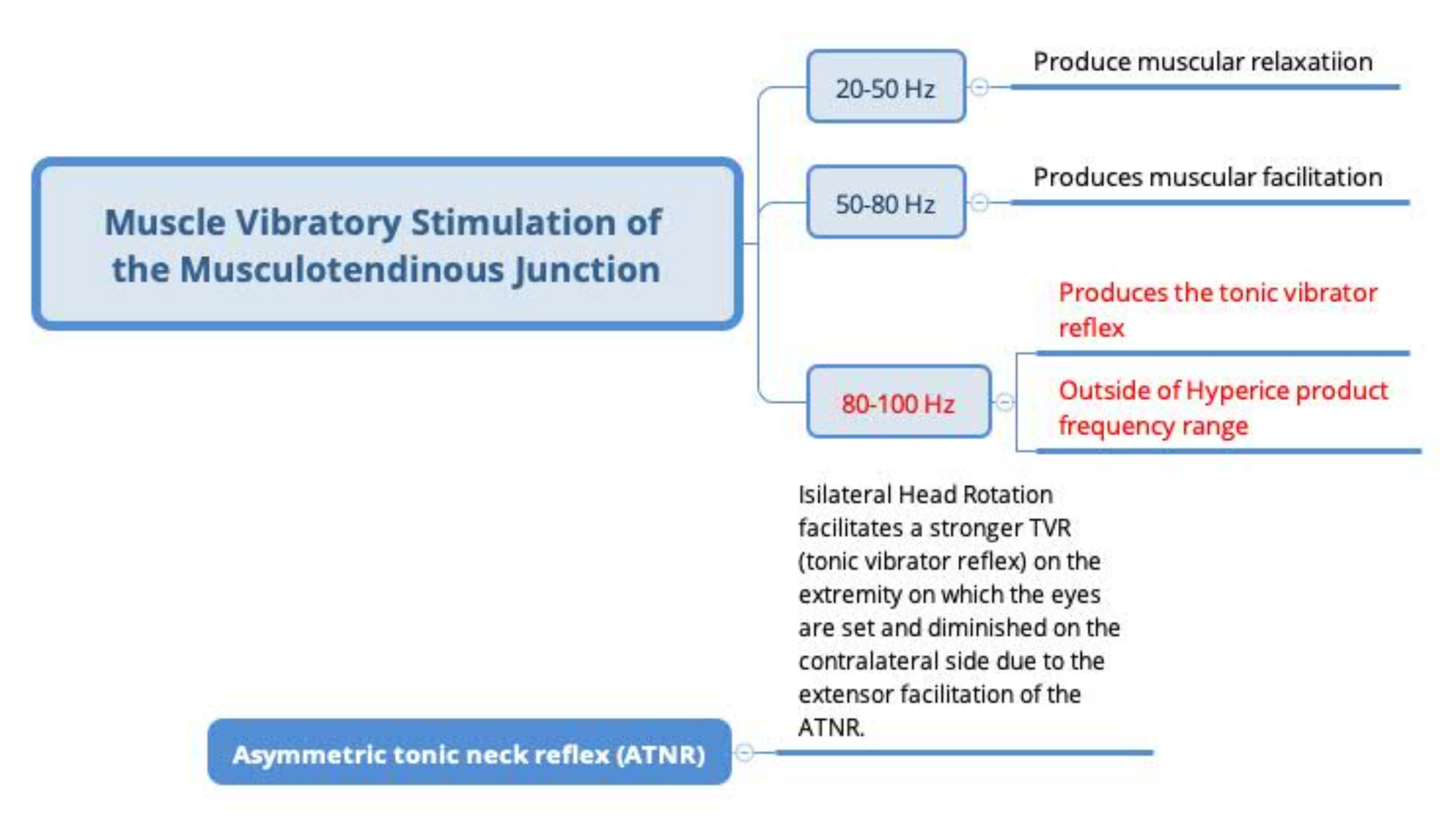
Cutaneous Mechanoreceptor Pathways to the Somatosensory Cortex from the Extremities



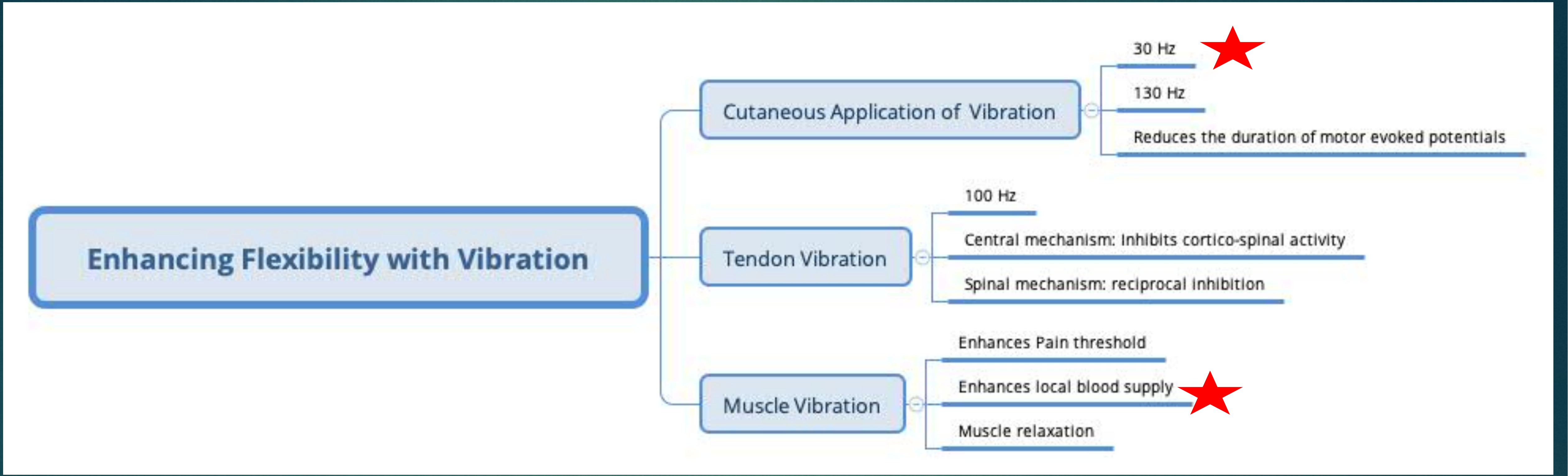


Cutaneous Mechanoreceptor Pathways to the Somatosensory Cortex from the Face




Muscle Vibratory Stimulation of the Musculotendinous Junction
20-50 Hz
Produce muscular relaxatiion
50-80 Hz
Produces muscular facilitation
80-100 Hz
Produces the tonic vibrator reflex
Outside of Hyperice product frequency range
Asymmetric tonic neck reflex (ATNR)
Isilateral Head Rotation facilitates a stronger TVR (tonic vibrator reflex) on the extremity on which the eyes are set and diminished on the contralateral side due to the extensor facilitation of the ATNR.

Tissue specific vibration for inhibition and flexibility



★ HYPERICE FREQUENCY RANGE OF INFLUENCE

Frequencies from 80-100 Hz Stimulate the Tonic Vibrator Reflex. Therapeutic applications? Future research!

Muscle and Tendon Pathways for Vibration: Tonic Vibrator Reflex (80-100 Hz)

80-100 HZ is above the Hyperice Hz range

- Muscle Spindle Vibratory Reflex (nuclear bag and nuclear chair fibers) streams through primary termination of 1a nerve fibers
  - Also intermediate:Tonic and phasic stretch reflexes
  - Primary termination end in the spinal motor neurons elicit a tonic contraction of the vibrated muscle
- Golgi Tendon Organ Reflex stream through secondary termination of 1a nerve fibers

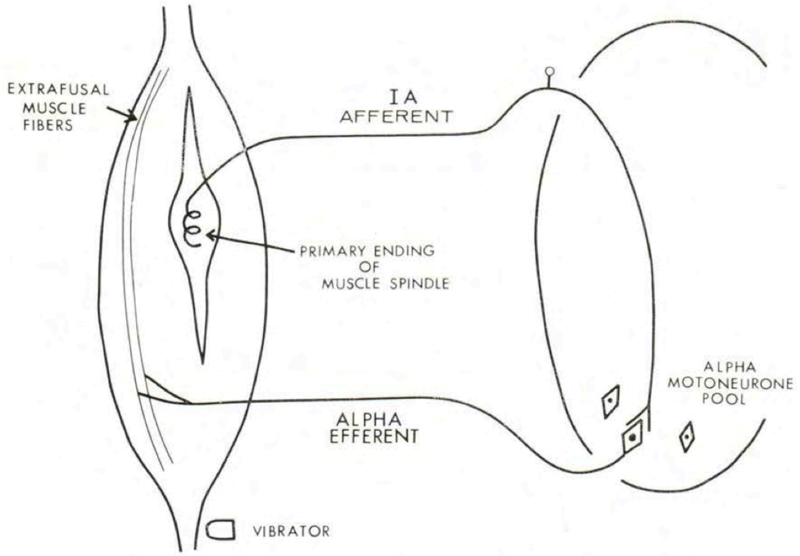
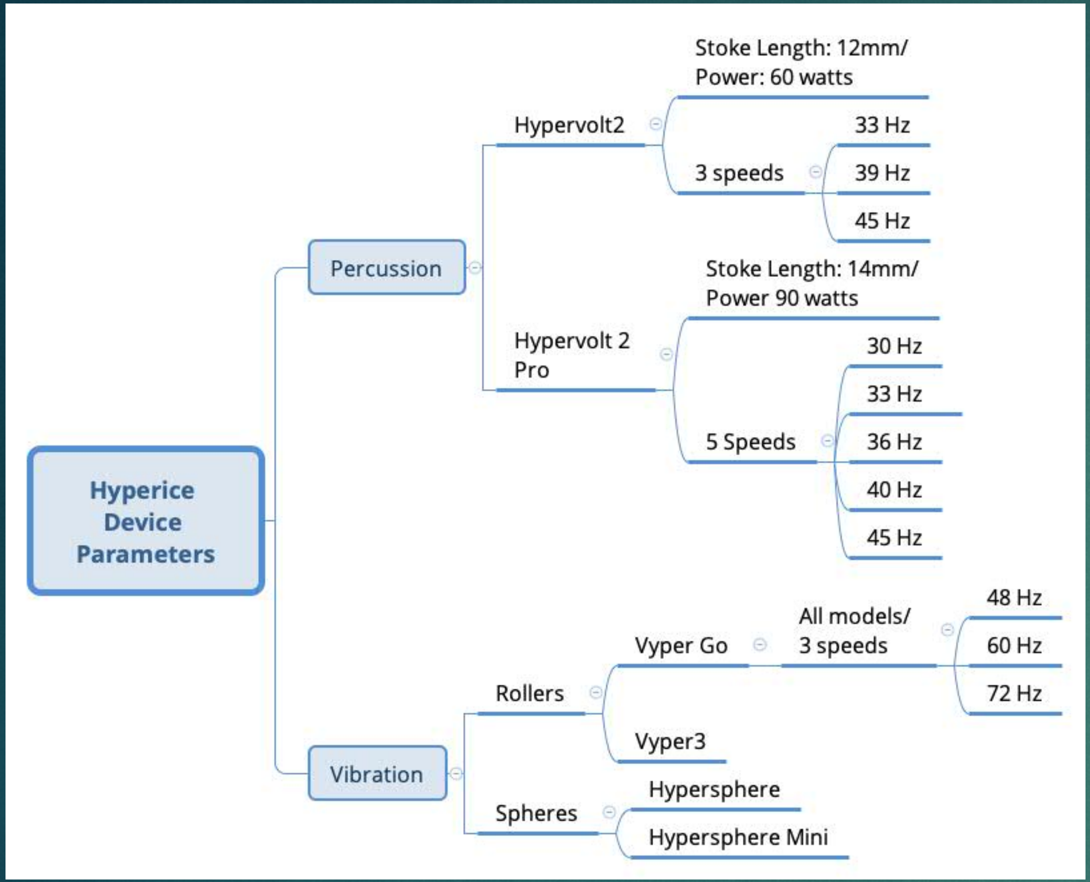
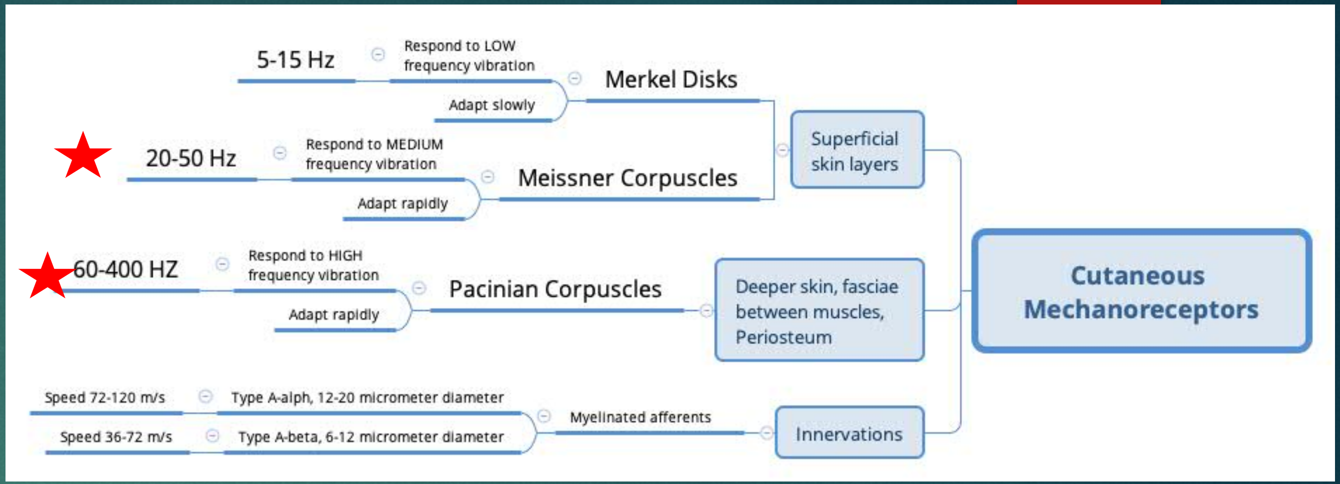
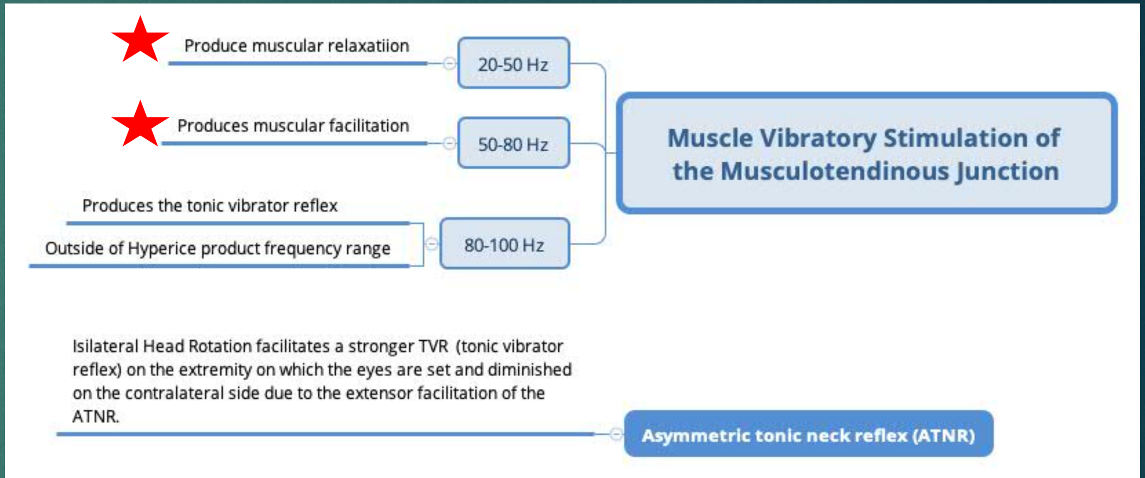
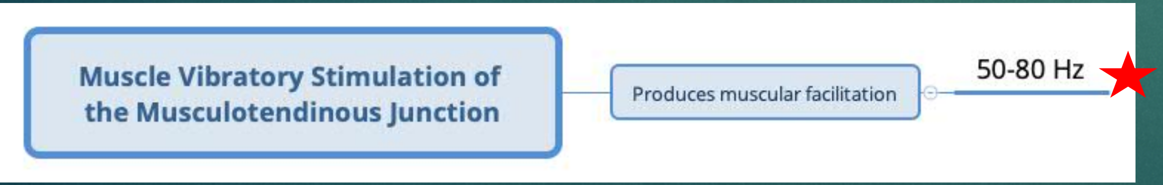


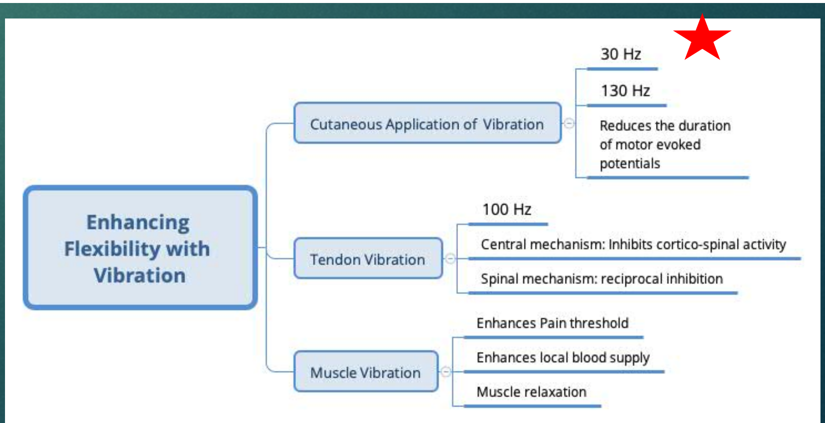
Fig. 1. The reflex arc used in the elicitation of the tonic vibration reflex.





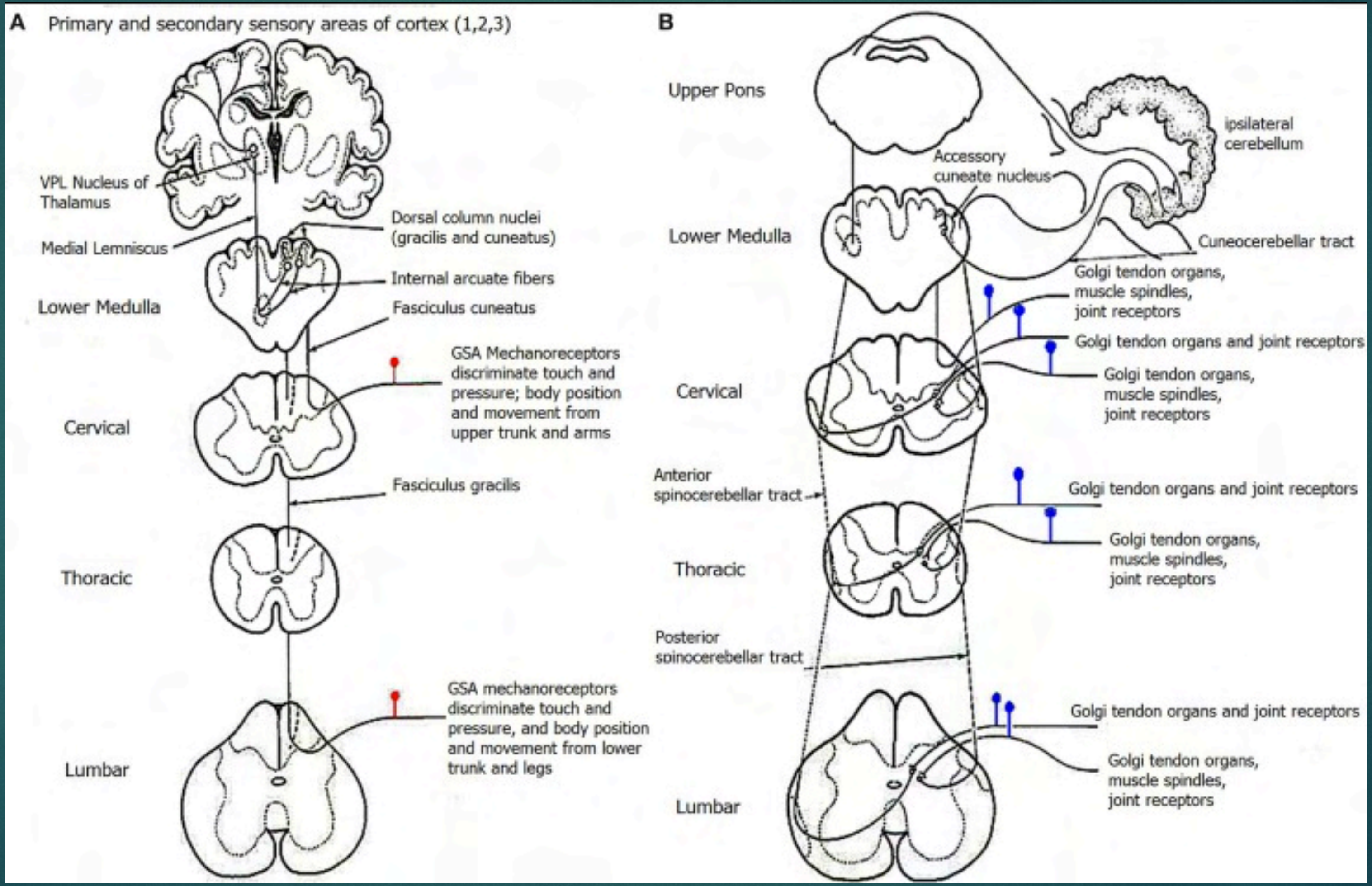




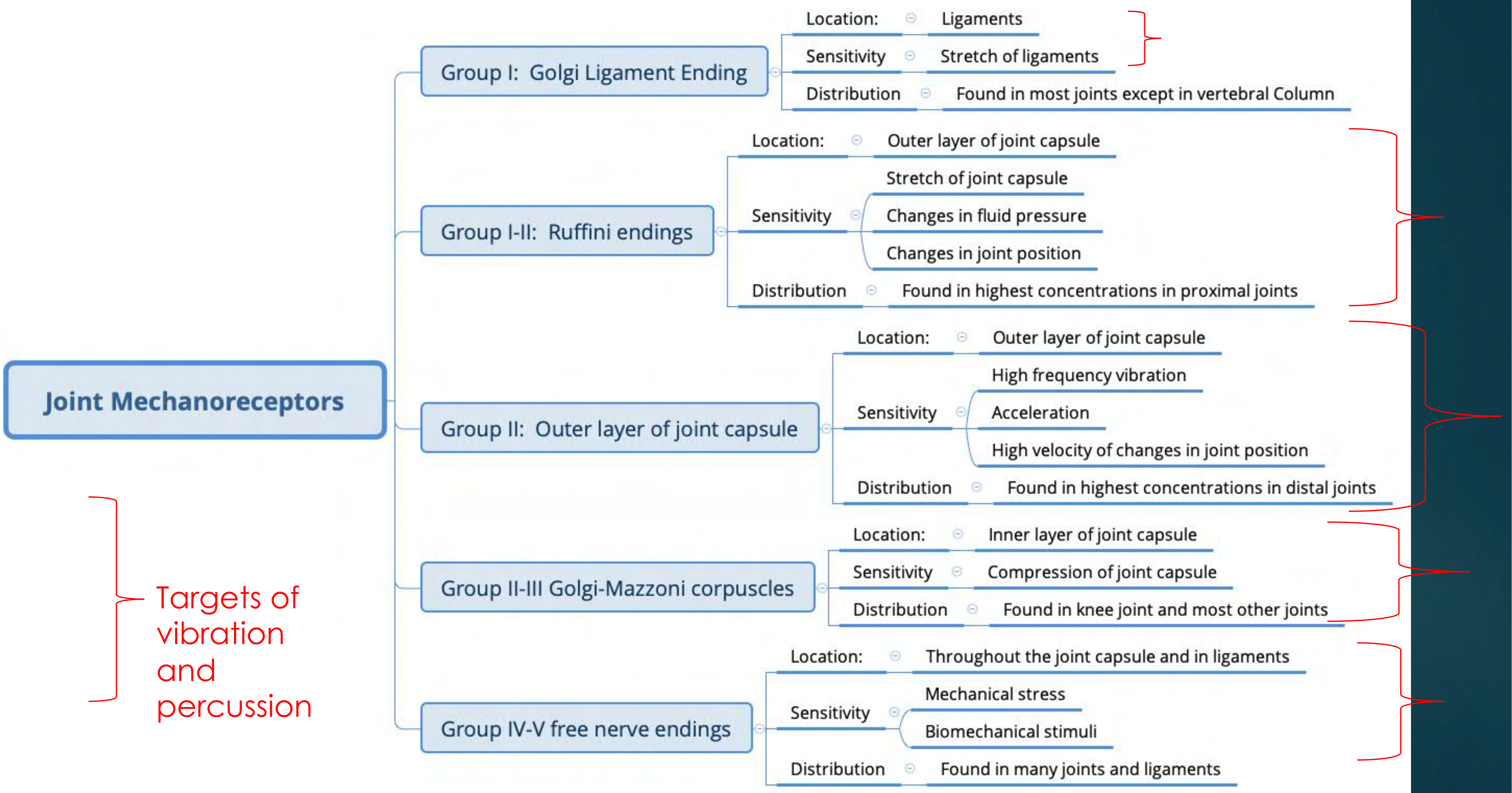


***Exception may bethe the foot: 40 Hz range can elicit muscle facilitation.

General Somatic Afferent (GSA) pathways for proprioception



Autism: the micro-movement perspective
Elizabeth B. Torres1,2*, Maria Brincker3, Robert W. Isenhower4, Polina Yanovich5, Kimberly A. Stigler6, John I. Nurnberger7, Dimitris N. Metaxas8 and Jorge V. José9


Joint Mechanoreceptors
Group I: Golgi Ligament Ending
Location: Ligaments
Sensitivity Stretch of ligaments
Distribution Found in most joints except in vertebral Column
Group I-II: Ruffini endings
Location: Outer layer of joint capsule
Sensitivity
Stretch of joint capsule
Changes in fluid pressure
Changes in joint position
Distribution Found in highest concentrations in proximal joints
Group II: Outer layer of joint capsule
Location: Outer layer of joint capsule
Sensitivity
High frequency vibration
Acceleration
High velocity of changes in joint position
Distribution Found in highest concentrations in distal joints
Group II-III Golgi-Mazzoni corpuscles
Location: Inner layer of joint capsule
Sensitivity Compression of joint capsule
Distribution Found in knee joint and most other joints
Group IV-V free nerve endings
Location: Throughout the joint capsule and in ligaments
Sensitivity
Mechanical stress
Biomechanical stimuli
Distribution Found in many joints and ligaments
Targets of vibration and percussion

Can pain be utilized as therapeutic inhibitory modality? Future research?

Arthrogenic Muscle Inhibition (AMI) of Quadriceps Activation and Strength

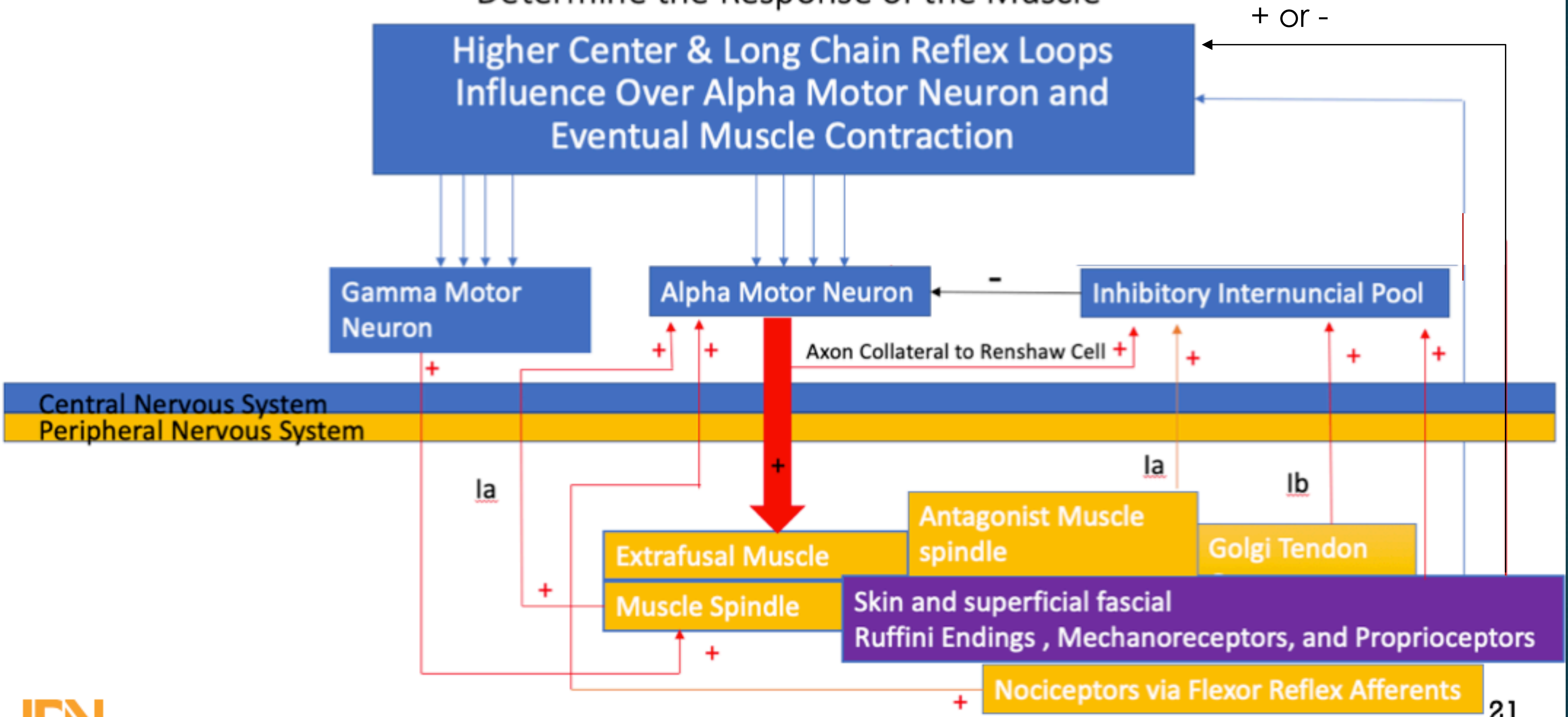
Definition: A neurological decline in muscle activation

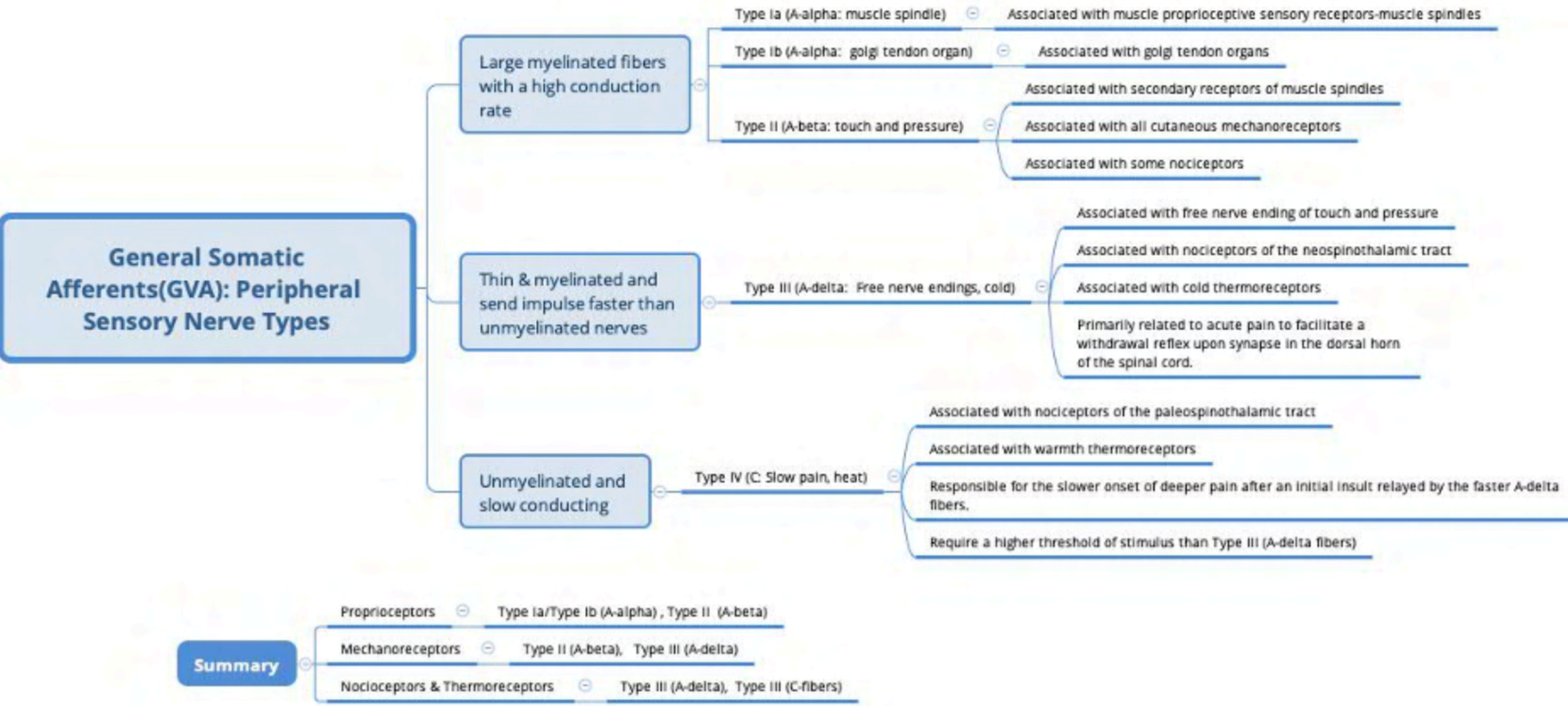
- Activation of Group III & IV Afferents
- Afferent signal potential damage or potential damage to joint structures
- Signals lead to facilitation of :
  - Group 1b internerons
  - Flexion reflex
  - Gamma Loop
- Quadriceps Inhibition

Pain and Effusion and Quadriceps Activation and Strength
Riann M. Palmieri-Smith, PhD, ATC*†; Mark Villwock, MS*†;
Brian Downie, PA-C, MS‡; Garin Hecht, MD§; Ron Zernicke, PhD*†Journal of Athletic Training 2013;48(2):186–191 doi: 10.4085/1062-6050-48.2.10
by the National Athletic Trainers' Association, Inc www.natajournals.org

Reflexive Influences on Alpha Motor Neuron-The Summation of Facilitatory and Inhibitory Activity on the Alpha Motor Neuron will Determine the Response of the Muscle

Return TOC




General Somatic Afferents(GVA): Peripheral Sensory Nerve Types
Large myelinated fibers with a high conduction rate
Type Ia (A-alpha: muscle spindle)
Associated with muscle proprioceptive sensory receptors-muscle spindles
Type Ib (A-alpha: golgi tendon organ)
Associated with golgi tendon organs
Type II (A-beta: touch and pressure)
Associated with secondary receptors of muscle spindles
Associated with all cutaneous mechanoreceptors
Associated with some nociceptors
Thin & myelinated and send impulse faster than unmyelinated nerves
Type III (A-delta: Free nerve endings, cold)
Associated with free nerve ending of touch and pressure
Associated with nociceptors of the neospinothalamic tract
Associated with cold thermoreceptors
Primarily related to acute pain to facilitate a withdrawal reflex upon synapse in the dorsal horn of the spinal cord.
Unmyelinated and slow conducting
Type IV (C: Slow pain, heat)
Associated with nociceptors of the paleospinothalamic tract
Associated with warmth thermoreceptors
Responsible for the slower onset of deeper pain after an initial insult relayed by the faster A-delta fibers.
Require a higher threshold of stimulus than Type III (A-delta fibers)
Summary
Proprioceptors
Type Ia/Type Ib (A-alpha) , Type II (A-beta)
Mechanoreceptors
Type II (A-beta), Type III (A-delta)
Nociceptors & Thermoreceptors
Type III (A-delta), Type III (C-fibers)

Return TOC

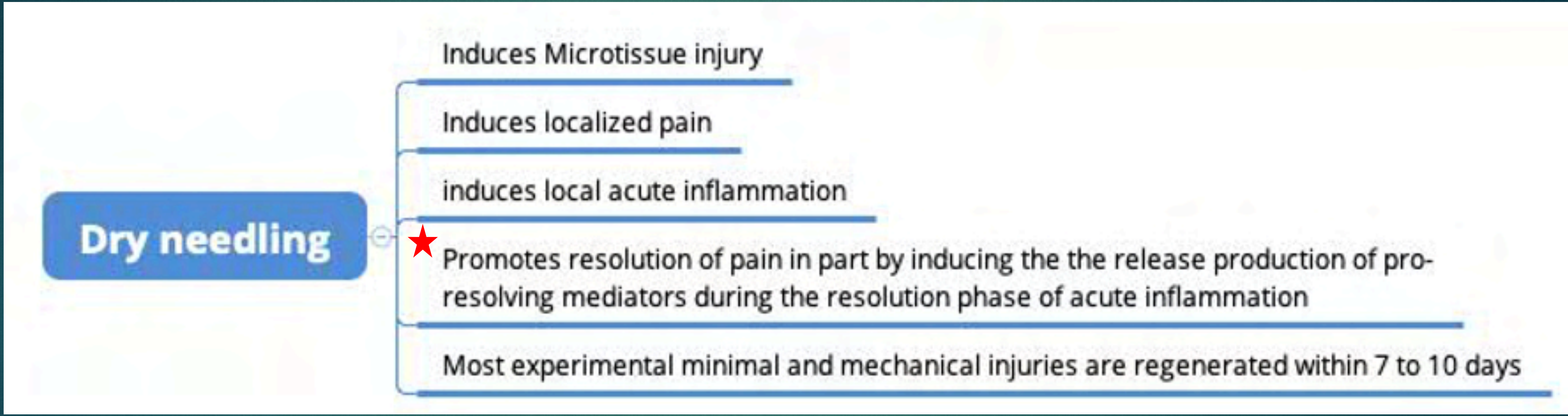
Peripheral Motor Nerve Types

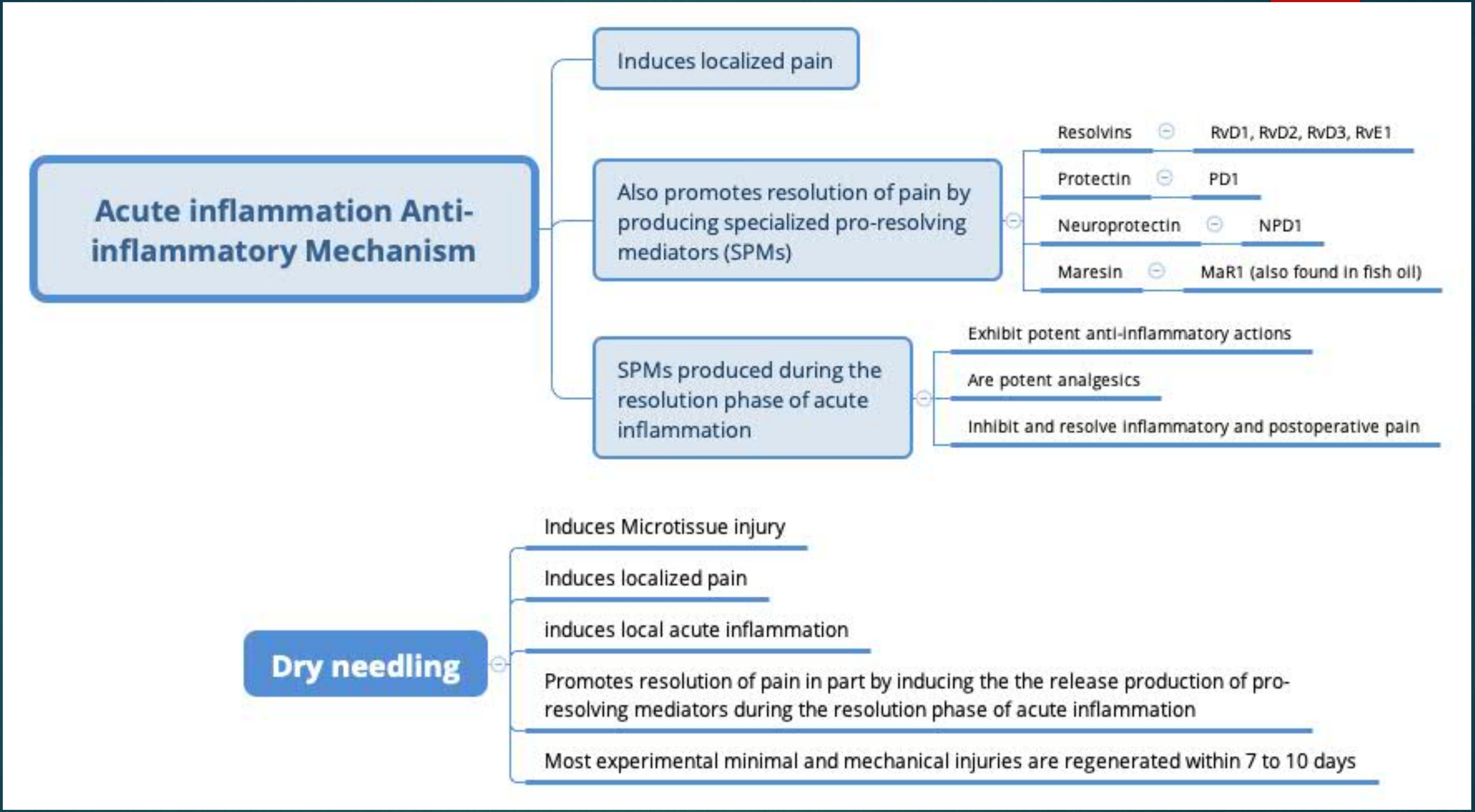
- **Type A Fiber:** Large myelinated fibers with a high conduction rate
  - **Type Ia** — Large nerve fibers from anterior horn cells of the alpha motor neuron system associated with extrafusal muscle fibers/skeletal muscle
  - **Type 1b** — Large nerve fibers associated with the intrafusal muscle fibers / muscle spindle

Definitions

- **Extrafusal muscle fibers**: Standard skeletal muscle fibers that are innervated by the alpha motor neuron allowing for skeletal movement
- **Alpha motor neuron**: Large, multipolar lower motor neurons of the brainstem and spinal cord. They innervate extrafusal muscle fibers of skeletal muscle and are directly responsible for initiating their contraction
- **Gamma Motor Neuron**: Innervate the muscle spindle at each end. They allow contraction of the intrafusal fibers and modulate their sensitivity to stretch. In this way the gamma motor neurons form an important muscle stretch reflex mechanism that acts in conjunction with the alpha motor neurons.
- **Muscle Spindle**: Stretch receptors within the body of a muscle that primarily detect changes in the length of the muscle. They convey length information to the central nervous system via Ia afferent nerve fibers. This information can be processed by the brain as proprioception. Their afferent innervation is via the gamma motor neuron.
- **Golgi Tendon Organ**: A mechanoreceptor that conveys muscle tension to the central nervous system via its Ib afferent nerve fibers. They send force information to the spinal cord, where interneurons receive input from the brain that specifies the amount of force that a muscle should produce. If that muscle's force level exceeds this set point, the GTO inputs inhibit the alpha motor neurons innervating that muscle, which lowers the force produced unless some other mechanism cancels that signal.
- **Renshaw cell**: The alpha motoneuron axon has a recurrent collateral in the spinal cord that synapses onto the Renshaw cell. Similarly to the neuromuscular junction, the neuro- transmitter onto the Renshaw cell is acetylcholine. The Renshaw cell then directly inhibits the alpha motoneuron using glycine as the neurotransmitter. This is called recurrent inhibition. It provides inhibitory feedback to the pool of alpha motoneurons to prevent excessive output.
- **Inhibitory Internuncial Pool**: Inhibitory neurons in the gray matter of the spinal cord interposed between and connecting two other neurons

Possible Explanations for Anti-inflammatory Effects of Foam Rolling May be Similar to Dry Needling. Future research?





Acute inflammation Anti-inflammatory Mechanism
Induces localized pain
Also promotes resolution of pain by producing specialized pro-resolving mediators (SPMs)
Resolvins
RvD1, RvD2, RvD3, RvE1
Protectin
PD1
Neuroprotectin
NPD1
Maresin
MaR1 (also found in fish oil)
SPMs produced during the resolution phase of acute inflammation
Exhibit potent anti-inflammatory actions
Are potent analgesics
Inhibit and resolve inflammatory and postoperative pain
Dry needling
Induces Microtissue injury
Induces localized pain
induces local acute inflammation
Promotes resolution of pain in part by inducing the the release production of pro-resolving mediators during the resolution phase of acute inflammation
Most experimental minimal and mechanical injuries are regenerated within 7 to 10 days

Dry Needling and Intramuscular Nerve Regeneration in Mammal Model

- Day 1
  - Fragmented axons of intramuscular nerves observed from the point of injury to the synaptic contacts
- Day 2-3
  - Motor endplates reinnervated by very fine axons covering a spread out postsynaptic component
- Day 3
  - Axonal growth cone visualized as an axonal dilatation beyond its endplate
  - Scatter receptors regroup under fine axons and axonal growth cone
  - Receptors aggregate below the axon and take the shape of normal adult synapses
  - Reinnervation after nerve damage by repetitive mechanical injury (dry needling) was rapid and complete by day 3. Neuromuscular synapses were reoccupied.

Dry Needling Tissue Inflammation and Muscle Tissue Regeneration Timeline in Mammal Model

- 24 Hours
  - Complete inflammatory reaction of damaged tissue can be observed
- 72 Hours
  - Muscle are in the initial phase of regeneration
  - Inflammatory reaction present
  - Inflammatory cells clean necrotic debis of the injured area while preserving healthy part of muscle tissue
- Day 3-5
  - Satellite cells are activated and transformed into myoblasts
  - Myoblast initiate a period of mitotic proliferation (Cell division)
  - Inflammatory cells coexist with myoblasts
  - Necrotic debris is complete phagocytosed by the inflammatory reaction
  - Myoblast fuse with each other and healthy parts of the injured muscle fibers
  - Myoblast fusion produces the myotubes
  - New myotubes start synthesis of actin and myosin (myofibrillogenesis)
- Day 5
  - Myotubules are in advances stage of myofibrillogenesis
  - Most cytoplasm is occupied by the neosynthesized contractile apparatus
  - Non-fused myoblast become satellite cells
- Days 5-7
  - Satellite cells clearly identified
- Day 7
  - Regeneration Complete

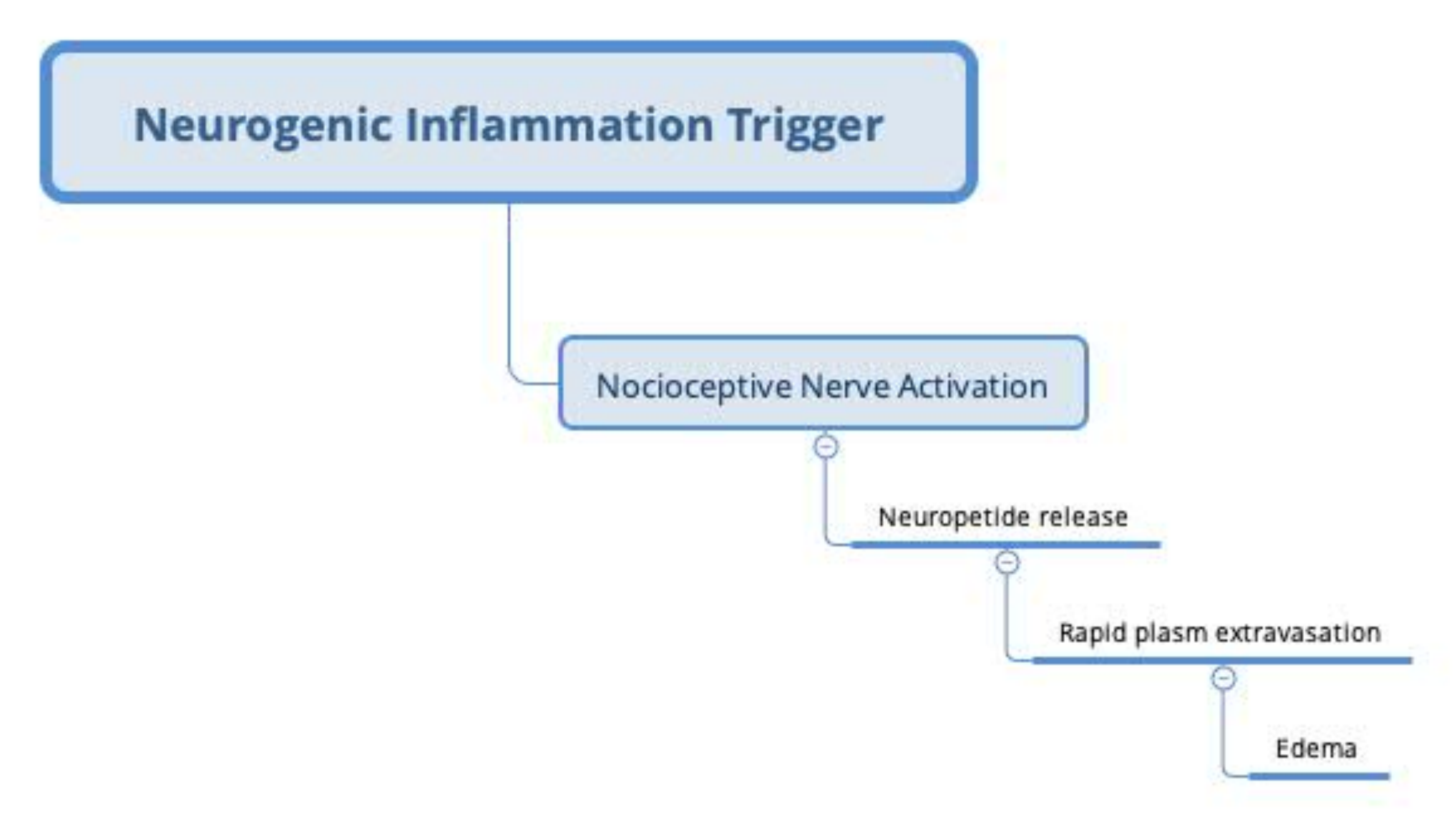
Myotube

- Form from myoblasts 3-4 days after damage from running or eccentric lengthening contractions
- In the stage of healing of the myotube, actin and myosin are synthesized to create sarcomeres
- Sarcomeres form in cytoplasm between 4-7 days depending on the severity of muscle injury

Satellite Cell

- Undifferentiate "sleeper" stem cells
- Reside on the surface of health adult mucle fibers
- When muscle in damaged they become myoblasts
- Myoblasts from satellite cells initiate a period of mitosis from 9-15 hours
- myoblasts resulting from this mitosis period fuse with each other and with the muscle fibers surrounding the area of injury. The resulting structure is a cell called a myotube

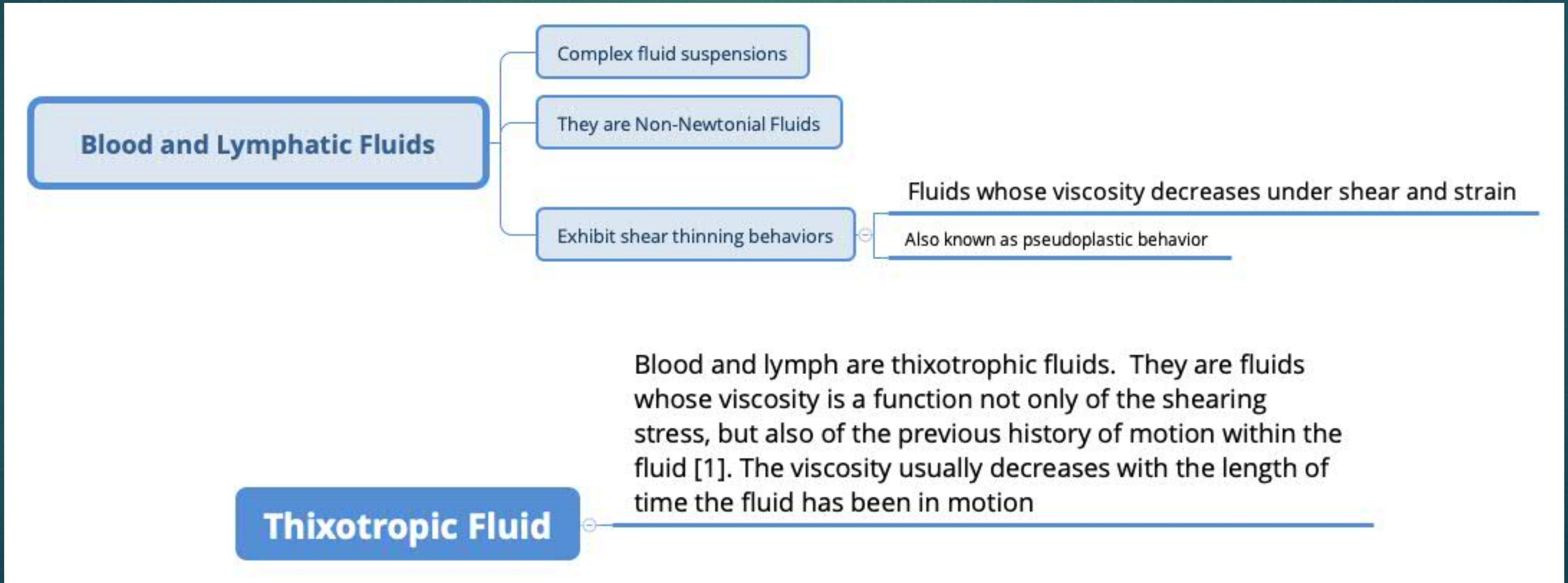
Restoring Homeostasis of Extracellular Matrix and Improving Tissue Mobility Through Neurogenic Trigger/Pain Induction. Future research?



Extracellular Matrix (ECM)

- **Polysaccharides**
  - Polymeric Carbohydrates
    - Long chain carbohydrated molecules
    - Composed of monosaccaride units
    - Units are bound by glycosidic linkages
    - React with water (hydrolysis: chemical rxn in which a molecule of water ruptures one or more chemical bonds) using amylase enzyme (catalyzes the hydrolysis of starch into sugars-monosaccharides or Oligosaccharides (saccharide polymer containing a small number of monosaccharides)
- **Glycoaminoglycans GAGs/mucopolysaccharides**
  - Long linear polysaccharides consisting of repeating disaccharide Units (double sugar units)
  - Highly polar and attracts water
  - Used in the body as a lubricant or shock absorber (Hyaluronic Acid)
- **Proteoglycans**
  - Proteins that are heavily glycosylated (enzymatic process that attaches glycans to proteins, or other organic molecules)
- **Water**
  - Interacts with hydrophilic substances
    - Takes on a gel like state/colloid chrystal in chemical structure adjacent to the hydrophilic substance
      - Exclusion zone (EZ) - Negative charge is next to the hydrophilic substance
      - Bulk water has Positive charge

Other Considerations: Percussion and vibration induced shear and strain as mechanisms of clearing inflammation. Future research?



Some Interesting References

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- Local Application of Vibration in Motor Rehabilitation – Scientific and Practical Considerations Daniela POENARUa, Delia CINTEZAa, Irina PETRUSCAb, Liliana CIOCb, Dan DUMITRASCUb MAEDICA – a Journal of Clinical Medicine 2016; 11(3):227-231
- Experimental Evidence of the Tonic Vibration Reflex during Whole-Body Vibration of the Loaded and Unloaded Leg Lisa N. Zaidell1*, Katya N. Mileva1, David P. Sumners1, Joanna L. Bowtell2
- The Use of Vibration as Physical Exercise and Therapy Giuseppe Musumeci 1,2 Journal of *Functional Morphology and Kinesiology*