*Core strength is a term many of us have heard. And while we might be able to identify muscles like the abdominals and gluteals, the term "core strength" is a bit harder to define. In this class, we'll look at the biomechanics of the core and its implications to activities from walking, golfing to making your world-famous pumpkin pie.*

*We'll also make the case that while your typical 'googlable' exercises like side planks and bridges are tremendously useful, they don't always address the neurophysiological causes of your "weak core." In this 2-part course, learn the cause & effects of a weak core as well as practical "food for thought" as you head into your next exercise class.*

# Core Principles: from the back to beyond
# Part 1

Peter Jo
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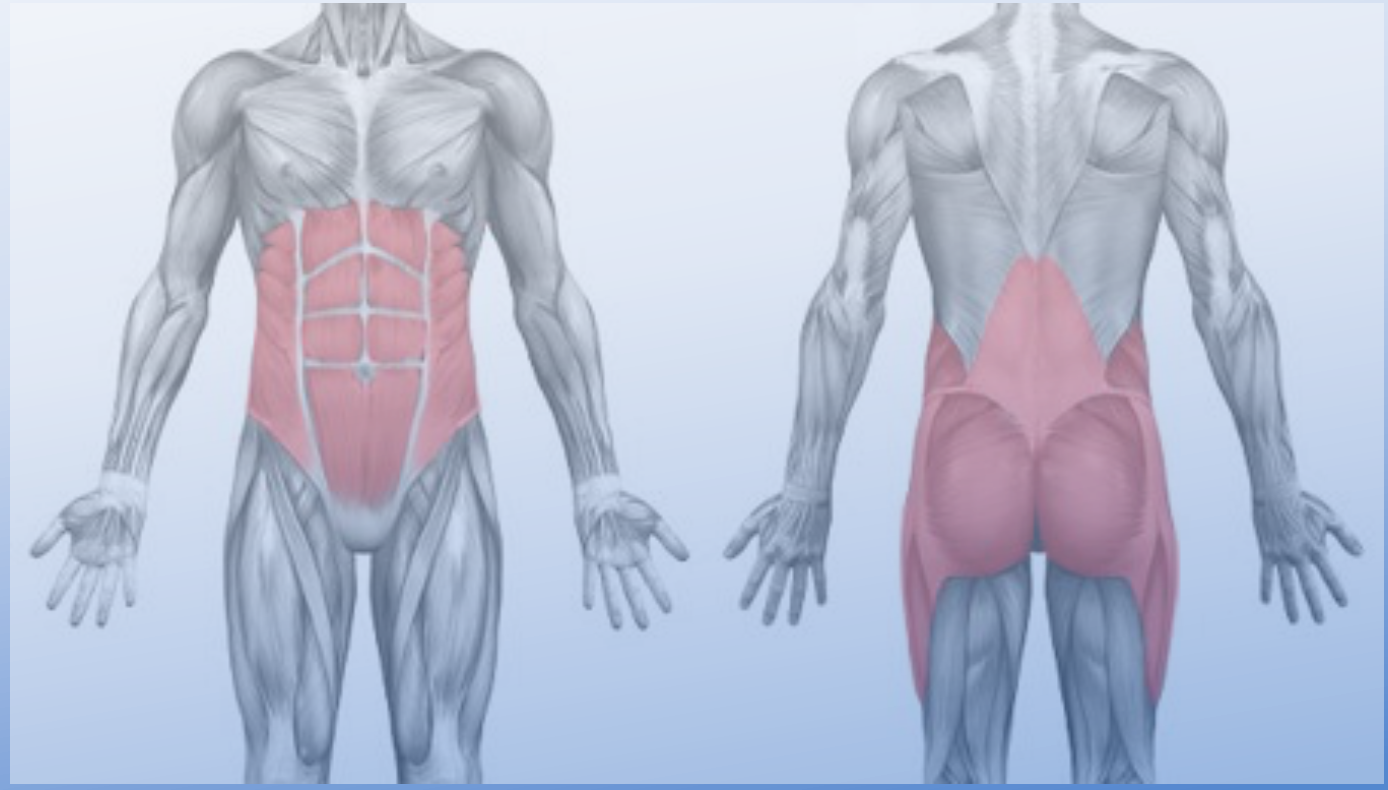


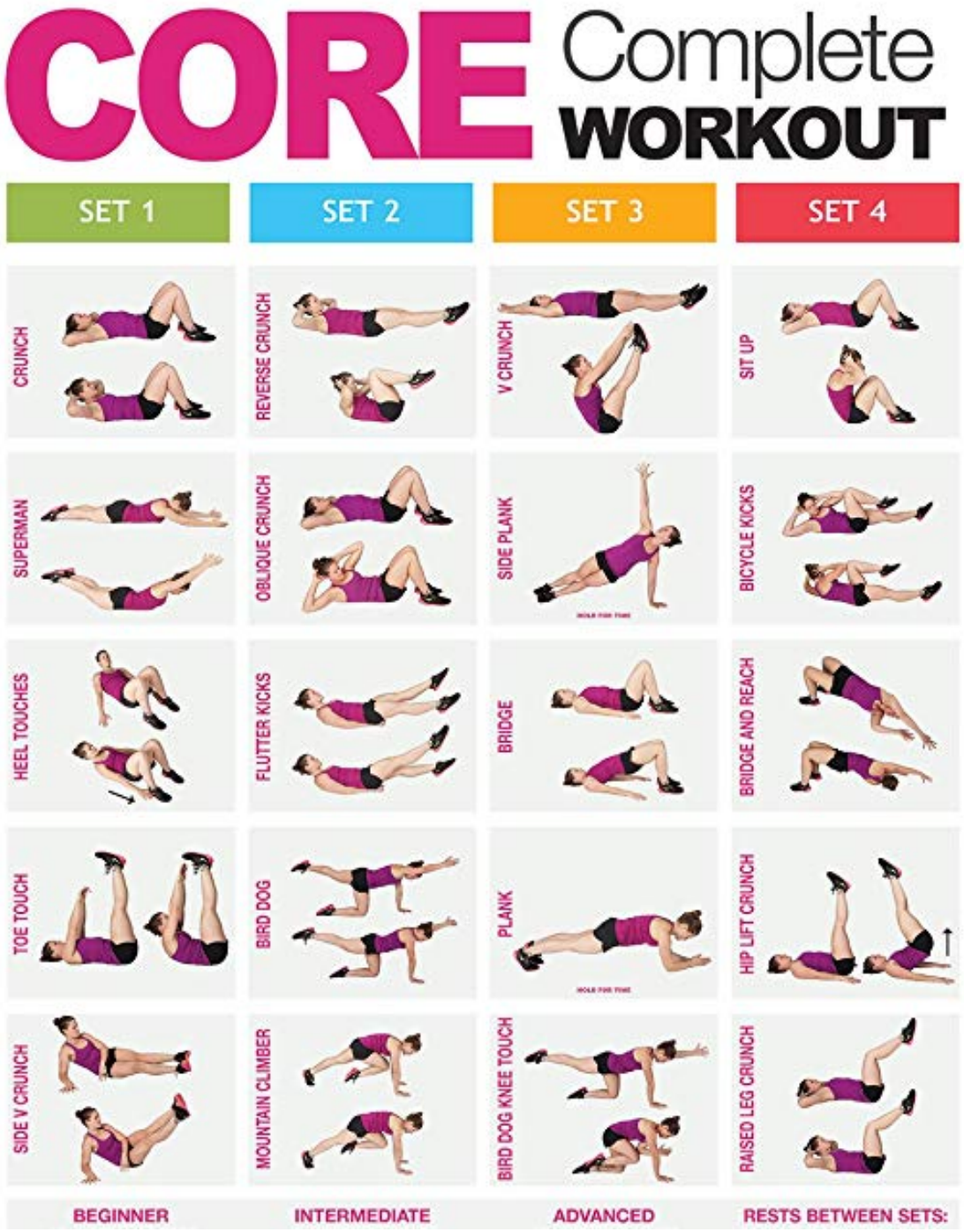
# Outline

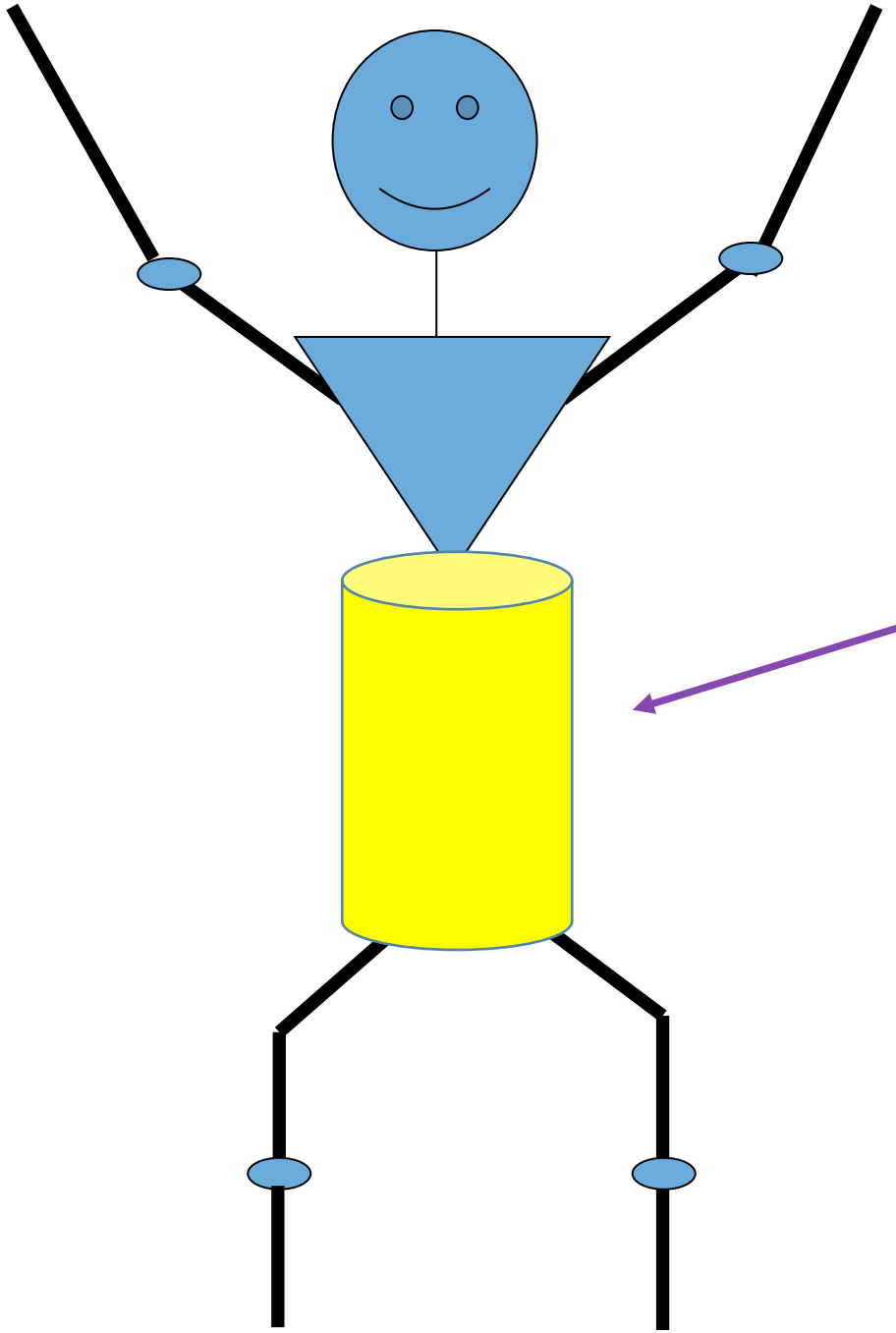
1. Why it matters

2. Anatomy:
   - Basic
   - Extended

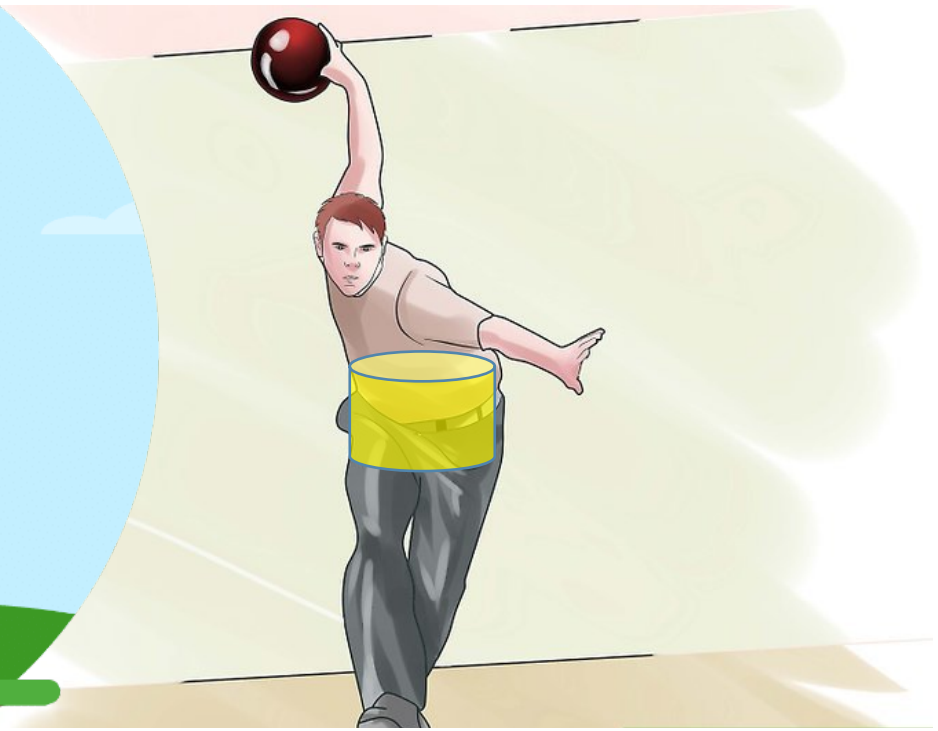
3. Neuromechanics
   - What is a “weak” core ?

4. Wiring of the nervous system





Should this be rigid or flexible?



# Core strength training for patients with chronic low back pain

- Through core strength training, patients with chronic low back pain can strengthen their deep trunk muscles …

- …All of the core strength training strategies examined in this study assist in the alleviation of chronic low back pain

J Phys Ther Sci. 2015 Mar; 27(3): 619–622.

# Lumbopelvic Core Stabilization Exercise and Pain Modulation Among Individuals with Chronic Nonspecific Low Back Pain.

- **BACKGROUND:**
- Lumbopelvic stabilization training (LPST) may provide therapeutic benefits on pain modulation in chronic nonspecific low back pain conditions. This study aimed to examine the effects of LPST on pain threshold and pain intensity in comparison with the passive automated cycling intervention and control intervention among patients with chronic nonspecific low back pain.

**CONCLUSIONS:**

- Lumbopelvic stabilization training may provide therapeutic effects by inducing pain modulation through an improvement in the pain threshold and reduction in pain intensity. LPST may be considered as part of the management programs for treatment of chronic low back pain.

**Pain** Pract. 2017 Nov;17(8):1008-1014. doi: 10.1111/papr.12552. Epub 2017 Feb 25.

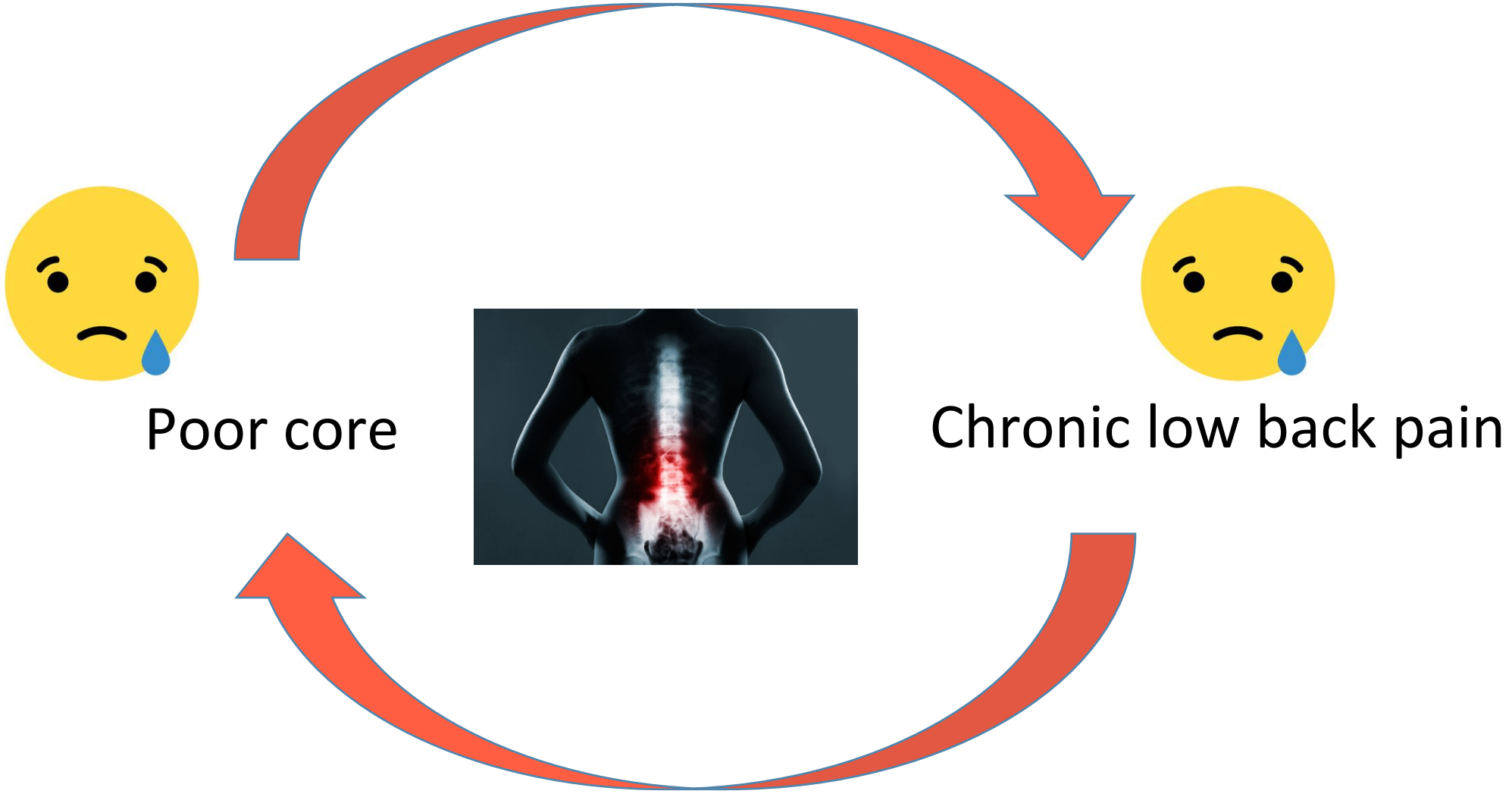
# Core Stability Exercise Versus General Exercise for Chronic Low Back Pain

- A meta-analysis of core stability exercise versus general exercise for chronic low back pain.

- Clinical Question: Is core stability exercise more effective than general exercise in the treatment of patients with nonspecific low back pain (LBP)?

**CONCLUSIONS:**
In the short term, core stability exercise was more effective than general exercise for decreasing pain and increasing back-specific functional status in patients with LBP.

J Athl Train. 2017 Jan;52(1):71-72. doi: 10.4085/1062-6050-51.11.16. Epub 2016 Nov 16


Poor core
Chronic low back pain

# Does a core stabilization exercise program have a role on shoulder rehabilitation? A comparative study in young females

- The aim of core stabilization training is to ensure appropriate muscular balance around the lumbo-pelvic-hip complex, creating a rigid cylinder against body perturbations, while allowing a stable base for accurate movement control.

- Our study showed that six-week core stabilization exercise program had a significant positive effect on the shoulder MVIC strength. This result may support the use of core stabilization exercises in the early periods of shoulder rehabilitation when the shoulder muscle strengthening exercises are painful.

Turk J Phys Med Rehabil. 2018 Dec; 64(4): 328–336.

# Is core stability a risk factor for lower extremity injuries in an athletic population? A systematic review.

**OBJECTIVES:**

- To research and summarize the literature regarding the role of core stability as a risk factor in the development of lower extremity injuries in an athletic population.

**RESULTS:**

- Nine articles were included in the systematic review. Various components of core stability were found to be related to lower extremity musculoskeletal injuries in healthy athletic populations.

- Core strength, core proprioception and neuromuscular control of the core were found to be a risk factor in the development of lower extremity injuries. However, conflicting evidence was found for core endurance as a risk factor for lower extremity injuries.

**CONCLUSION:**

- Deficits in various aspects of **core stability** were identified as potential risk factors for lower extremity injuries. As such, **core stability** needs to be considered when screening athletes.

Phys Ther Sport. 2018 Mar;30:48-56. doi: 10.1016/j.ptsp.2017.08.076. Epub 2017 Aug 24.

# Outline

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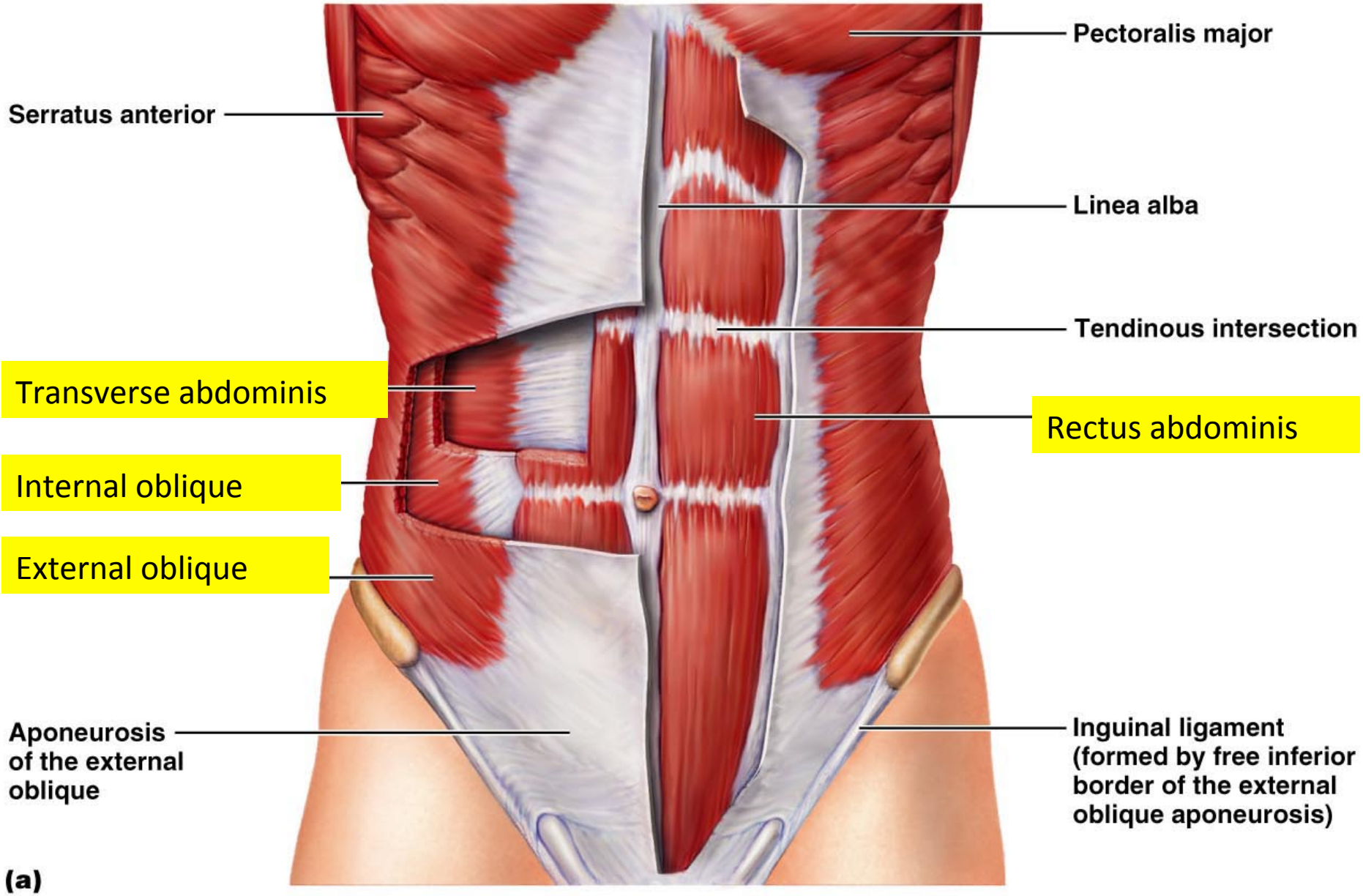
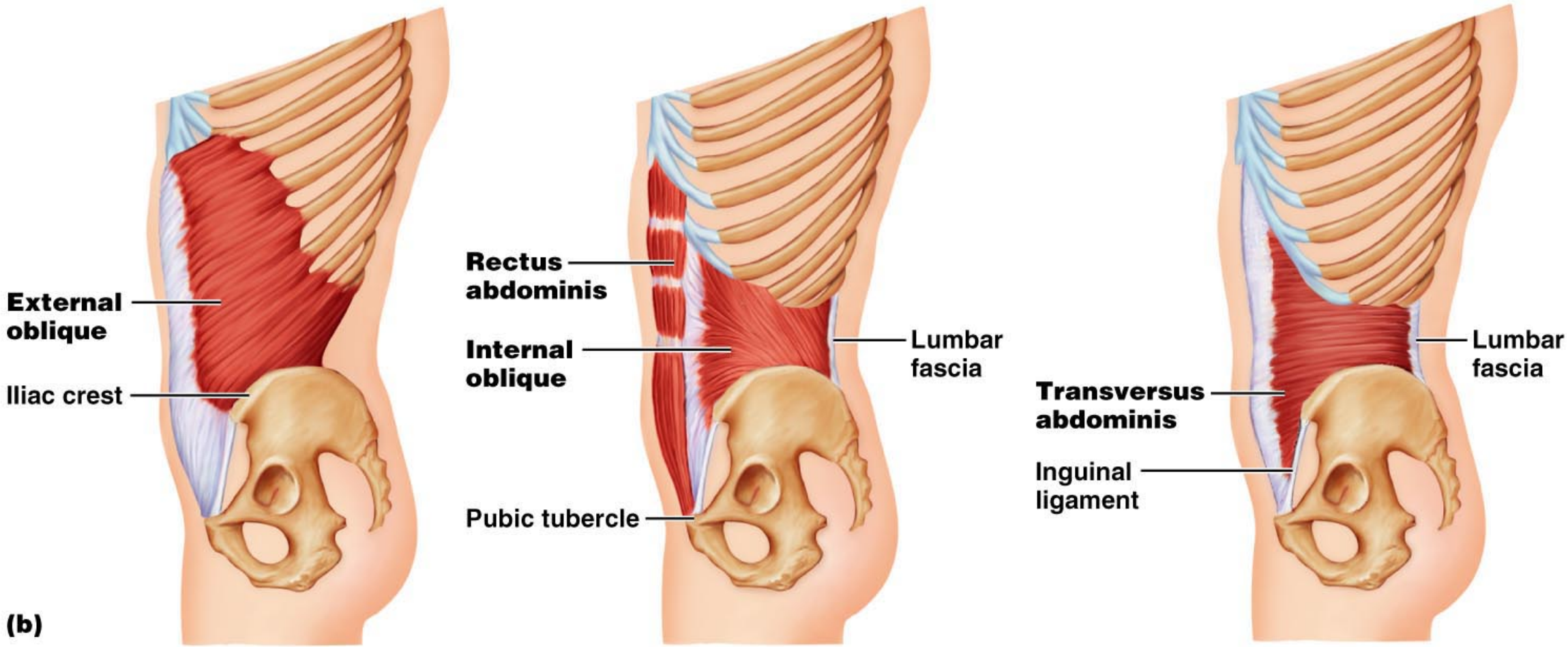
   - **Low back pain**
   - **Upper extremity function**
   - **Lower extremity function**

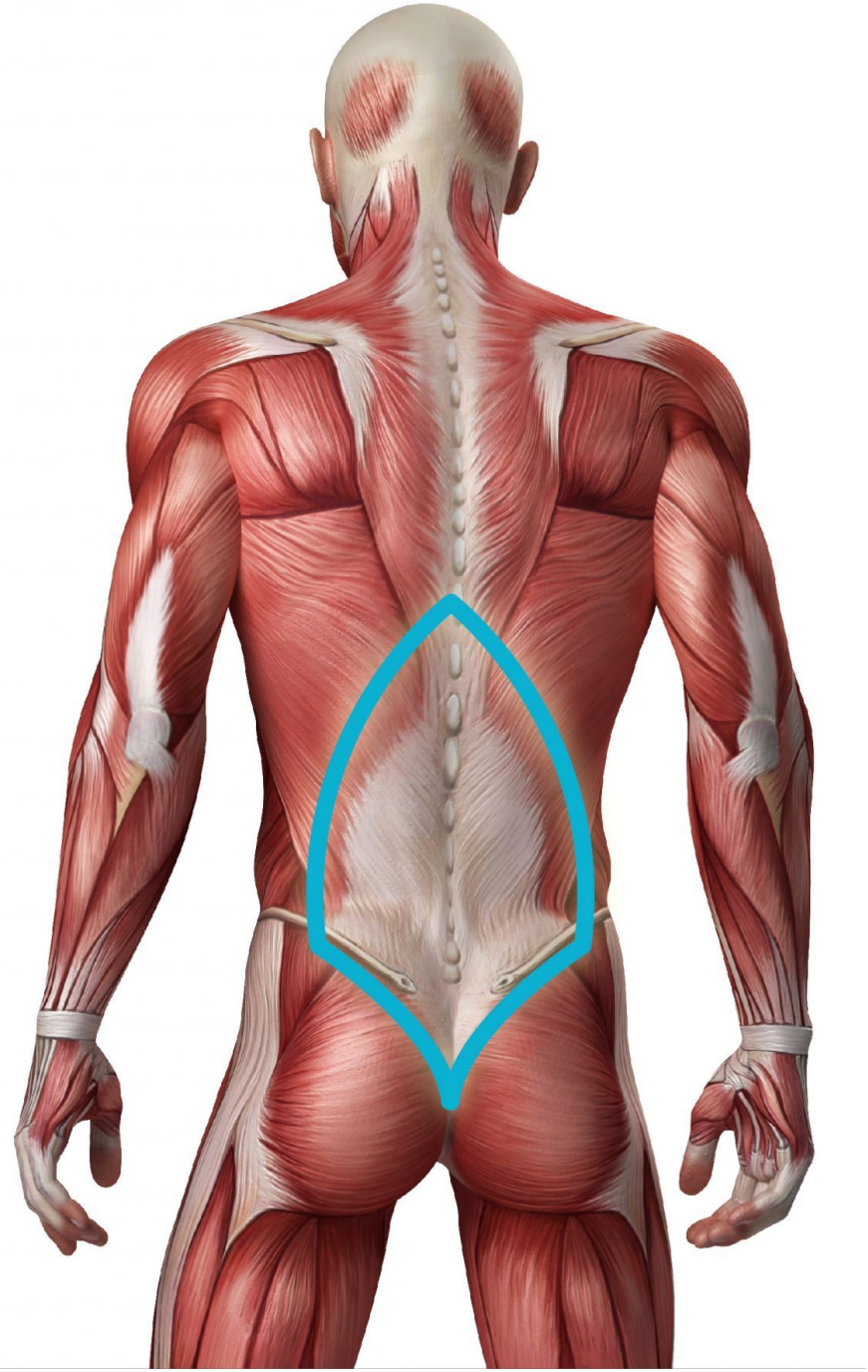
2. Anatomy:
   - Basic
   - Extended

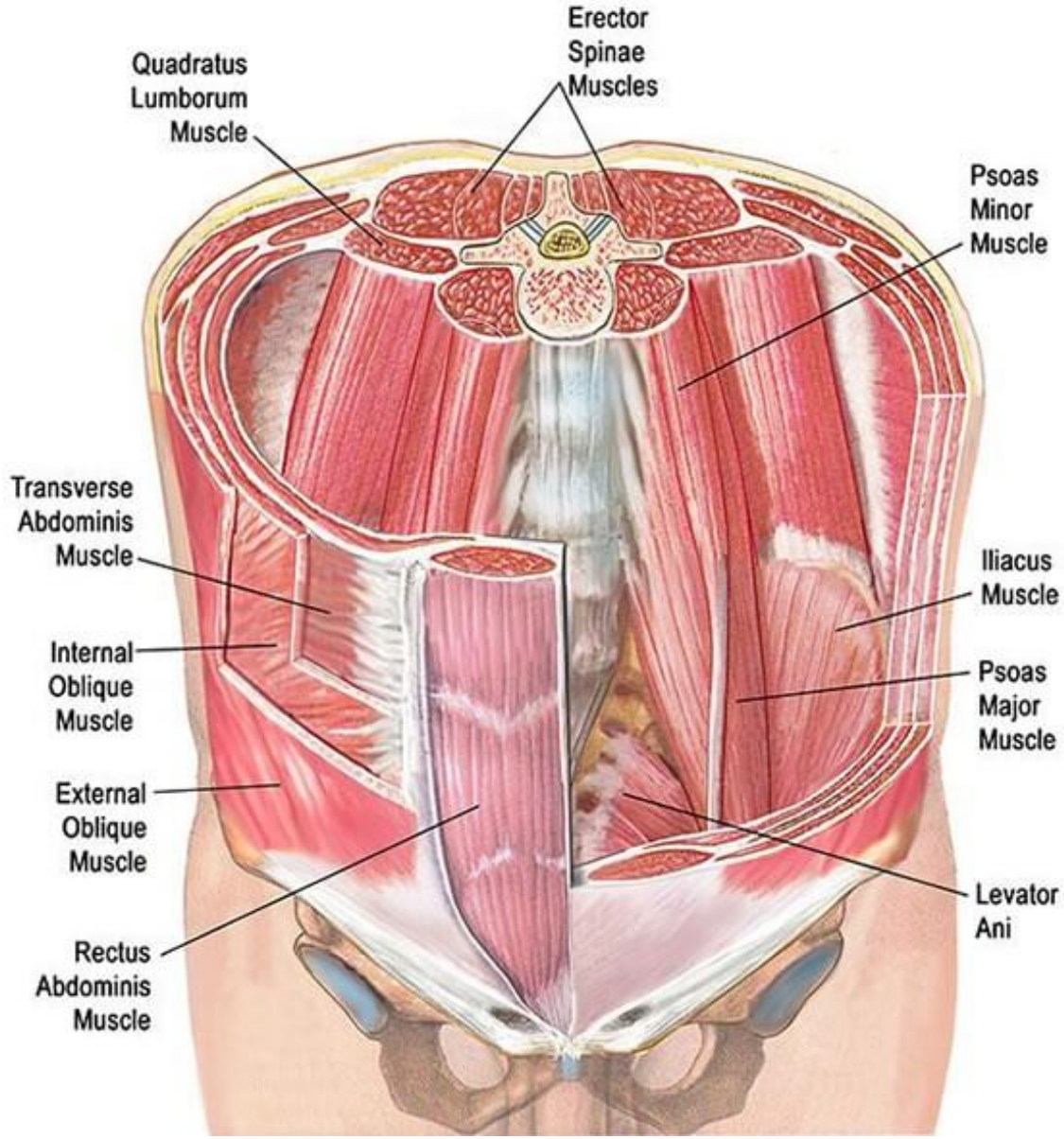
3. Neuromechanics
   - What is a “weak” core ?

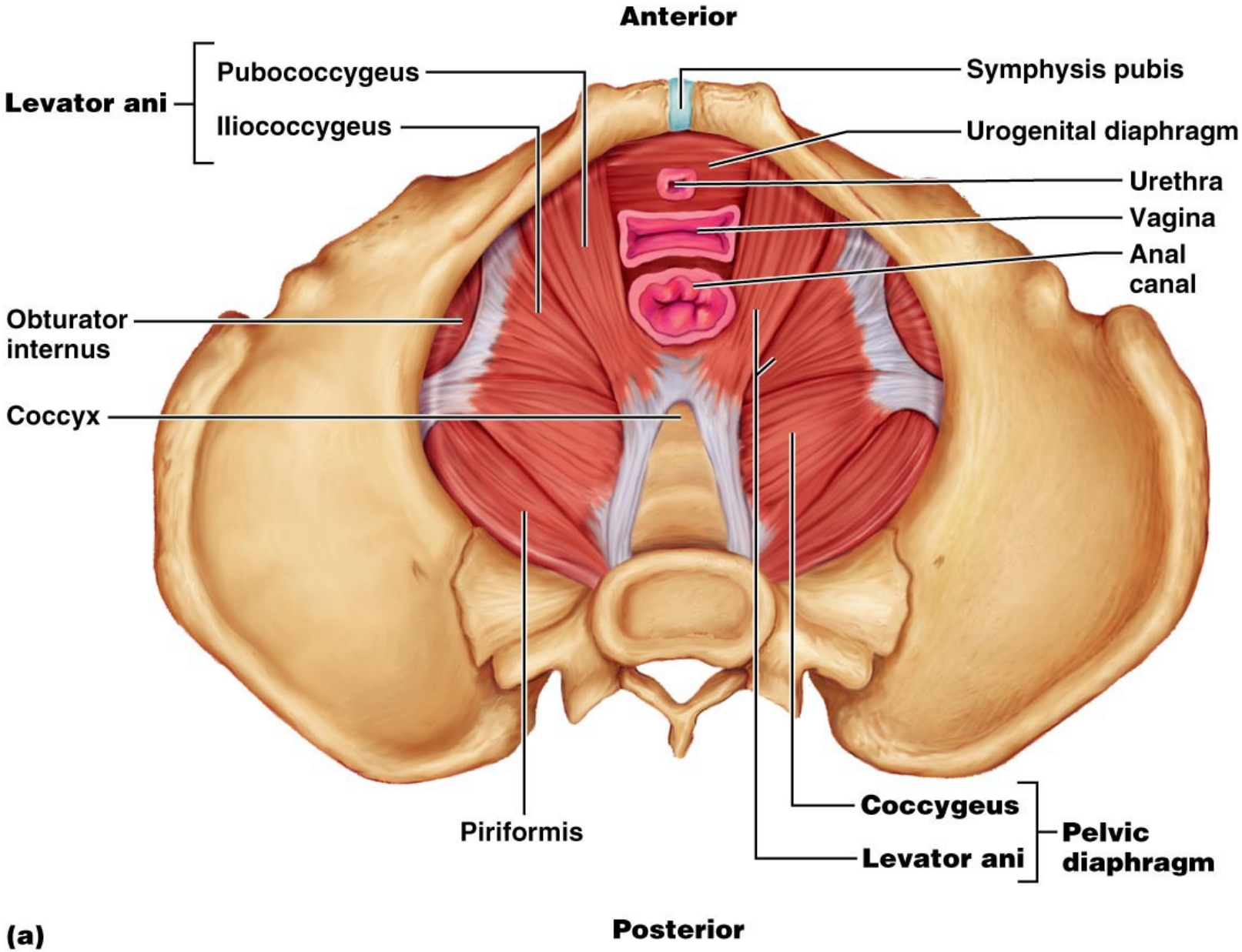
4. Wiring of the nervous system


Pectoralis major
Serratus anterior
Linea alba
Tendinous intersection
Transverse abdominis
Rectus abdominis
Internal oblique
External oblique
Aponeurosis of the external oblique
Inguinal ligament (formed by free inferior border of the external oblique aponeurosis)
(a)

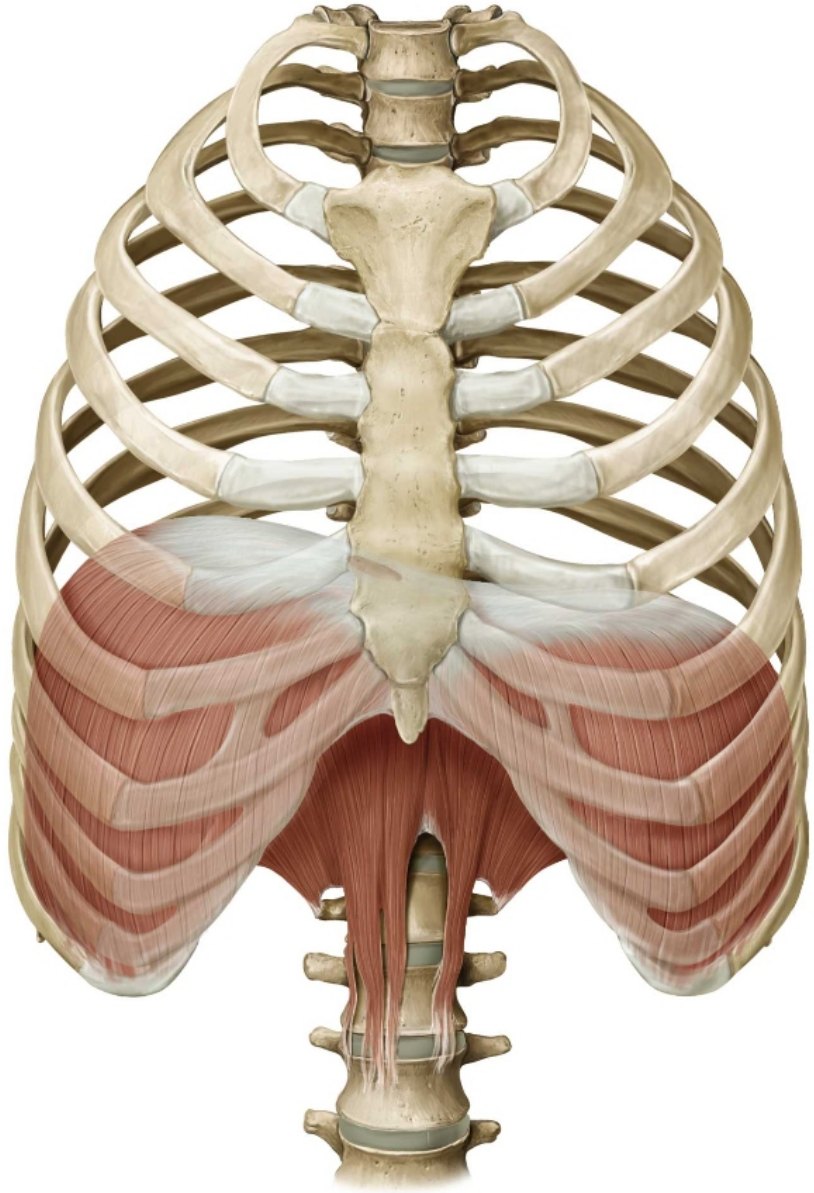

External oblique
Iliac crest
(b)
Rectus abdominis
Internal oblique
Pubic tubercle
Lumbar fascia
Transversus abdominis
Inguinal ligament
Lumbar fascia

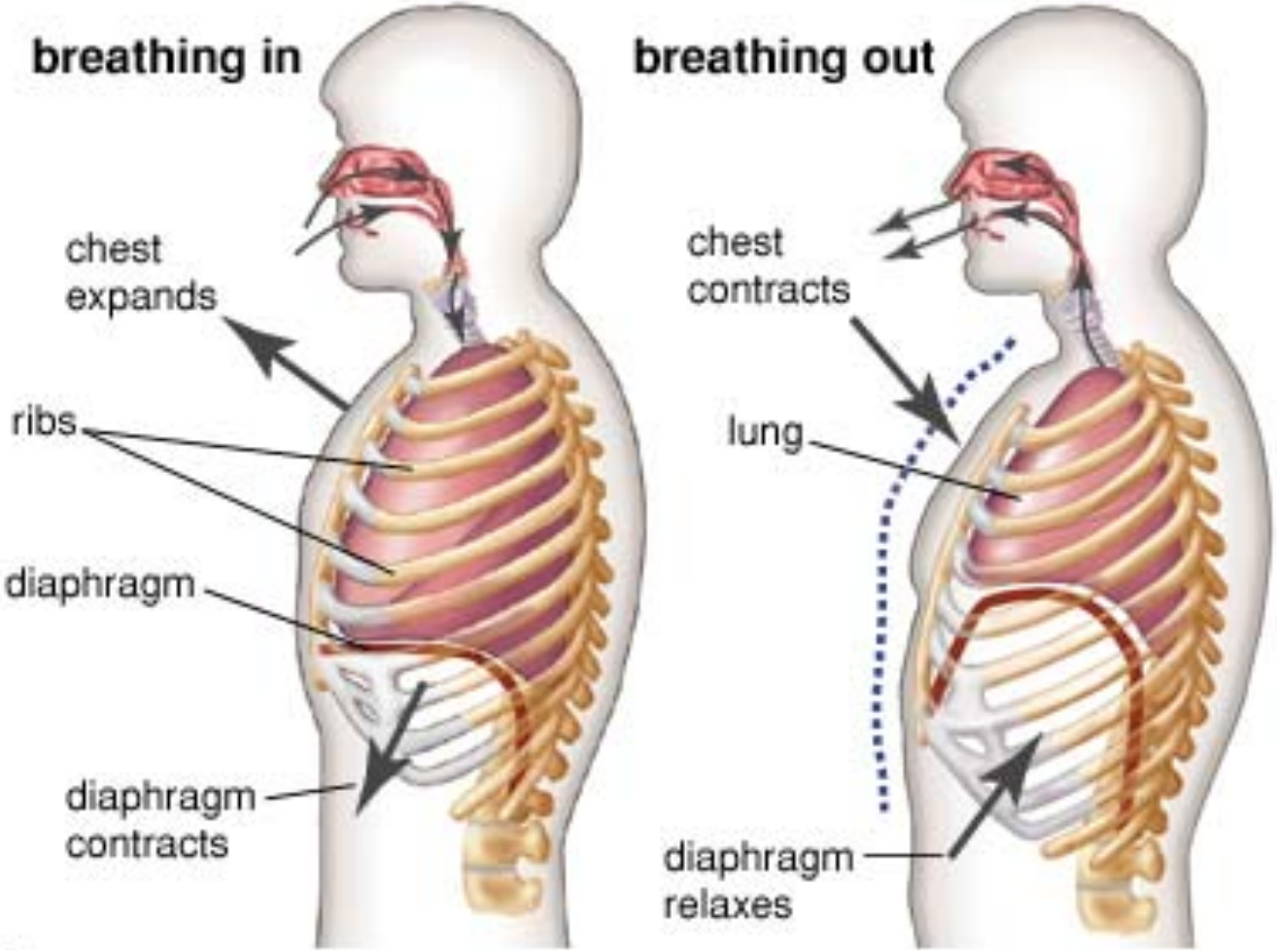


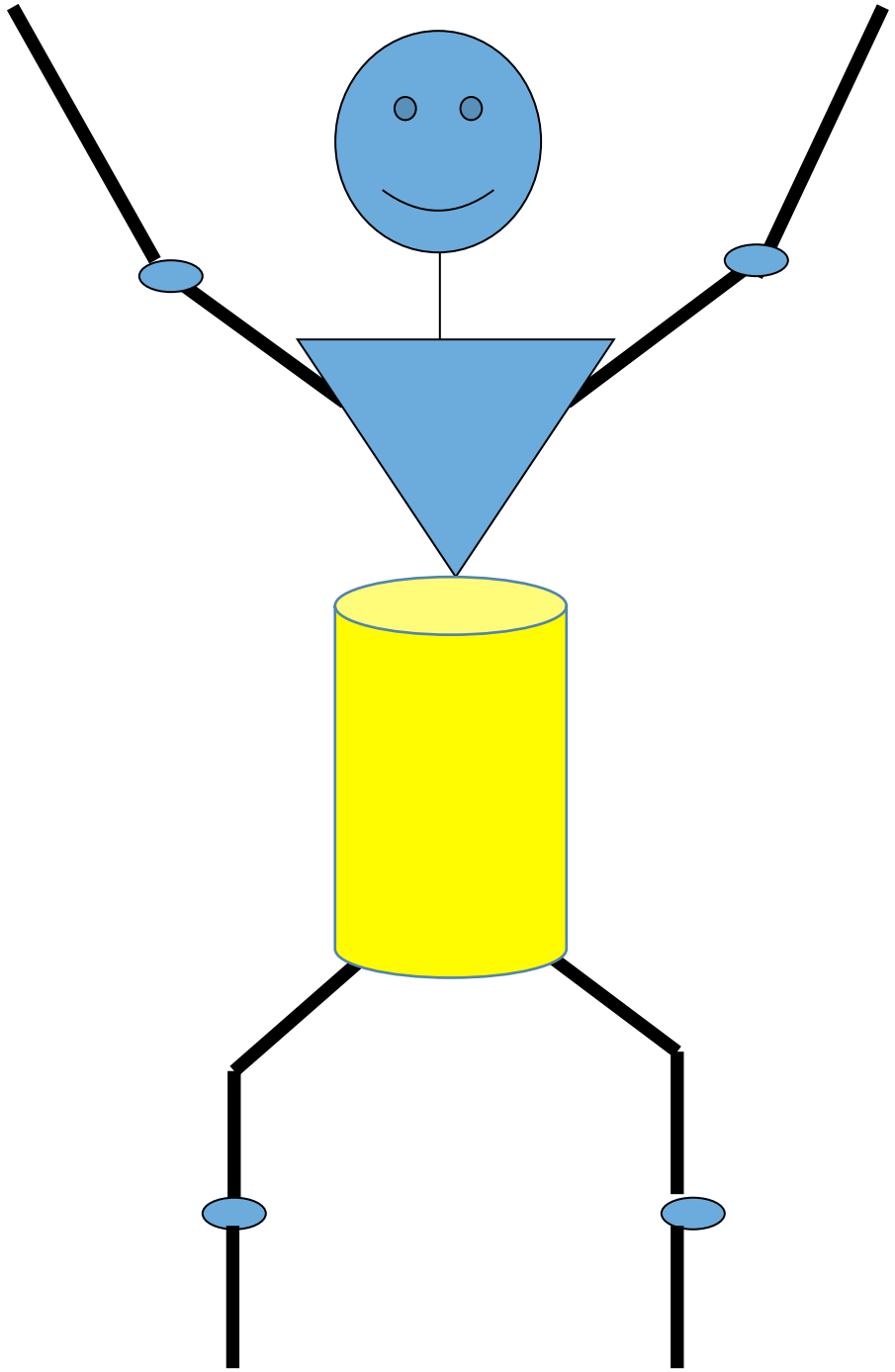

Quadratus Lumborum Muscle
Erector Spinae Muscles
Psoas Minor Muscle
Transverse Abdominis Muscle
Iliacus Muscle
Internal Oblique Muscle
Psoas Major Muscle
External Oblique Muscle
Levator Ani
Rectus Abdominis Muscle

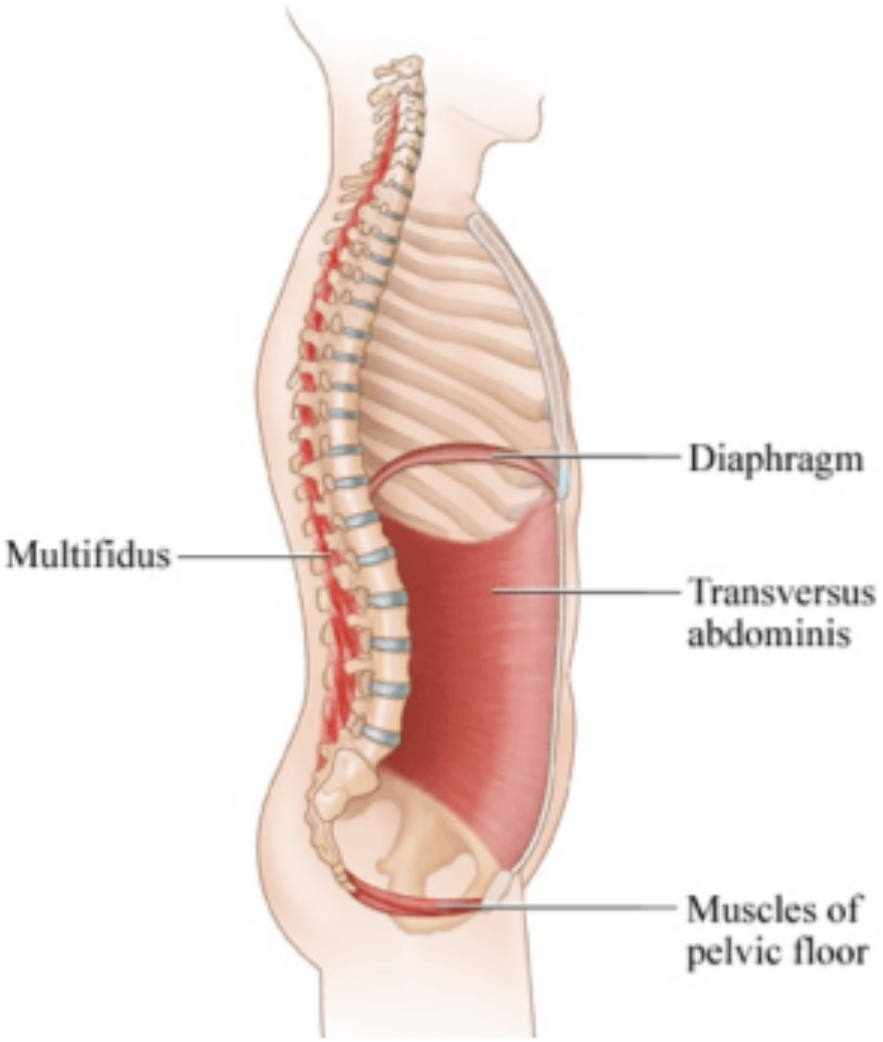

Anterior
Levator ani
Pubococcygeus
Iliococcygeus
Symphysis pubis
Urogenital diaphragm
Urethra
Vagina
Anal canal
Obturator internus
Coccyx
Piriformis
Coccygeus
Levator ani
Pelvic diaphragm
Posterior

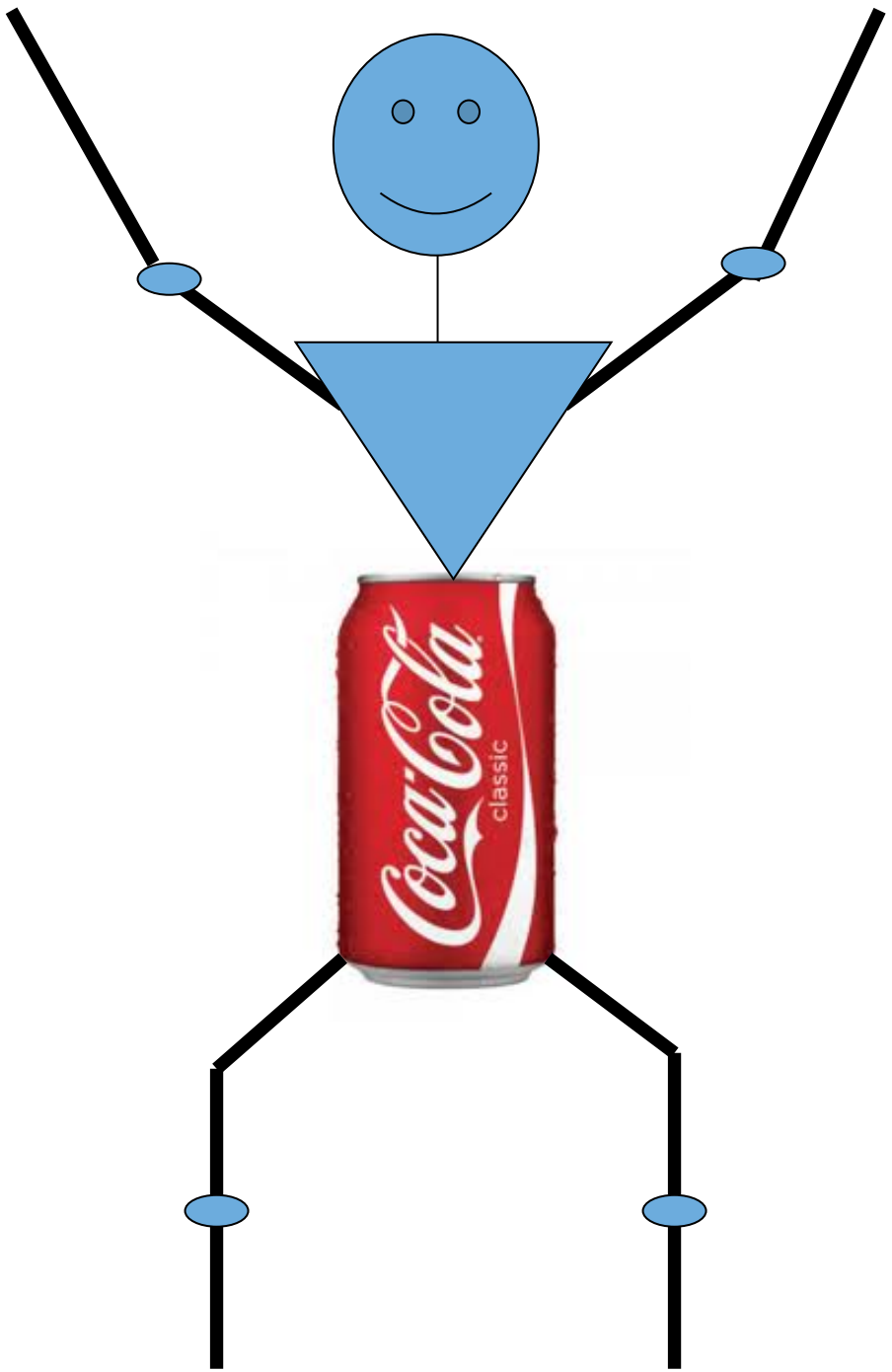
(a)

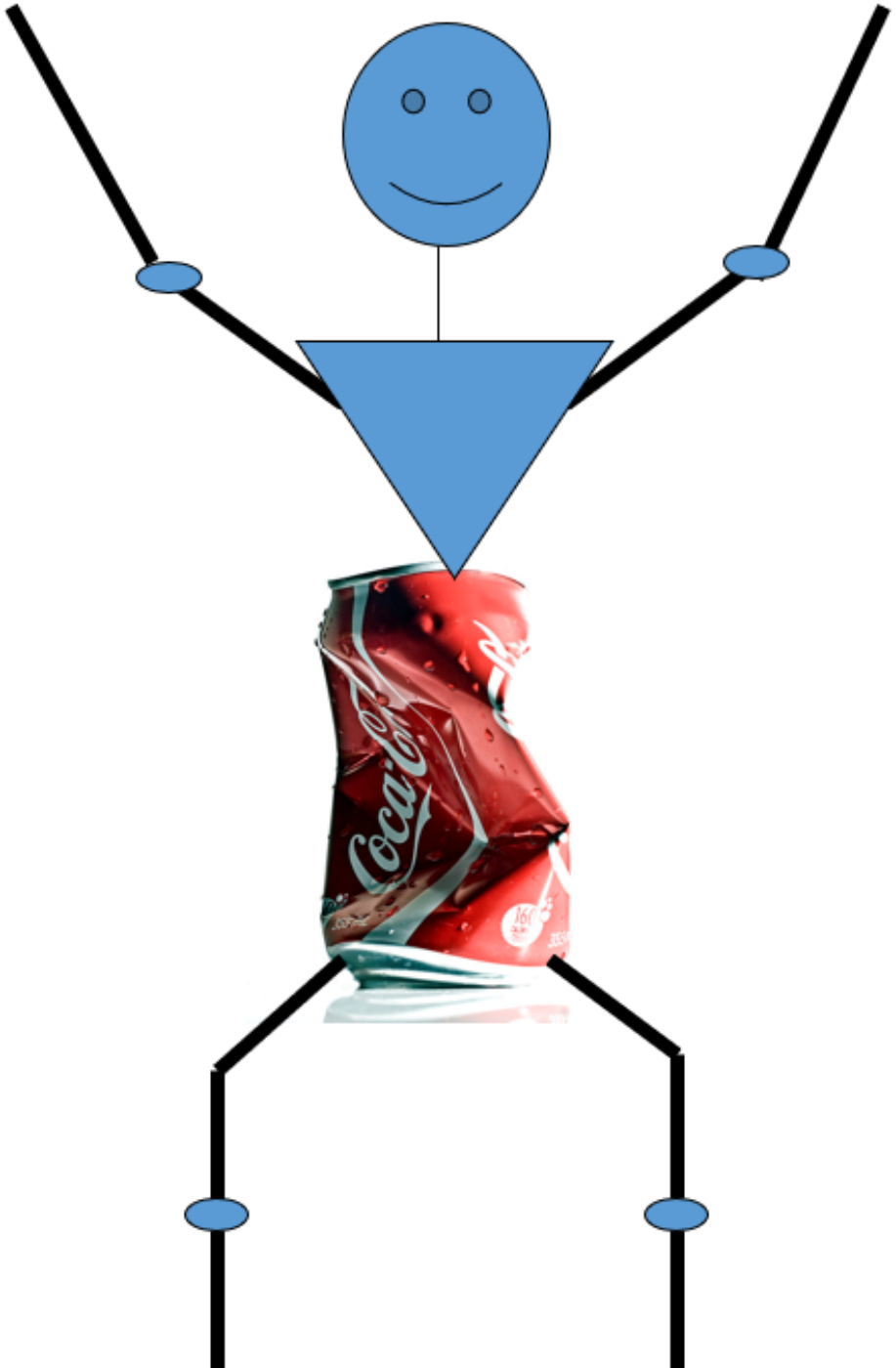


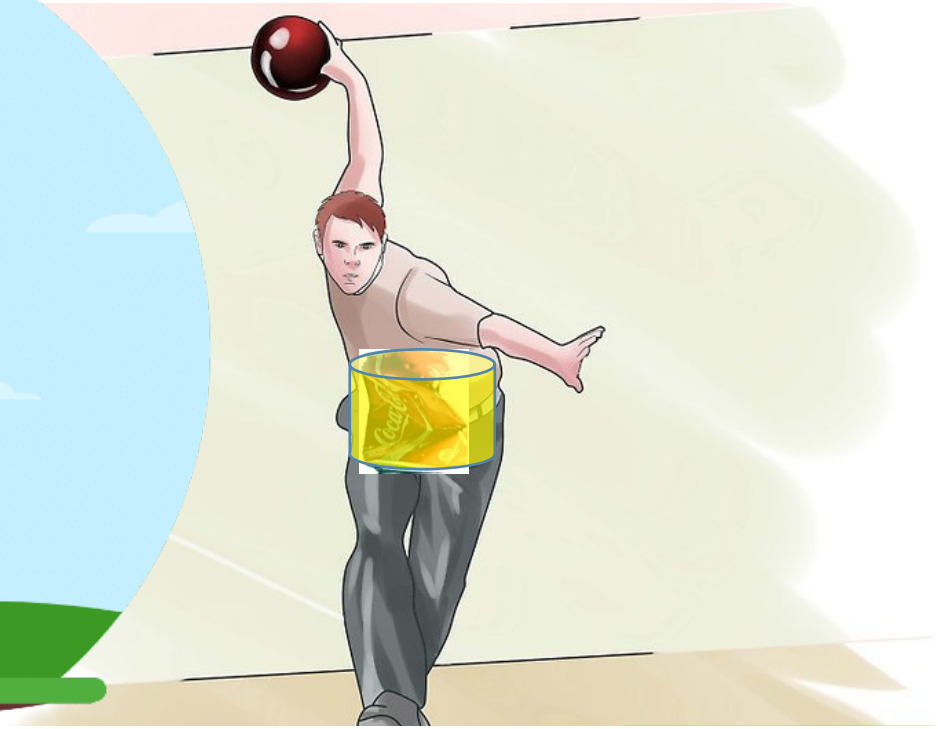

breathing in
chest expands
ribs
diaphragm
diaphragm contracts
breathing out
chest contracts
lung
diaphragm relaxes




Diaphragm
Multifidus
Transversus abdominis
Muscles of pelvic floor


Coca-Cola
classic


Coca-Cola



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   - **Extended ***

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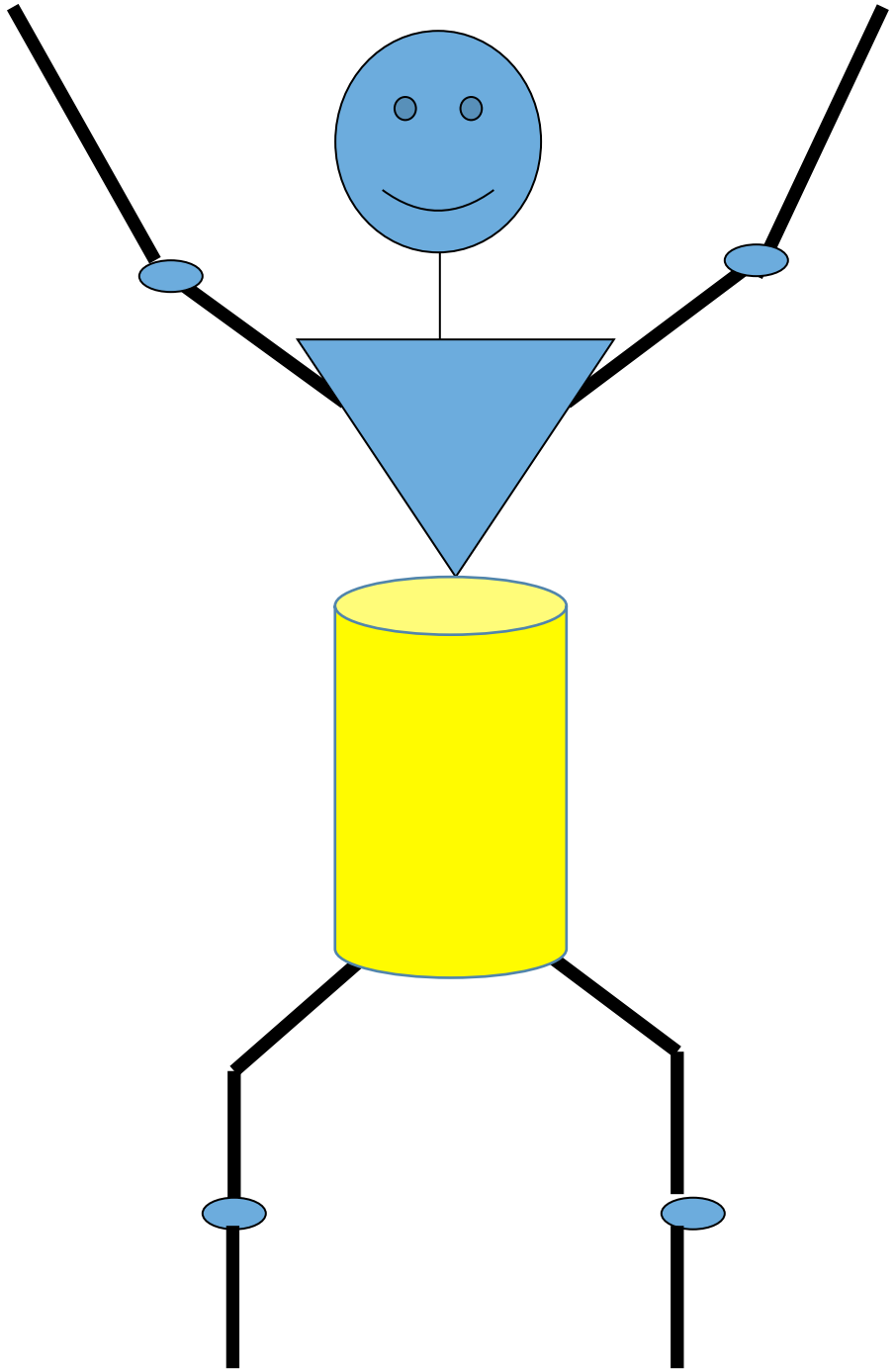
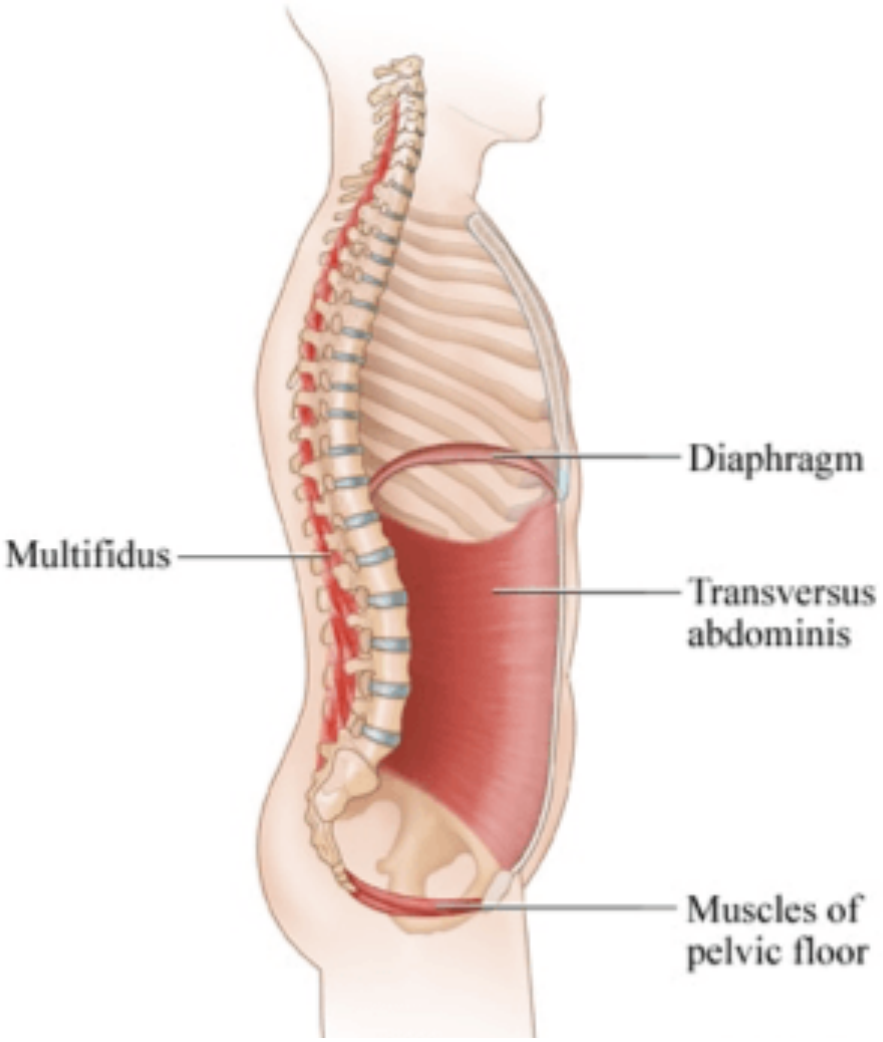
   - What is a “weak” core ?

4. Wiring of the nervous system




Diaphragm
Multifidus
Transversus abdominis
Muscles of pelvic floor

# The first muscle to contract is…

- Transverse abdominis, multifidus and internal abdominal oblique do not get “weak” in a conventional sense

- **It is a timing issue**

# Transversus Abdominis Activation and Timing Improves Following Core Stability Training: a Randomized Trial

- Patients with non-specific low back pain (LBP) often present with a decrease in transversus abdominis (TrA) muscle activation and delayed onset of contraction with extremity movements, potentially contributing to recurrent LBP.

- Core stability is required for extremity movement and if the timing of when the TrA contracts is not corrected patients may continue to experience LBP.

- TrA activation and timing were altered following a four-week core stability program in people with and without LBP. Clinicians should consider incorporating these exercises for improving the function of the TrA.

Int J Sports Phys Ther. 2017 Dec; 12(7): 1048–1056.

# Outline

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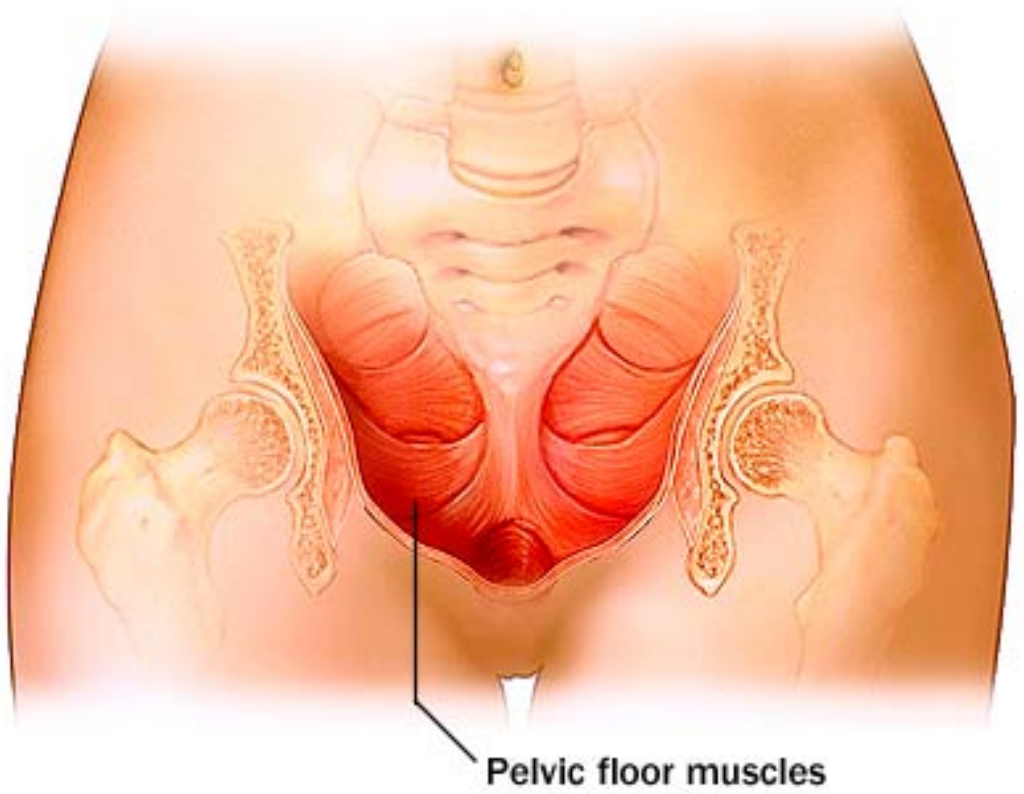
     - **Abdominal muscles**
     - Pelvic floor
     - Diaphragm

4. Wiring of the nervous system

# Thinking about key muscles:  pelvic floor

<u>Kegel exercises</u>

- Females→ after delivery
- Men→ prostate problems
- Urinary incontinence
  - Laughing
  - Exercising
  - Coughing
  - Standing up



# Postural and respiratory functions of the pelvic floor muscles

**AIMS:** Due to their contribution to modulation of intra-abdominal pressure (IAP) and stiffness of the sacroiliac joints, the pelvic floor muscles (PFM) have been argued to provide a contribution to control of the lumbar spine and pelvis. Furthermore, as IAP is modulated during respiration this is likely to be accompanied by changes in PFM activity.

**METHODS:** In order to evaluate the postural and respiratory function of the PFM, recordings of anal and vaginal electromyographic activity (EMG) were made with surface electrodes during single and repetitive arm movements that challenge the stability of the spine. EMG recordings were also made during respiratory tasks.

**RESULTS:** EMG activity of the PFM was increased in advance of deltoid muscle activity as a component of the pre-programmed anticipatory postural activity. This activity was independent of the direction of arm movement.

**CONCLUSIONS:**

- This study provides evidence that the PFM contribute to both postural and respiratory functions.

Neurourol Urodyn 2007;26(3):362-71

# Postural activity of the pelvic floor muscles is delayed during rapid arm movements in women with stress urinary incontinence.

- The aim of this study was to determine whether postural activity of the pelvic floor (PF) and abdominal muscles differs between continent and incontinent women during rapid arm movements that present a postural challenge to the trunk.

- Electromyographic activity (EMG) of the PF, abdominal, erector spinae (ES), and deltoid muscles was recorded with surface electrodes.
  - During rapid shoulder flexion and extension, PF EMG increased before that of the deltoid in continent women, but after the deltoid in incontinent women ($p = 0.002$).
  - In many incontinent women, PF EMG decreased before the postural activation.

- These findings would be expected to have negative consequences for continence and lumbopelvic stability in women with incontinence.

Int Urogynecol J Pelvic Floor Dysfunct. 2007 Aug;18(8):901-11. Epub 2006 Dec 1.

# Pelvic floor muscle exercise for chronic low back pain

**OBJECTIVE:**

- To assess the effect of pelvic floor muscle exercise in patients with chronic low back pain.

**METHODS:**

- Adults (aged ≥ 18 years) with chronic low back pain (with or without radiculopathy) were randomized to undergo either routine treatment (ultrasonography, short wave diathermy and lumbar strengthening exercises; control group) or routine treatment with pelvic floor exercises (intervention group) for 24 weeks. Pain, disability (Oswestry Disability Index [ODI] score) and trunk muscle function were assessed at baseline and after completion of treatment.

**CONCLUSION:**

- Pelvic floor exercise in combination with routine treatment provides significant benefits in terms of pain relief and disability over routine treatment alone.

J Int Med Res. 2013 Feb;41(1):146-52. doi: 10.1177/0300060513475383. Epub 2013 Jan 23.

# Outline

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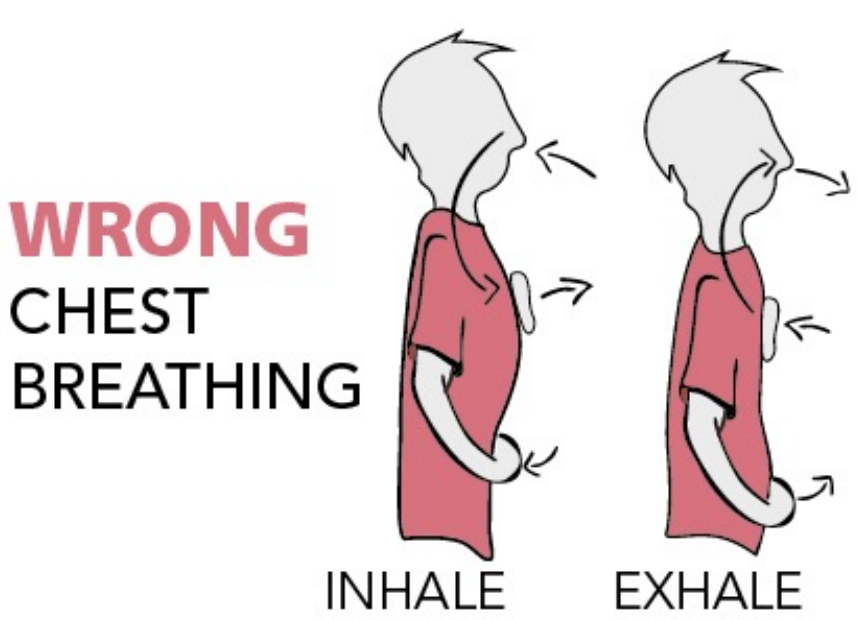
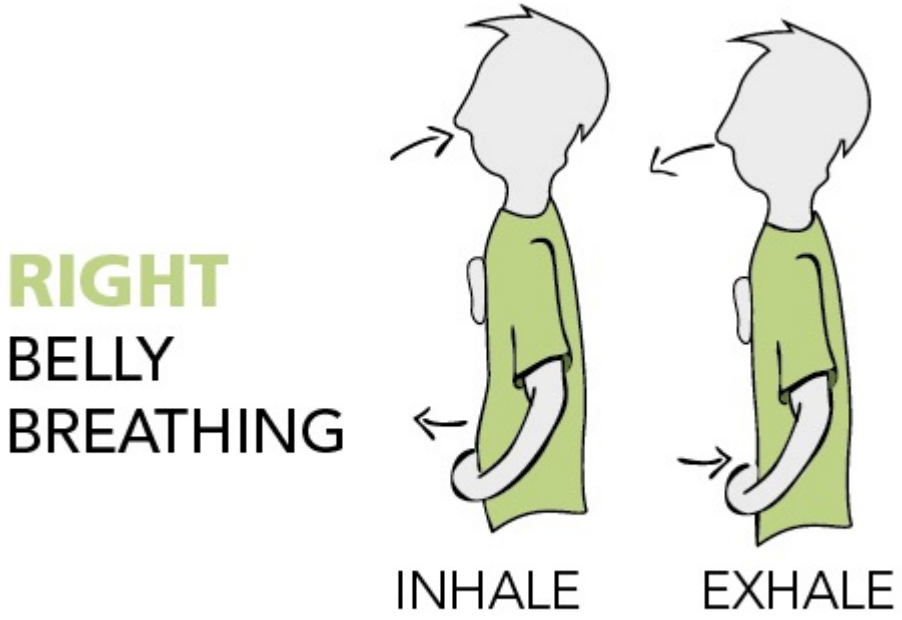
   - **Extended**

3. **Neuromechanics**
   - **What is a “weak” core ?**
     - **Abdominal muscles**
     - **Pelvic floor**
     - Diaphragm

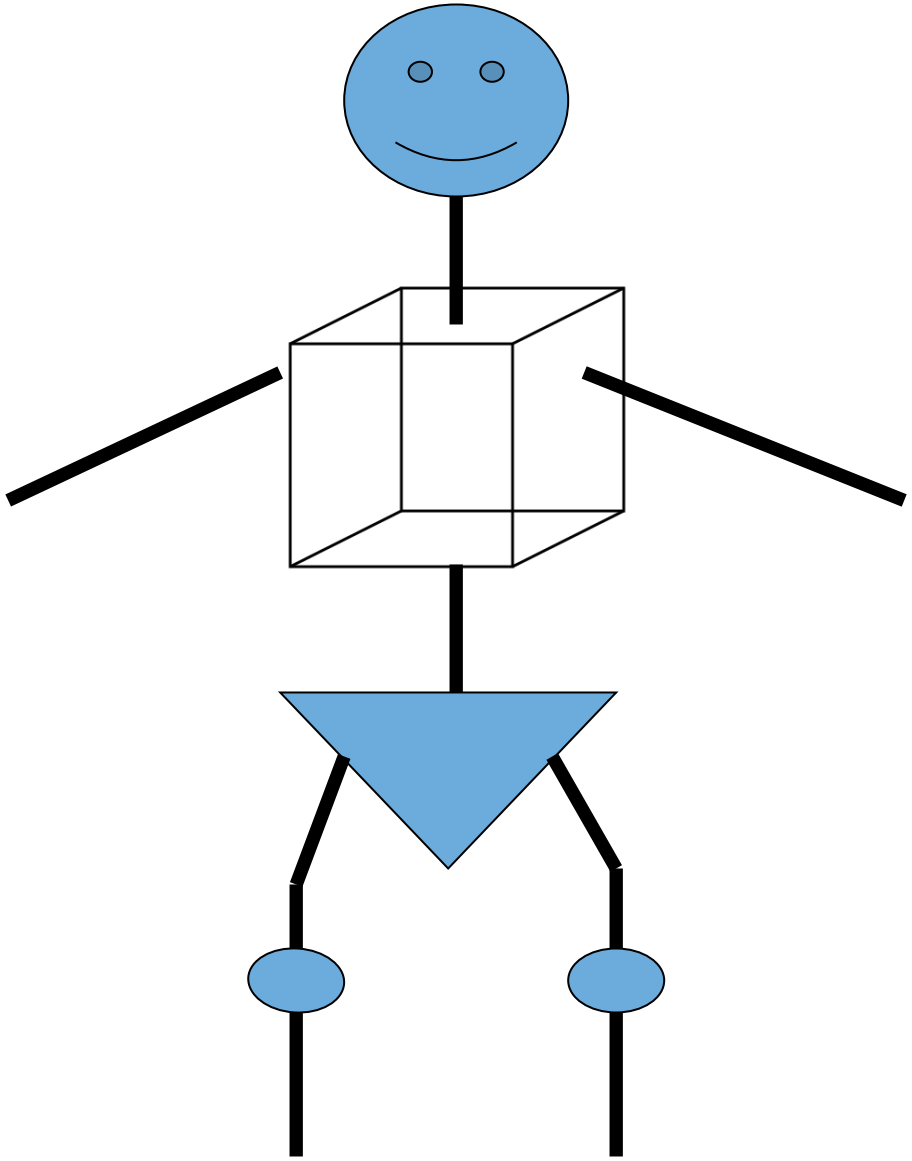
4. Wiring of the nervous system

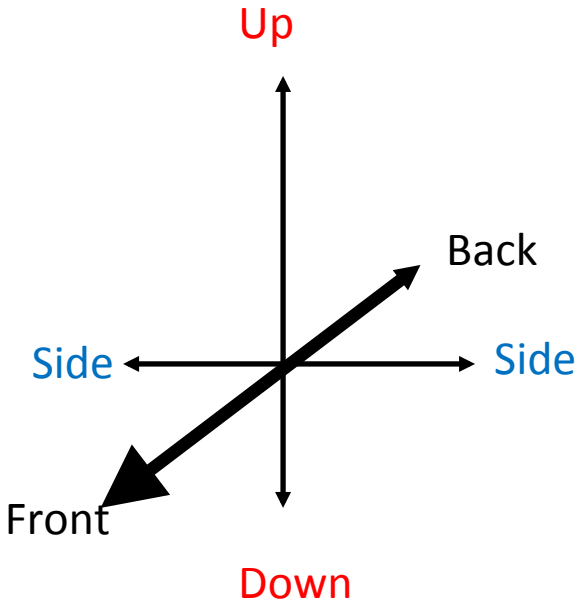



What can cause poor diaphragmatic excursion?

And what are the consequences?

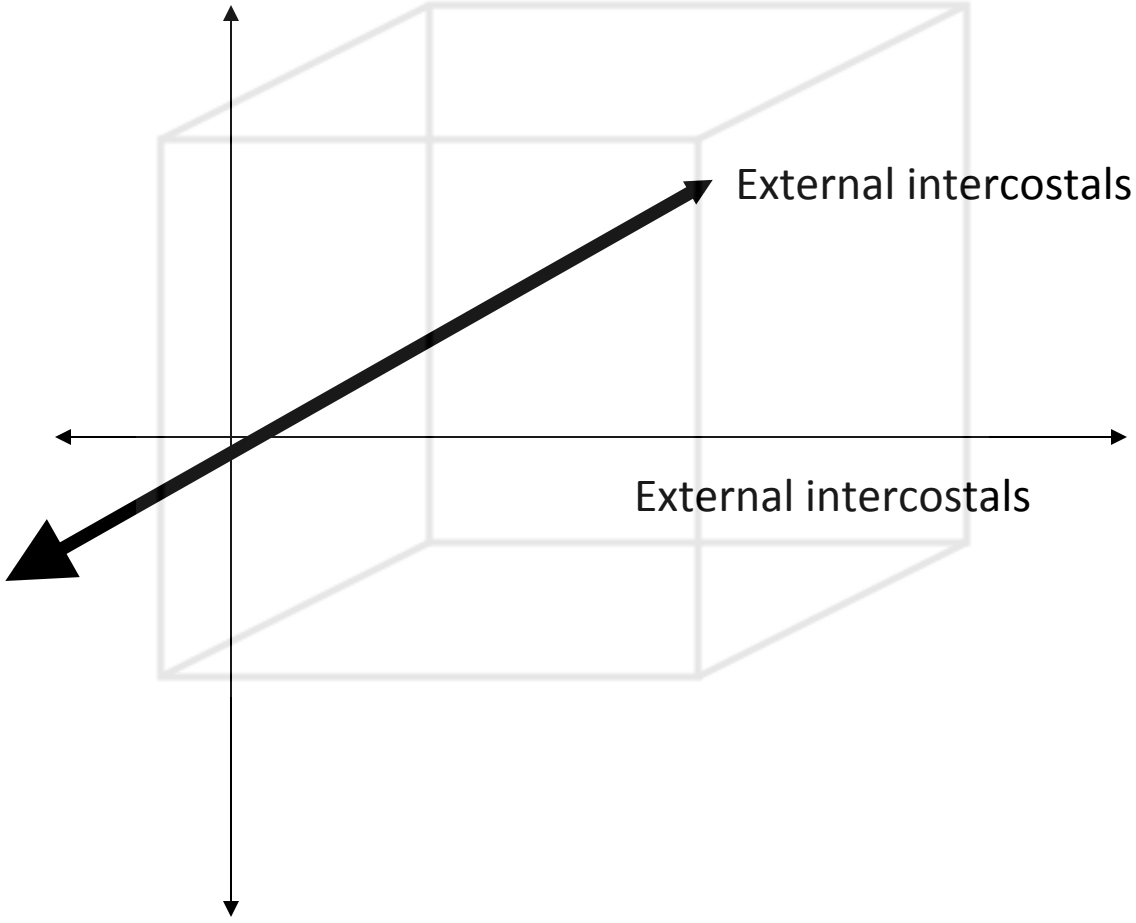



Up
Back
Side
Side
Front
Down

# Breathing

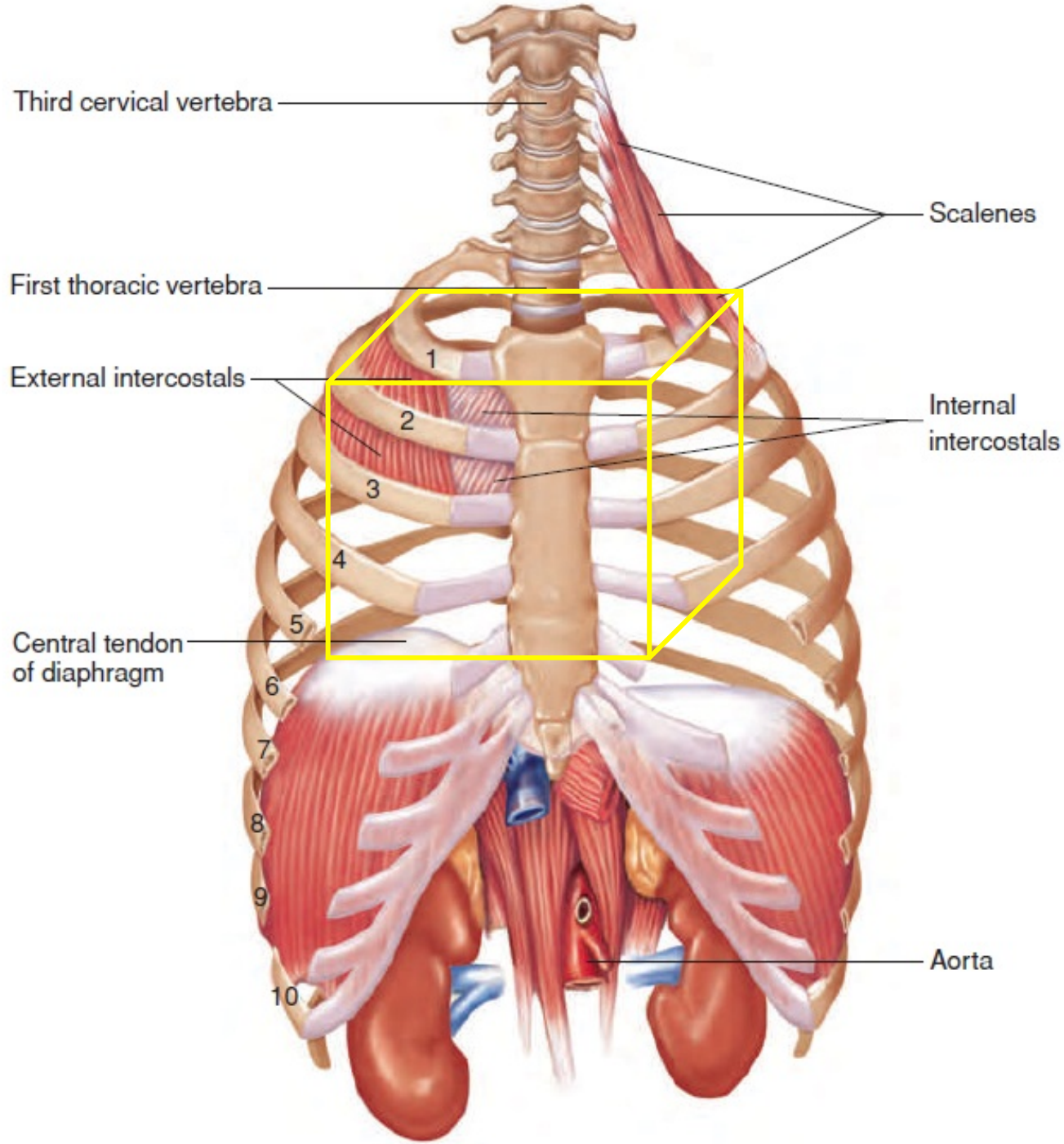
<u>Raise the top</u>

- Scalenes
- Sternocleidomastoid
- Pectoralis minor

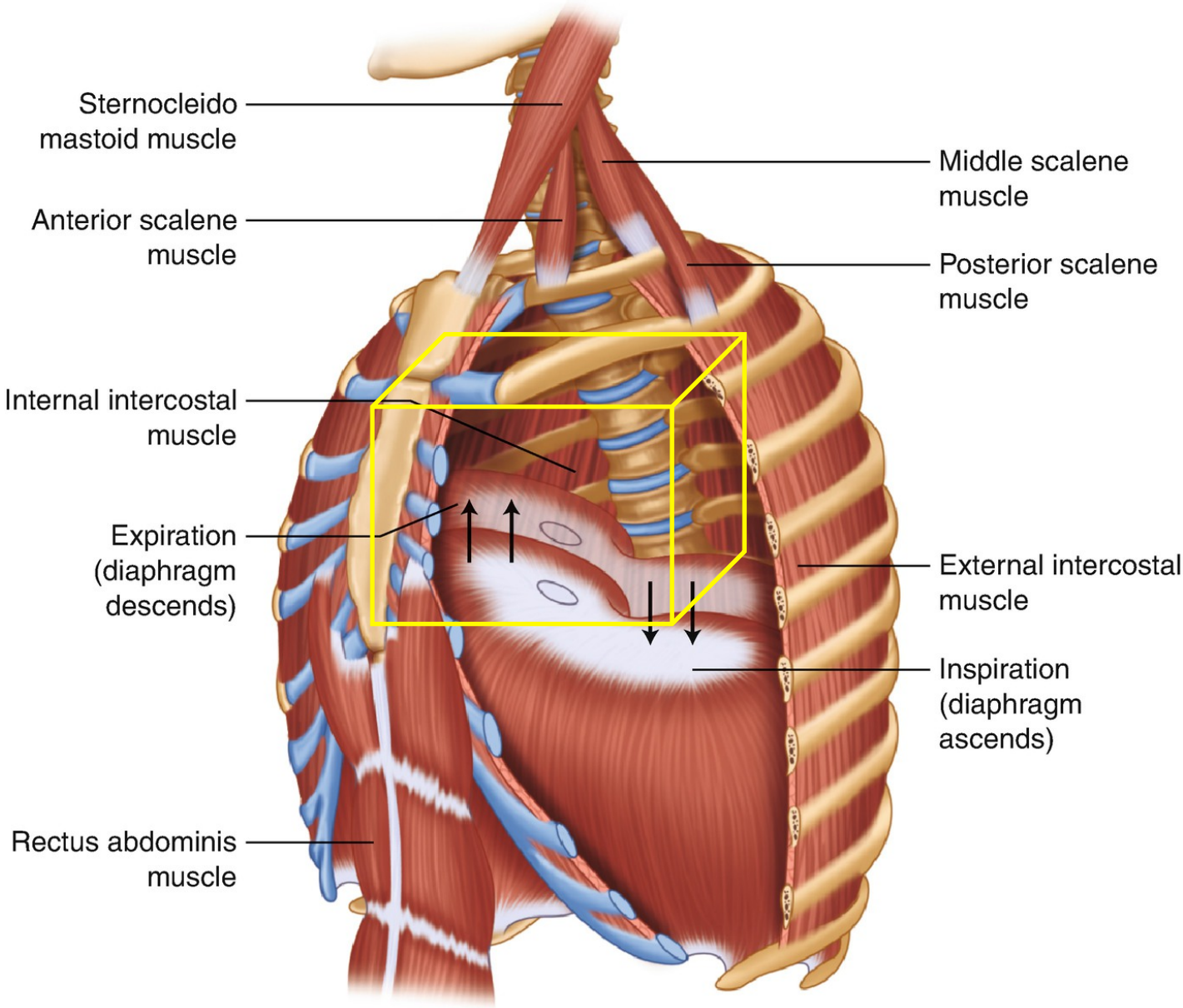



<u>Drop the bottom</u>

- Diaphragm


Third cervical vertebra
First thoracic vertebra
External intercostals
Central tendon of diaphragm
Scalenes
Internal intercostals
Aorta
1
2
3
4
5
6
7
8
9
10

- Diaphragm activity is **directly** dependent on
  a. Stabilized ribs
  b. Neutral lumbar spine
  c. Neutral thoracic spine
  d. Happy quadratus lumborum
  e. All of the above
  f. All of the above and more!



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1. **Why it matters**

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   - **What is a “weak” core ?**
     - **Abdominal muscles**
     - **Pelvic floor**
     - **Diaphragm**

4. Wiring of the nervous system

# Summary of the core

1. Transverse abdominis is always the 1st muscle to contract

2. This is coupled with simultaneous activation of the pelvic floor

3. Respiration and abdominal/pelvic activity are intimately linked.

4. A disruption in any single variable causes a domino effect of biomechanical demise.

# Deeper thinking

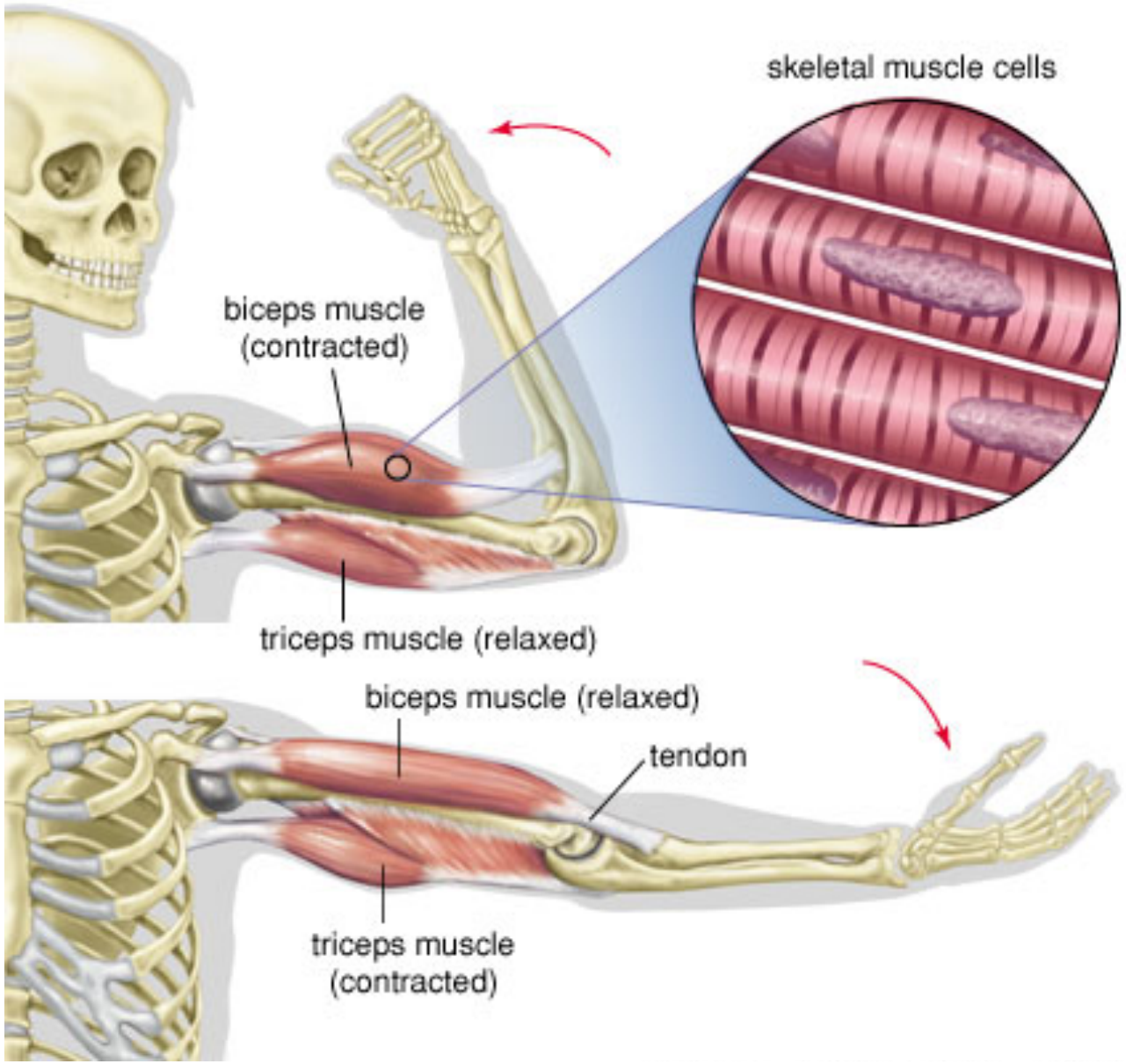
1. **You must think of muscles in pairs**
   - When one muscle "talks" the other tends to quiet down … in an open chain
   - In a closed chain, we see patterns of co-contraction to stabilize the joint

2. When any joint moves, there is a constellation of events to stabilize structures that are proximal
   - This is where we fail. The problem is generally poor stability… not a loss in ROM

3. There are predictable (but not absolute) patterns of decline

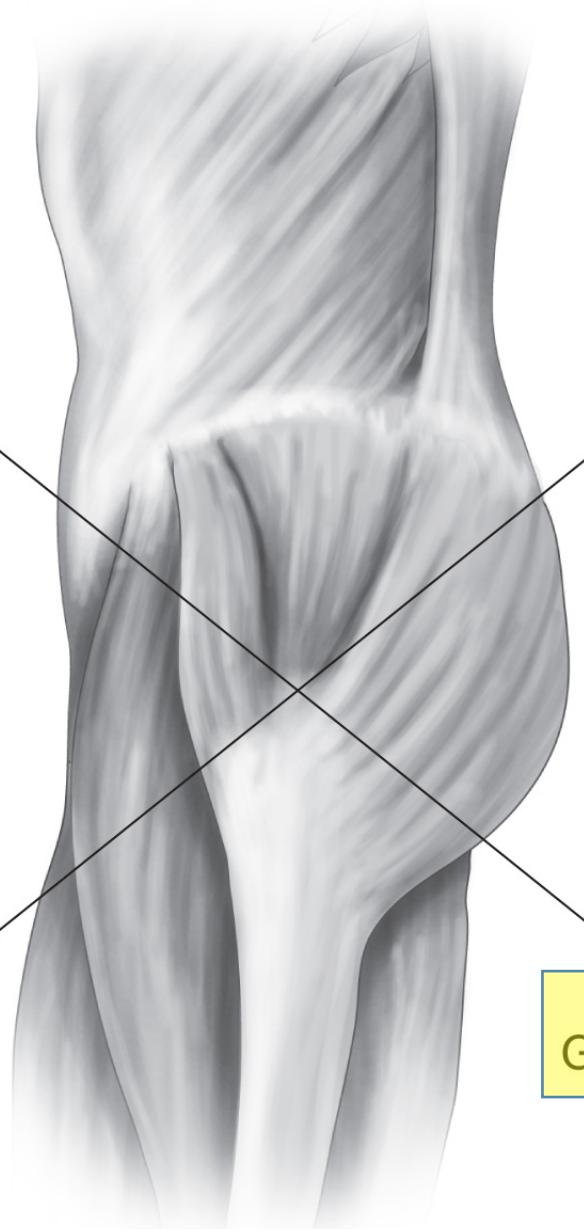
4. Our body is strongly predisposed to flex, internally rotate and adduct

- Does the biceps talk to the triceps?



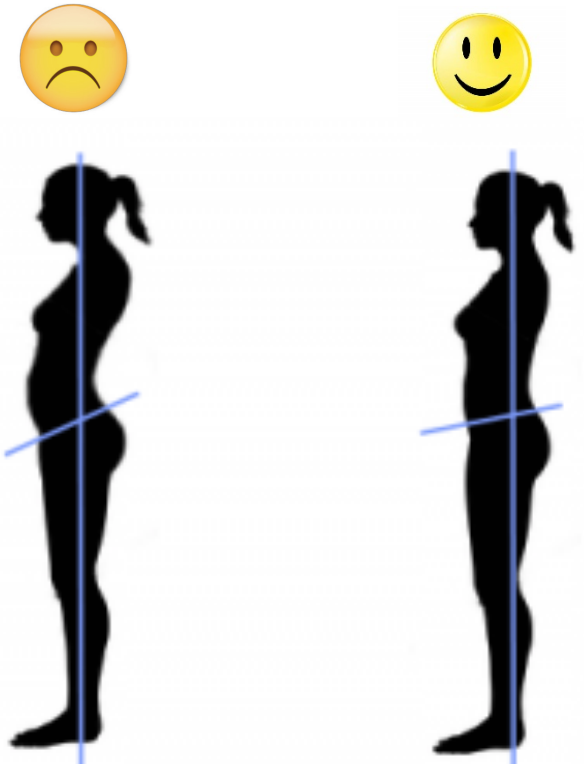
Weak:
Abdominals

Tight:
Thoracolumbar
extensors



Tight:
Hip flexors

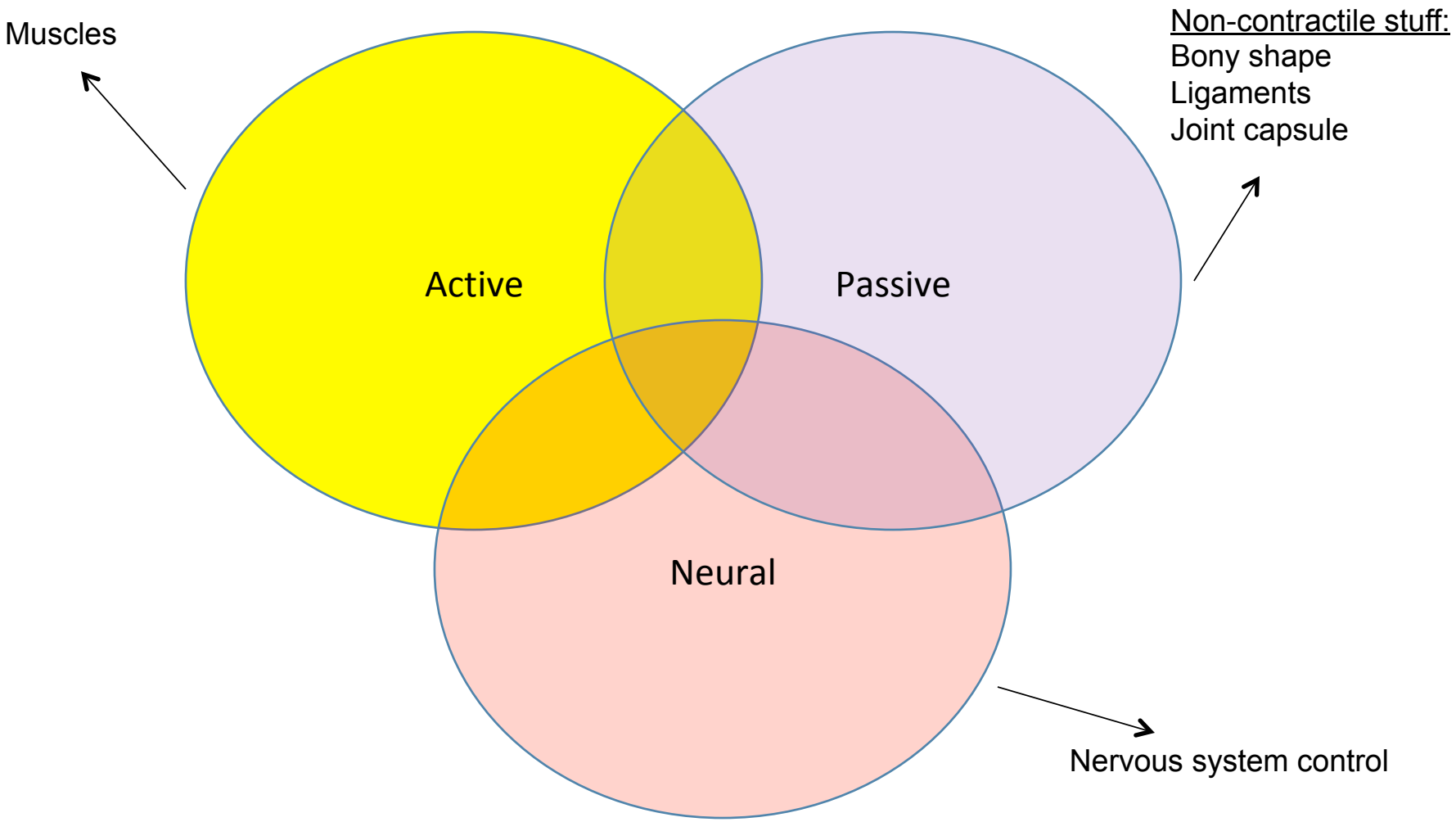
Weak:
Gluteus maximus



# What does this mean?

1. There is more than meets the eye with a “tight muscle”
2. A “tight muscle” is usually part of a larger pattern
3. This pattern can be either biomechanically or neurologically driven.  Often, there is a duality of cause and effect.

# Mechanisms of Core Stability



# End of part 1- questions?

Peter Jo

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# Core Principles: from the back to beyond
# Part 2

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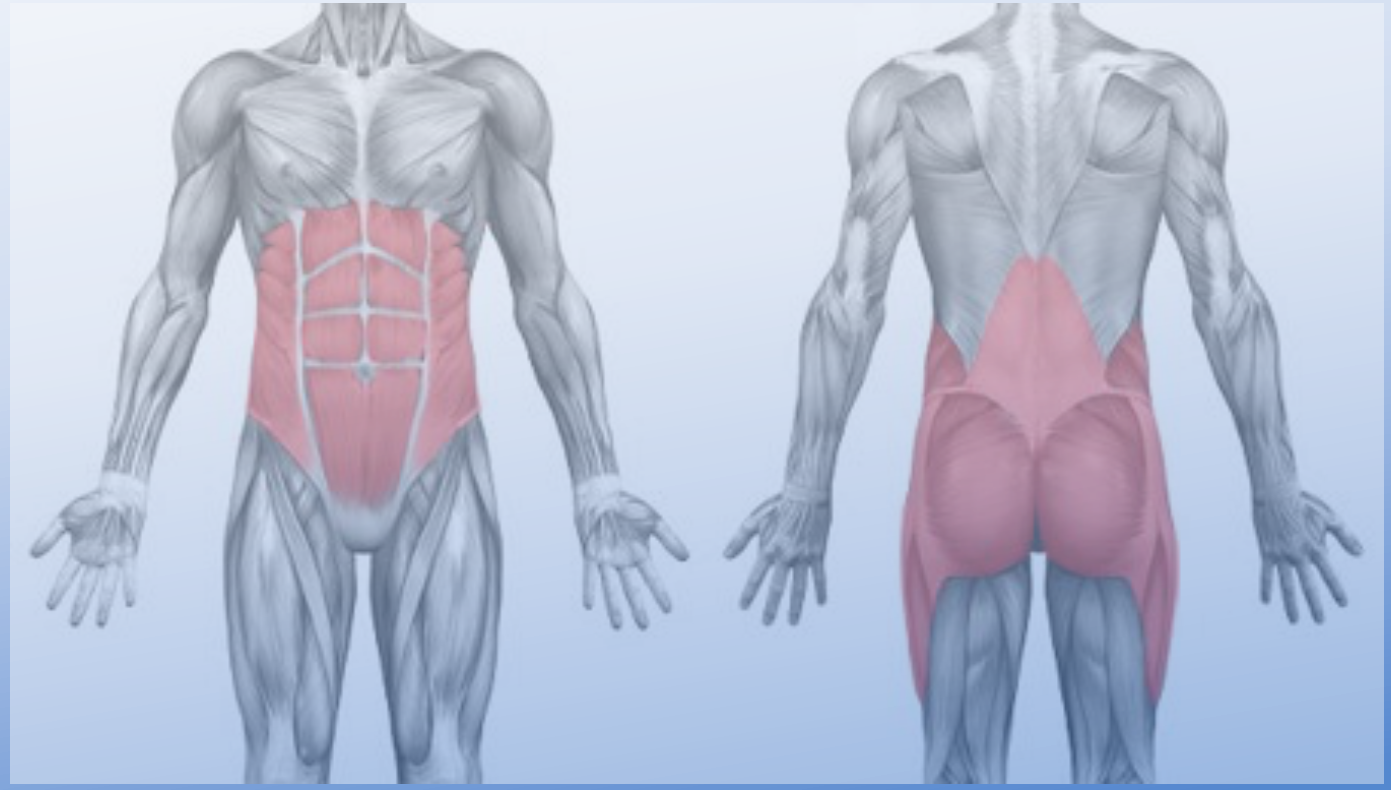


# Review of Part 1 concepts

1. Why it matters

2. Anatomy:
   - Basic
   - Extended

3. Neuromechanics
   - What is a “weak” core ?
     - Abdominal muscles
     - Pelvic floor
     - Diaphragm

4. Wiring of the nervous system

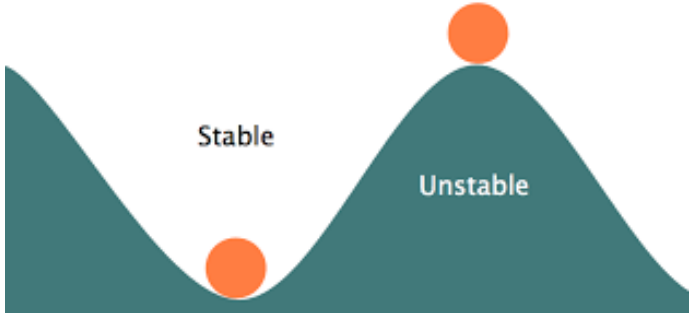
a. It matters!

b. Anatomy:
   - Front-back-sides
   - Top - bottom

c. Neuromechanics
   - Timing
   - Coordination

d. Wiring of the nervous system
   - Pairs

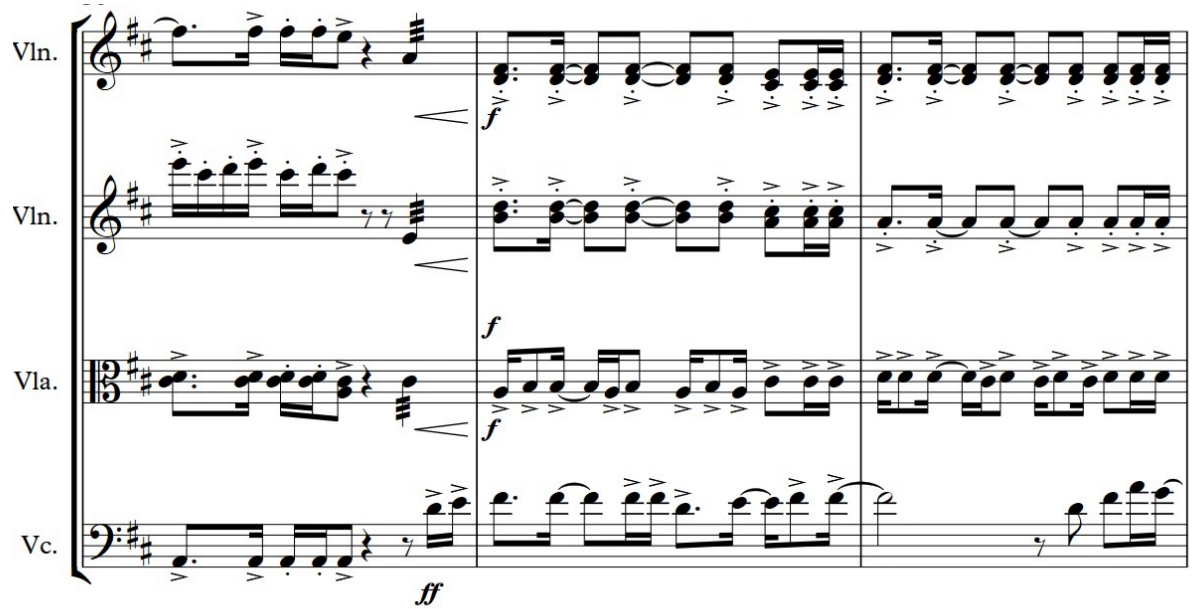
# Let’s ignore strength and talk about stability



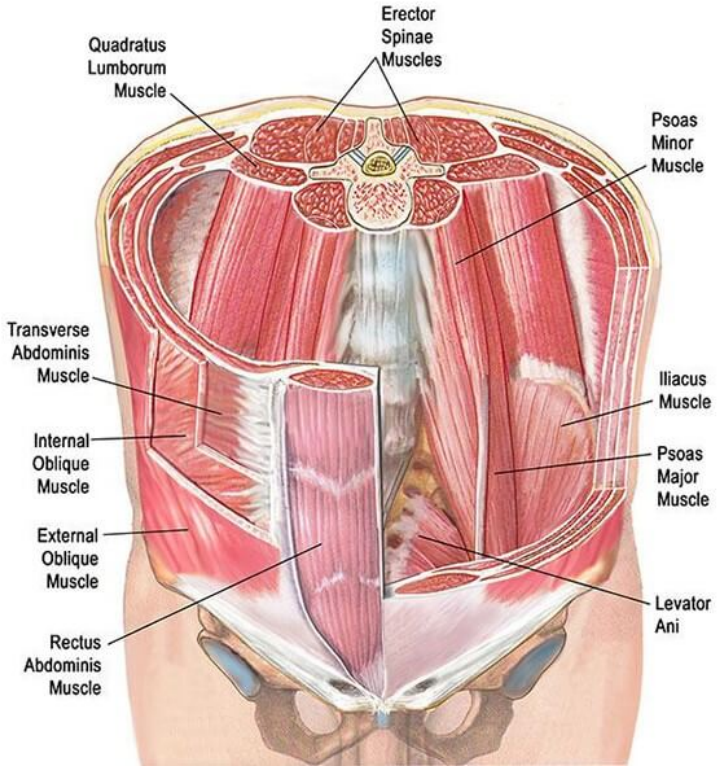
# Stability. Rigid… but not immobile

Q. Why does this matter?

R. Because the core is a dynamic orchestration of “moving parts.”

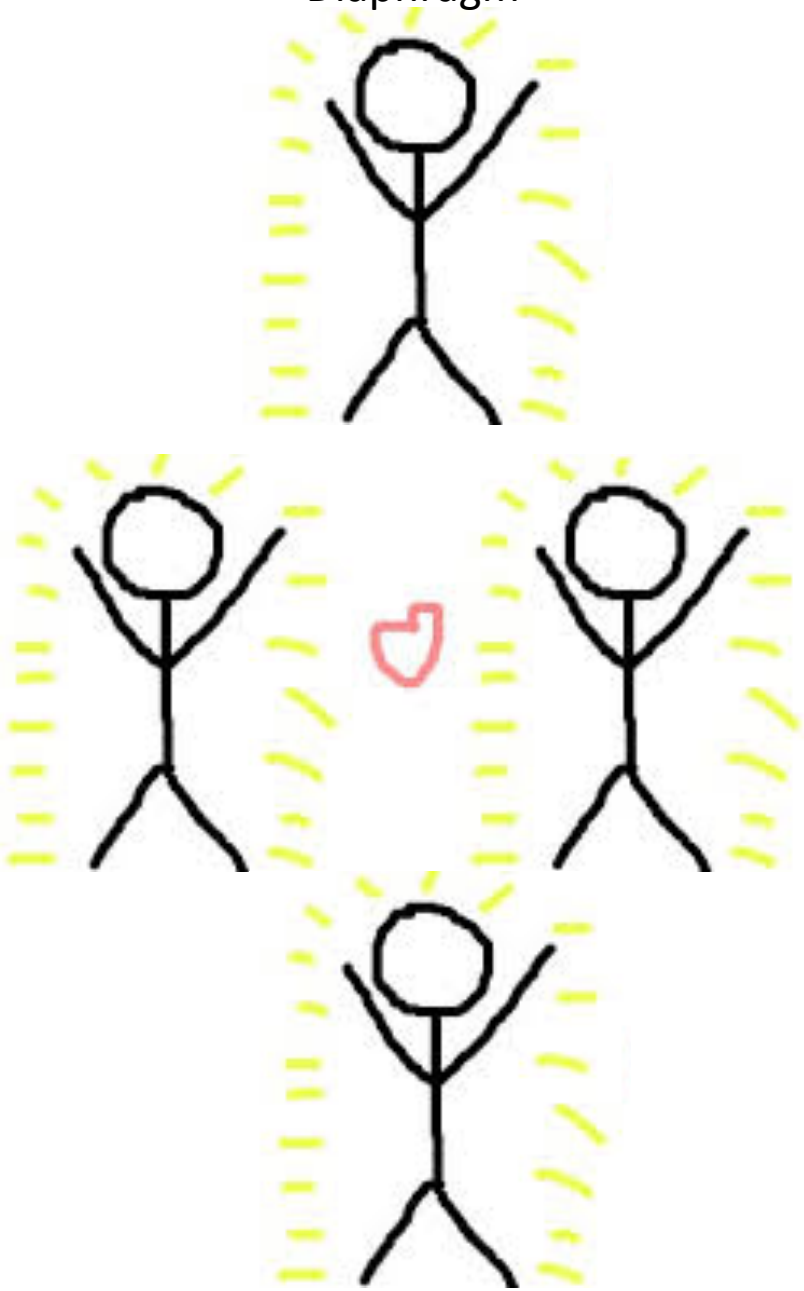


# It’s about relationships !




Abdominal muscles

Diaphragm



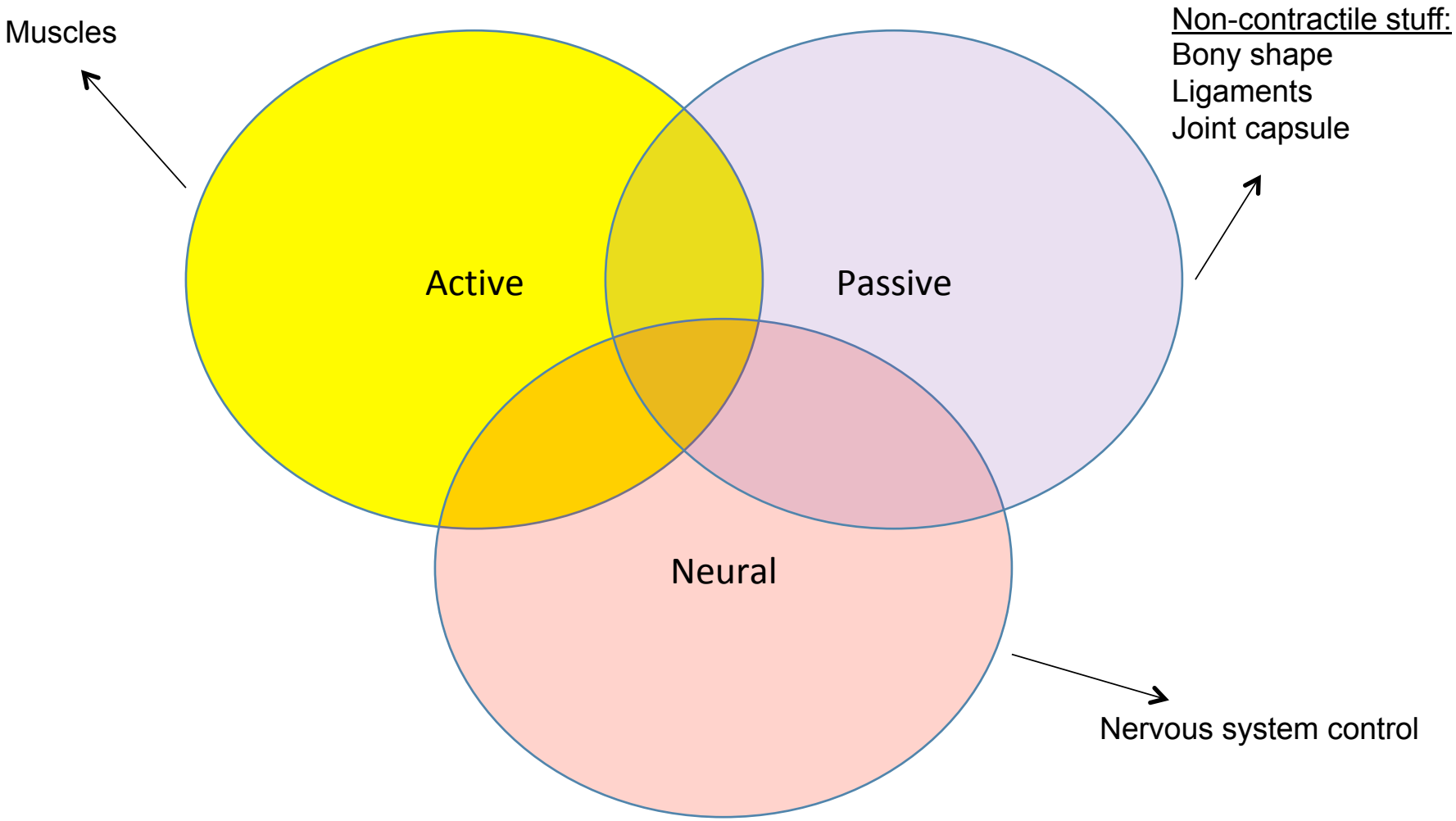
“Back” muscles

Pelvic floor

# Muscles are … _____

…dumb pieces of flesh that only do what they're told to do!

# Mechanisms of Core Stability



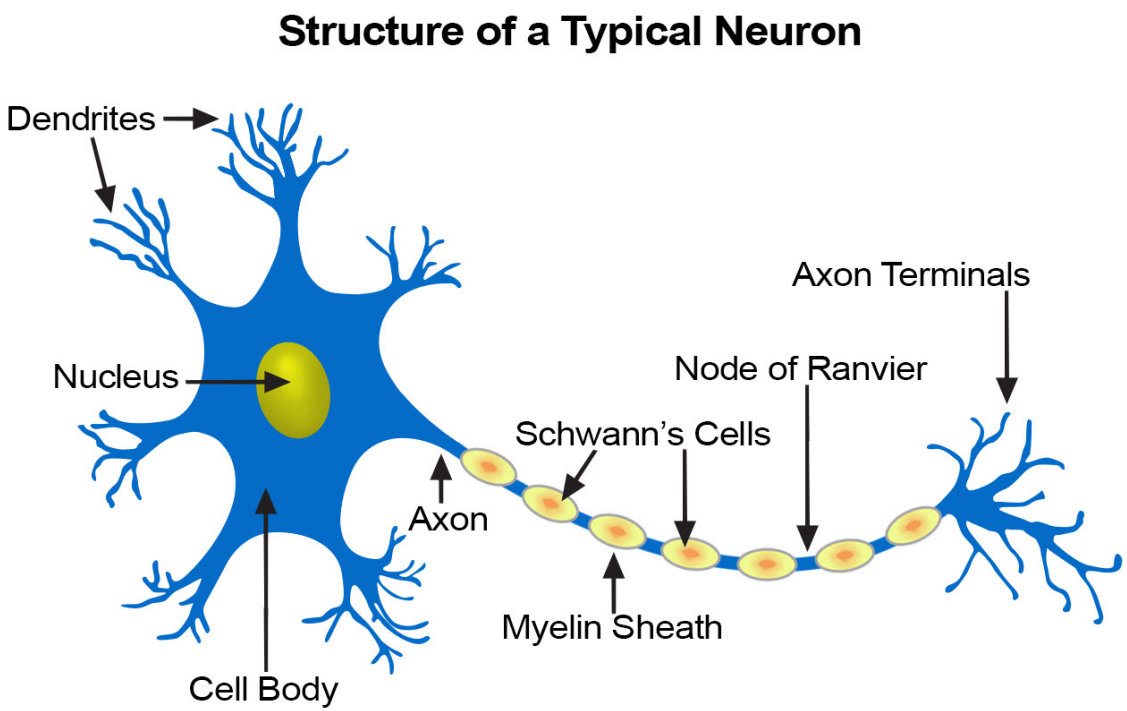
# Core strengthening

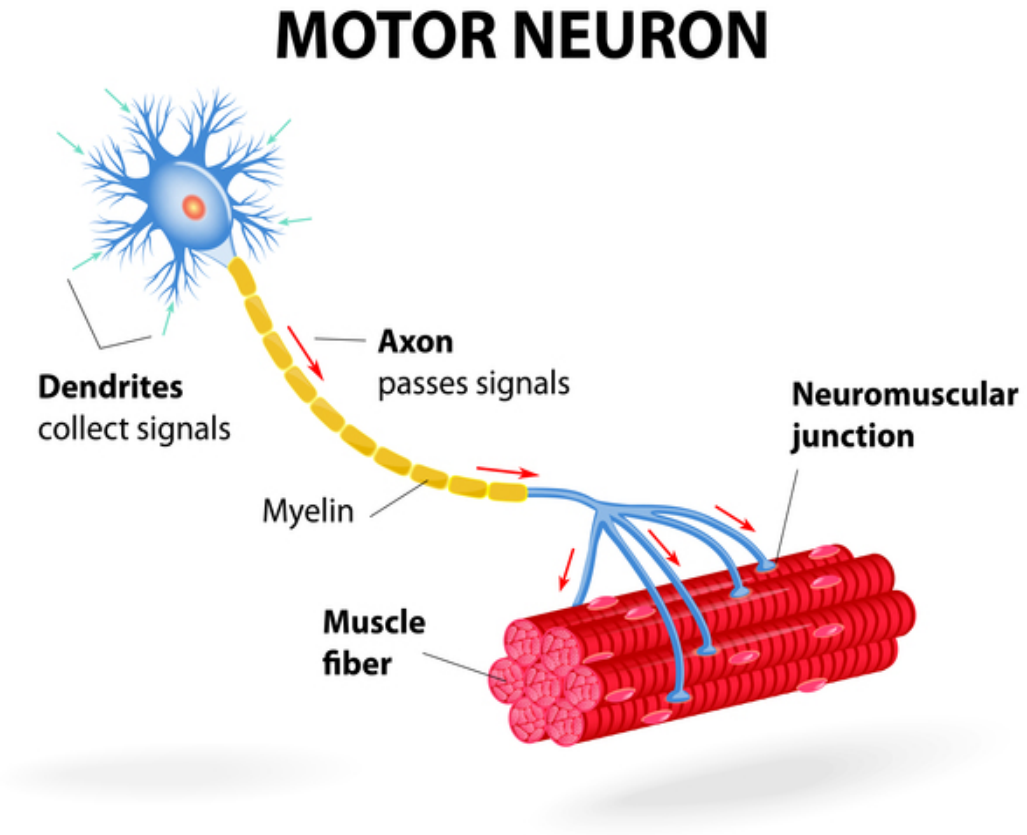
- Exercise of the core musculature is more than trunk strengthening. In fact, motor relearning of inhibited muscles may be more important than strengthening in patients with LBP.

- The overload principle advocated in sports medicine is a nemesis in the back. In other words, the progressive resistance strengthening of some core muscles, particularly the lumbar extensors, may be unsafe to the back. In fact, many traditional back strengthening exercises may also be unsafe.

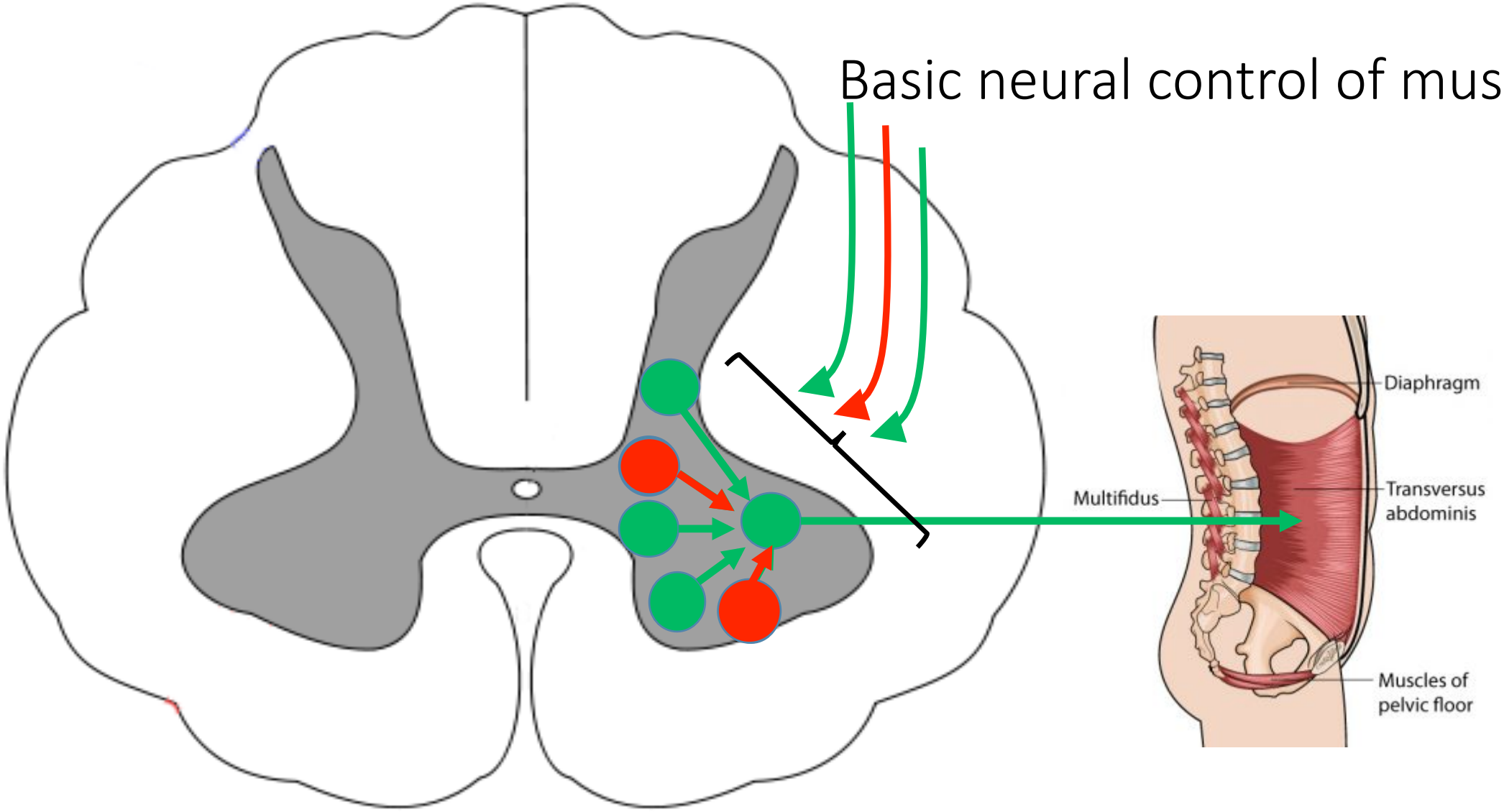
Arch Phys Med Rehabil 2004; 85 (3 Suppl 1): S86-92

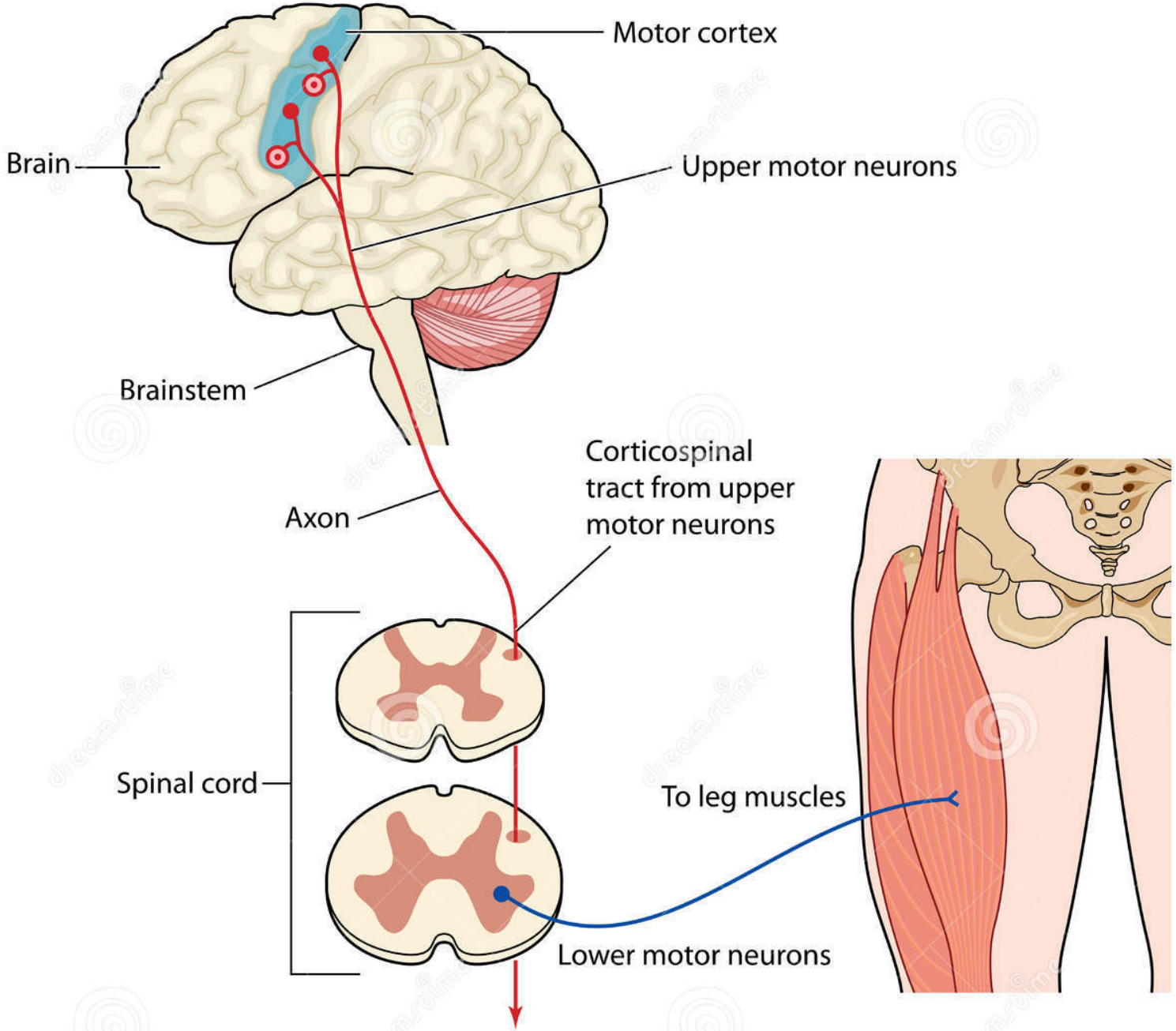
# Neural control of muscles




# Basic neural control of muscles




Motor cortex
Brain
Upper motor neurons
Brainstem
Corticospinal
tract from upper
motor neurons
Axon
Spinal cord
To leg muscles
Lower motor neurons

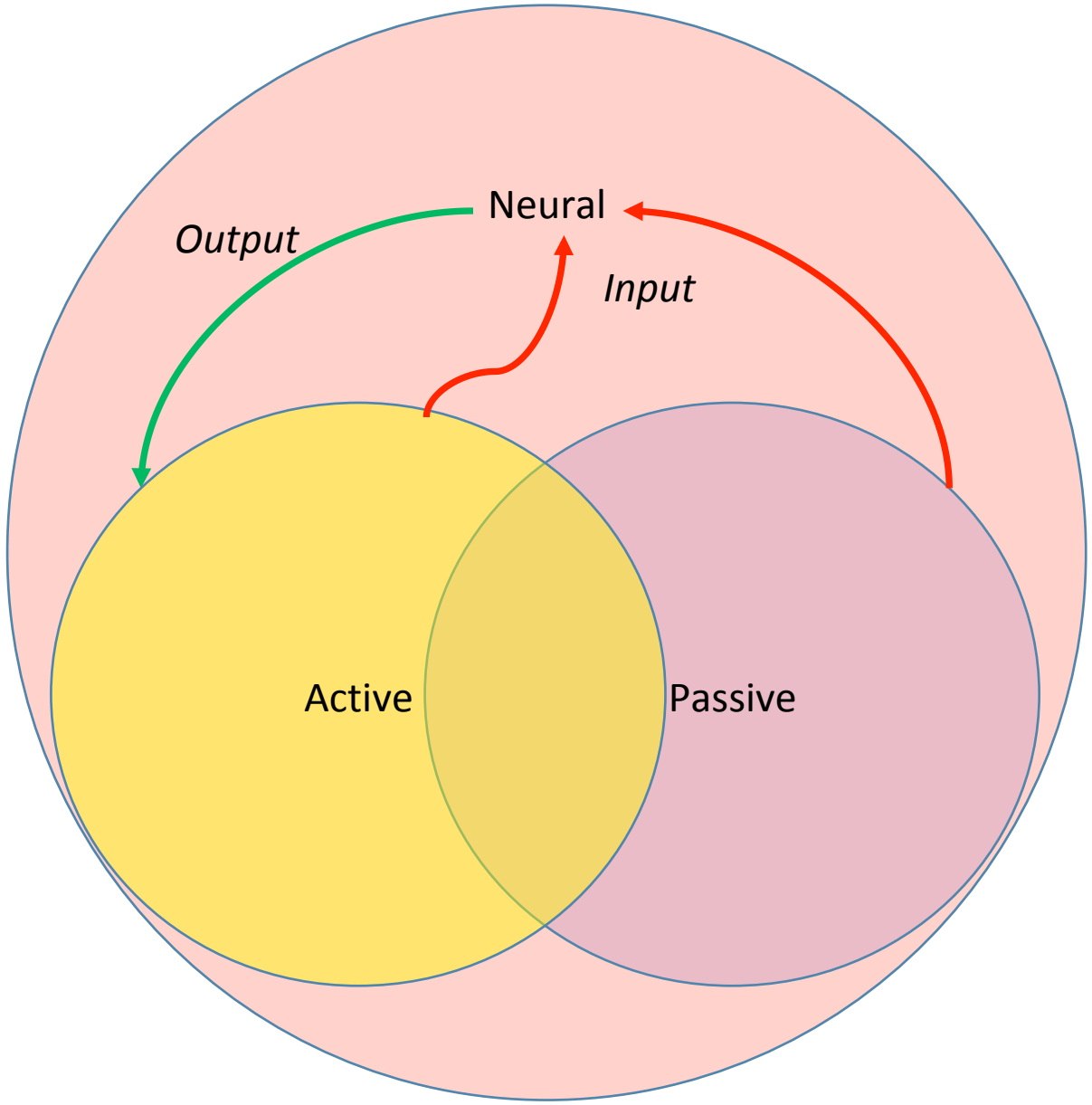
# The importance of sensory-motor control in providing core stability: implications for measurement and training.

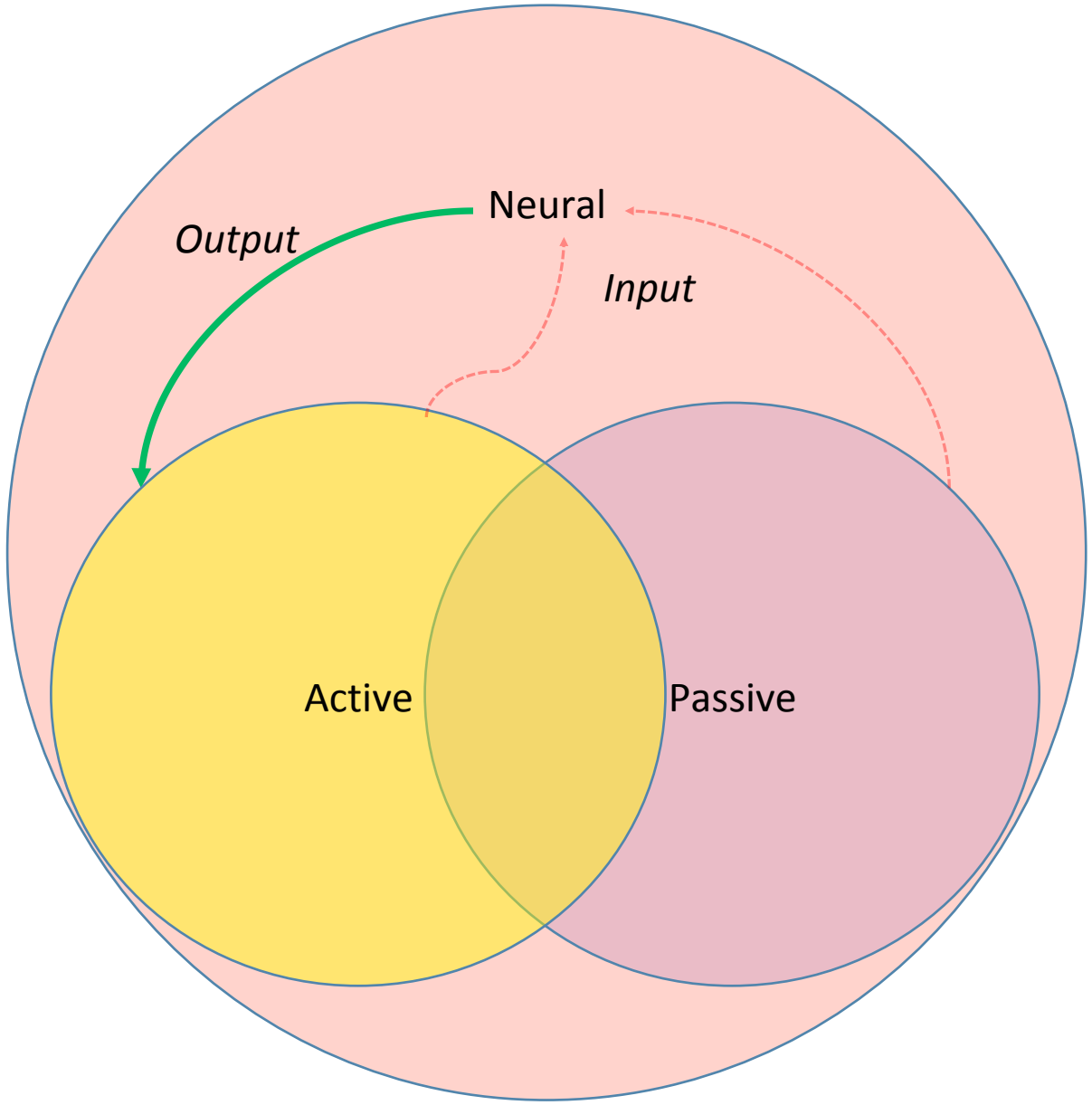
- A low level of co-contraction of the trunk muscles is important for core stability. It provides a level of stiffness, which gives sufficient stability against minor perturbations.

- It appears that most trunk muscles, both the local and global stabilization system, must work coherently to achieve core stability. The contributions of the various trunk muscles depend on the task being performed. In the search for a precise balance between the amount of stability and mobility, the role of sensory-motor control is much more important than the role of strength or endurance of the trunk muscles.

- Most importantly, a significant correlation was found between poor balance performance in a sitting balance task and delayed firing of the trunk muscles during sudden perturbation. **It was suggested that both phenomena are caused by proprioceptive deficits.**

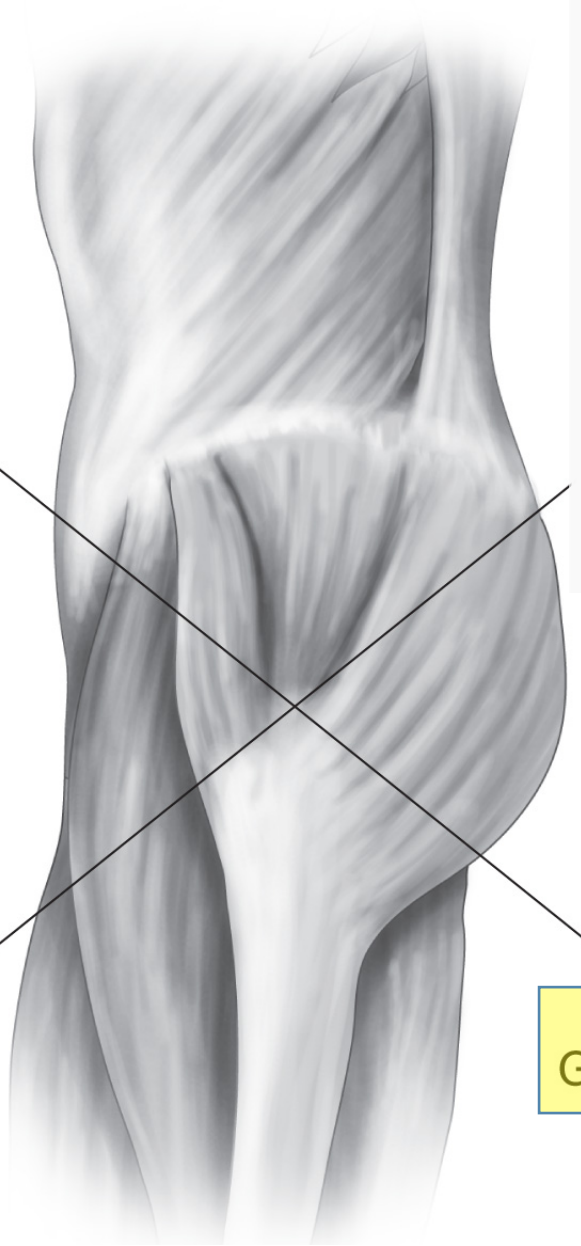
Sports Med. 2008;38(11):893-916. doi: 10.2165/00007256-200838110-00002.


Neural
Output
Input
Active
Passive


Neural
Output
Input
Active
Passive

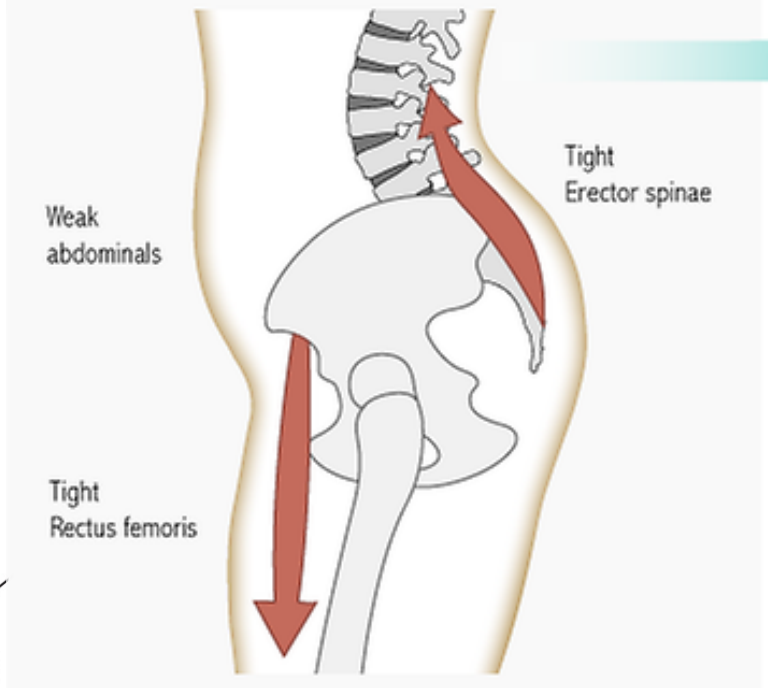

CASIO
12345678
MS-80B

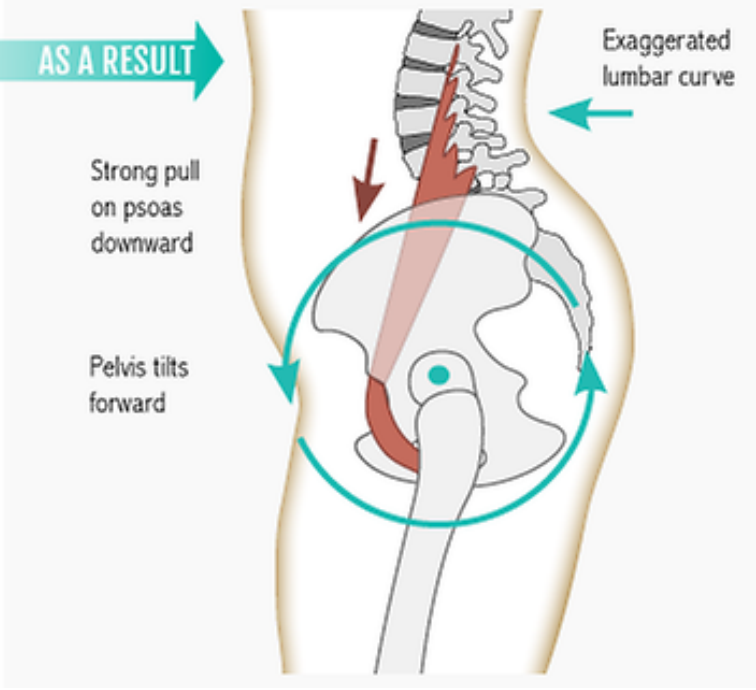
Weak:
Abdominals

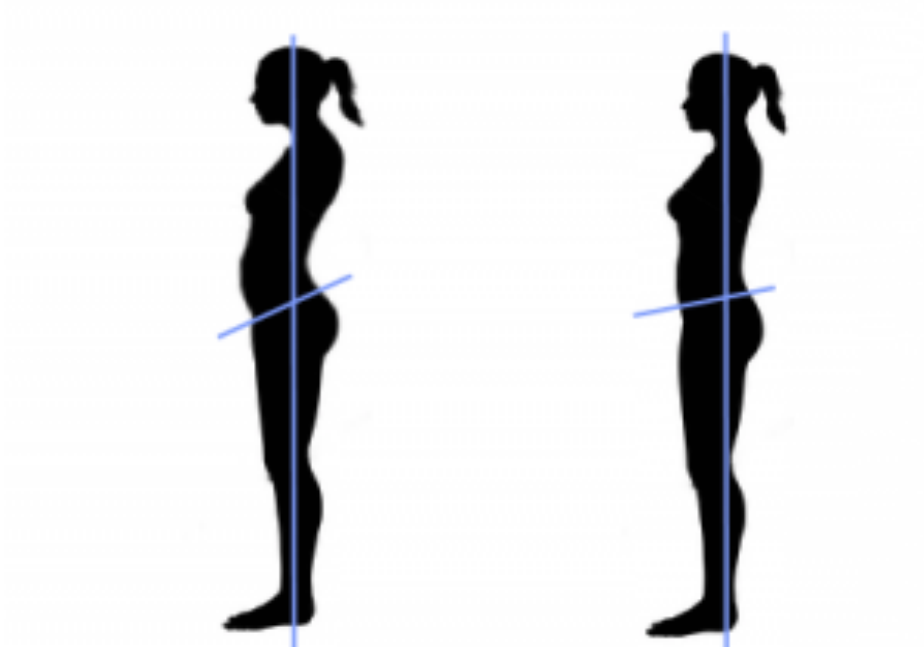


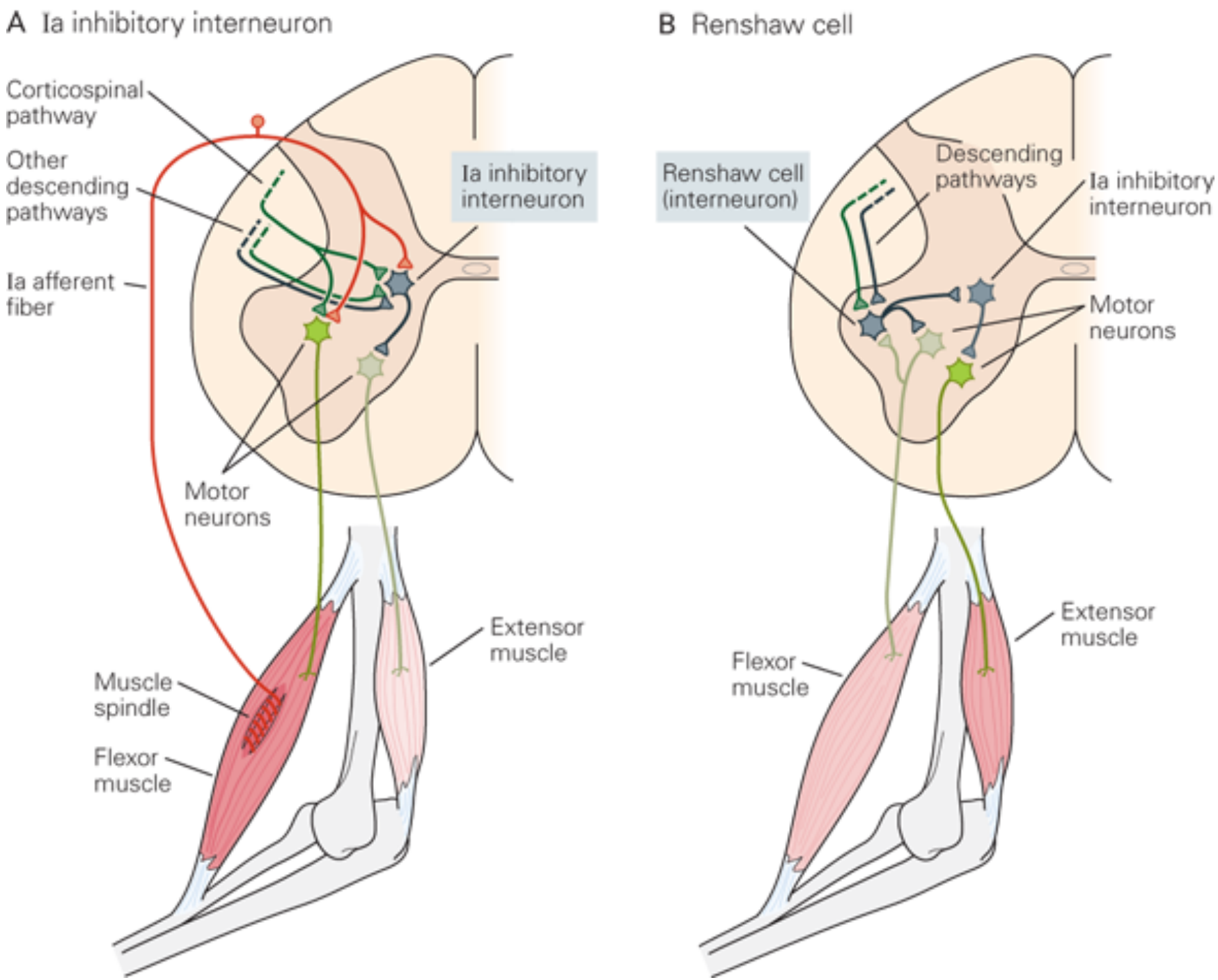
Tight:
Hip flexors

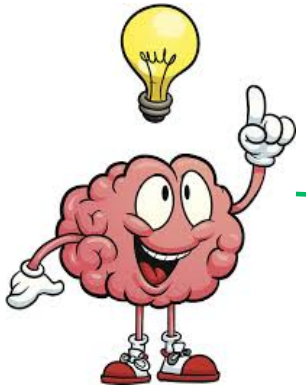
Weak:
Gluteus maximus

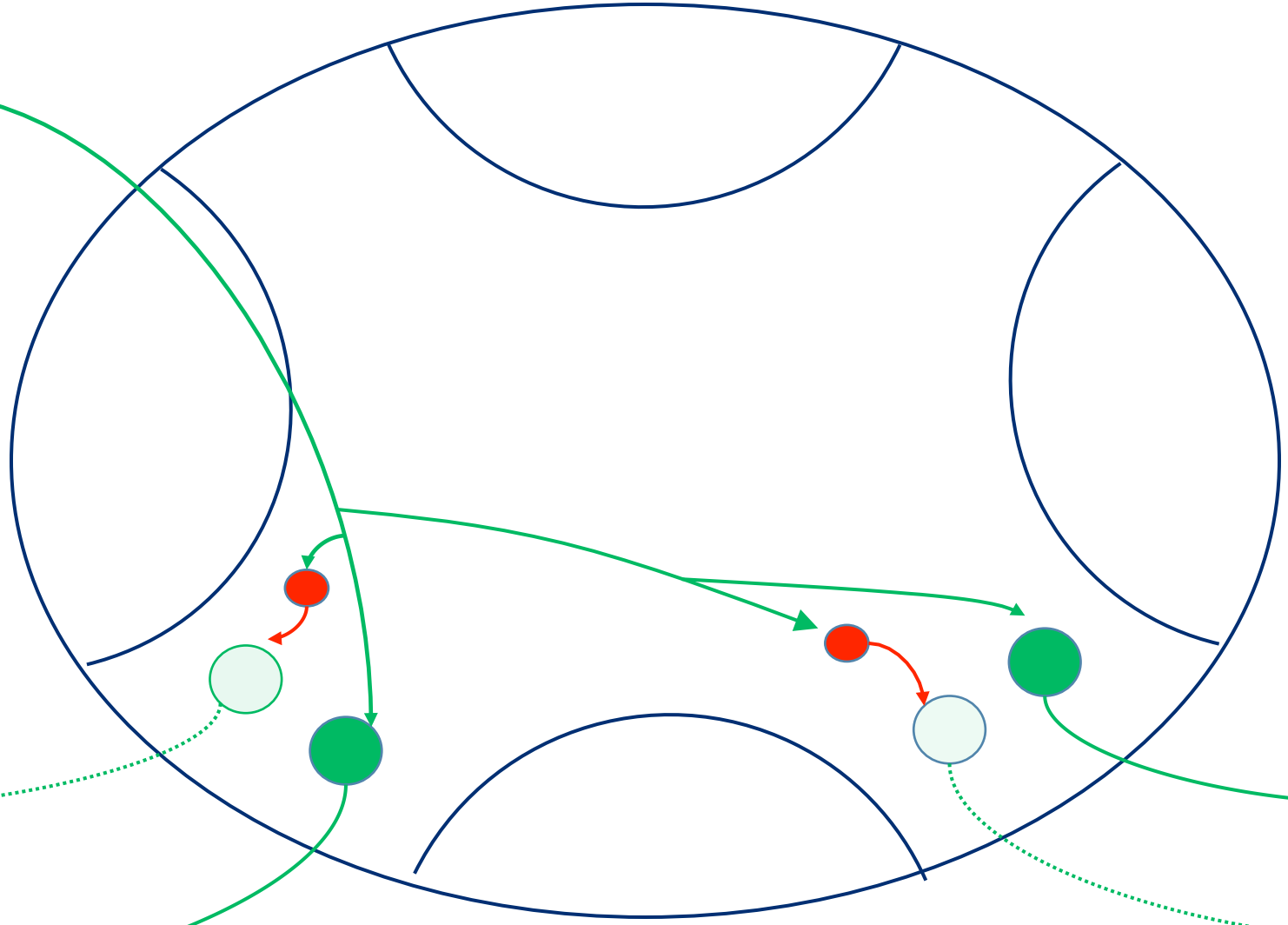



A Ia inhibitory interneuron
Corticospinal pathway
Other descending pathways
Ia afferent fiber
Ia inhibitory interneuron
Motor neurons
Extensor muscle
Muscle spindle
Flexor muscle
B Renshaw cell
Renshaw cell (interneuron)
Descending pathways
Ia inhibitory interneuron
Motor neurons
Extensor muscle
Flexor muscle



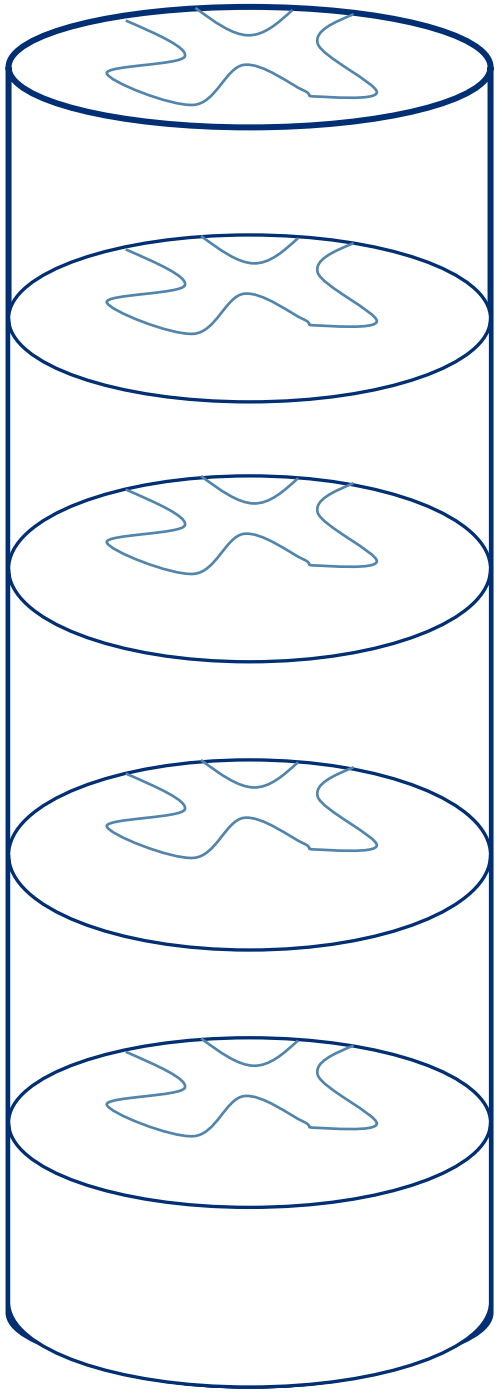


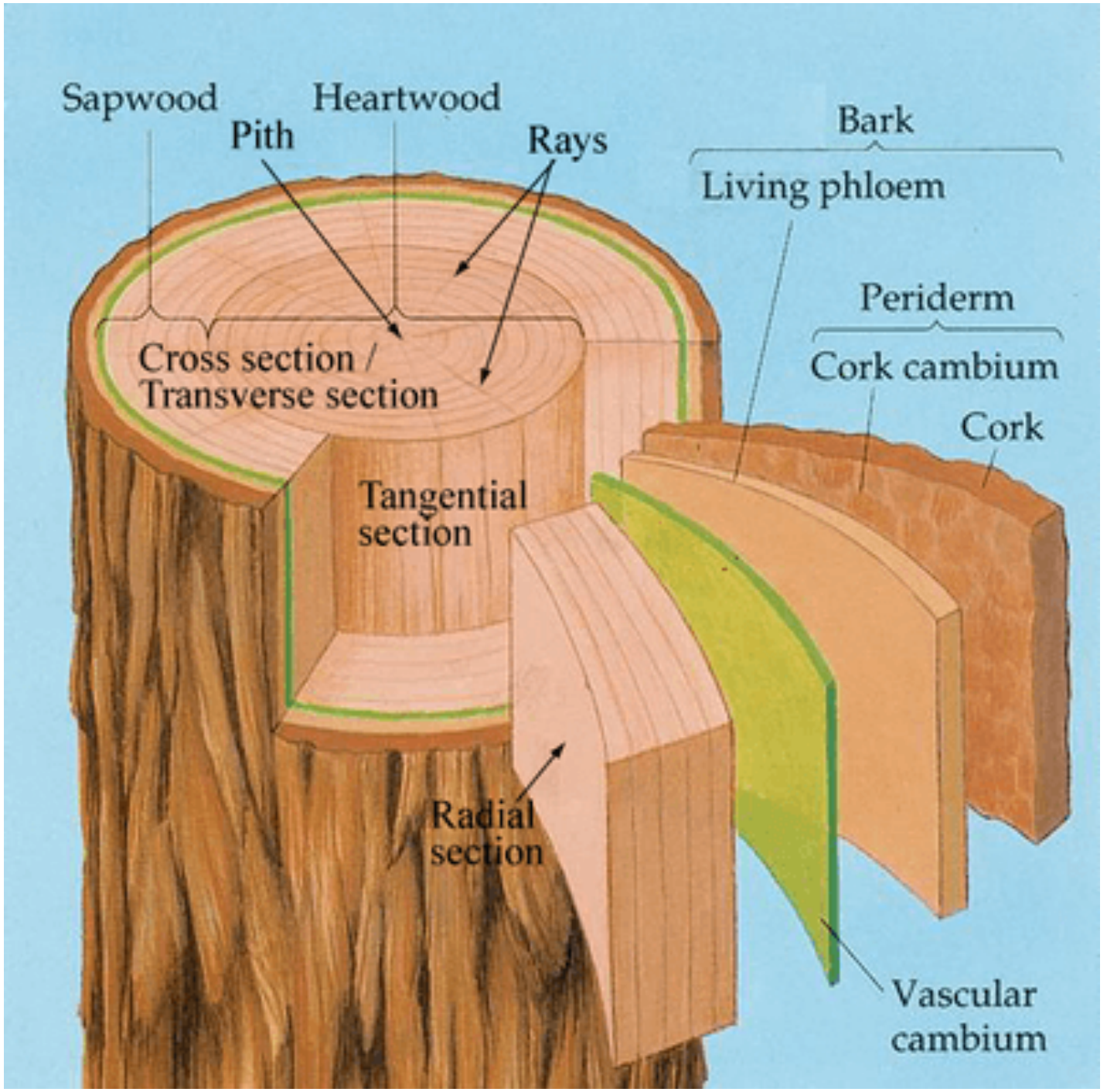
Hip Extensors

Hip Flexors

Hip Extensors

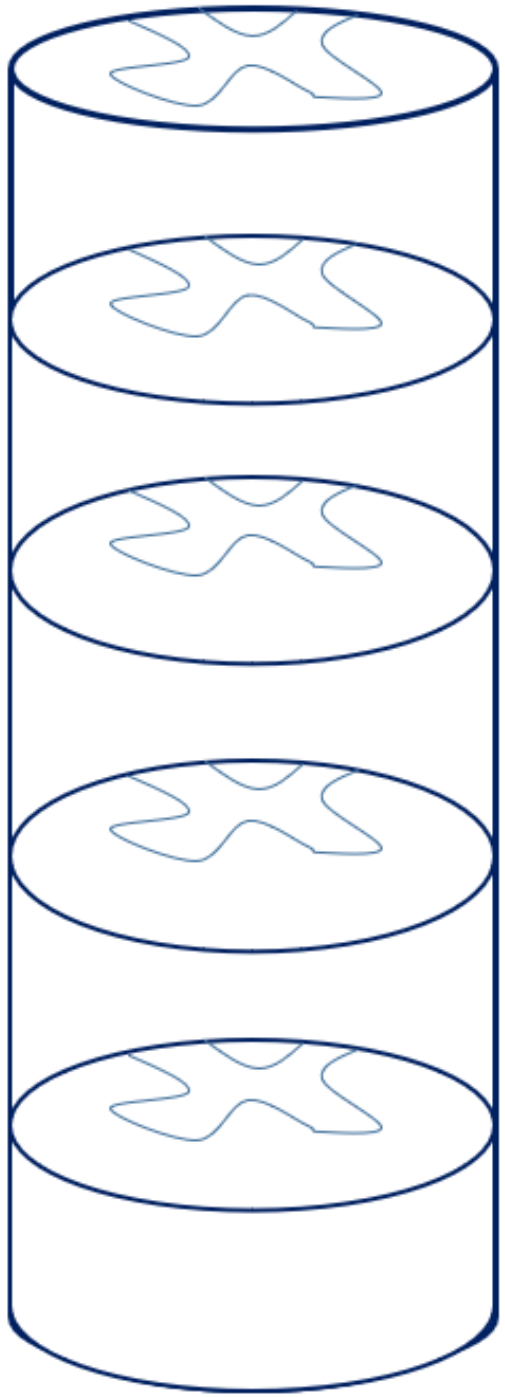
Hip Flexors

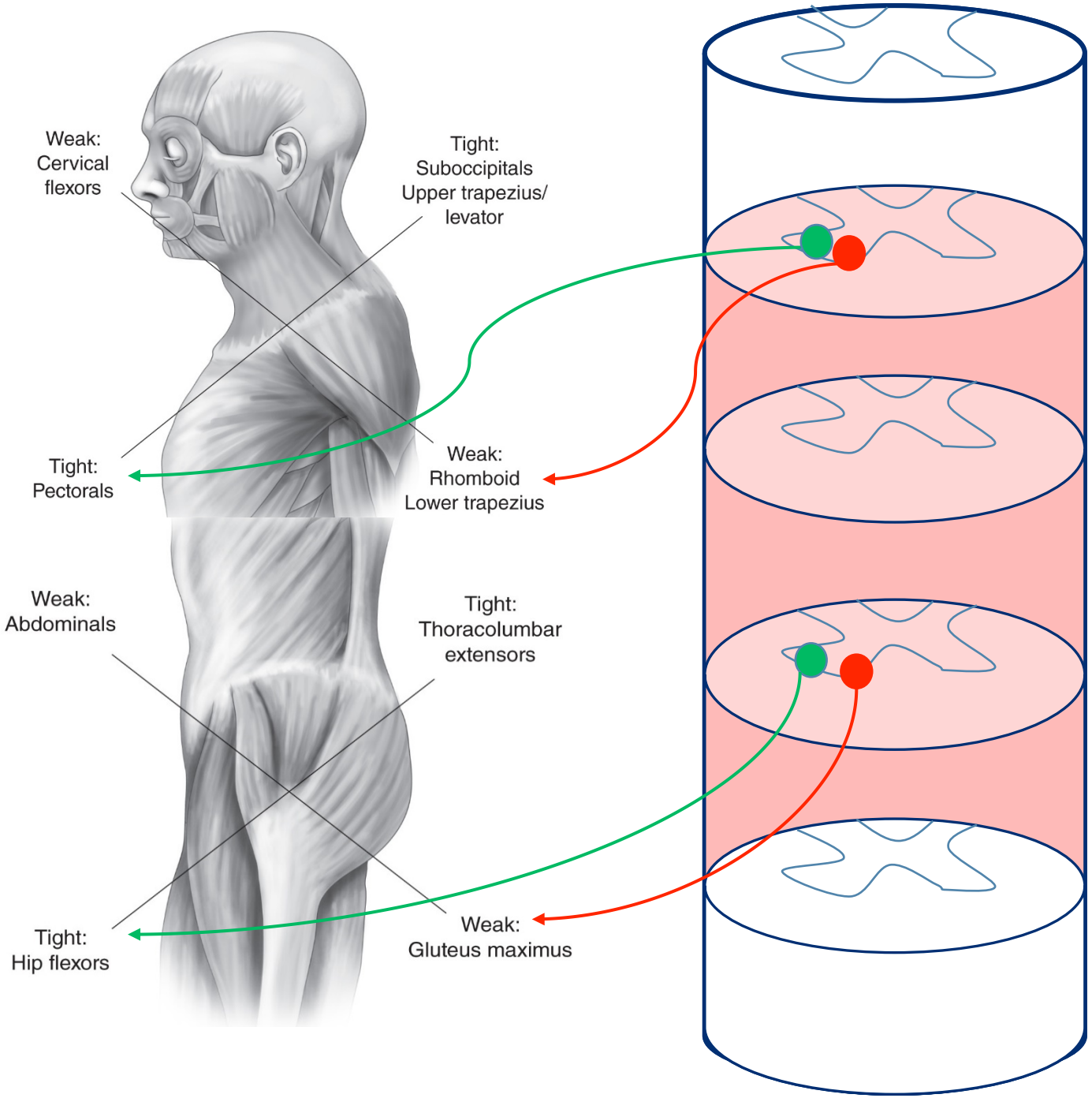



Sapwood
Pith
Heartwood
Rays
Bark
Living phloem
Periderm
Cork cambium
Cork
Cross section /
Transverse section
Tangential
section
Radial
section
Vascular
cambium

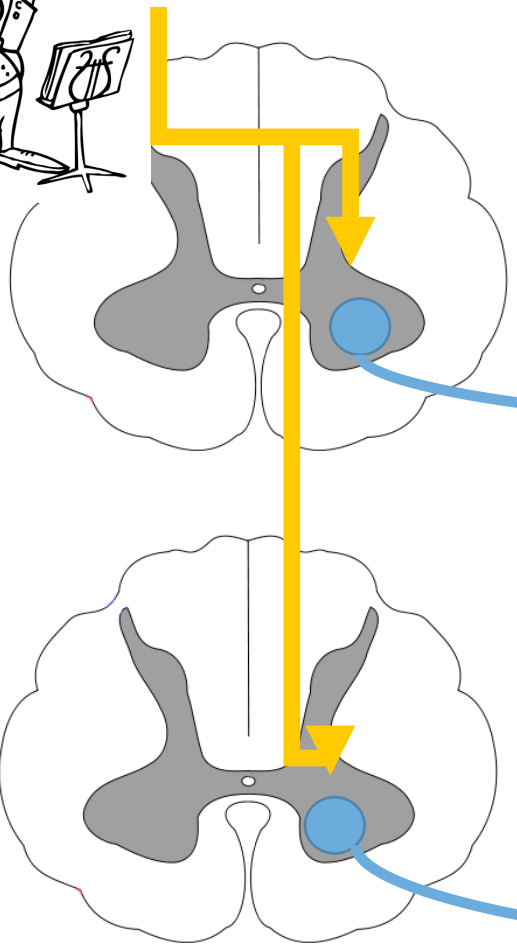
# Who cares about the trees?

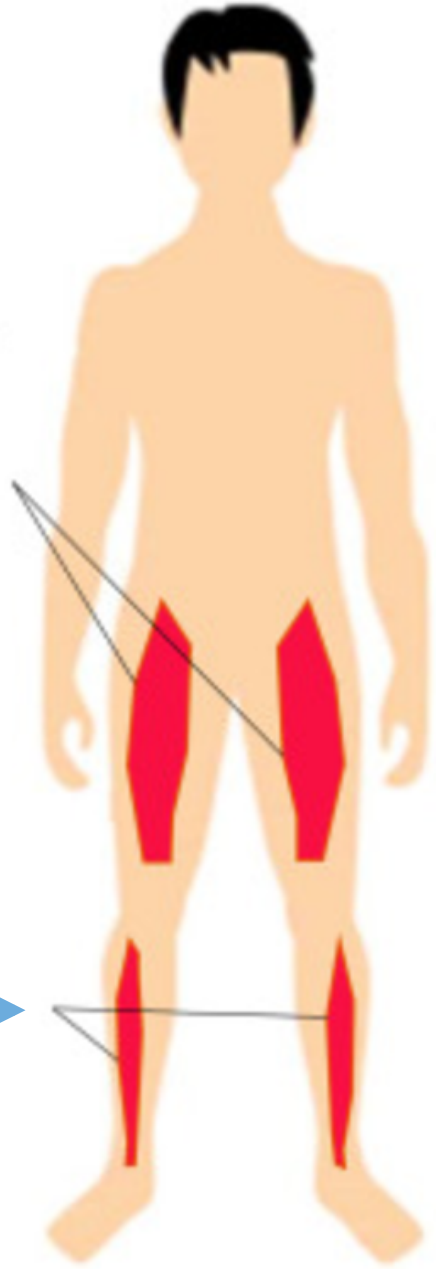
- Whatever affects the tree at 5 feet… also affects the tree at 30 feet.






What is impacting these parts of the “tree?”





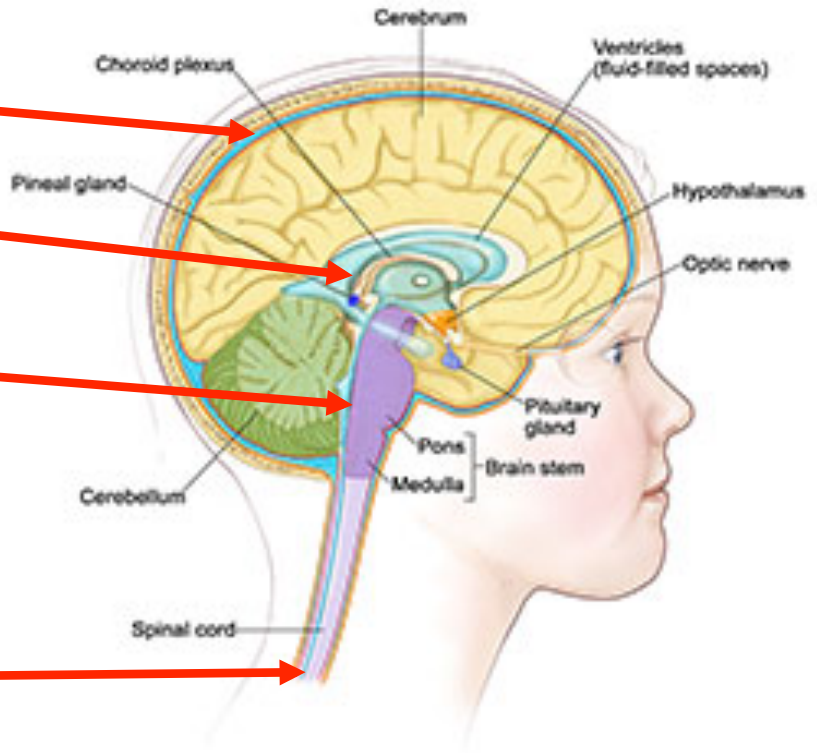
# Structural organization of the nervous system "Rule of Thumb"

Outer brain (cortex)

Inner brain (subcortical)

Brain stem

Spinal cord



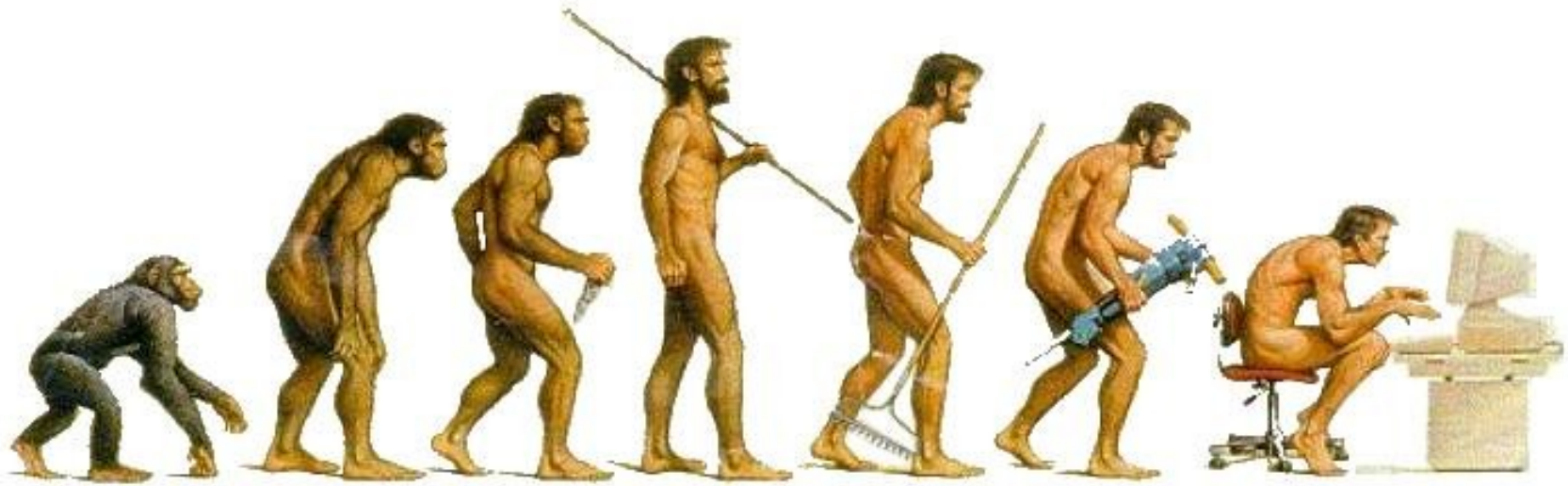

Newer

Older

# Patterns of degeneration

- When you don’t eat well, sleep well, exercise… when you have bad relationships and allow your body to degenerate, there are somewhat predictable patterns of decline.

- Heart rate?
- Blood pressure?
- Thyroid conditions?
- Posture?



# Lessons from neurodevelopment

Month 1-  Lifts head momentarily, strong grasp reflex

Month 2- Lifts head, reduced grasp reflex

Month 3- Lifts head and shoulders, no grasp reflex

Month 4- Sits with support

Month 5- Holds head up when sitting

Month 6- Rolls over (back to front)

Month 7- Weight bearing on feet, sits without support

Month 8- Stands with support

Month 9- Crawling

Month 10- Moves from stomach to sitting

Month 11- Walks with support

Month 12- First independent steps

Month 1- Lifts head momentarily, strong grasp reflex

Month 2- Lifts head, reduced, grasp reflex

Month 3- Lifts head and shoulders, no grasp reflex

Month 4- Sits with support

Month 5- Holds head up when sitting

Month 6- Rolls over (back to front)

Month 7- Weight bearing on feet, sits without support

Month 8- Stands with support

Month 9- Crawling

Month 10- Moves from stomach to sitting

Month 11- Walks with support

Month 12- First independent steps

Flexor dominance

Initial appearance of extensor tone

Increased extensor tone upper extremity, early core tone

Increase core strength

Functional stability of the core (transverse plane), improved fine motor control

Lower extremity extensor tone appears

Coordination between sides through highly functional core

Continuing development of extensor tone

## Older stuff

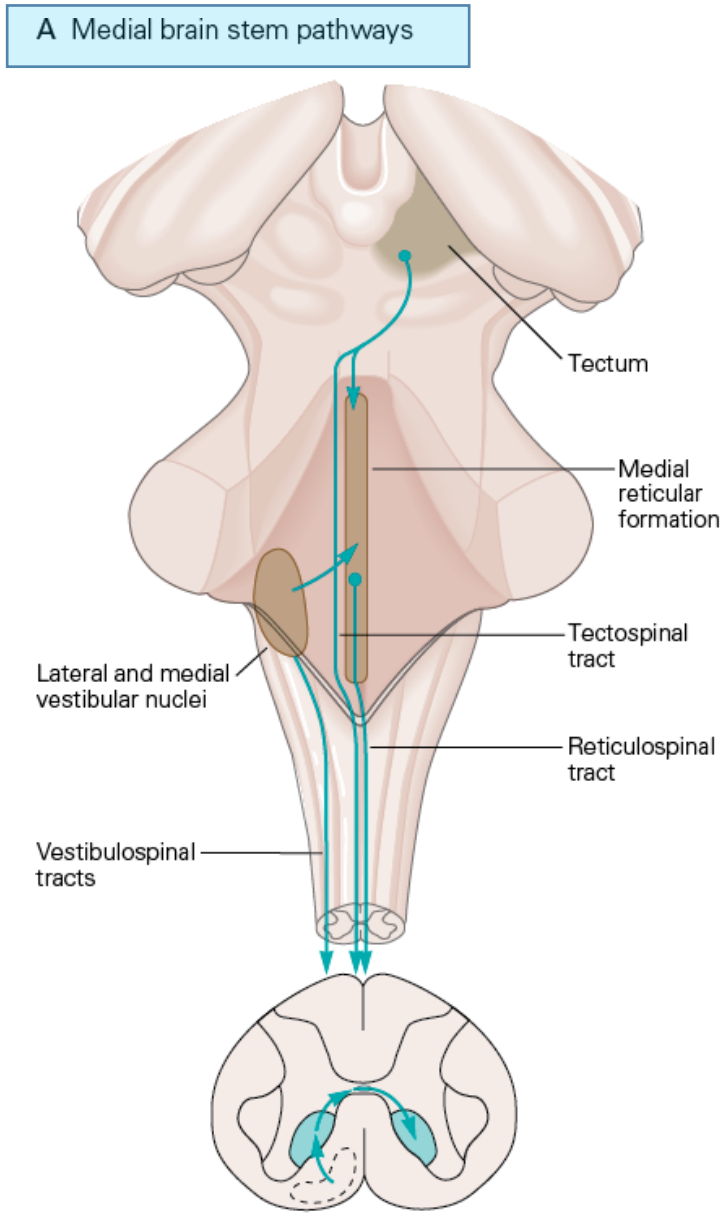
- Posture
  - Vestibulospinal
  - Reticulospinal

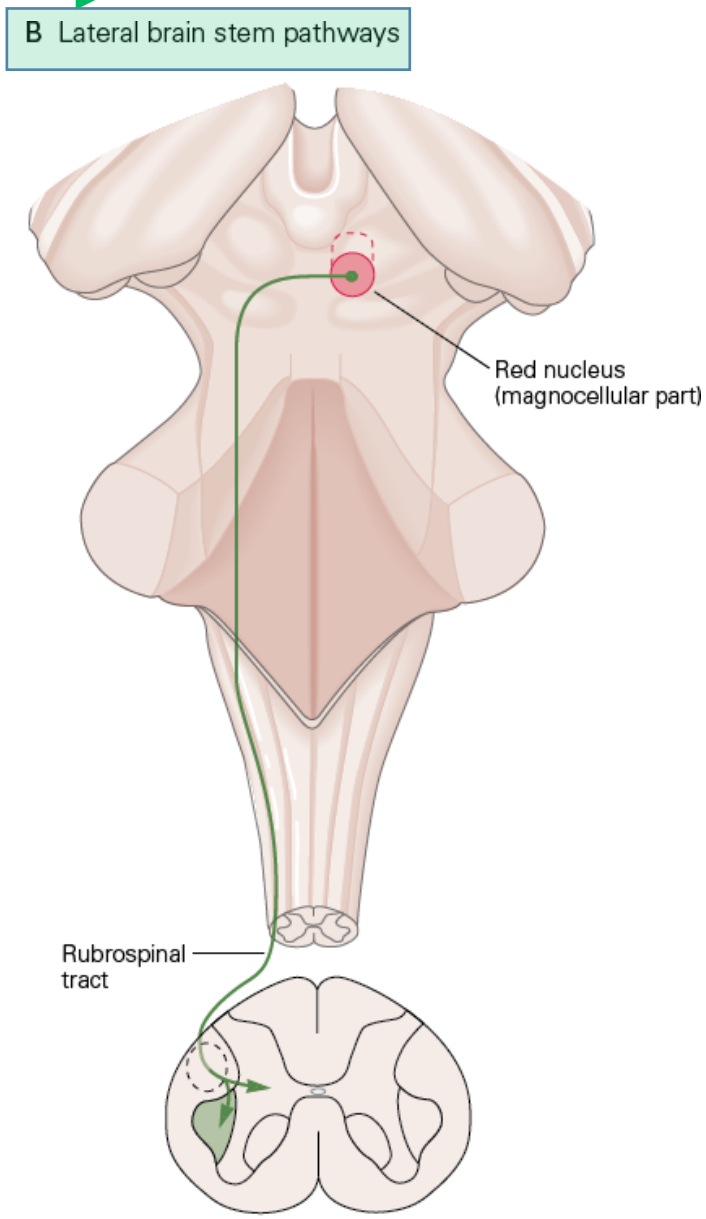
## Little less old stuff

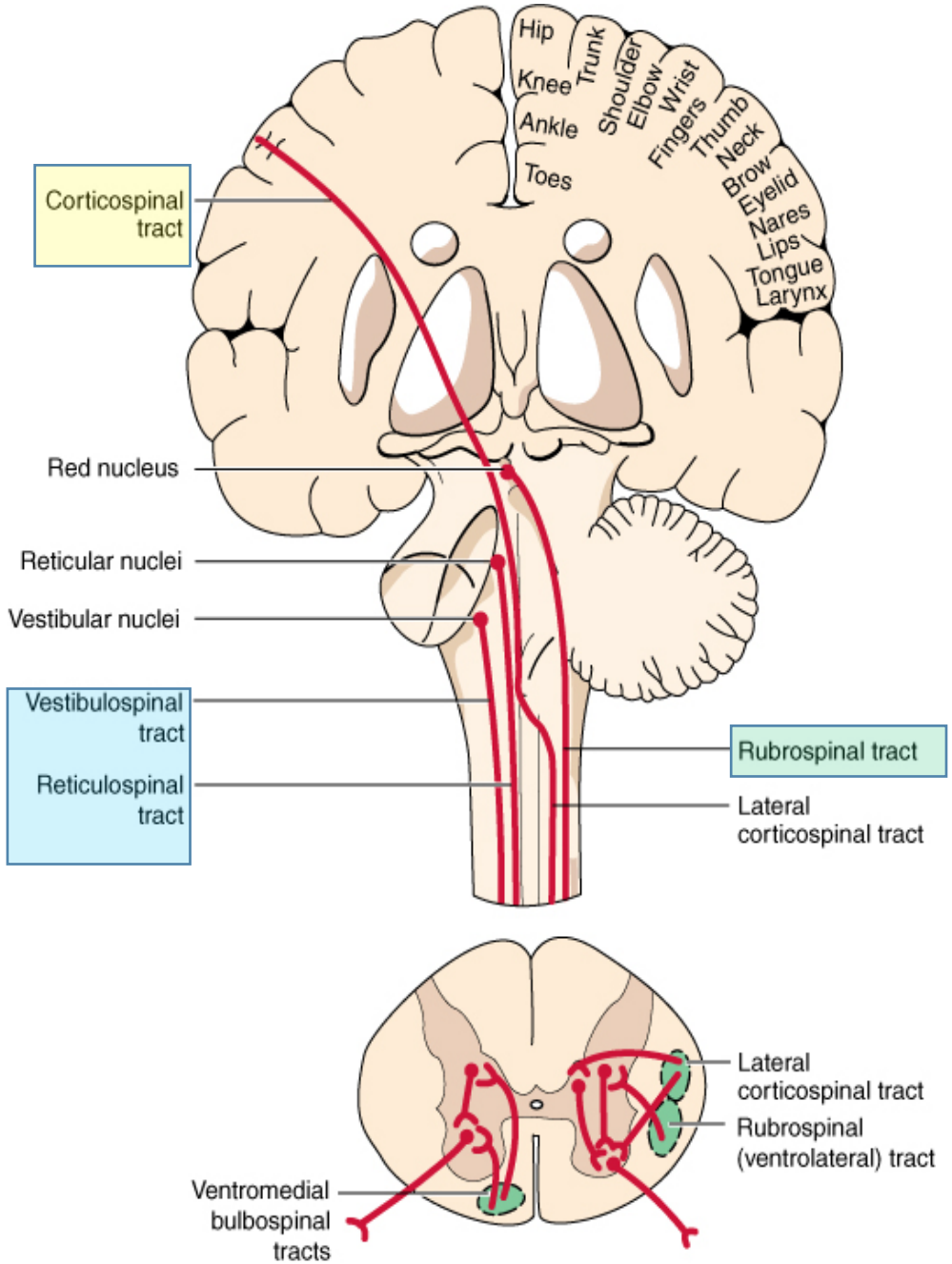
- Gross voluntary movement
  - Rubrospinal

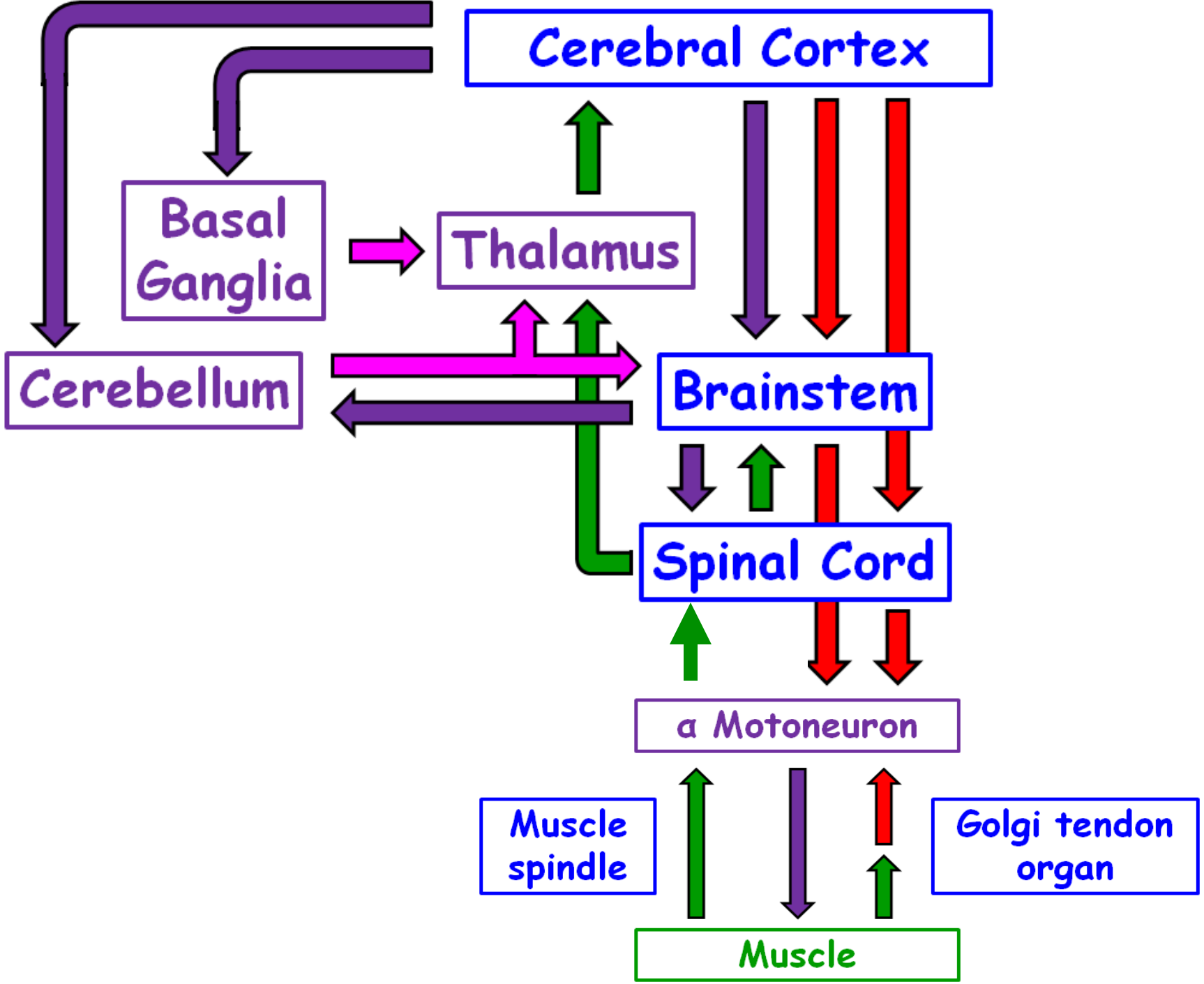
## Newer stuff

- Fine voluntary movement
  - Corticospinal




Hip
Knee
Ankle
Toes
Trunk
Shoulder
Elbow
Wrist
Fingers
Thumb
Neck
Brow
Eyelid
Nares
Lips
Tongue
Larynx
Corticospinal tract
Red nucleus
Reticular nuclei
Vestibular nuclei
Vestibulospinal tract
Reticulospinal tract
Rubrospinal tract
Lateral corticospinal tract
Lateral corticospinal tract
Rubrospinal (ventrolateral) tract
Ventromedial bulbospinal tracts


Cerebral Cortex
Basal Ganglia
Thalamus
Cerebellum
Brainstem
Spinal Cord
α Motoneuron
Muscle spindle
Golgi tendon organ
Muscle

People with “altered patterns in forebrain sites responsible for autonomic control…. will be at risk for cardiovascular disease as they age.”

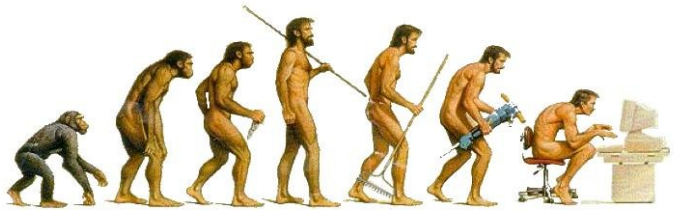
Higher brain function

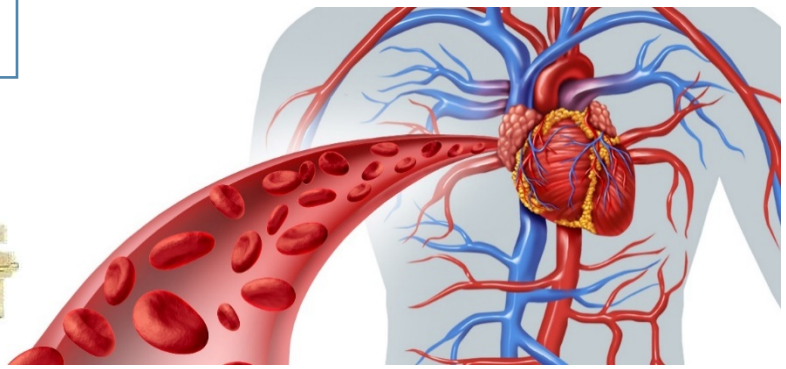
newer

Older motor systems

“sympathetic nervous system dysfunction is crucial in the development of heart failure and essential hypertension. This takes the form of persistent and adverse activation of sympathetic outflows to the heart and kidneys in both conditions.”

Increased flexion
Decreased extension





Cechetto, D. F. (2014). Cortical control of the autonomic nervous system. *Experimental Physiology*, *99*(2), 326–331. https://doi.org/10.1113/expphysiol.2013.075192

Parati, G., & Esler, M. (2012). The human sympathetic nervous system: its relevance in hypertension and heart failure. *European Heart Journal*, *33*(9), 1058–1066. https://doi.org/10.1093/eurheartj/ehs041

# When the higher brain “poops out”…

“It has long been known that brain damage and neurological phenomena (e.g. epilepsy, stroke) can result in detrimental effects on circulatory control via the autonomic nervous system…”

Another way to say this…

… the primitive brain predominates.

Ginty, A. T., Kraynak, T. E., Fisher, J. P., & Gianaros, P. J. (2017). Cardiovascular and autonomic reactivity to psychological stress: Neurophysiological substrates and links to cardiovascular disease. *Autonomic Neuroscience*, *207*, 2–9. https://doi.org/10.1016/j.autneu.2017.03.003

# Reorganization of the motor cortex is associated with postural control deficits in recurrent low back pain

Many people with recurrent low back pain (LBP) have deficits in postural control of the trunk muscles and this may contribute to the recurrence of pain episodes. However, the neural changes that underlie these motor deficits remain unclear. As the motor cortex contributes to control of postural adjustments, the current study investigated the excitability and organization of the motor cortical inputs to the trunk muscles in 11 individuals with and without recurrent LBP.

EMG activity of the deep abdominal muscle, transversus abdominis (TrA), was recorded bilaterally using intramuscular fine-wire electrodes. Postural control was assessed as onset of TrA EMG during single rapid arm flexion and extension tasks. Motor thresholds (MTs) for transcranial magnetic stimulation (TMS) were determined for responses contralateral and ipsilateral to the stimulated cortex.

These findings provide preliminary evidence of reorganization of trunk muscle representation at the motor cortex in individuals with recurrent LBP, and suggest this reorganization is associated with deficits in postural control.

Brain. 2008 Aug;131(Pt 8):2161-71. doi: 10.1093/brain/awn154. Epub 2008 Jul 18.

# Differences in brain processing of proprioception related to postural control in patients with recurrent non-specific low back pain and healthy controls

- Patients with non-specific low back pain (NSLBP) show an impaired postural control during standing and a slower performance of sit-to-stand-to-sit (STSTS) movements. Therefore, we investigated brain activity during ankle and back proprioceptive processing by applying local muscle vibration during functional magnetic resonance imaging in 20 patients with NSLBP and 20 controls.

- However, the relationship between brain activity during proprioceptive processing and behavioral indices of proprioceptive use differed significantly between NSLBP and healthy control groups….

- These findings suggest that functional brain changes during proprioceptive processing in patients with NSLBP may contribute to their postural control impairments.

- …. However, future studies are needed to clarify the cause-effect relationship between functional brain changes and NSLBP, and to examine which interventions could aid in normalizing brain changes and postural control in this population.

NeuroImage:Clinical 23 (2019) 101881

# Influence of paravertebral muscles training on brain plasticity and postural control in chronic low back pain

- Isometric activation (ISOM) of deep multifidi muscles (MF) can influence postural adjustments and primary motor cortex (M1) function in chronic low back pain (CLBP).

- Changes of corticospinal excitability and of MF-S postural adjustments suggest that ISOM better influenced brain plasticity.

- This original study presents how motor control exercises can influence brain plasticity and postural control in chronic low back pain. This knowledge will impact on the decision of clinicians to prescribe specific exercises with a view of improving motor control in this musculoskeletal condition.

Scand J of Pain Vol 12, July 2016, 74-83

# Neuroplasticity of Sensorimotor Control in Low Back Pain.

- Low back pain (LBP) is an important medical and socioeconomic problem. Impaired sensorimotor control has been suggested to be a likely mechanism underlying development and/or maintenance of pain. Although early work focused on the structural and functional abnormalities within the musculoskeletal system, **in the past 20 years there has been an increasing realization that patients with LBP might also have extensive neuroplastic changes within the central nervous system.**

- Neuroplastic changes may be addressed by top-down cognitive-based interventions and bottom-up physical interventions. An integrated clinical approach that combines contemporary pain neuroscience education, cognition-targeted sensorimotor control, and physical or function-based treatments may lead to better outcomes in patients with recurrent and persistent LBP.

- This approach will need to consider variation among individuals, as no single finding/mechanism is present in all individuals, and no single treatment that targets neuroplastic changes in the sensorimotor system is likely to be effective for all patients with LBP.

J Orthop Sports Phys Ther. 2019 Jun;49(6):402-414. doi: 10.2519/jospt.2019.8489.

# A Modern Neuroscience Approach to Chronic Spinal Pain: Combining Pain Neuroscience Education With Cognition-Targeted Motor Control Training

- Chronic spinal pain (CSP) is a severely disabling disorder, including nontraumatic chronic low back and neck pain, failed back surgery, and chronic whiplash-associated disorders. Much of the current therapy is focused on input mechanisms (treating peripheral elements such as muscles and joints) and output mechanisms (addressing motor control), while there is less attention to processing (central) mechanisms. **In addition to the compelling evidence for impaired motor control of spinal muscles in patients with CSP, there is increasing evidence that central mechanisms (ie, hyperexcitability of the central nervous system and brain abnormalities) play a role in CSP.**

- Hence, treatments for CSP should address not only peripheral dysfunctions but also the brain. Therefore, a modern neuroscience approach, comprising therapeutic pain neuroscience education followed by cognition-targeted motor control training, is proposed.

*Physical Therapy*, Volume 94, Issue 5, 1 May 2014, Pages 730 738, https://doi.org/10.2522/ptj.20130258

https://academic.oup.com/ptj/article/94/5/730/2735638

# Let’s briefly change gears and step away from the core

# Stress !

From a combined neurobiological and **evolution**-theoretical perspective, the stress response is a subcortically subserved response to uncertainty that is not 'generated' but 'default': the stress response is 'always there' but as long as safety is perceived, the stress response is under tonic prefrontal **inhibition**, reflected by high vagally mediated heart rate variability.

Uncertainty of safety leads to disinhibiting the default stress response, even in the absence of threat. Due to the stress response's survival value, this 'erring on the side of caution' is passed to us via our genes. Thus, intolerance of uncertainty is not acquired during the life cycle, but is a given property of all living organisms, only to be alleviated in situations of which the safety is learned. When the latter is deficient, generalized unsafety ensues, which underlies chronic anxiety and stress and their somatic health risks, as well as other highly prevalent conditions carrying such risks, including loneliness, obesity, aerobic unfitness and old age.

… removal of prefrontal inhibition “permits” rather than “causes” an increase in physiological activity (dishinhibition)

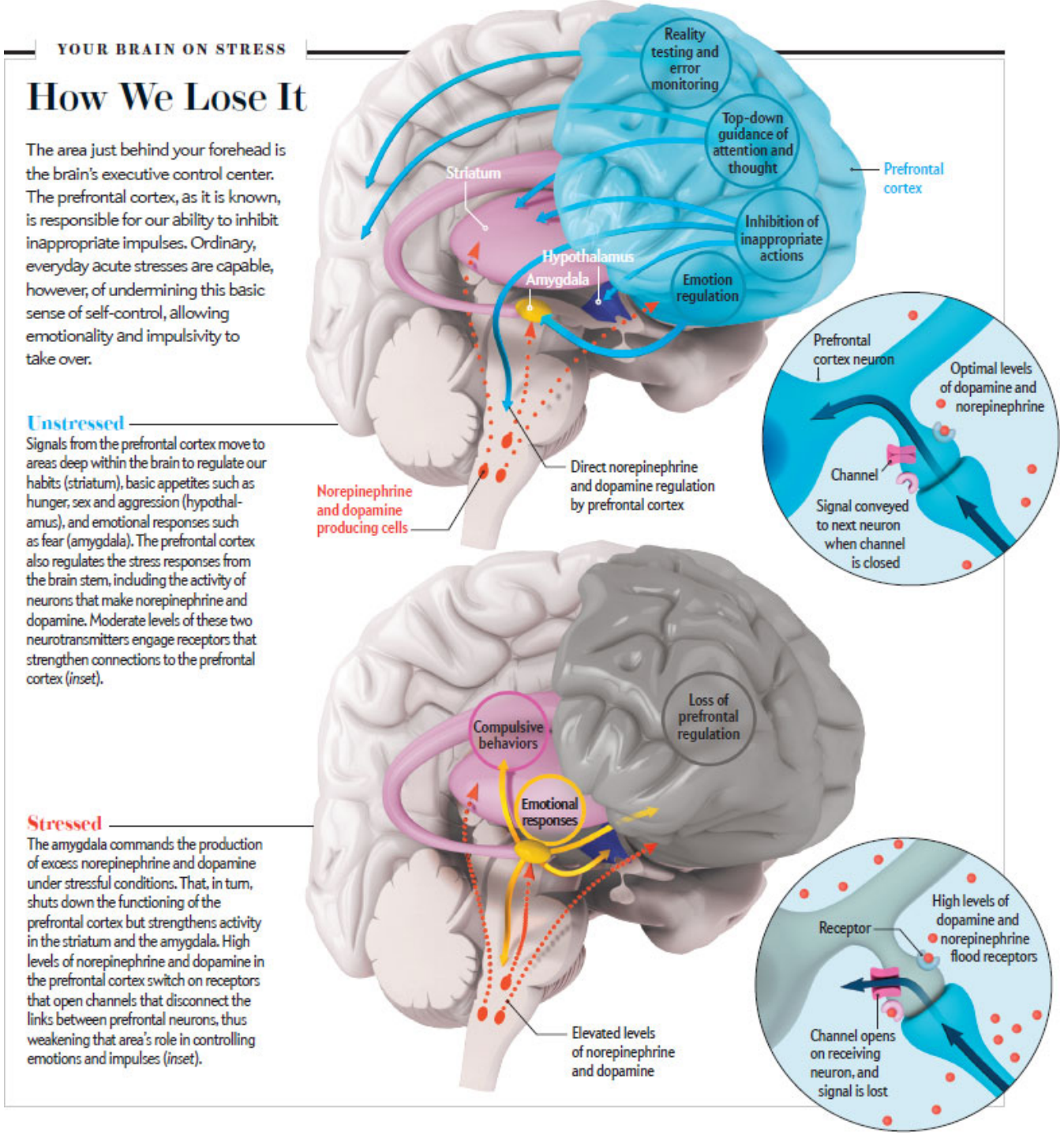
Brosschot, J. F., Verkuil, B., & Thayer, J. F. (2016). The default response to uncertainty and the importance of perceived safety in anxiety and stress: An evolution-theoretical perspective. *Journal of Anxiety Disorders, 41,* 22–34. https://doi.org/10.1016/j.janxdis.2016.04.012

## Newer stuff

- Prefrontal inhibition

## Older stuff

- Limbic




This is your brain in meltdown. Arnseten, Mazure, Sinha. *Scientific American* 306, 48-53 (2012) Published online: 20 March 2012.

# Question

- Is neocortical inhibition of subcortical regions in the stress response a “one-off ?”

- ***The “evolved brain” inhibiting the “primitive brain”…. is this the exception or the rule?***

# Functional organization of the nervous system "Rule of Thumb"

Newer

Older

- Prefrontal cortex

lots of other neuro stuff

- Autonomic nervous system

*"…can be considered the evolutionary oldest part of what makes up the vertebrate nervous system."*

Karemaker, J. (2017). An introduction into autonomic nervous function. *Physiological Measurement*, *38*, R89–R118. https://doi.org/10.1088/1361-6579/aa6782
Ribas, G. C. (2006). Considerations about the nervous system phylogenetic evolution, behavior, and the emergence of consciousness. *Revista Brasileira De Psiquiatria (Sao Paulo, Brazil: 1999)*, *28*(4), 326–338.

# Anterior pelvic tilt

## Biomechanical view

1. Pronation of ankle→ IR of tibia→ IR of hip→ adduction and flexion of hip→ anterior pelvic tilt

2. Big belly→ (tight hip flexor)→ anterior pelvic tilt→ IR/adduction of hip→ knee/ankle pain

3. “Weak muscles” as described in lower cross syndrome causes anterior pelvic tilt

## Neurological view

Poor brain…

1. **Flexor dominance** (iliopsoas, rectus femoris)
2. Weak gluteus maximus
   - Reciprocally inhibited by hip flexors
3. Impaired abdominal muscles which are normally reflexogenically activated

…. Anterior pelvic tilt


# Questions ?

Peter Jo

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Associate Professor, Biology

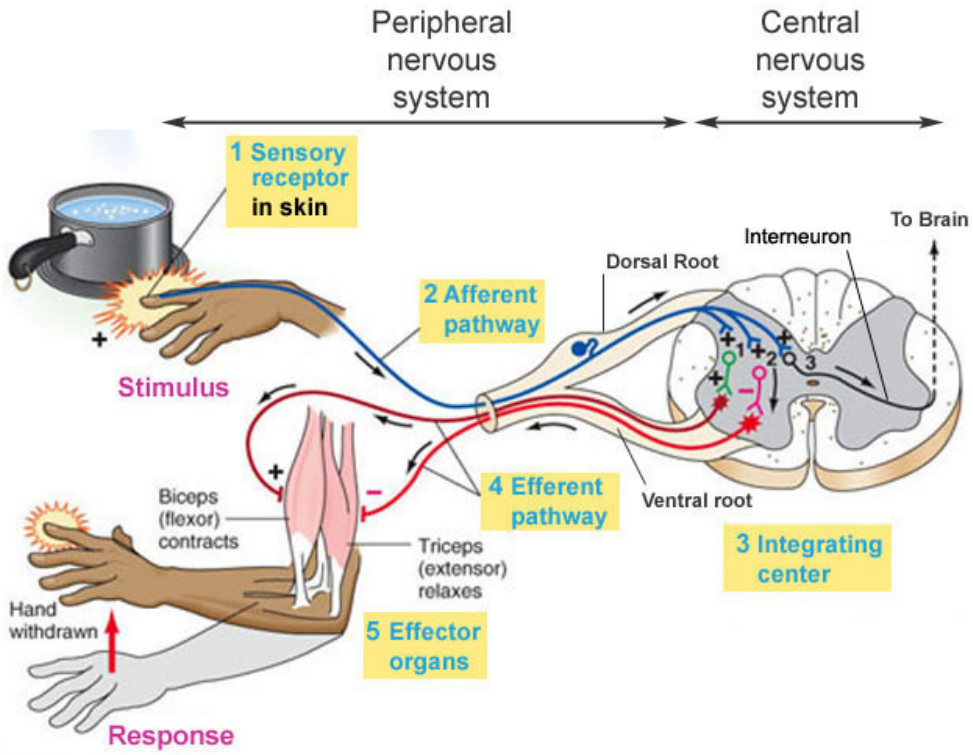
Northern Virginia Community College

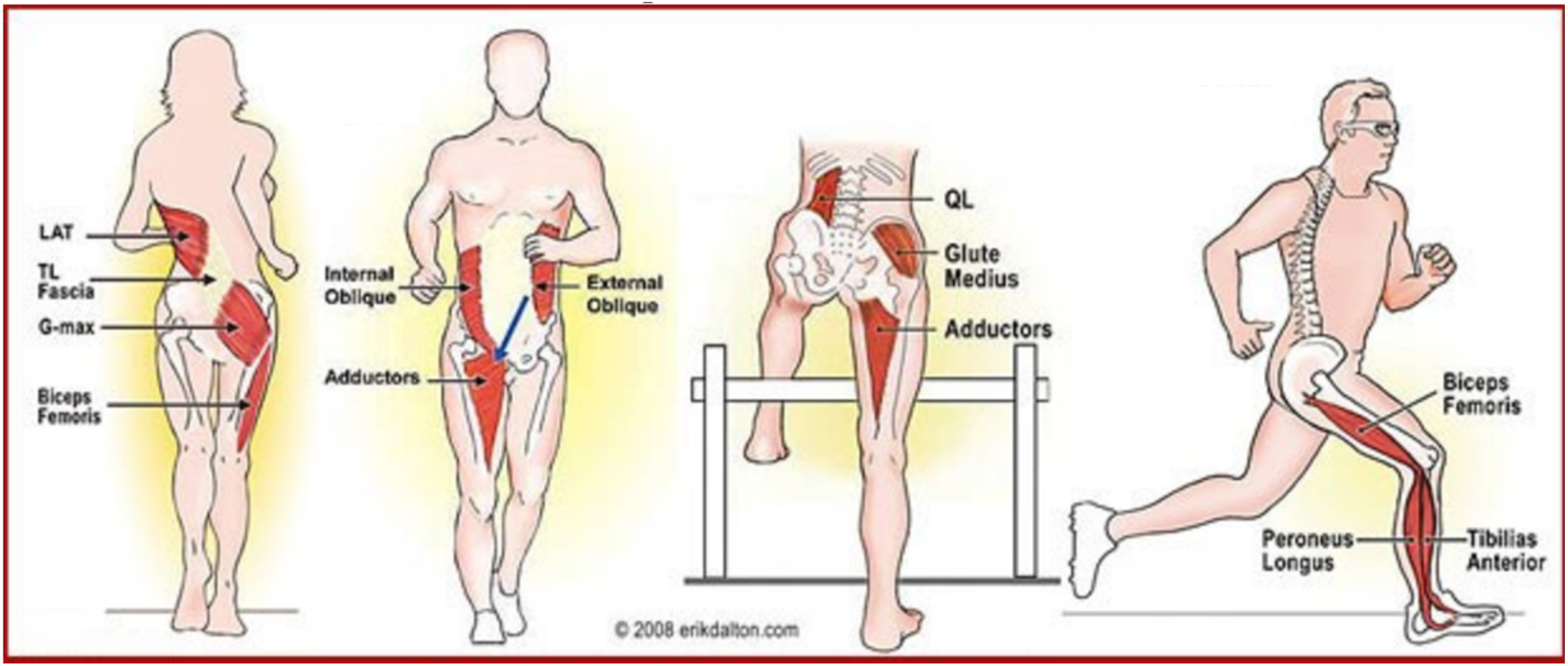
# What happens to muscles when experiencing pain?

A. Facilitation of muscles

B. Inhibition of muscles

C. It depends. We are able to predict some patterns but must rely on research data for other muscles.




LAT
TL Fascia
G-max
Biceps Femoris
Internal Oblique
External Oblique
Adductors
QL
Glute Medius
Adductors
Biceps Femoris
Peroneus Longus
Tibilias Anterior
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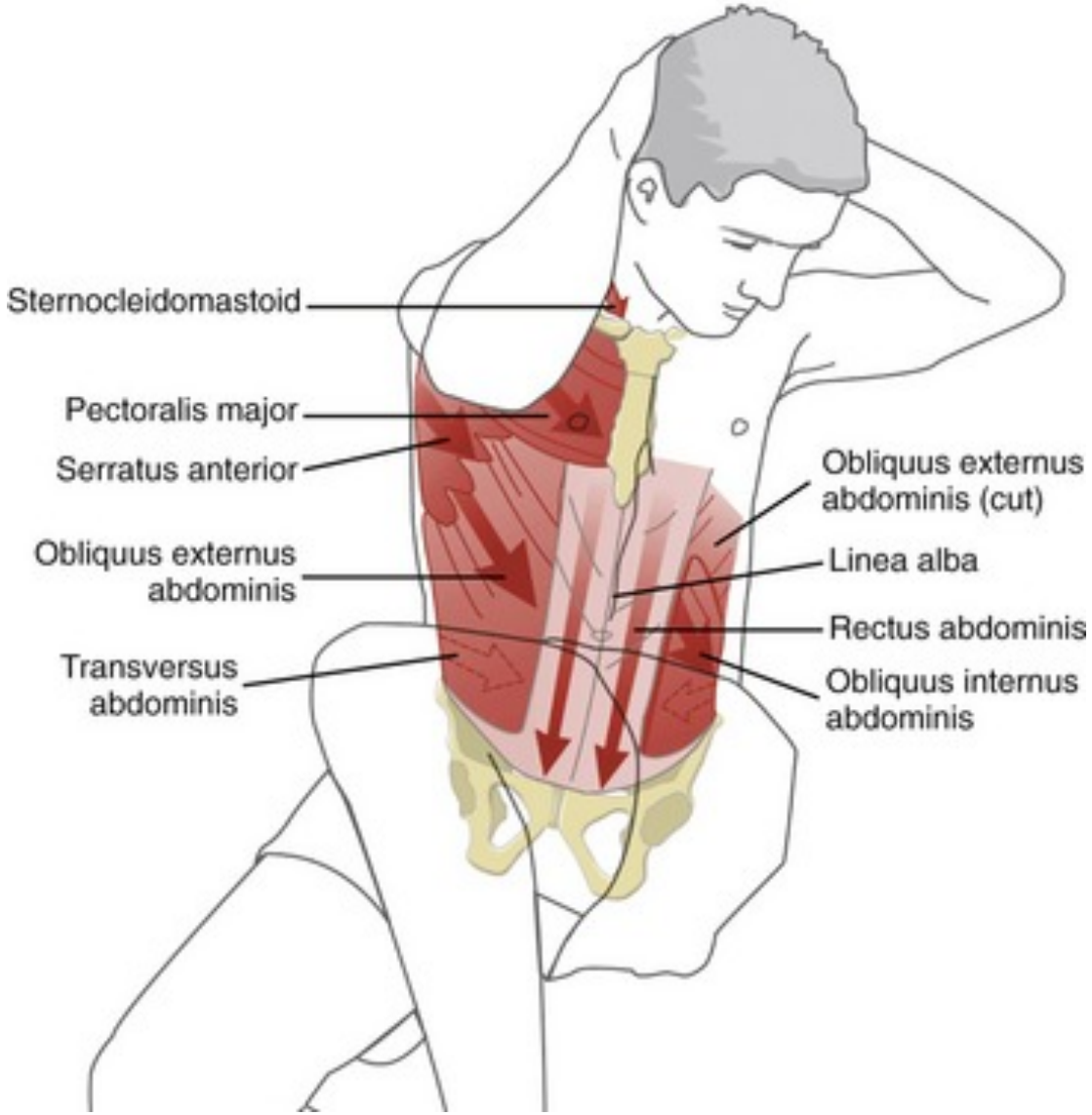
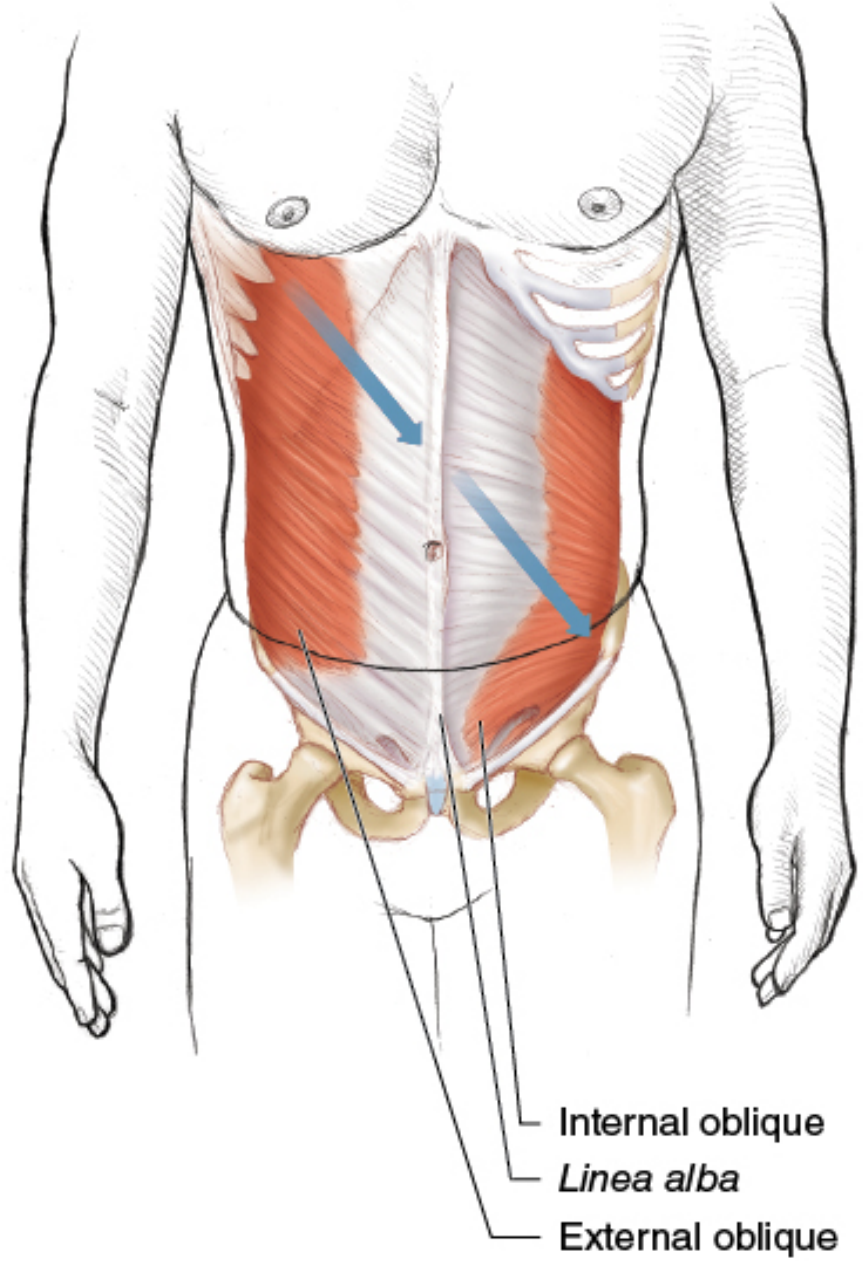

Sternocleidomastoid
Pectoralis major
Serratus anterior
Obliquus externus abdominis
Transversus abdominis
Obliquus externus abdominis (cut)
Linea alba
Rectus abdominis
Obliquus internus abdominis


Internal oblique
*Linea alba*
External oblique