# Joint Approaches in Children Principles & Concepts

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- Environment
- Body size proportions
- Age specific requirements for development
- Infant: Discovering self & environment
- Toddler: Packaged for functionality & crash protection
- Adolescents: Muscle, bone & ligamentous strengths have differential rates of growth

*‘The skeleton begins as a continuum, & a continuum it remains all lifelong.*

*The things that link bone with bone, cartilage, ligaments, membranes, are fashioned out of the same primordial tissue, & come into being pari passu, with the bones themselves.*

*The entire fabric has its soft parts & its hard, its rigid & its flexible parts; but until we disrupt & dismember its bony, gristly & fibrous parts, one from another, it exists simply as a ‘skeleton', as one integral & individual whole.’*

*(Thompson, 1917* “On growth & Form” pp 712-713*).*

# Joints as a window to Developing physiology

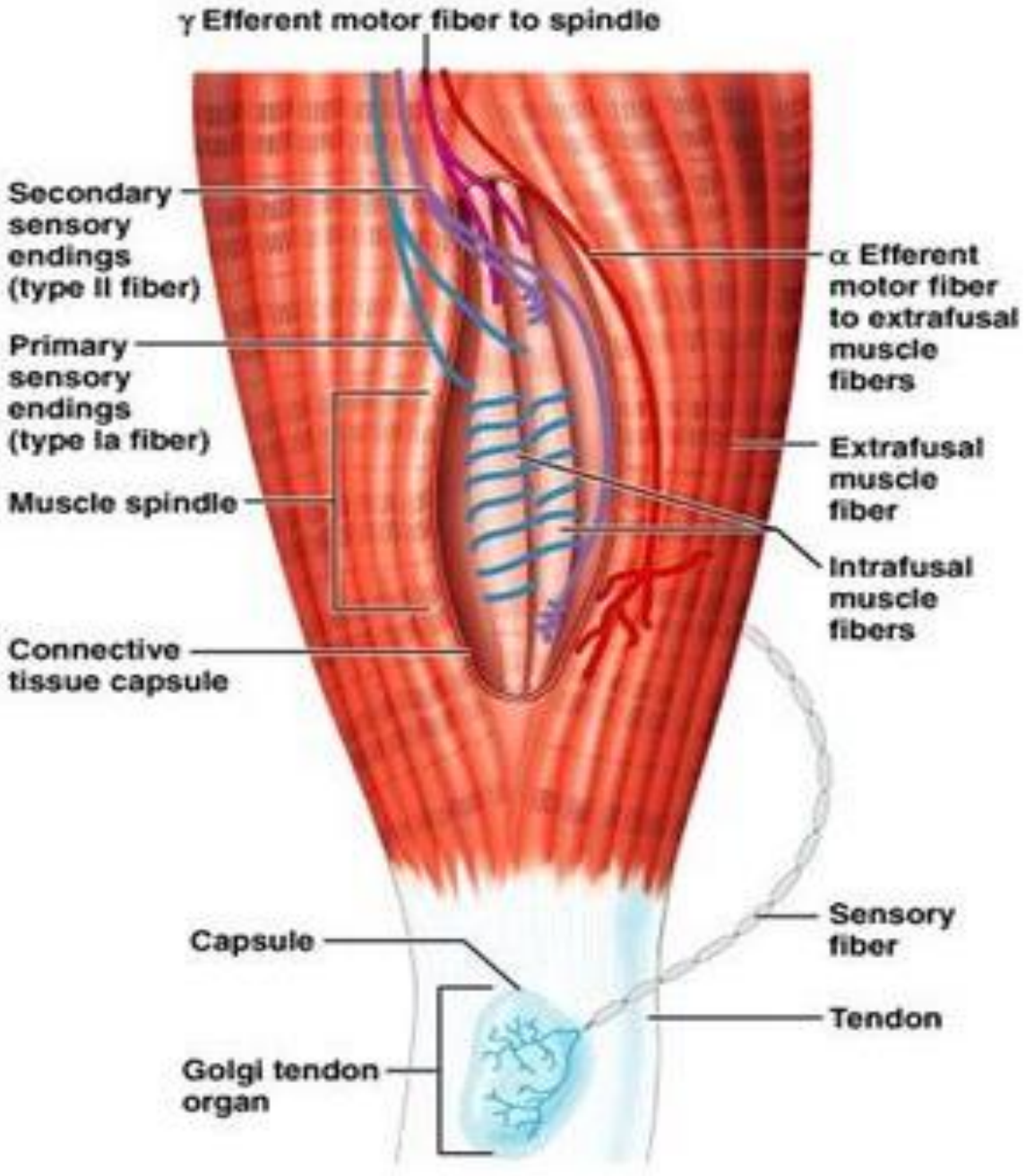
- Joint Issue local & in isolation
- Associated observations of whole body
- May be a sign of systemic condition
- Musculoskeletal development incomplete
- Nervous system development incomplete
- Myelination incomplete
- Psyche developing
- Myelination & Proprioceptive mechanisms on affect motion & development of musculoskeletal system & Vice versa

# Signs of Musculoskeletal & Behavioural Adaptations to ANS Disharmony

- Disproportionate startle response
- Vigilance, Alertness
- Sweaty palms & feet
- Hyperventilation
- Increased muscular tension
- Reduced motion
- Hypotonicity
- Excessively fat
- Anxiety
- Sleep/wake cycle affected

# Hypermobility
# The joint unit: a window

- Frequent joint & ligament injuries, dislocations & sprains
- Joint & muscle stiffness.
- Fatigue
- Clumsiness/poor balance
- Bladder & bowel issues
- Dizziness & Fainting
- Thin, stretchy skin




# Proprioceptive system

- Senses biomechanical environment
- Rpidly initiates a neural response & ultimately
- Modulates local muscle tension, thus forming the Muscle Spindle & Golgi Tendon Organ reflex arc

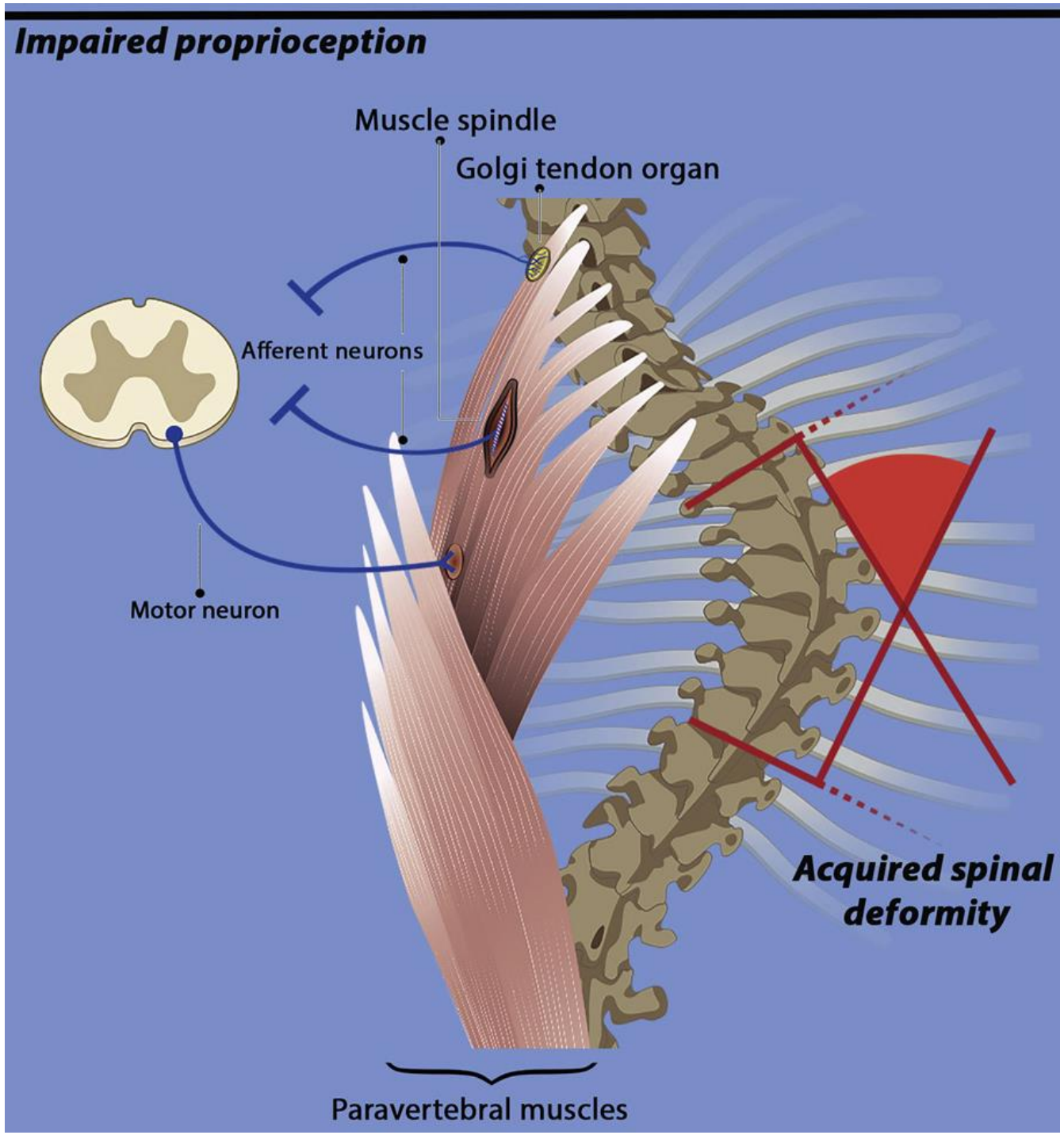
# Proprioceptors: sync body with the mind

- Detects mechanical stimuli arising within the musculoskeletal system itself giving sense of relative position of body parts (co-ordinated movement)
- Level of effort exerted by acting muscles (correct force per task)
- Control of movement & posture
- Components of nervous system developed by movement
- Begins in utero; matures 6-8 yoa; from 5-18 yoa gains precision
- Developmental course reflects maturation within nervous system

# Proprioceptive System Masterminds Spinal Alignment: Insight into the Mechanism of Scoliosis

Bletcher, Krief et al., Developmental cell Vol 42, Issue 4, 21 August 2017, Pp 388-399.e3

- Skeletons of mice with proprioception impairment are apparently intact prior to the appearance of scoliosis
- The dynamics of deformative process progresses at highest rate around puberty & slowly thereafter
- Commonly accentuated right-sided curve of thoracic spine characteristic of AIS.

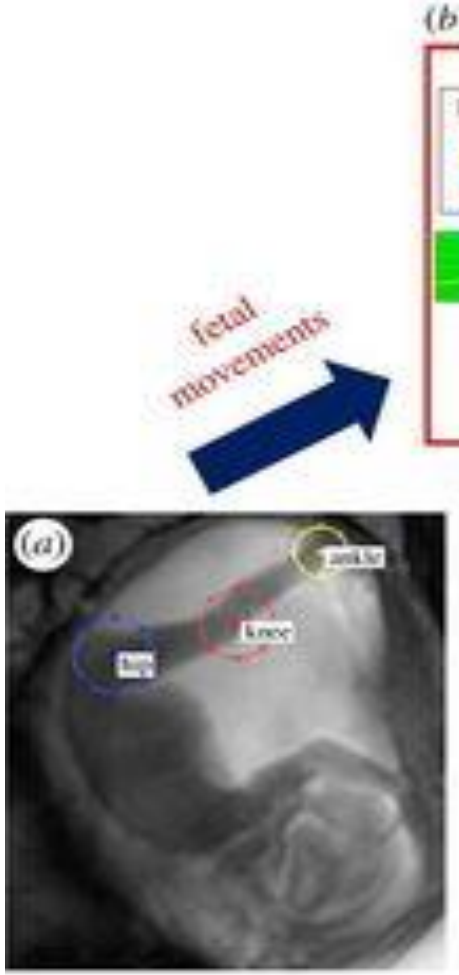



- Proprioceptive system maintains spinal alignment through tight regulation of position & orientation of numerous spinal components
- Regulation of skeletal development & function

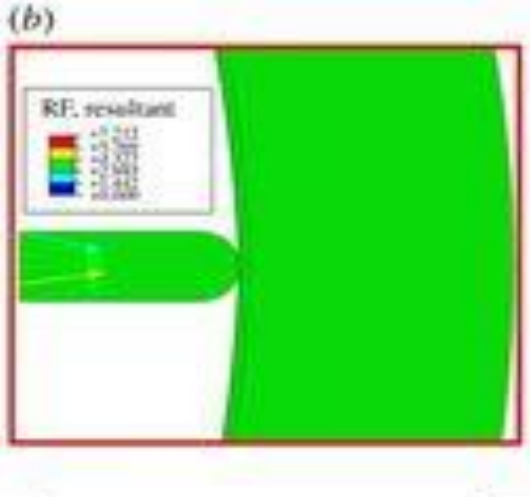
# Musculoskeletal development – the joint unit

# Stresses & strains on foetal skeleton during development

## computational model Vol:15, Issue: 138, DOI: (10.1098/rsif.2017.0593)



Tracking foetal joint movements




Reaction force from foetal movements against uterine wall

kinematics


Musculoskeletal modelling to predict muscle forces

muscle forces

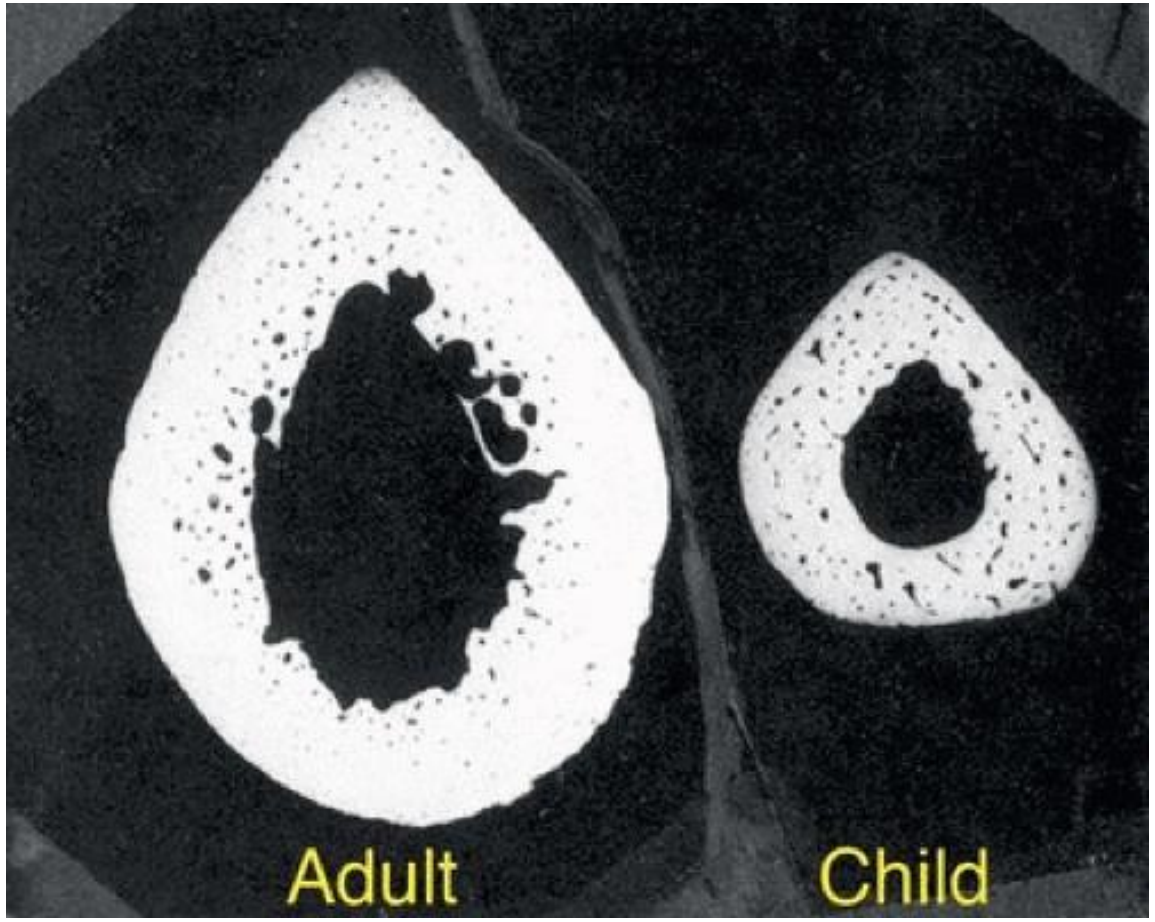

Muscle forces

Ad magnus

G Max

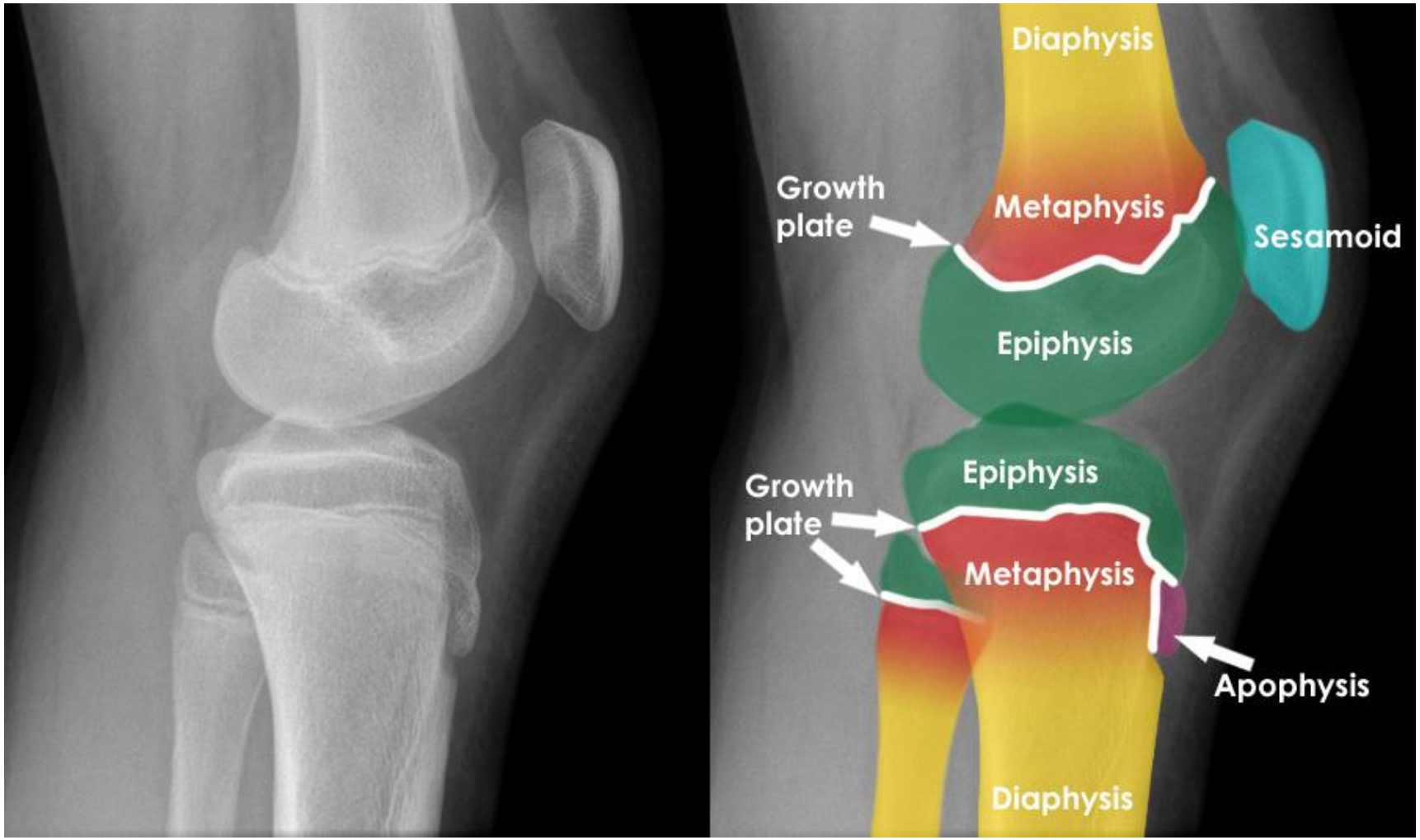
B Fem

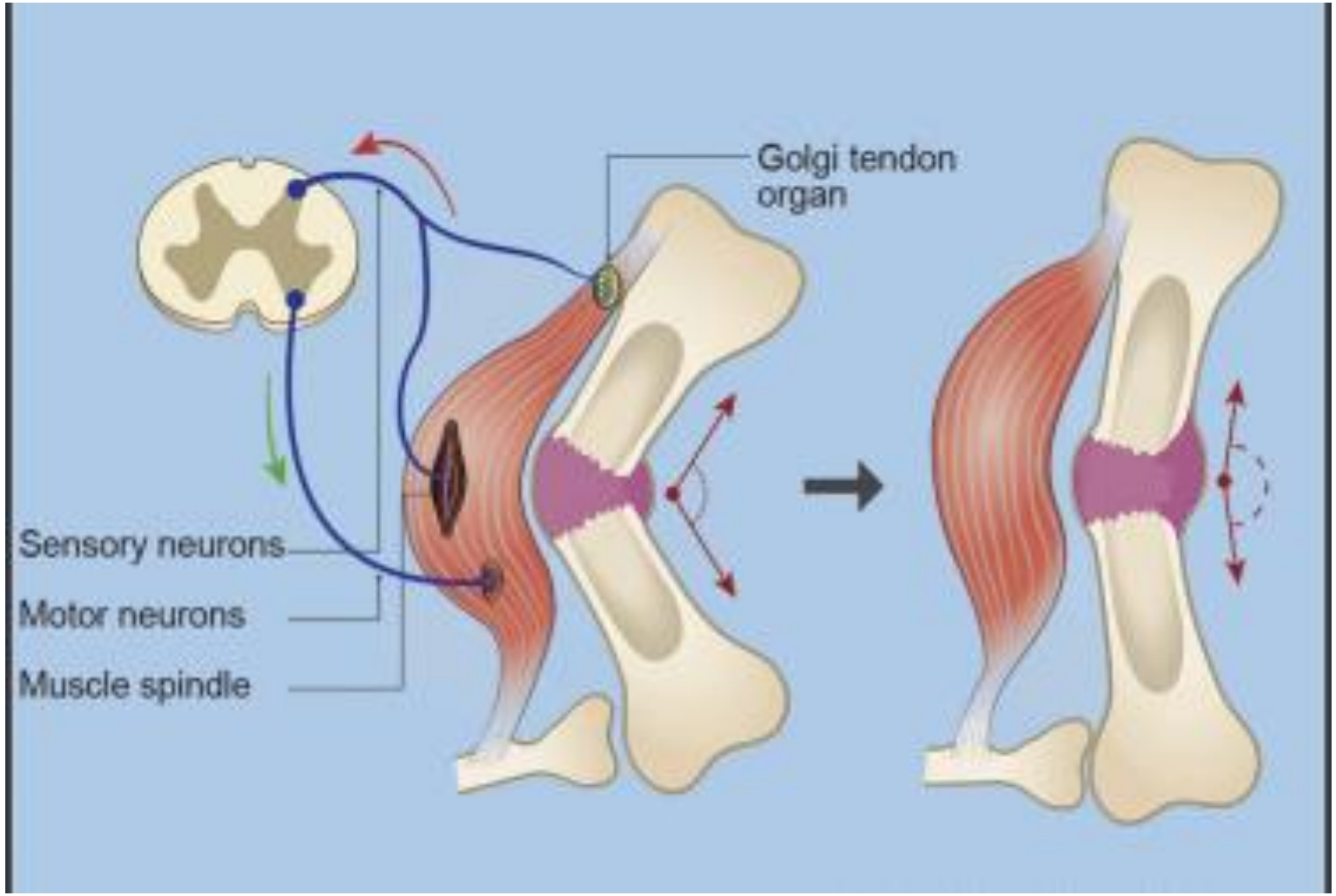
# Biomechanics of Childs Bone




Microradiographs of distal radial diaphysis of an adult & 8yoa

- Osteoid (unmineralized bone tissue) has less density than adult
- Haversian canals larger & occupy greater space than adult
- Bones more porous with pitted cortex (Gruyere V cheddar)
- Tolerates greater deformation than adult
- Moulding possibilities

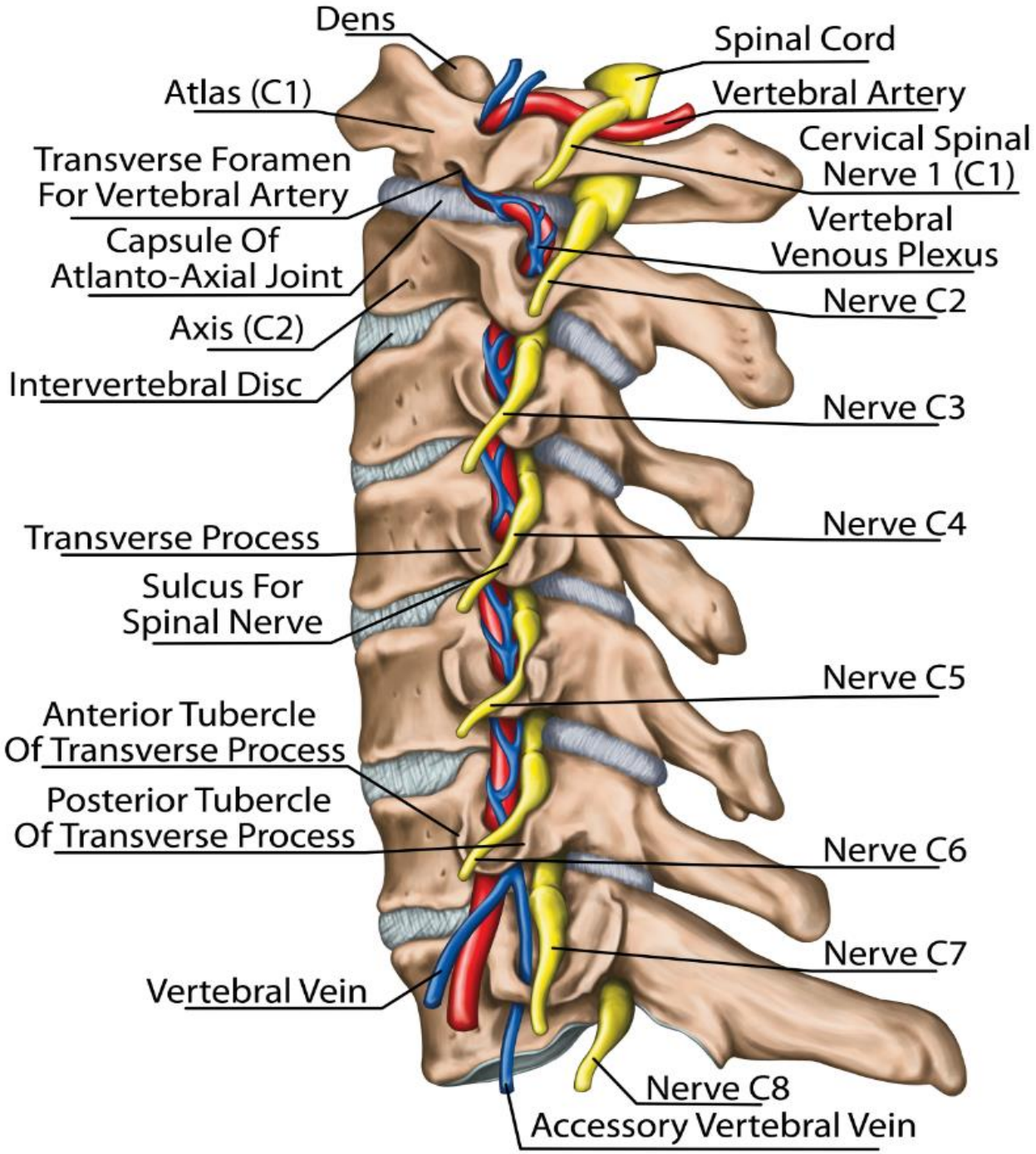

Diaphysis
Growth plate
Metaphysis
Sesamoid
Epiphysis
Epiphysis
Growth plate
Metaphysis
Apophysis
Diaphysis

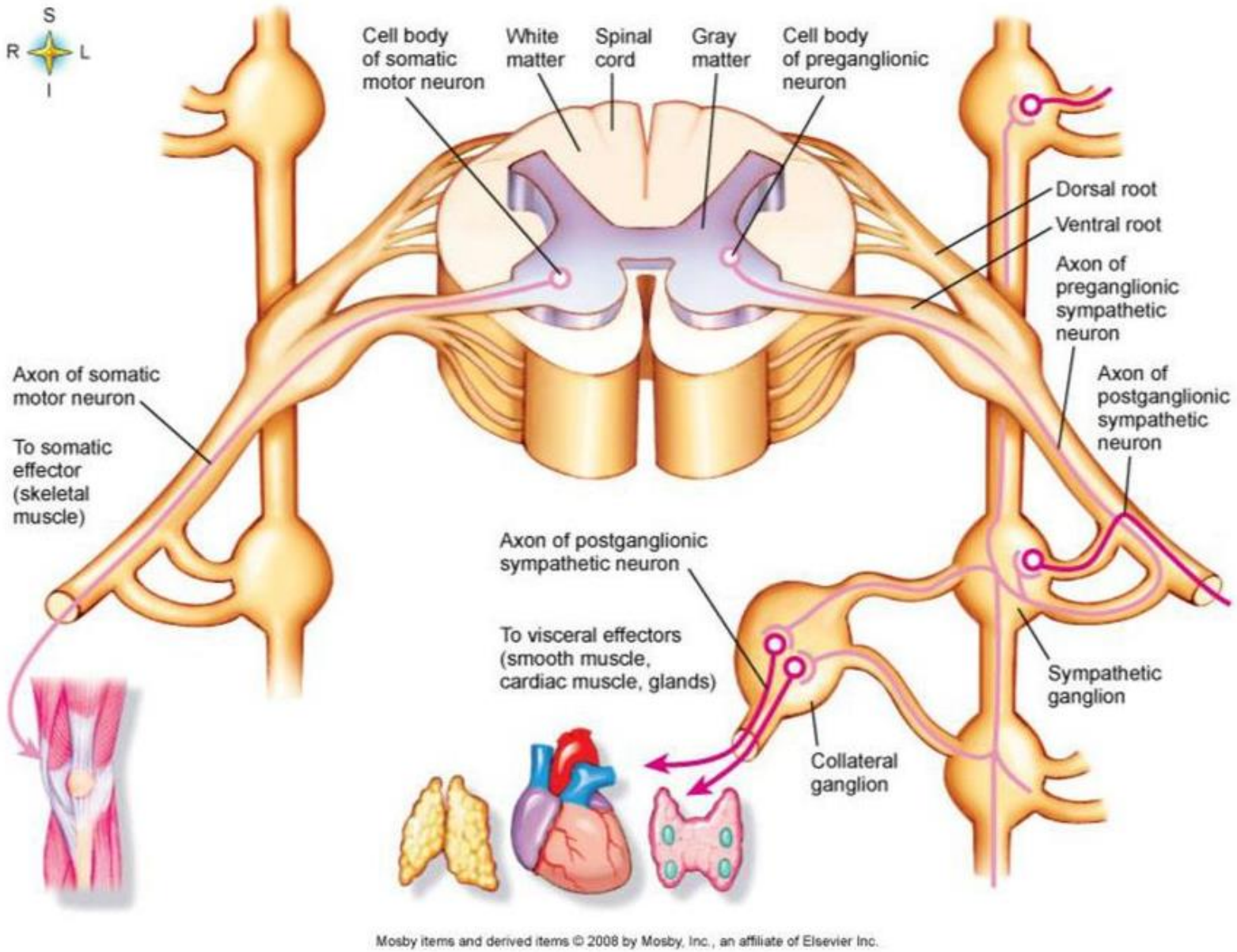



# Fracture Healing Initially Guided by Proprioceptive System

# Spinal Joints

## Vertebro-segmental Unit








# Propioceptive & Joint Kinesthetic Receptors require myelination

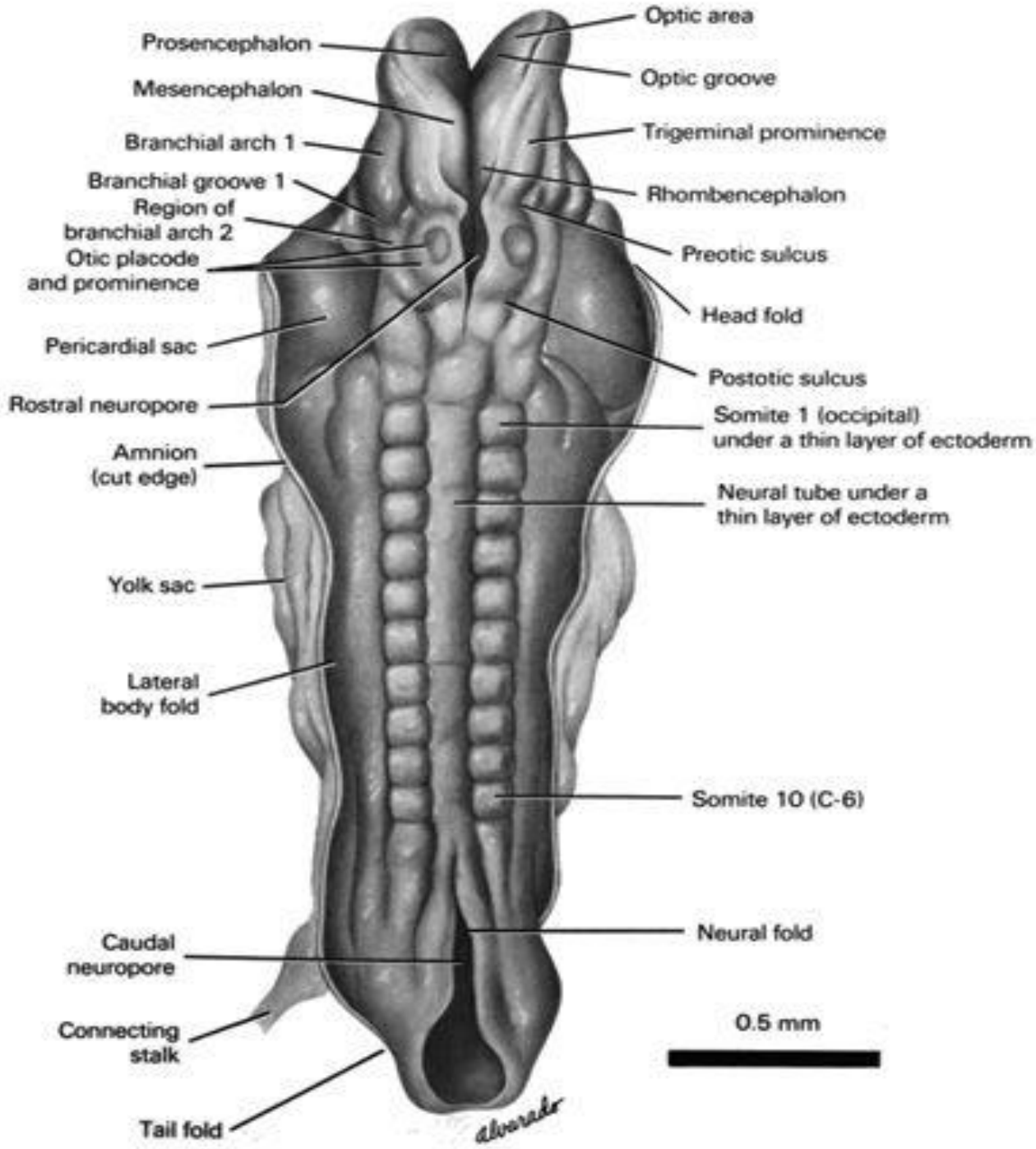
Monitor stretch in synovial joints

Spinal reflex arcs

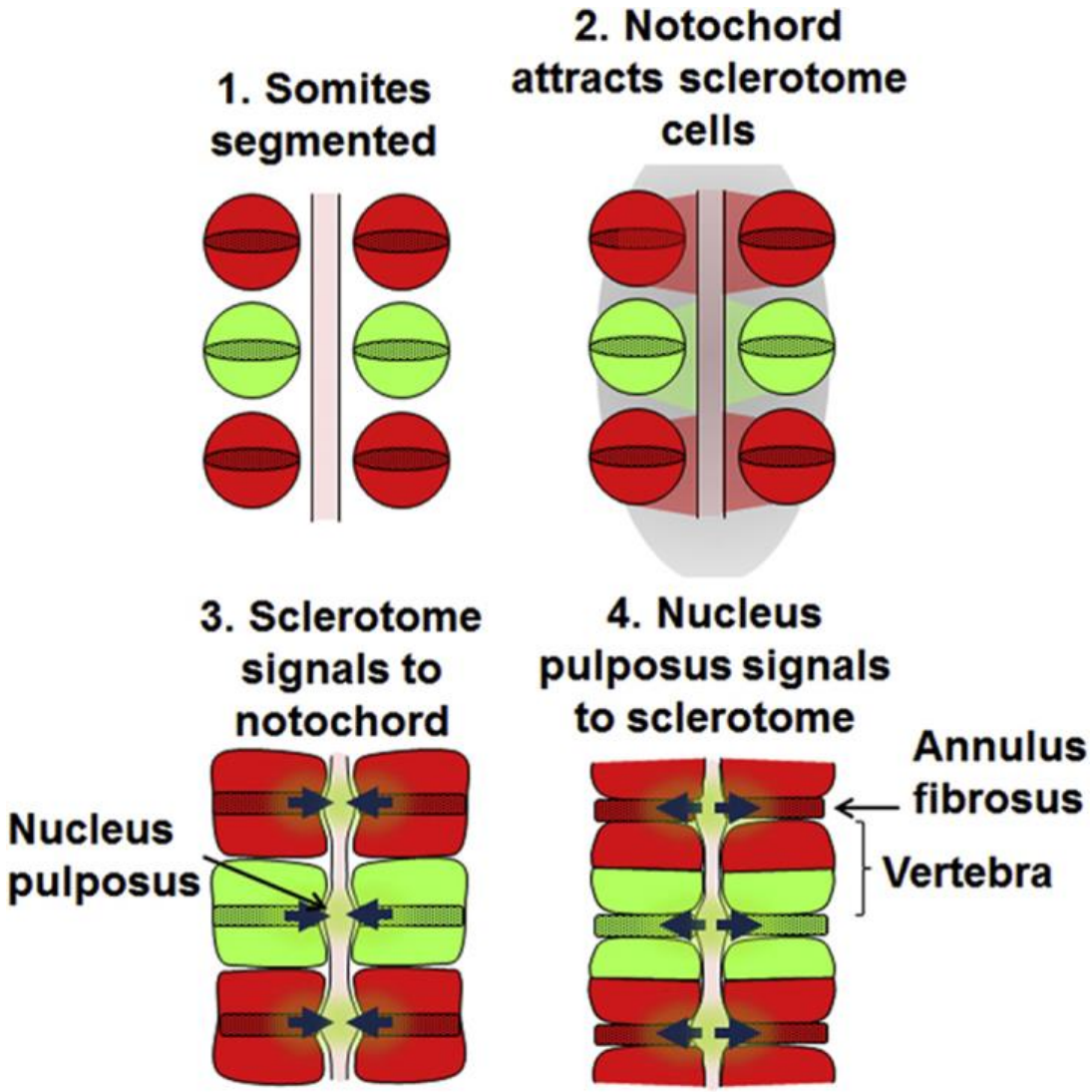
Cerebellum & Brainstem co-ordinate proprioceptive input & output

# Somites

Give rise to the cells forming  vertebrae & ribs
dermis of dorsal skin
skeletal muscles of back, body wall & limbs

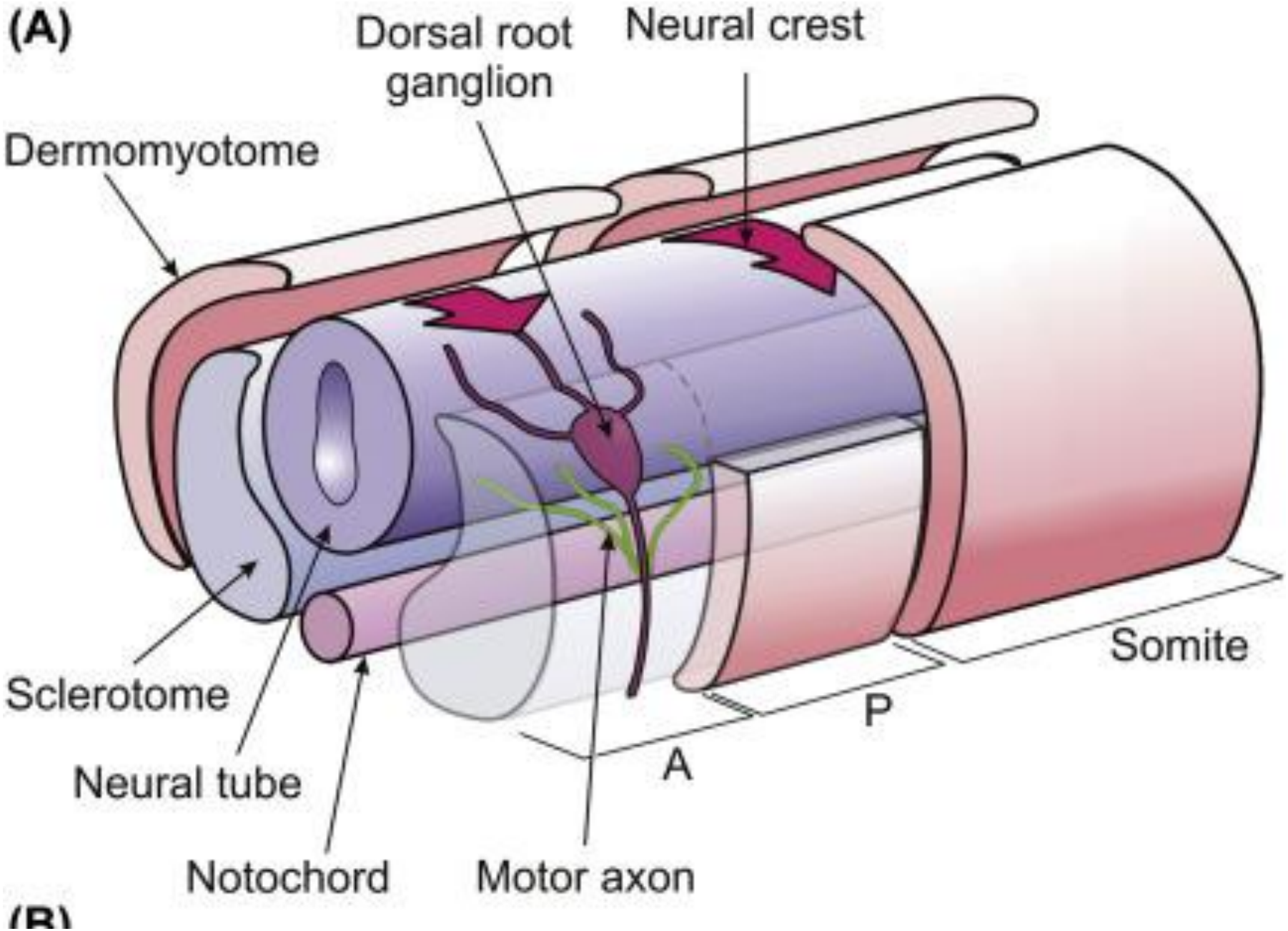


# Development of vertebral column



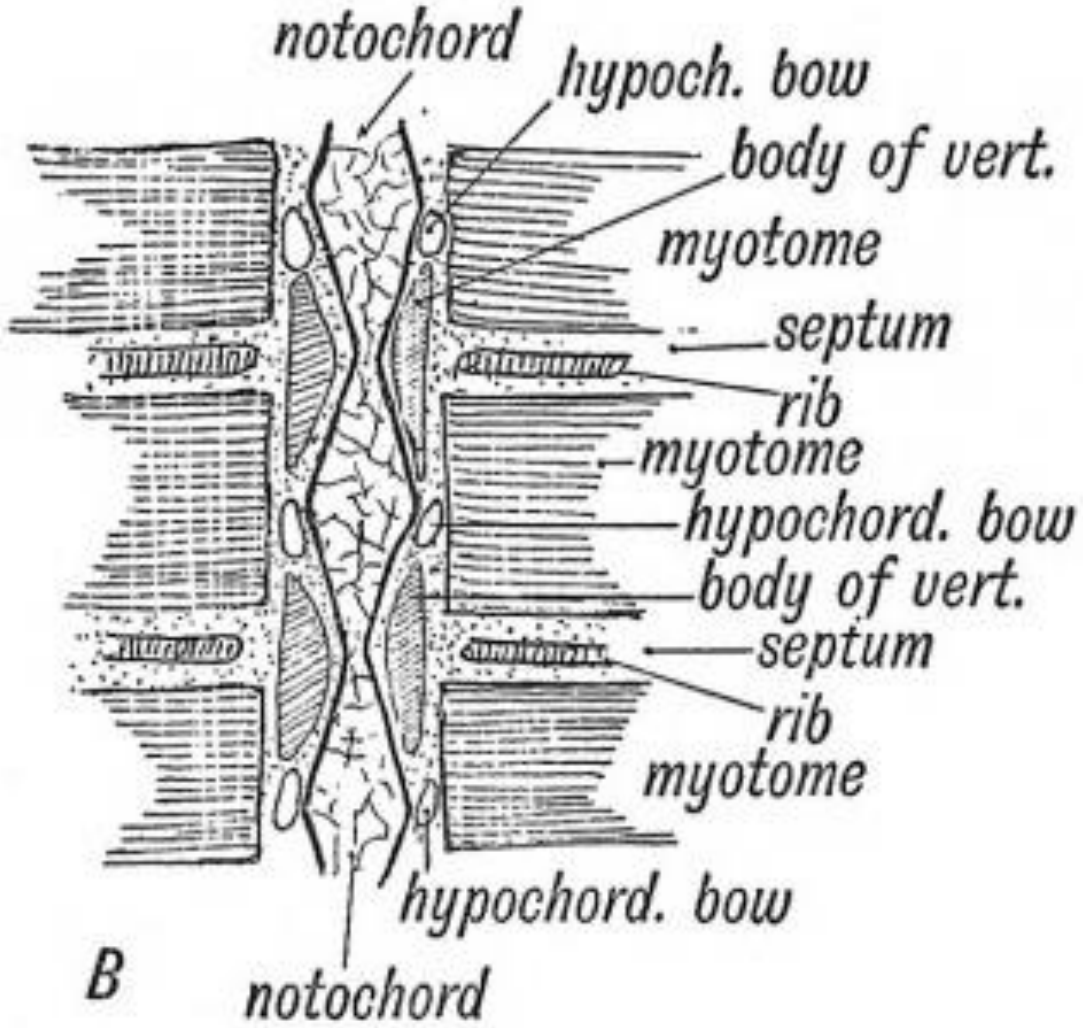

- Sclerotome: Part of each somite in a vertebrate embryo giving rise to bone or other skeletal tissue
- Vertebrae & Annulus fibrosus of disc derived from the sclerotome but nucleus pulposus derived from the notochord
- Vertebral unit derived from 2 embryonic tissues, somites & notochord

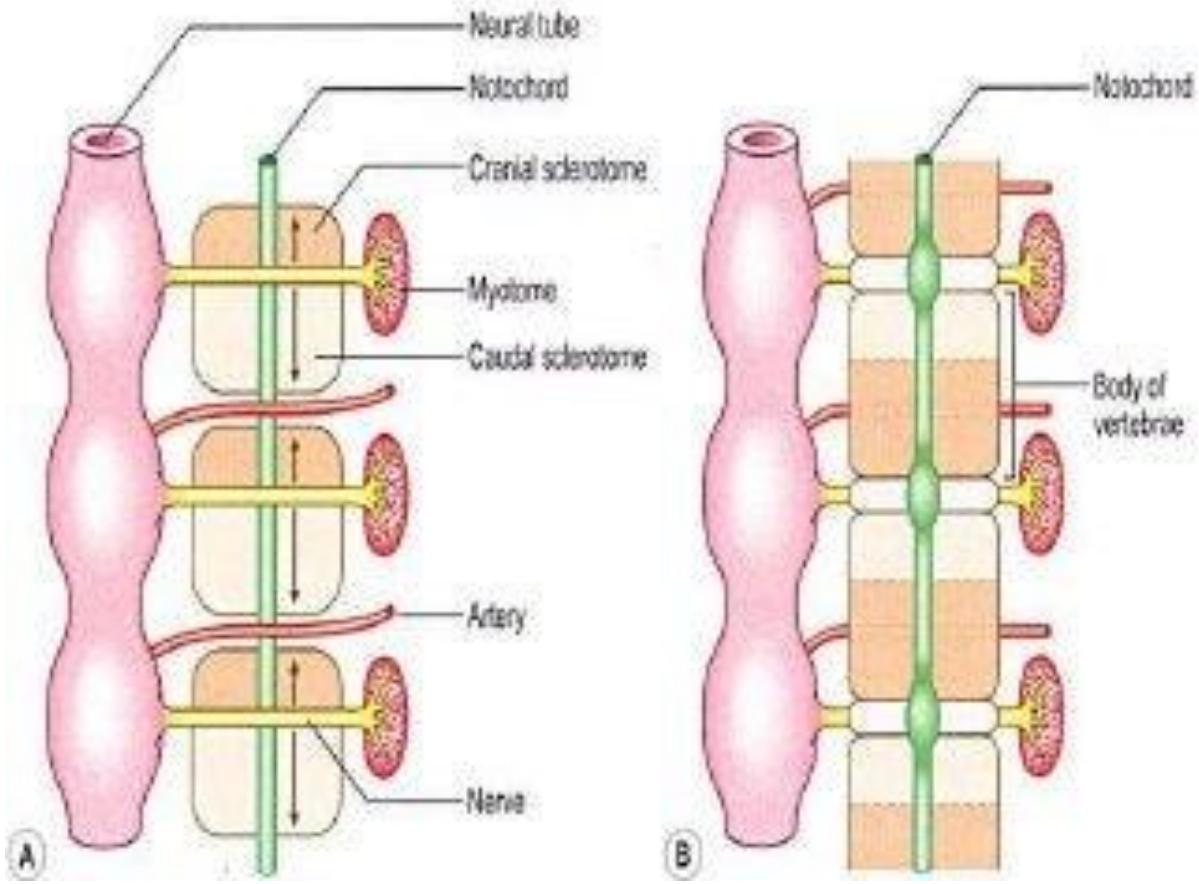
Dev Biol. 2018 Jul 1; 439(1): 3–18.
doi: 10.1016/j.ydbio.2018.04.005




# Spinal Segmentation

# The vertebral unit



# The Embryological Segment (J Jealous)

- Consider segment in embryological terms Includes all structure that is visceral, somatic & psychic
- Includes all blood vessels, lymphatics, tissues, metabolic & psychological aspects related to development midline of segment
- Form of segment extends dynamically in many directions
- Complete expression of structural & metabolic motions