Joint Approaches in Children Principles & Concepts

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‘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

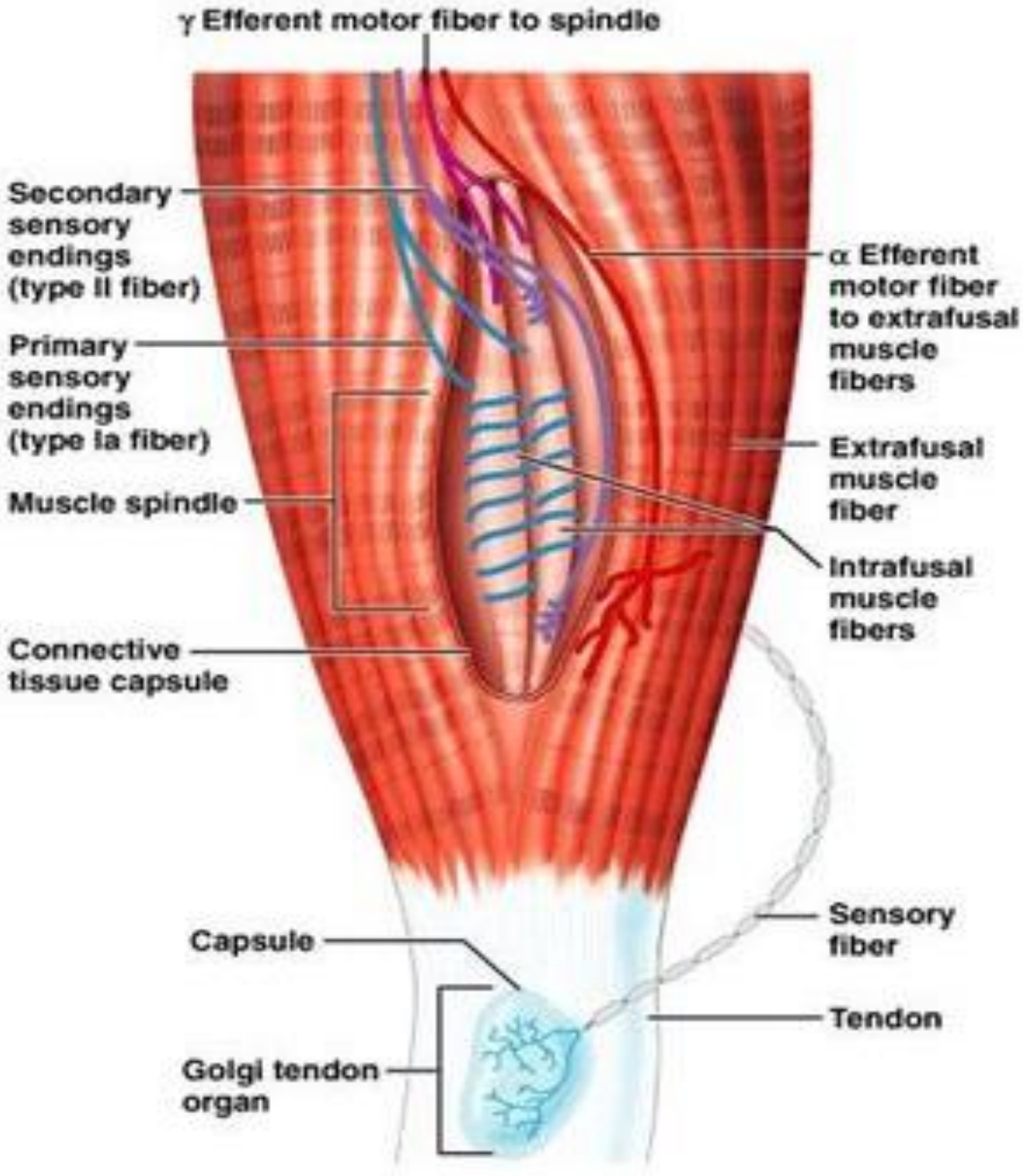
- Joint Issue local & in isolation
- Associated observations of whole body
- May be a sign of systemic condition
- Musculoskeletal development incomplete
- Nervous system development incomplete
- Myelination incomplete
- Psyche developing
- Myelination & Proprioceptive mechanisms on affect motion & development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

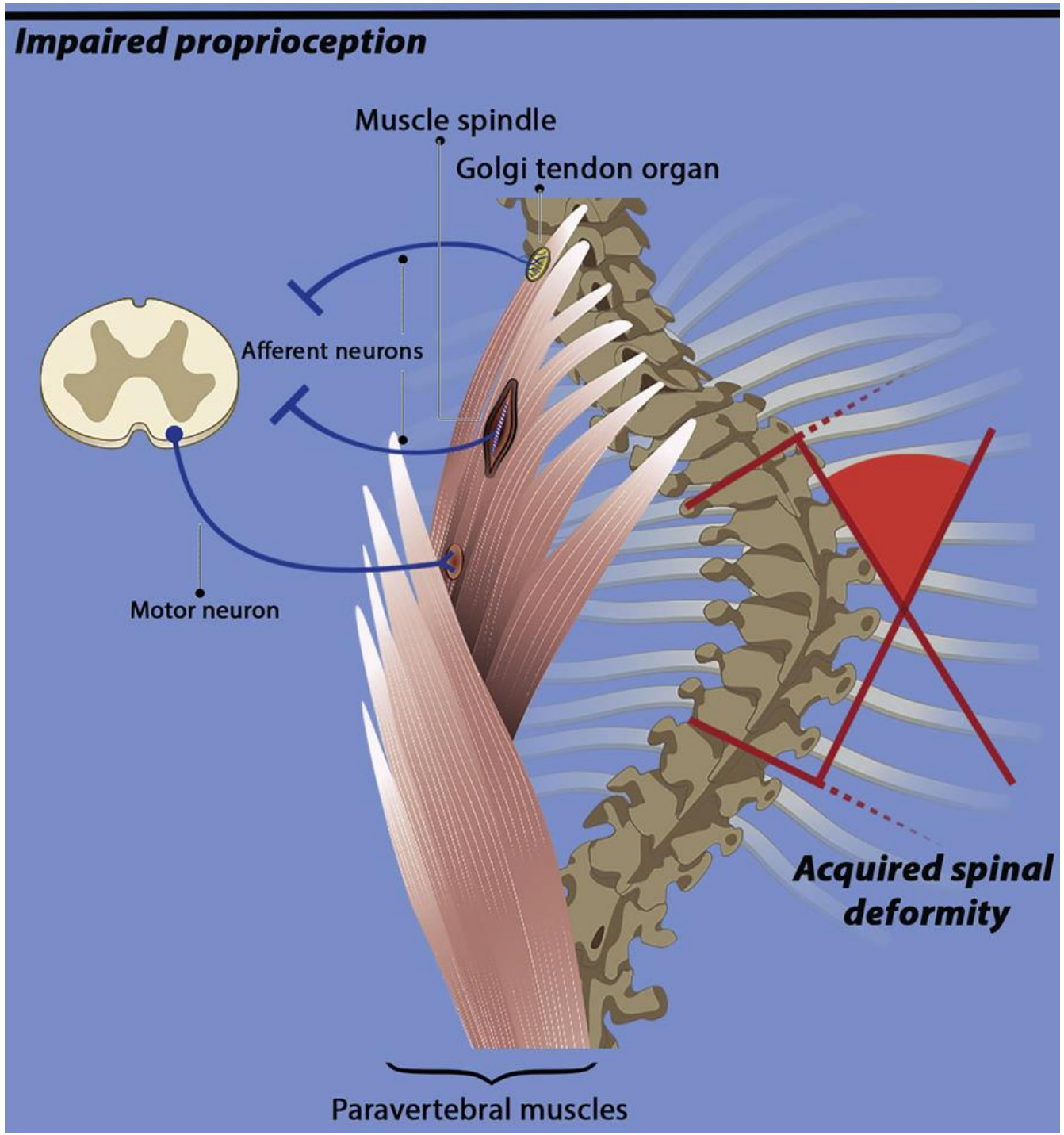
Proprioceptors: sync body with the mind

- 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

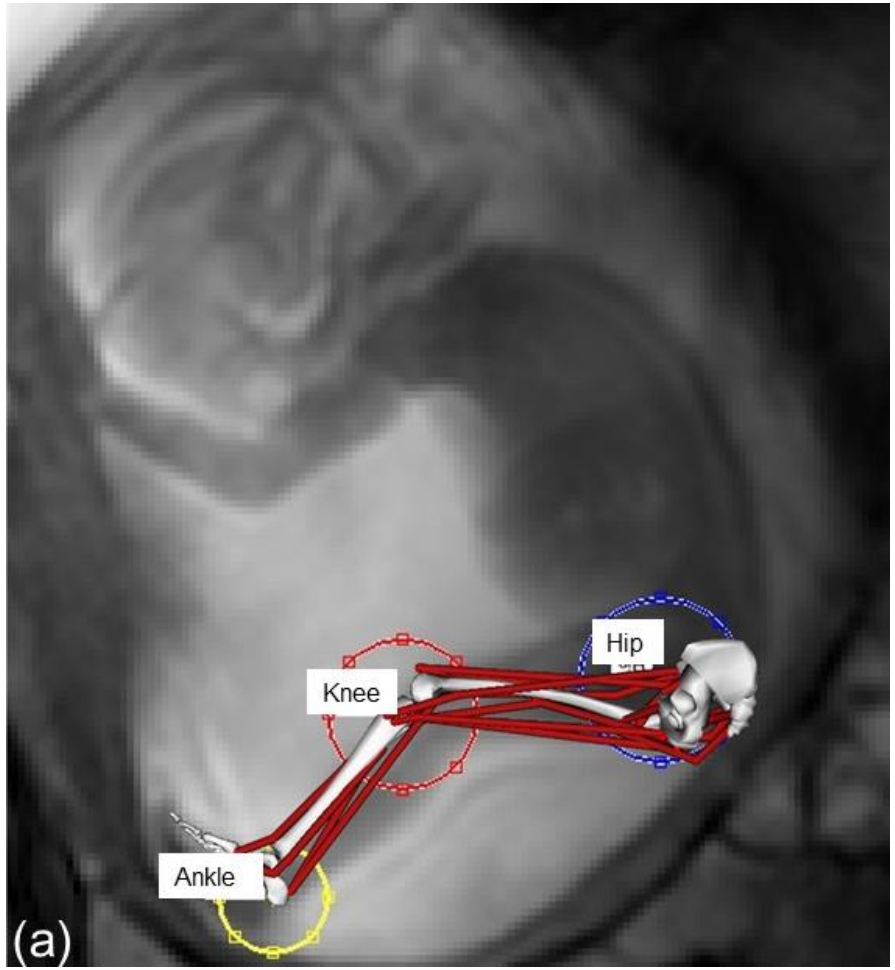
Bletcher, Krief et al., Developmental cell Vol 42, Issue 4, 21 August 2017, Pp 388-399.e3

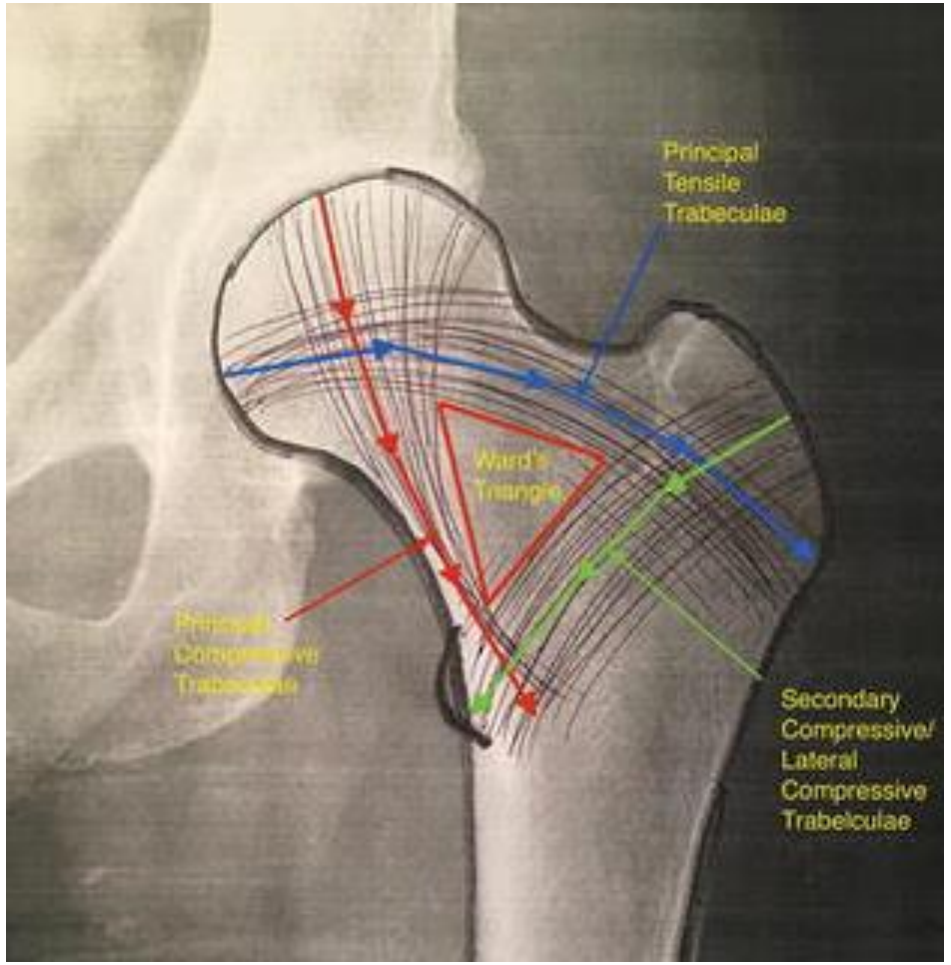
- Skeletons of mice with proprioception impairment are apparently intact prior to the appearance of scoliosis
- The dynamics of deformative process progresses at highest rate around puberty & slowly thereafter
- Commonly accentuated right-sided curve of thoracic spine characteristic of AIS.



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

Hip development: Prenatal Biodynamic forces

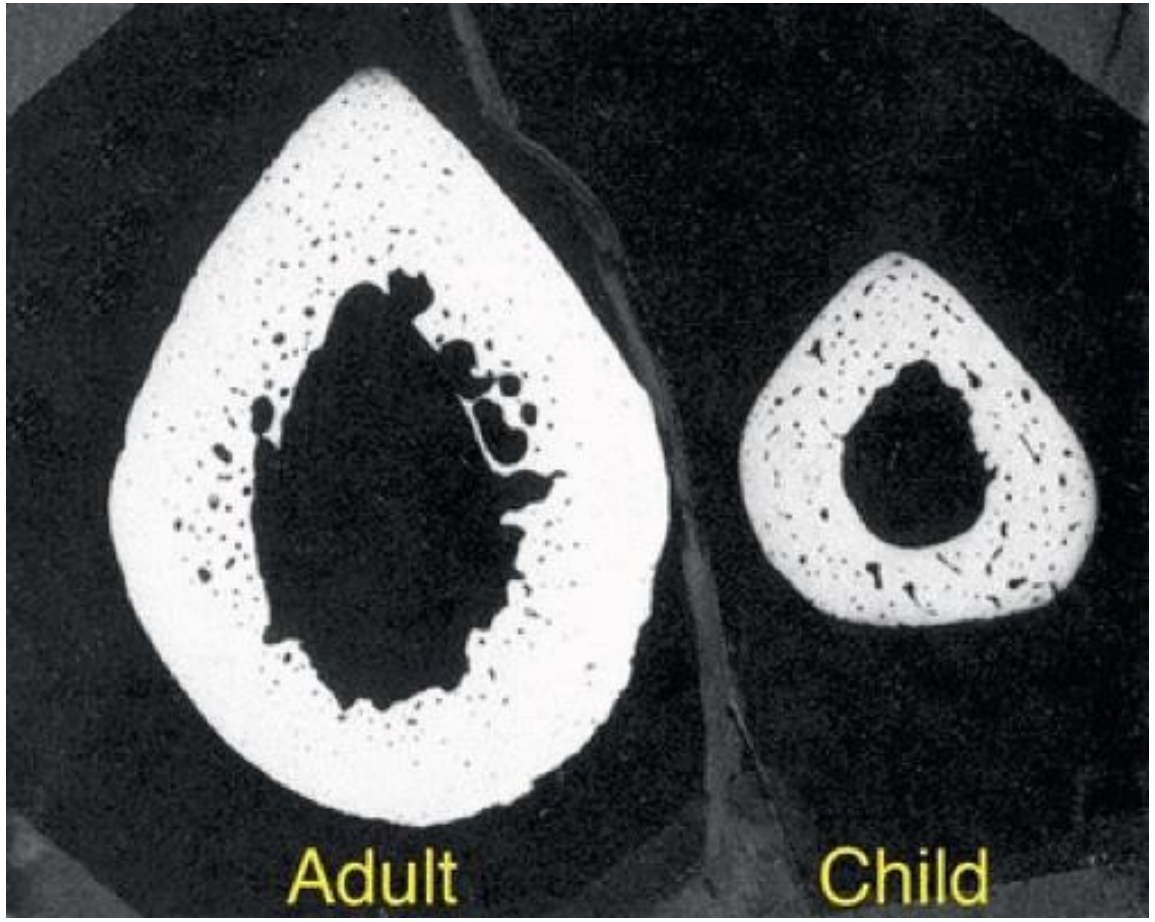




Leg flexion, kicking induces stresses & strains in bones, muscles & joints

- Biodynamic forces through Growth Plates: compressive, tensile, torsional (Developmental biomechanics group)

Biomechanics of Childs Bone



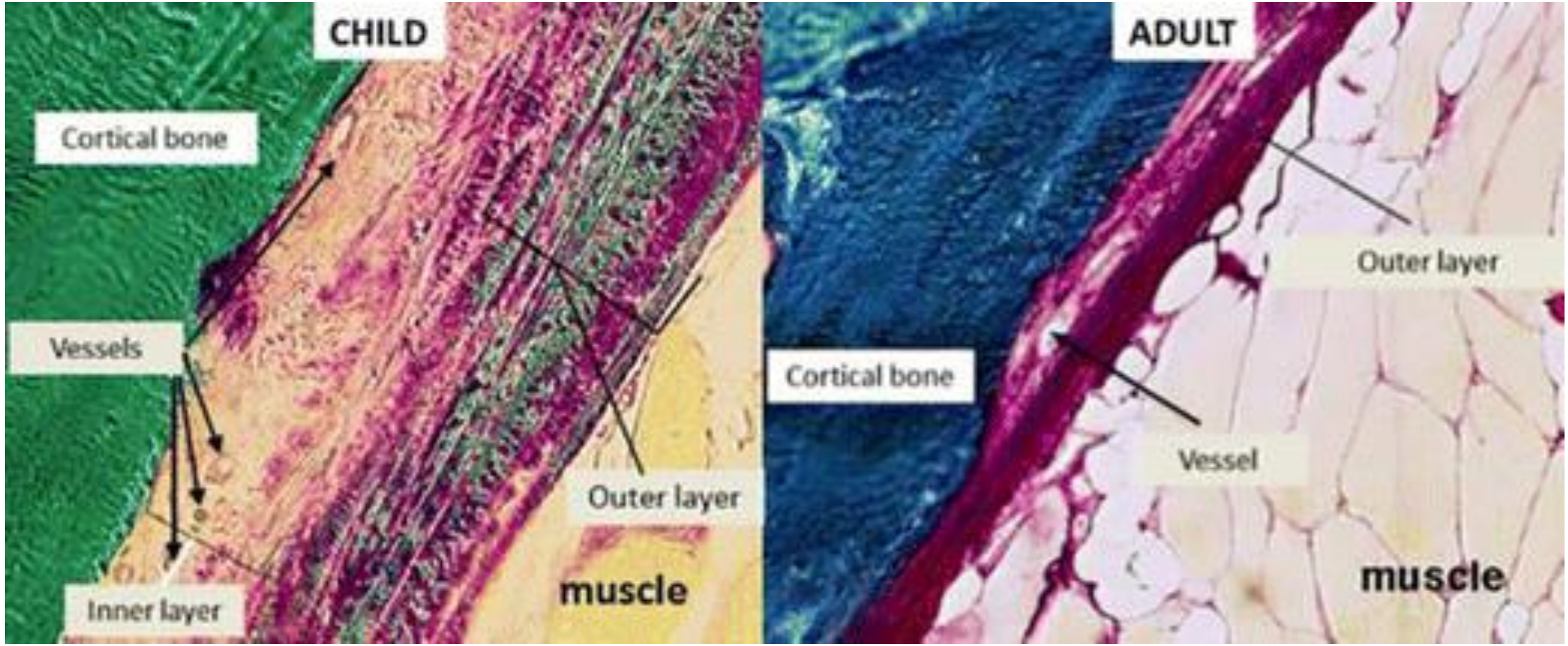
Microradiographs of distal radial diaphysis of an adult & 8yoa

- 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

Childs Periosteum

- Very strong & Loosely attached
- Muscles arise from, & are inserted onto periosteum rather than bone itself permitting coordinated growth of bone & soft tissues
- Embryologically the periosteum, perichondrium & fibrous capsule are all continuous
- Periosteum extends along the centre of ossification of a bone to the level of the physis where it is tightly attached

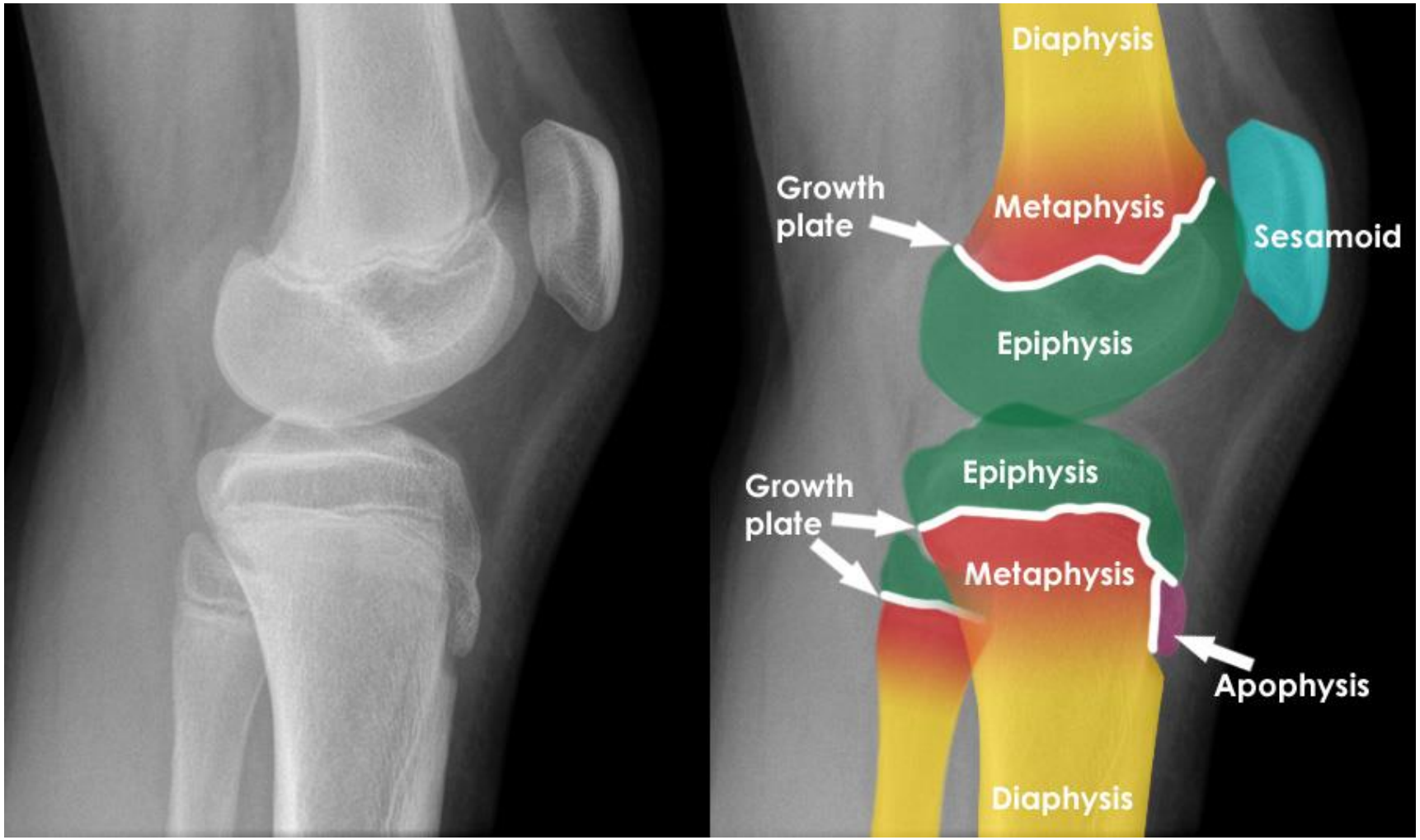
- Ref: Jerry Dwek “The periosteum: what it is, where it is and what mimics it in its absence? Skeletal Radiol (2010) 39:319-323 DOI 10.1007/s00256-009-0849-9

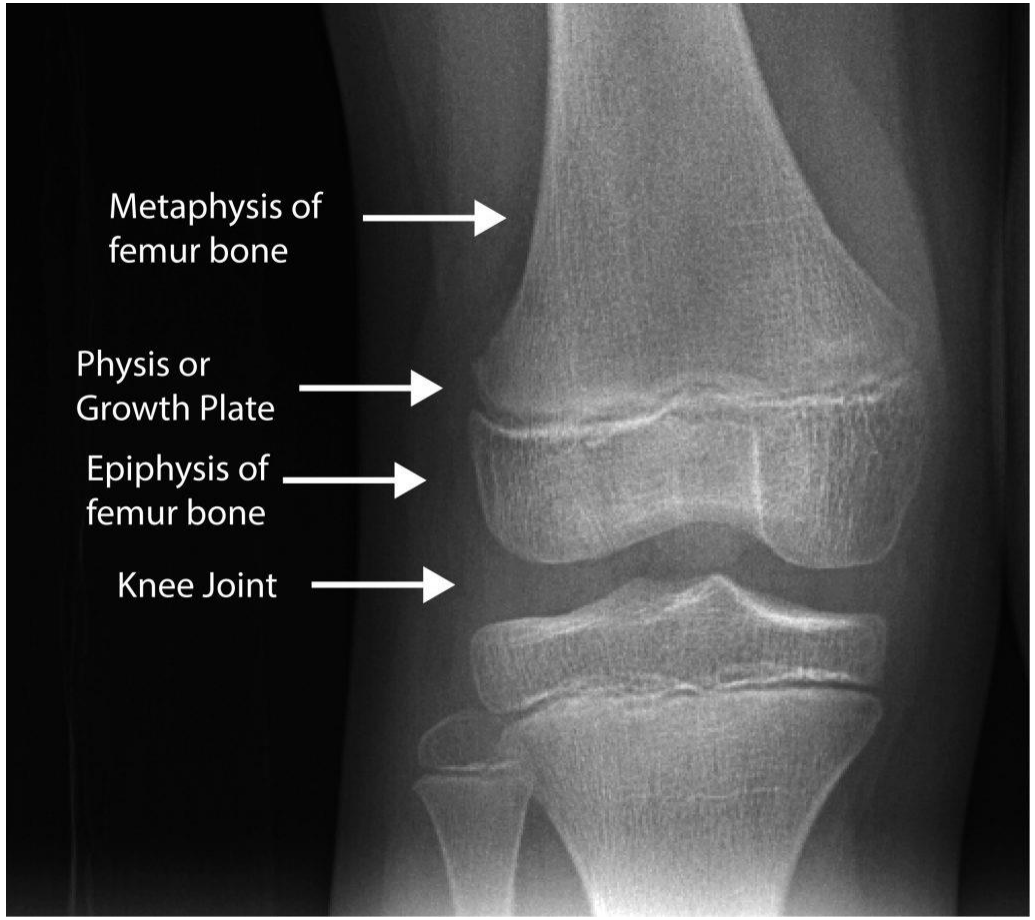


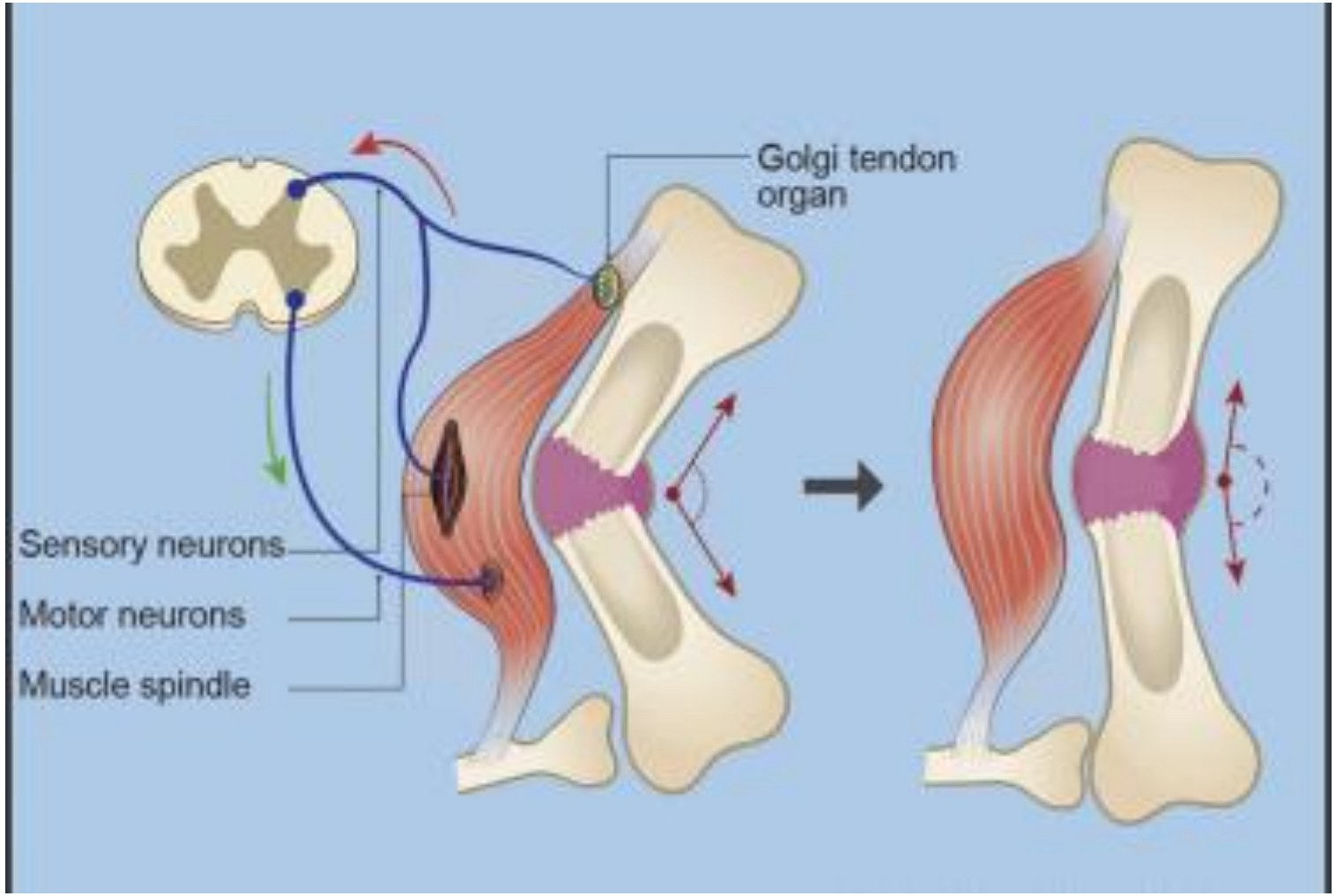
Bisseret, D., Kaci, R., Lafage-Proust, MH. *et al.* Periosteum: Characteristic imaging findings with emphasis on radiologic-pathologic comparisons. *Skeletal Radiol* **44**, 321–338 (2015). https://doi.org/10.1007/s00256-014-1976-5

Plastic bowing

- Long bones may bend without breaking the cortex.
- Can be bent to 45 degrees before cortex disruption & a greenstick or a complete fracture occurs.
- If bending force is released, bone only partially returns to its pre-bent position, resulting in plastic bowing.
- Commonly affected are the ulna & fibula.
- Since no obvious fracture, injury frequently undiagnosed, resulting in long-term morbidity.


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

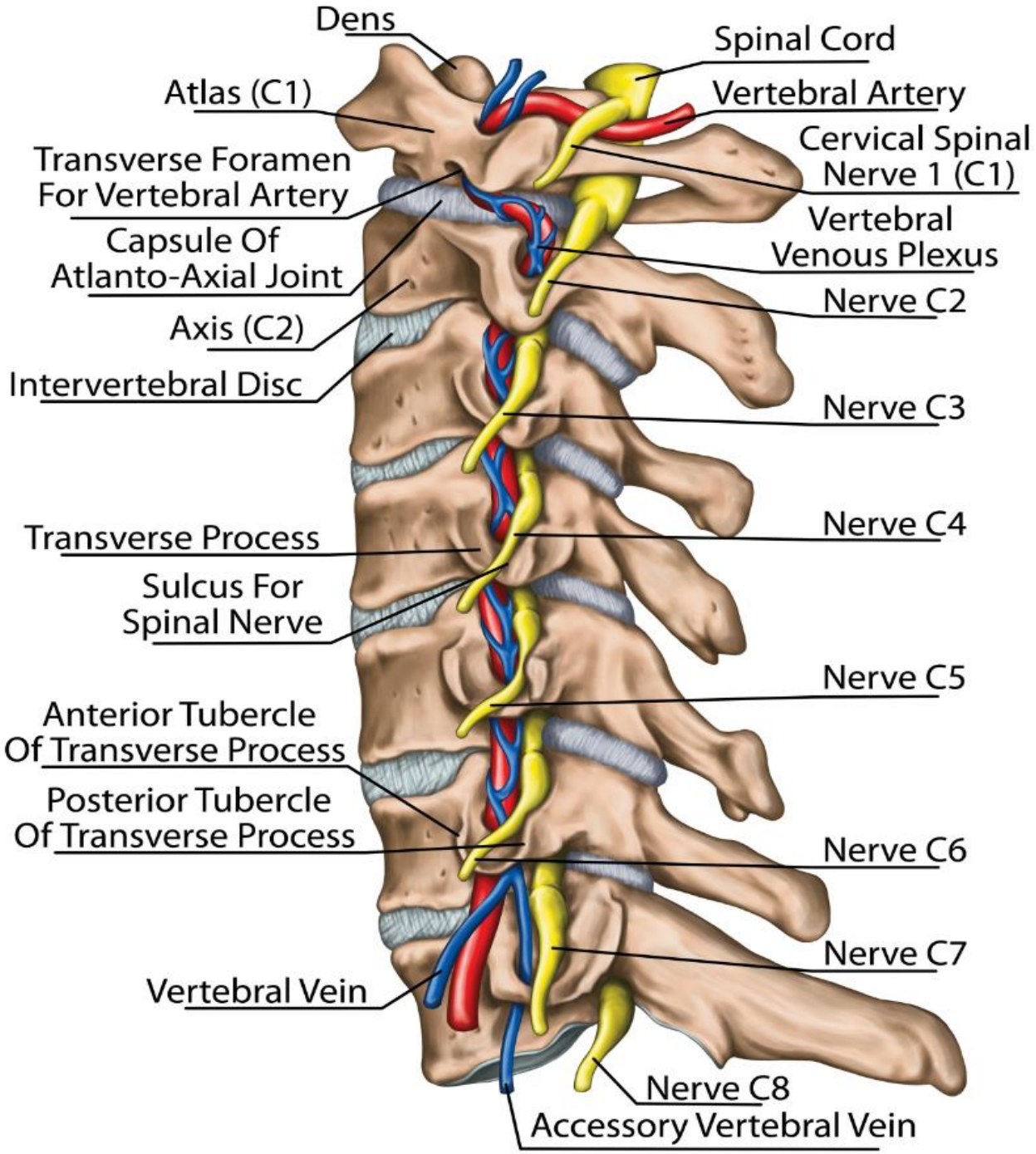

Metaphysis of
femur bone
Physis or
Growth Plate
Epiphysis of
femur bone
Knee Joint

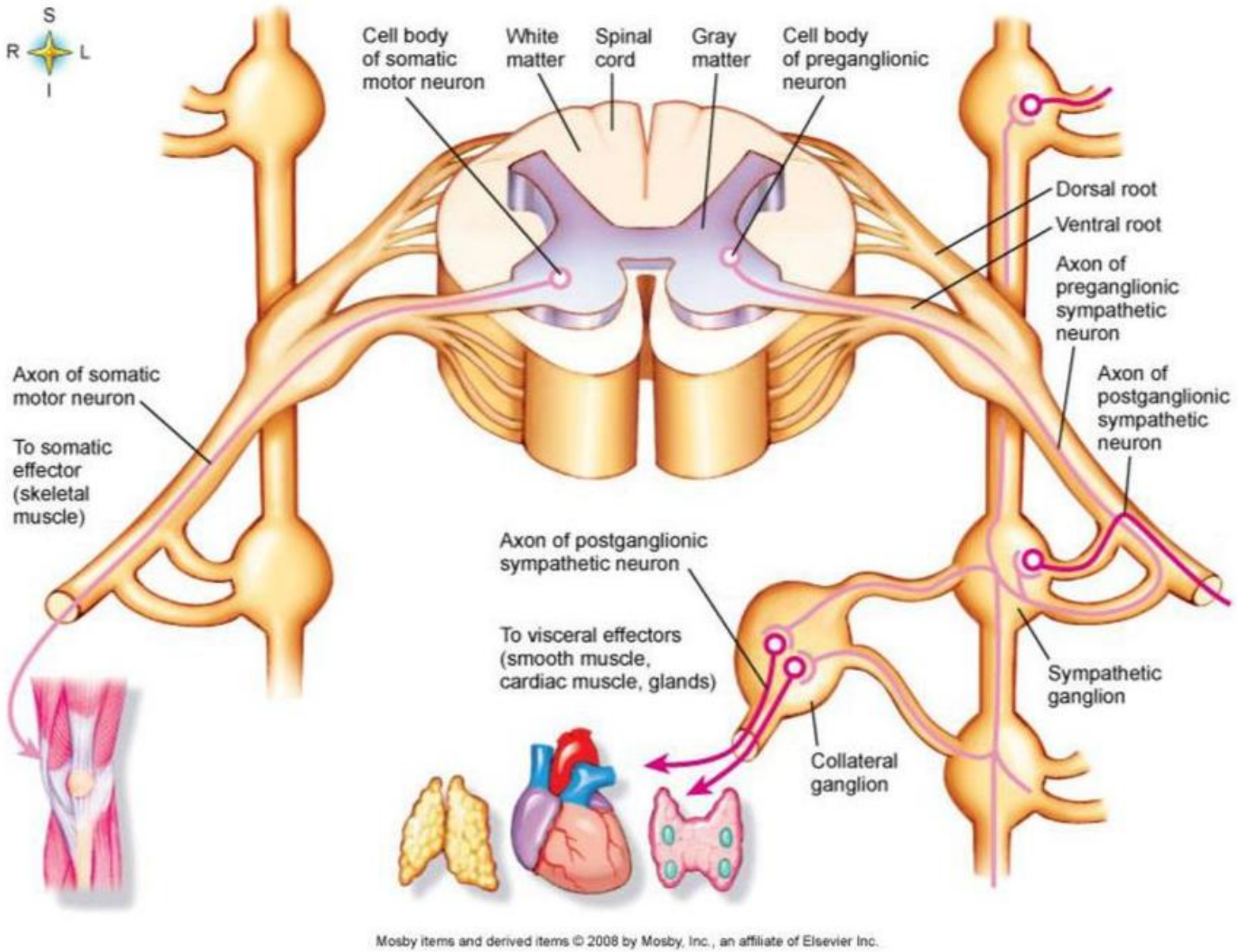


Fracture Healing Initially Guided by Proprioceptive System

Spinal Joints

Vertebro-segmental Unit





Propioceptive & Joint Kinesthetic Receptors require myelination

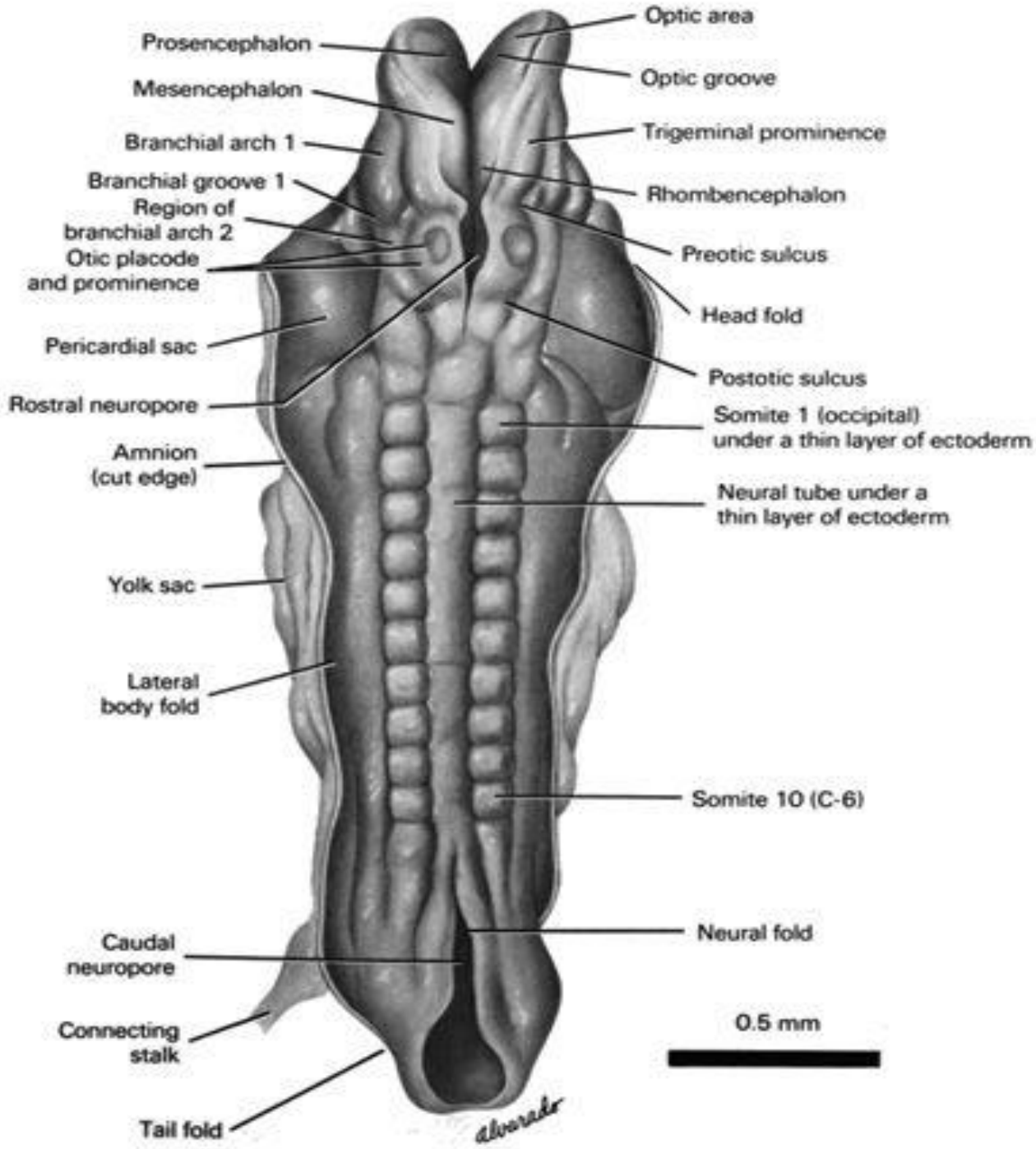
Monitor stretch in synovial joints

Spinal reflex arcs

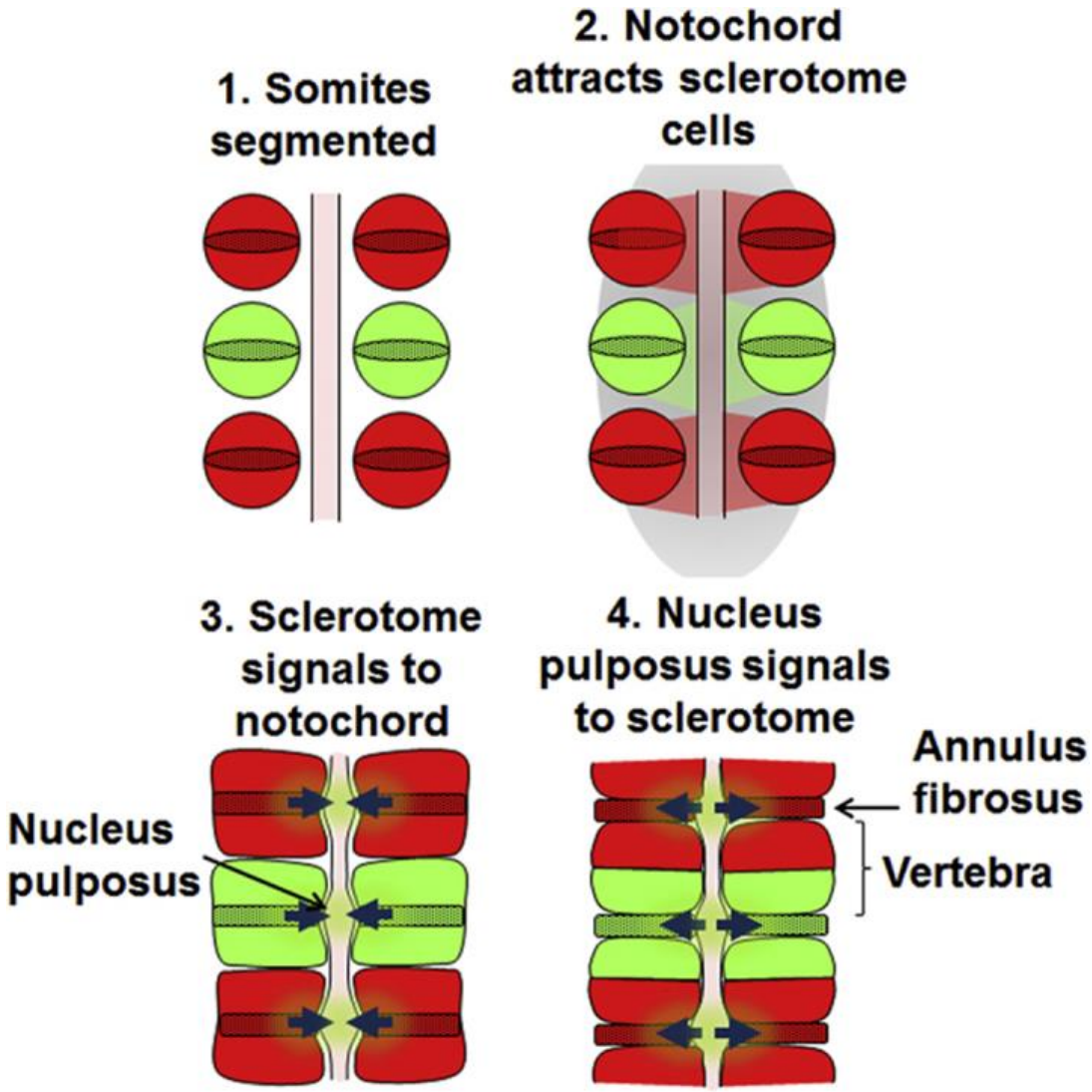
Cerebellum & Brainstem co-ordinate proprioceptive input & output

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

The vertebral unit