University of BRISTOL

Growing old gracefully

Professorial inaugural lecture

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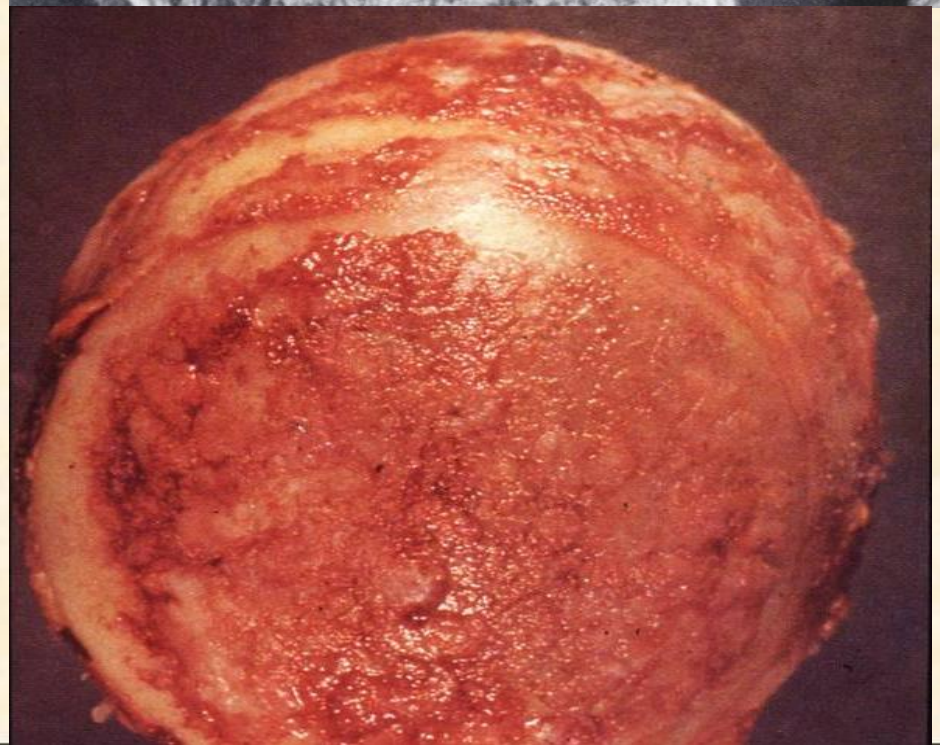


Growing old gracefully

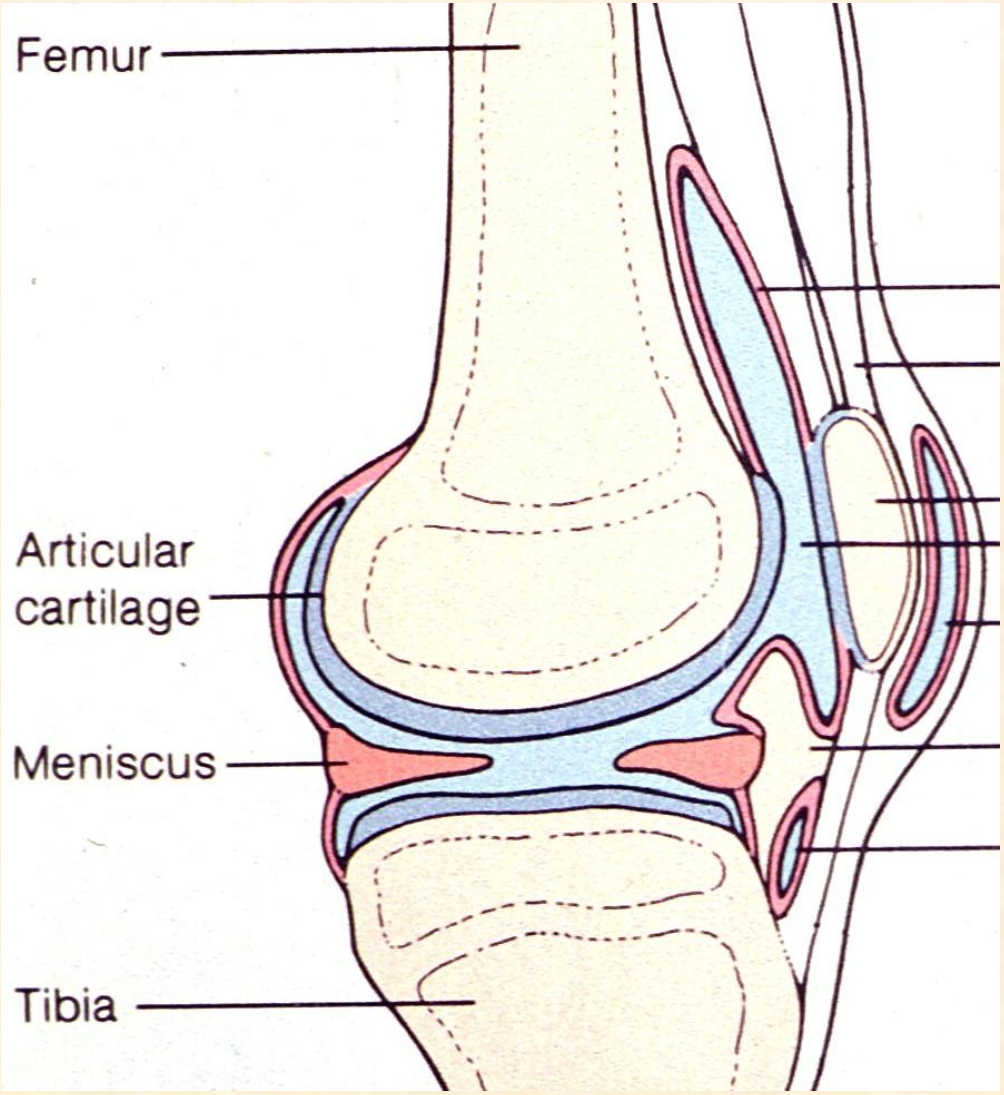
- The adaptable framework of our bodies
- The ageing musculoskeletal system
- My own scientific ‘bricks in the wall’
- An aside – some problems in Academia
- Action: growing old gracefully

‘Tissues’ are biological materials made up of living **cells** and **matrix**

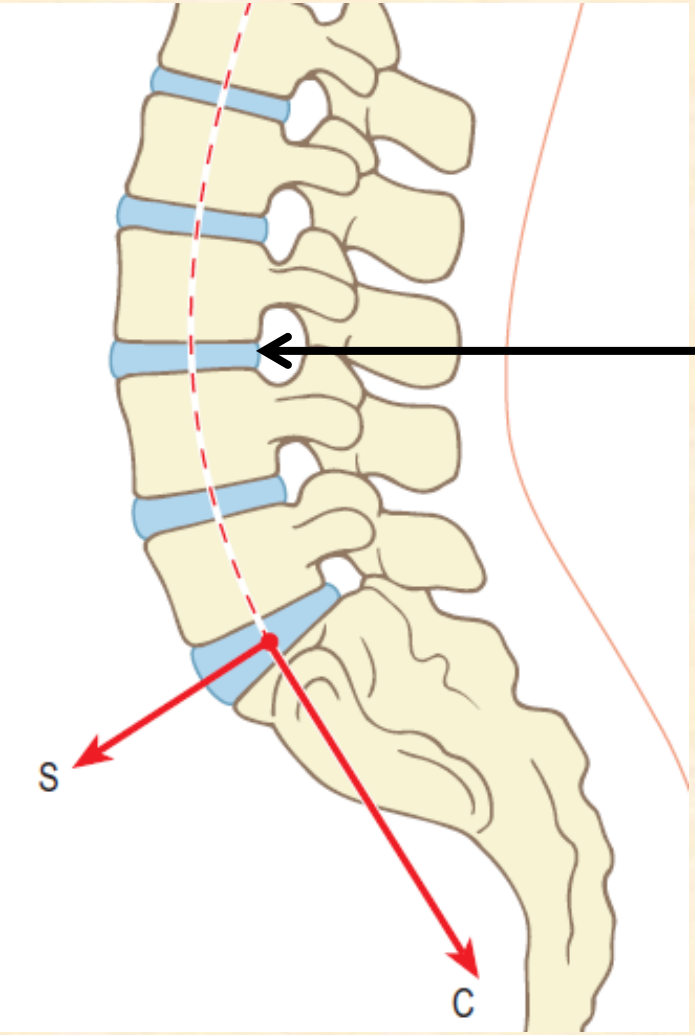
muscle, bone, cartilage, tendon, ligament

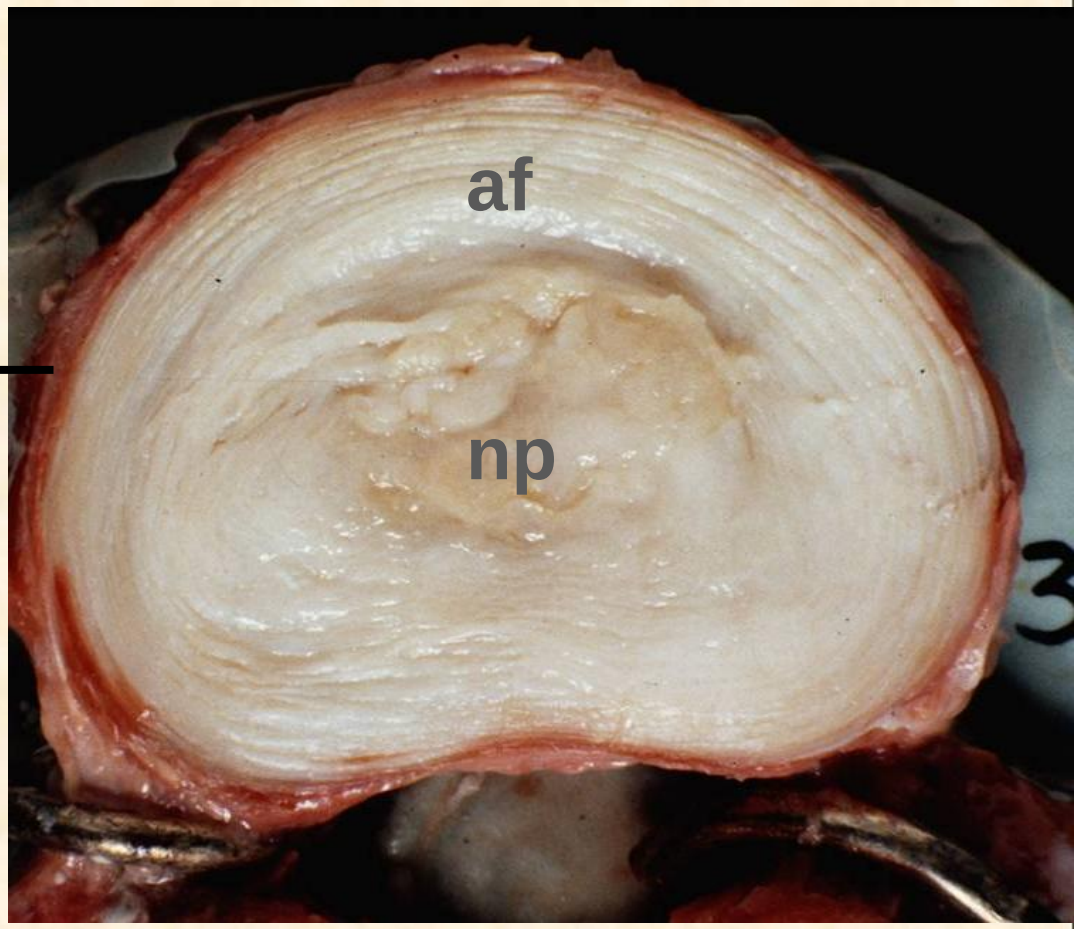
(tendon: muscle-bone, **ligament:** bone-bone)

Free-moving ‘synovial’ joints



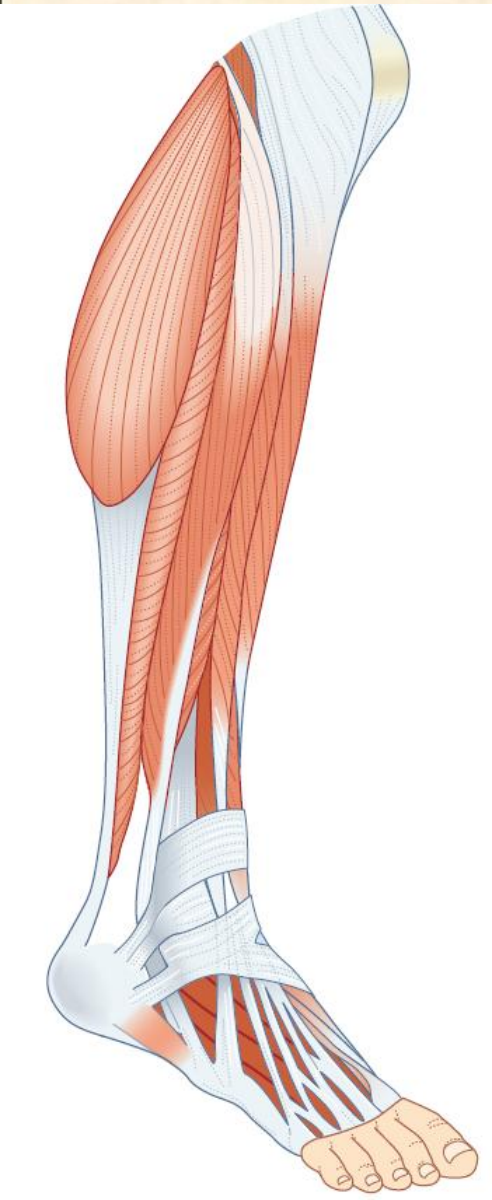
The spine
- vertebrae and intervertebral discs



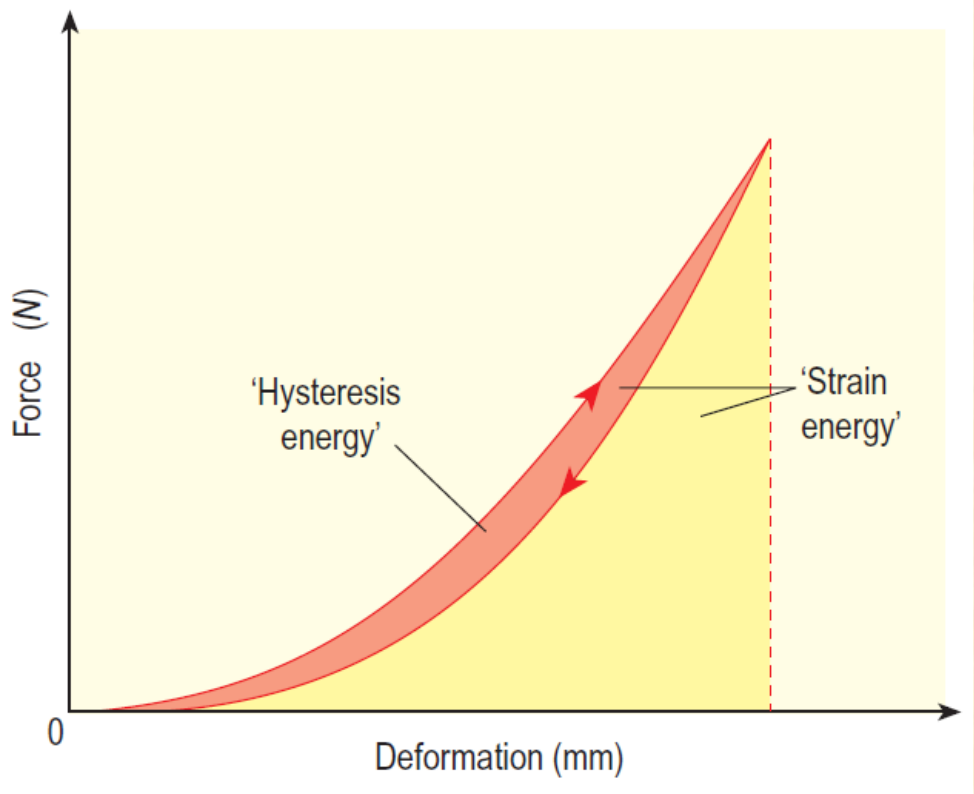


annulus fibrosus: af
nucleus pulposus: np

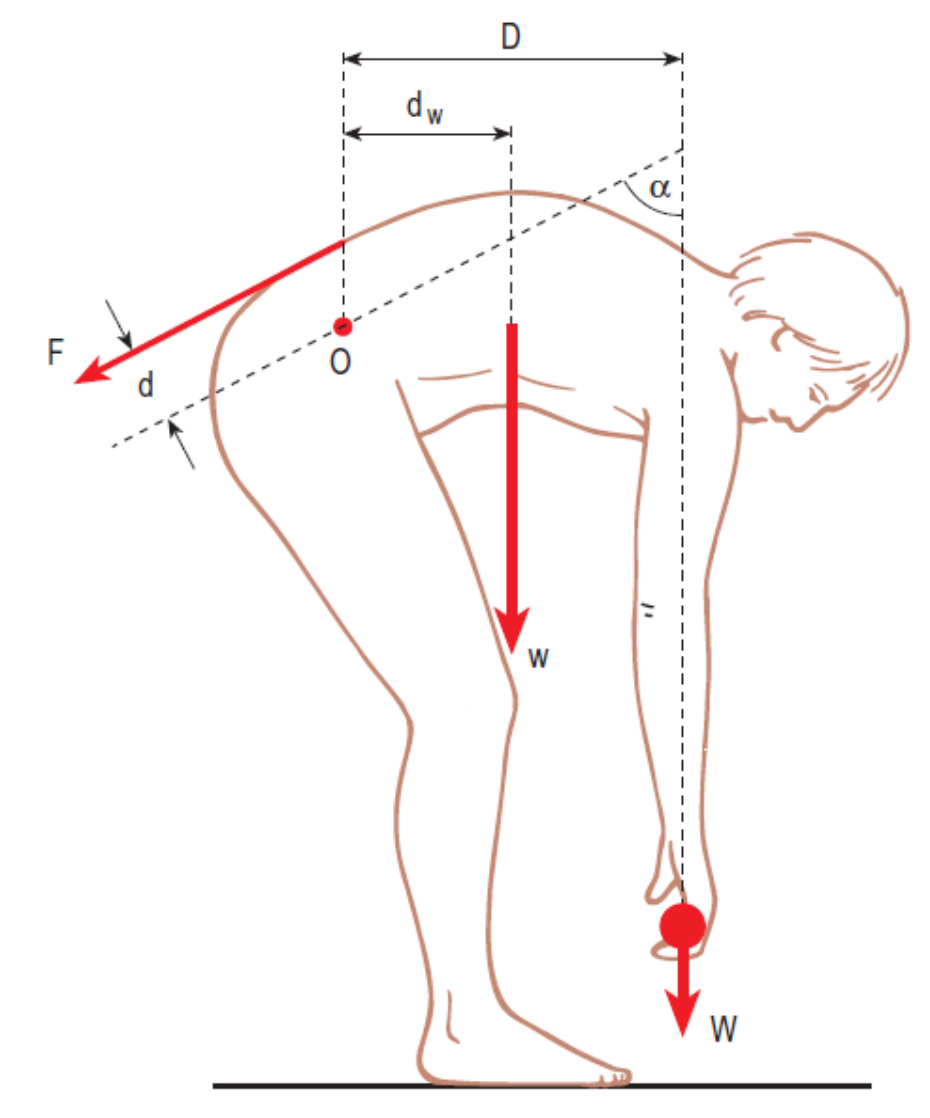
Tendons and “shock absorption”



When stretched by muscles, they store and release ‘strain energy’



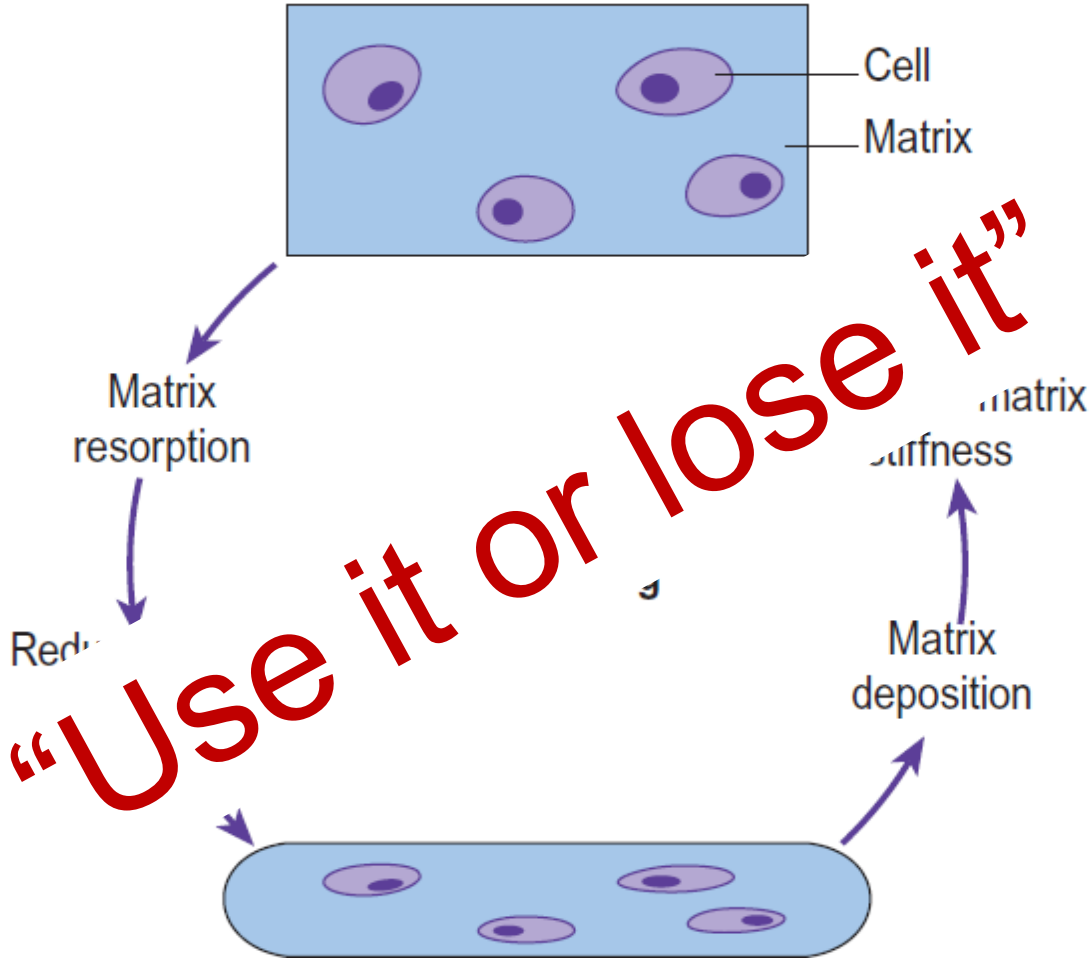
High ‘internal’ muscle forces



Muscles act on short lever arms (d) to move external objects on big lever arms (D)

The highest forces acting on skeletal tissues generally come from muscle tension, rather than body weight

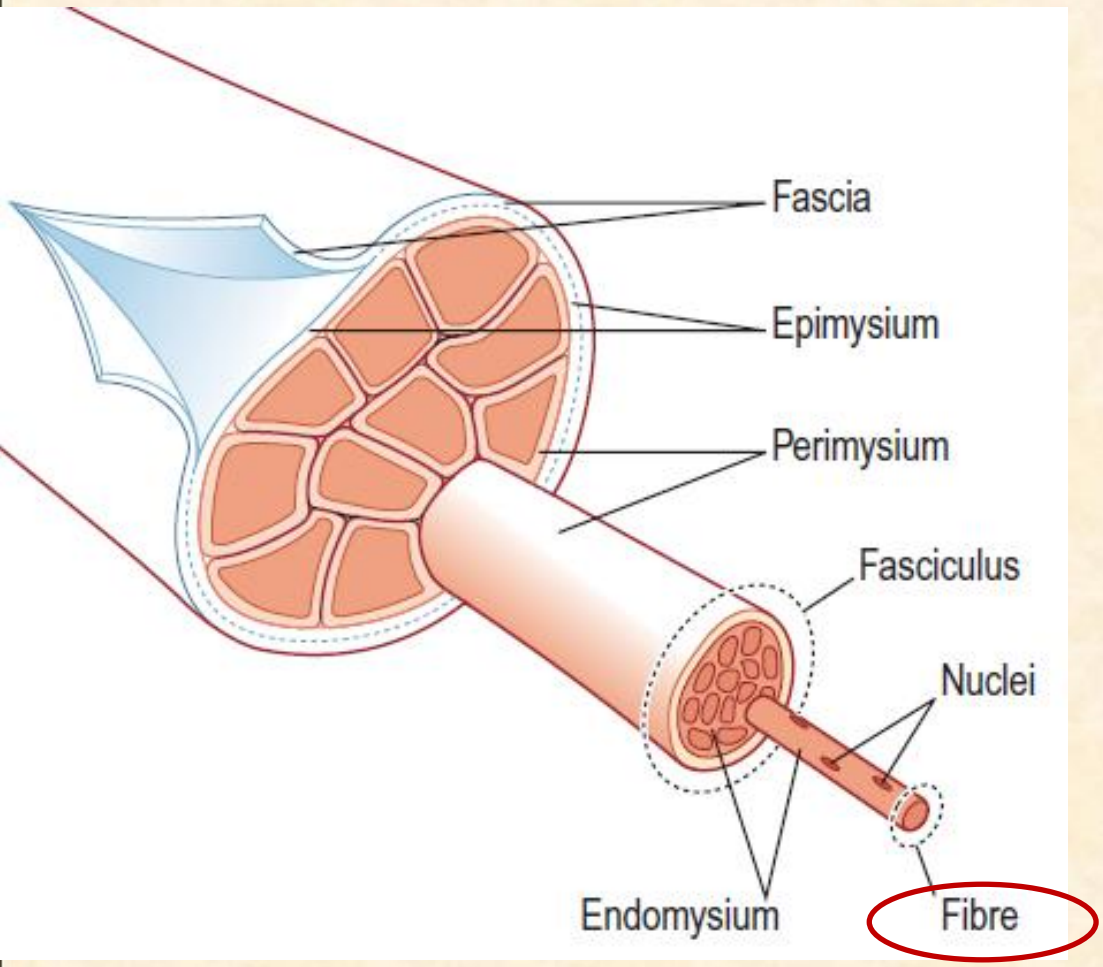
All musculoskeletal tissues can adapt!

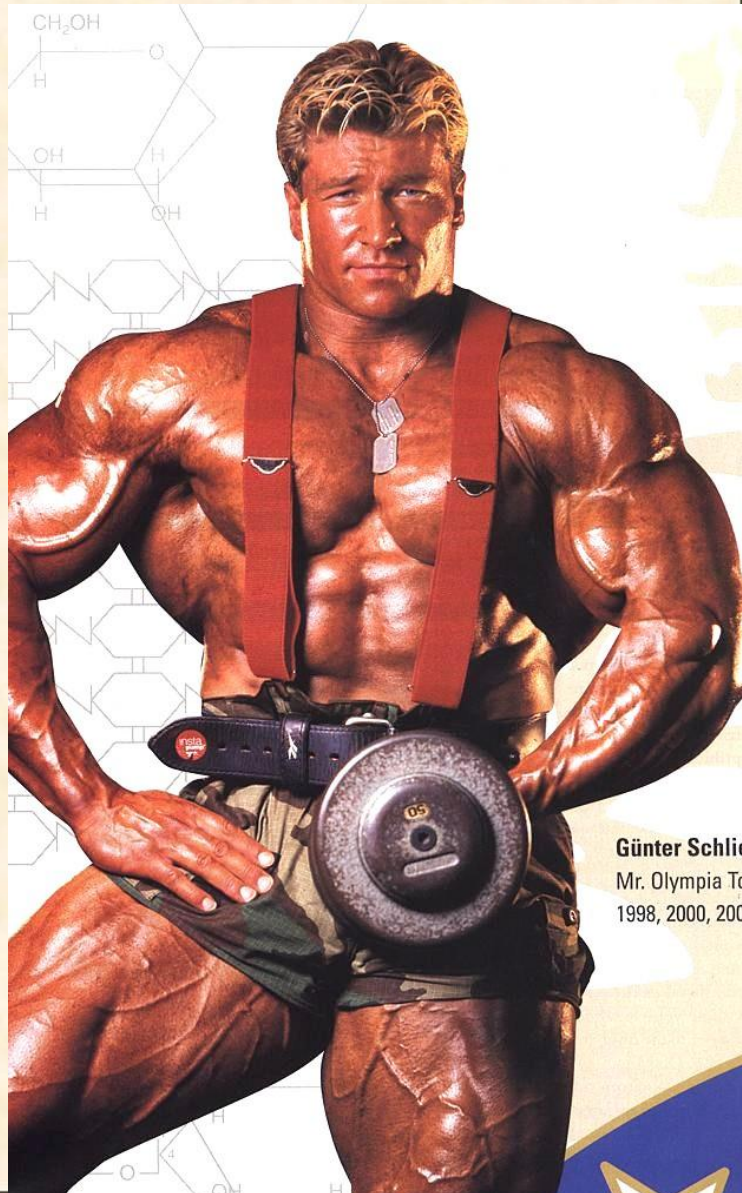


"Use it or lose it"

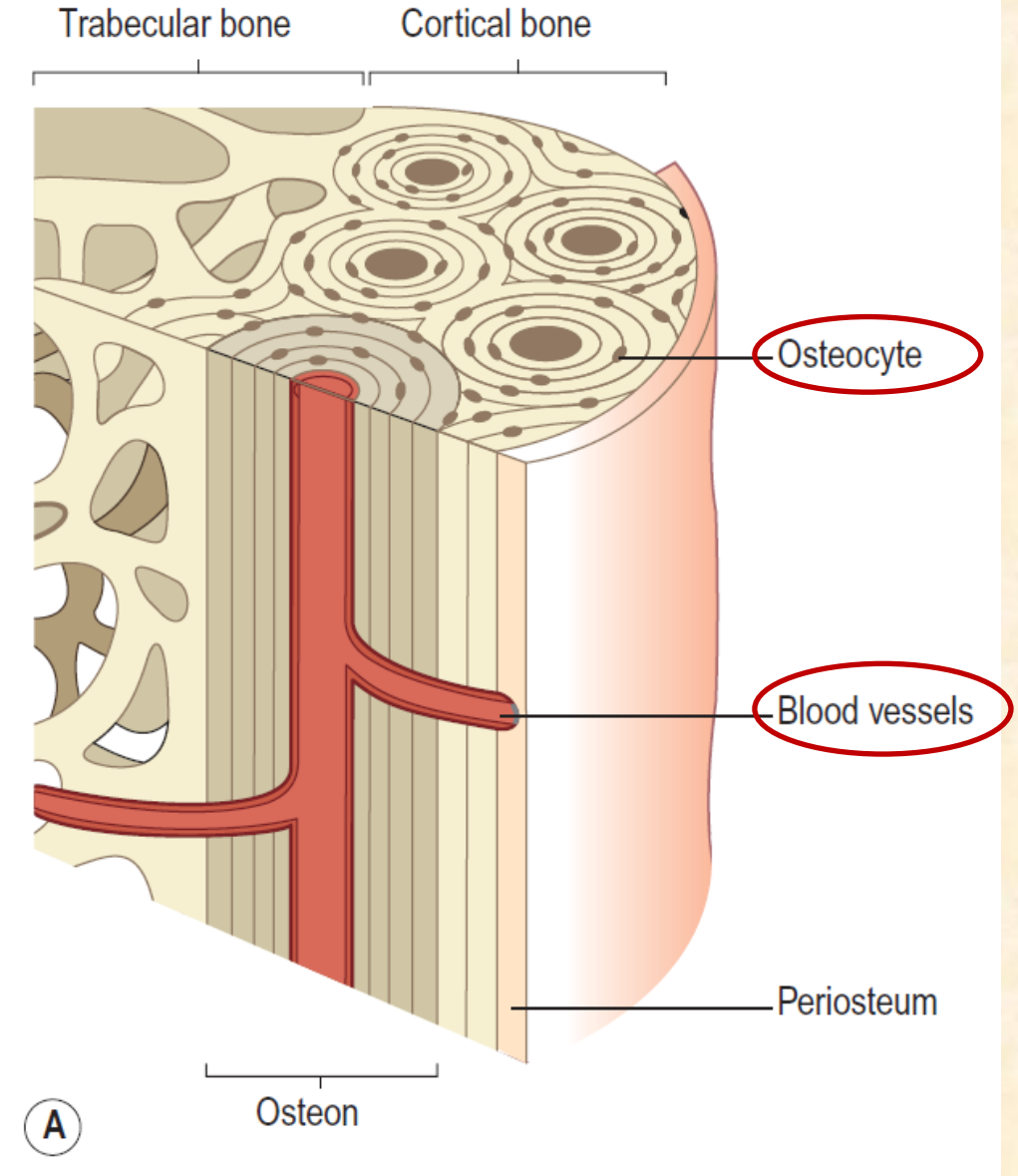
Adams, Bogduk, Burton, Dolan (2002, 2006, 2012).
'Biomechanics of Back Pain', Churchill Livingstone.

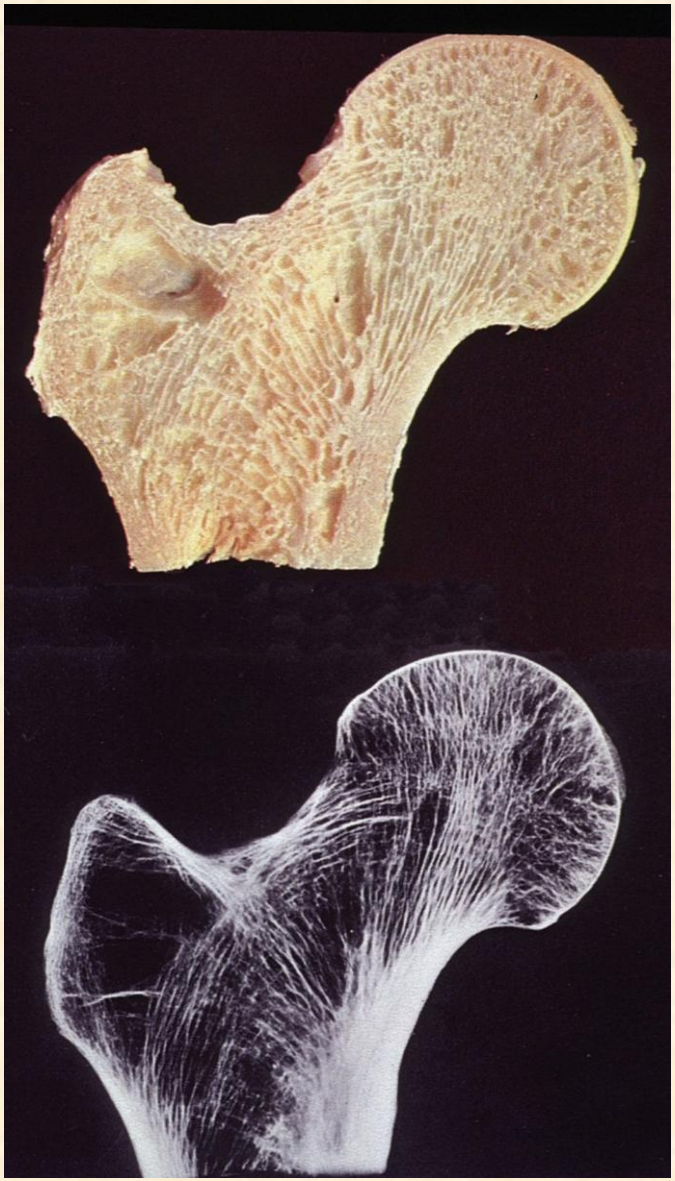
Muscle is a tissue that adapts quickly



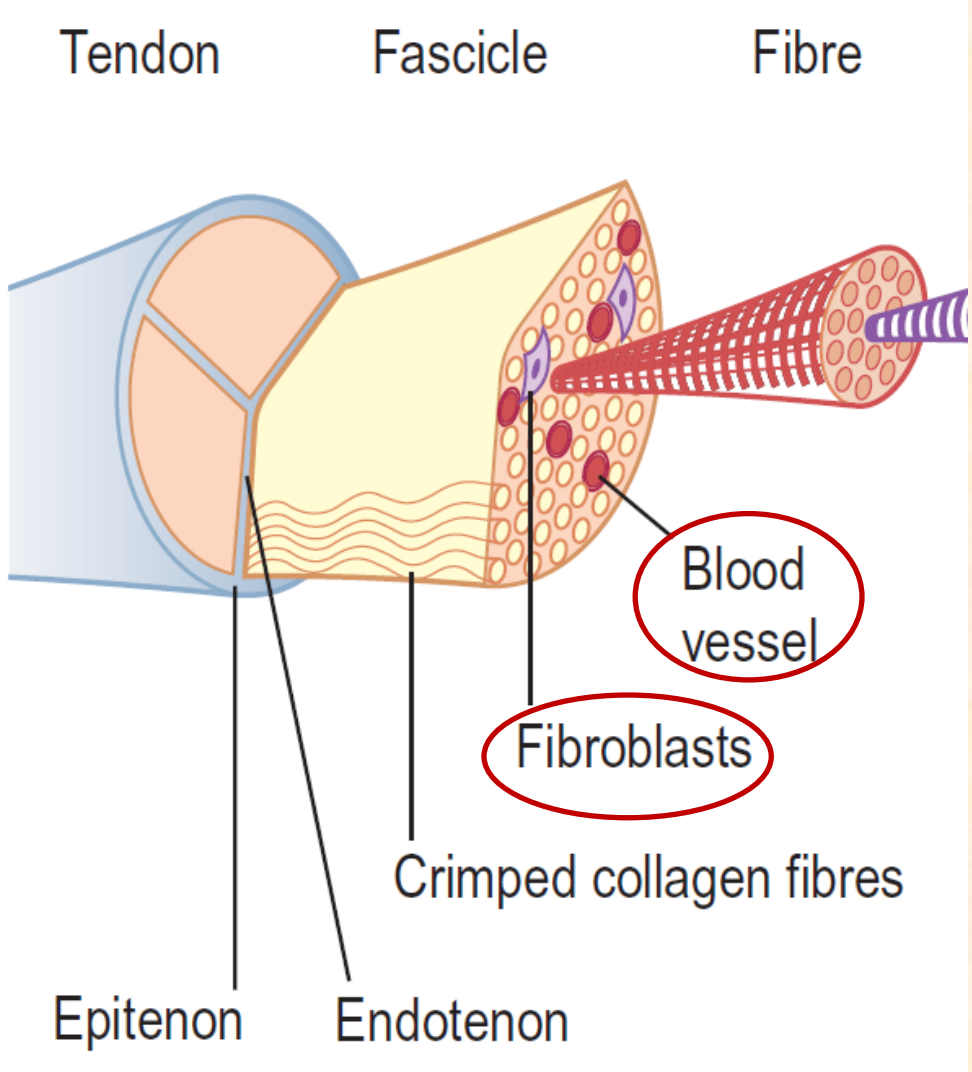


Bone is a tissue that adapts well

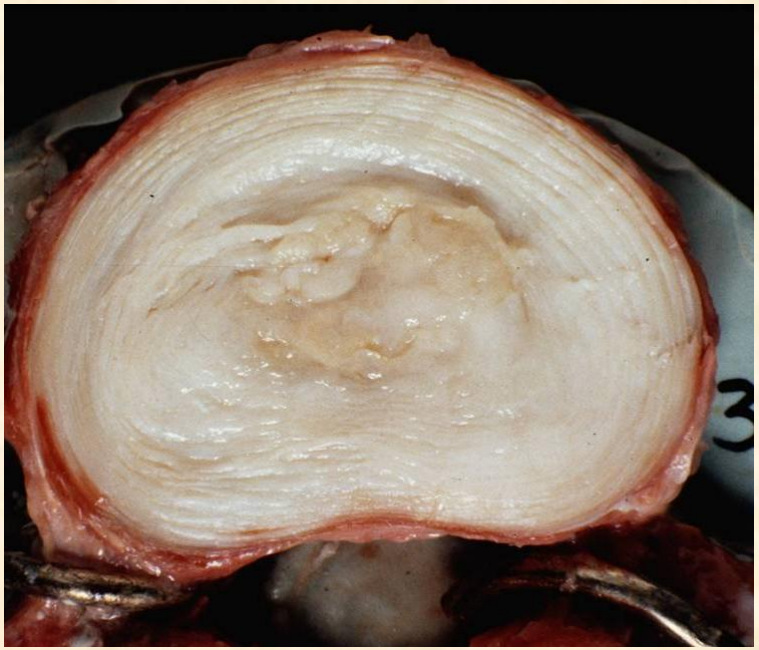


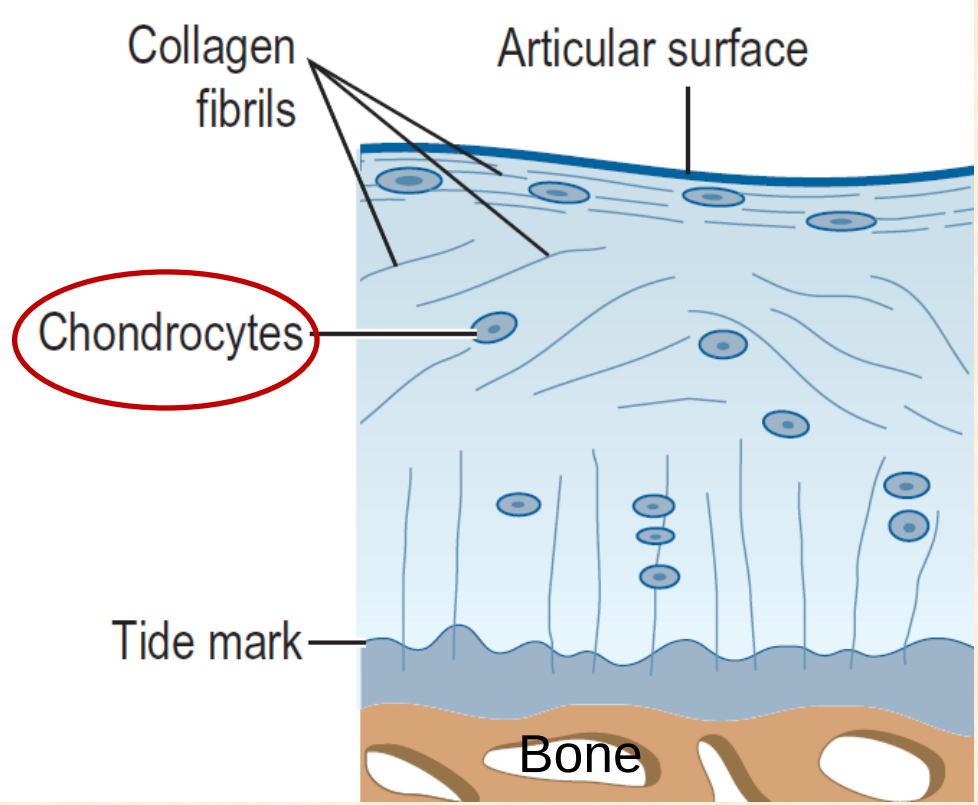


Tendon is a tissue that adapts slowly



Cartilage is a tissue that tries to adapt





fibrocartilage

articular cartilage

How can these tissues adapt together?

- Simple lifestyle: tissues gradually adapt together
- Modern lifestyle: some tissues play ‘catch-up’? (1)

1. Adams, Dolan (1997). Could sudden increases in physical activity cause degeneration of intervertebral discs? Lancet 350(9079): 734-735.

Growing old gracefully

- The adaptable framework of our bodies
- **The ageing musculoskeletal system**
- My own scientific ‘bricks in the wall’
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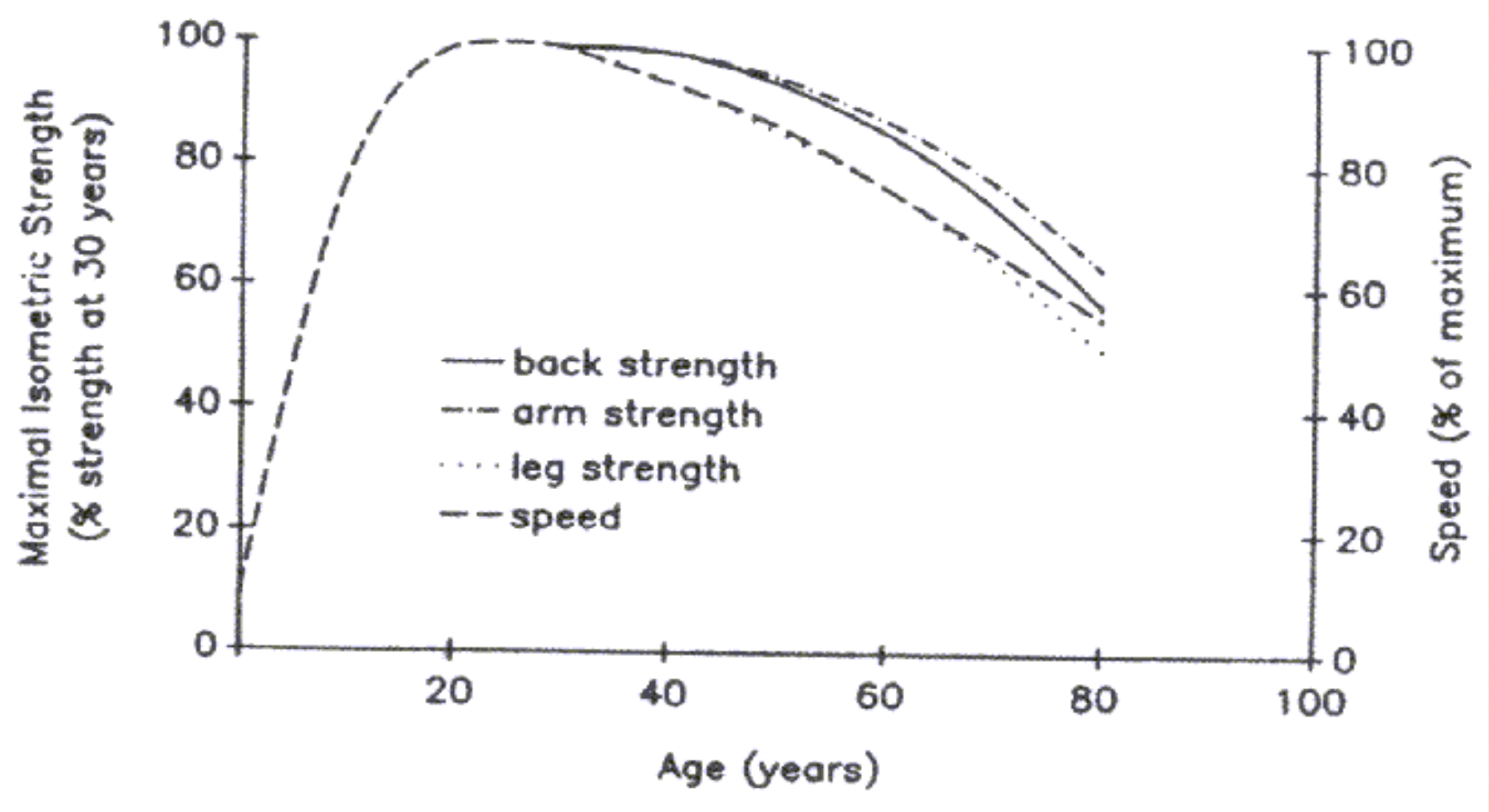
Muscles weaken with age

- changes in hormone levels AND reduced activity levels
- helps explain why all skeletal tissues weaken with age



Brooks & Faulkner (1994) Med Sci Sports Exerc 26: 432-9.

Ageing cartilage

- tissue dehydrates
- collagen profilerates
- glycation & yellowing
- tissue is stiffer & weaker
- fewer *active* cells
- ageing doesn’t hurt!

Similar changes occur in other ageing tissues (incl. skin)

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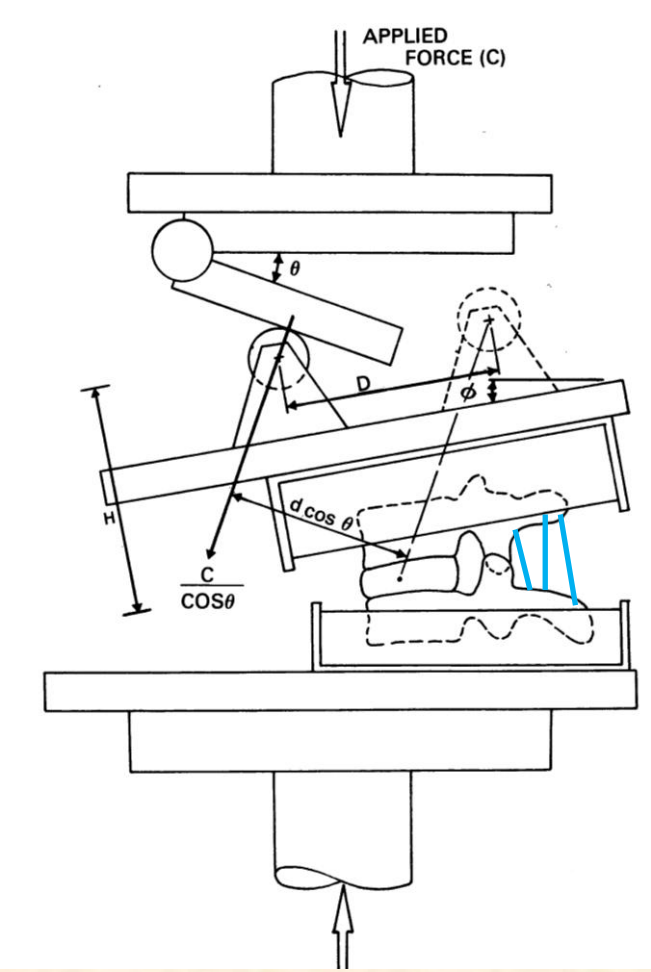
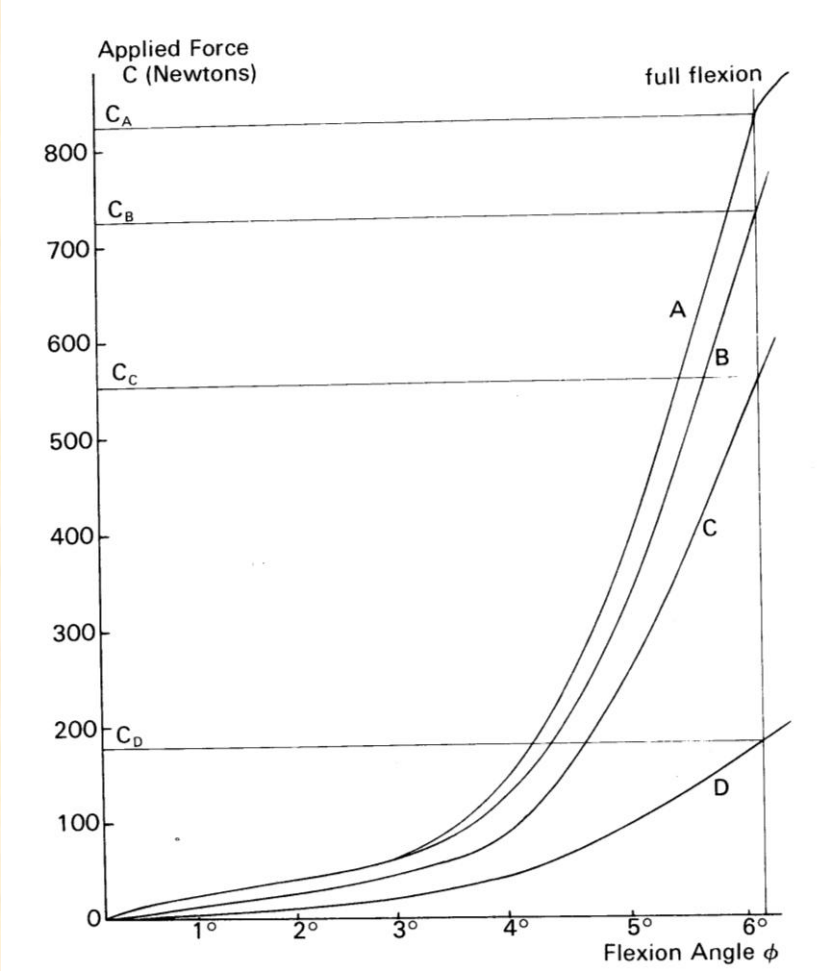
The mysterious interspinous ligament





Adams MA, Hutton WC, Stott JRR (1980). The resistance to flexion of the lumbar intervertebral joint. Spine 5 245-253.

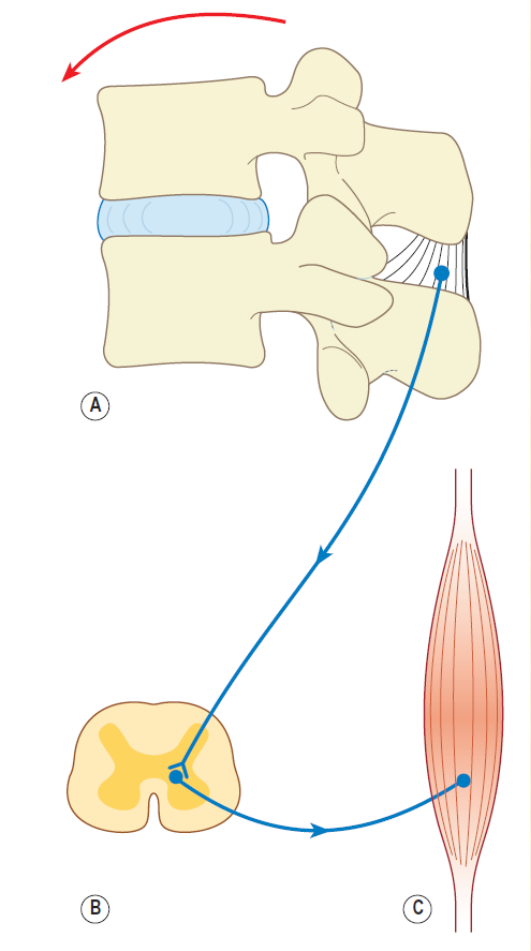
‘Slipped disc’ can be a mechanical injury!

Adams MA, Hutton WC (1982). Prolapsed intervertebral disc. A hyperflexion injury Spine 7 184-191.

Beware of sustained bending!

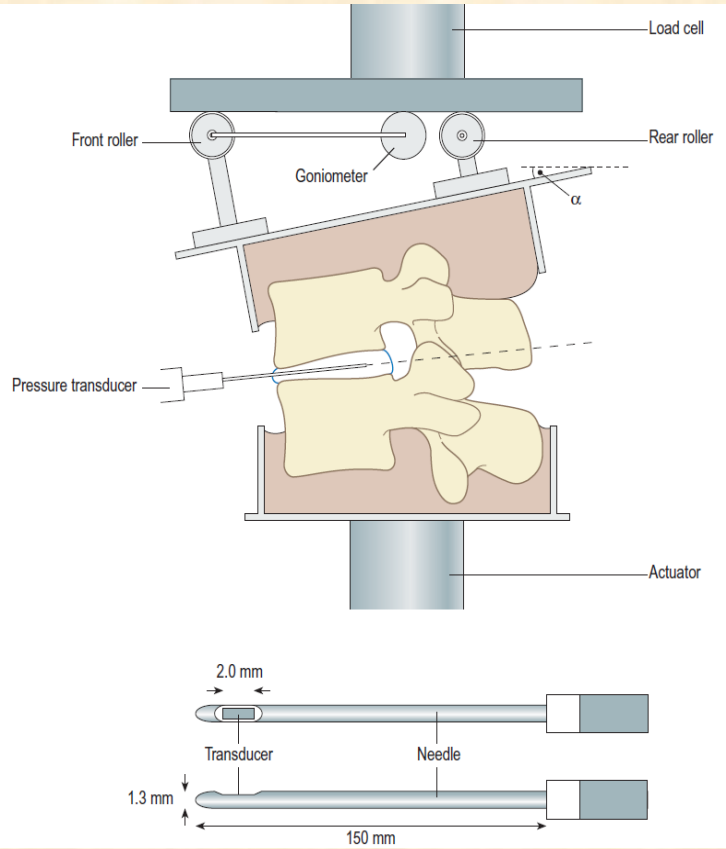
Reflex back muscle protection for the spine is impaired:

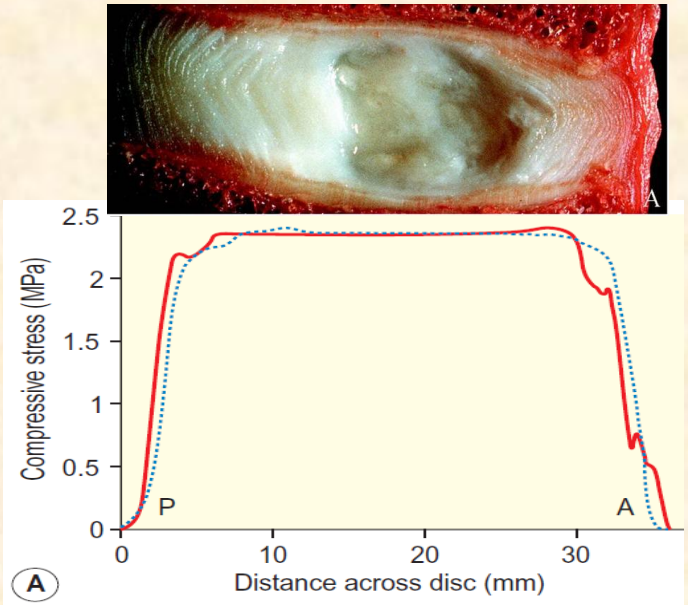
a) in early morning,
b) after repeated or sustained bending

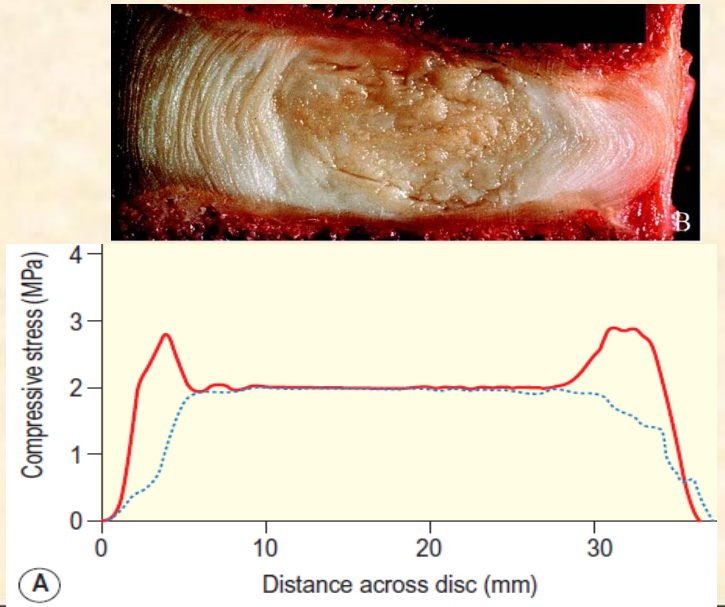


1. Adams MA, Dolan P, Hutton WC (1987). Spine 12 130-137.
2. Sanchez-Zuriaga D, Adams MA, Dolan P (2010). Spine 35(5) 517-25.

Internal ‘workings’ of intervertebral discs



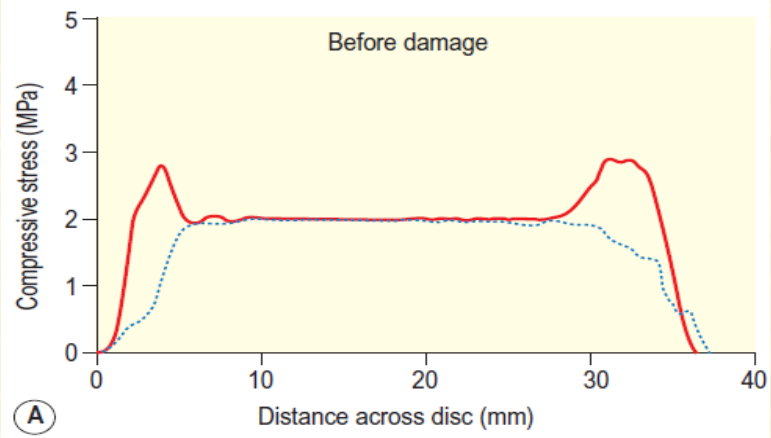


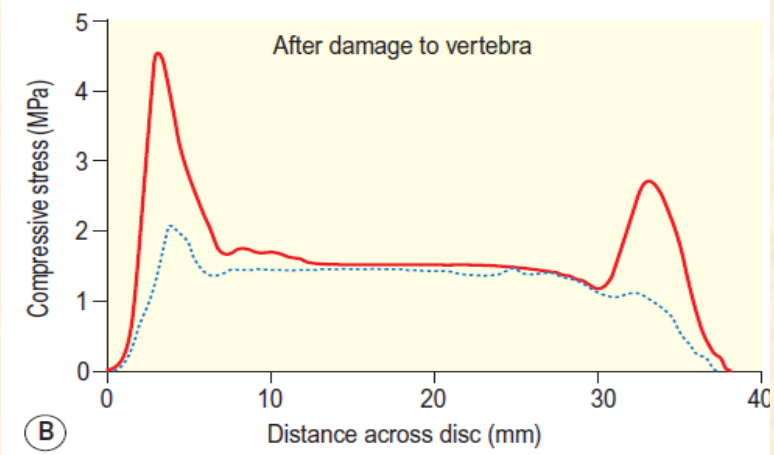


McNally DM, Adams MA (1992). Internal intervertebral disc mechanics as revealed by stress profilometry. Spine 17 1 66-73.

Mechanical initiation of disc degeneration

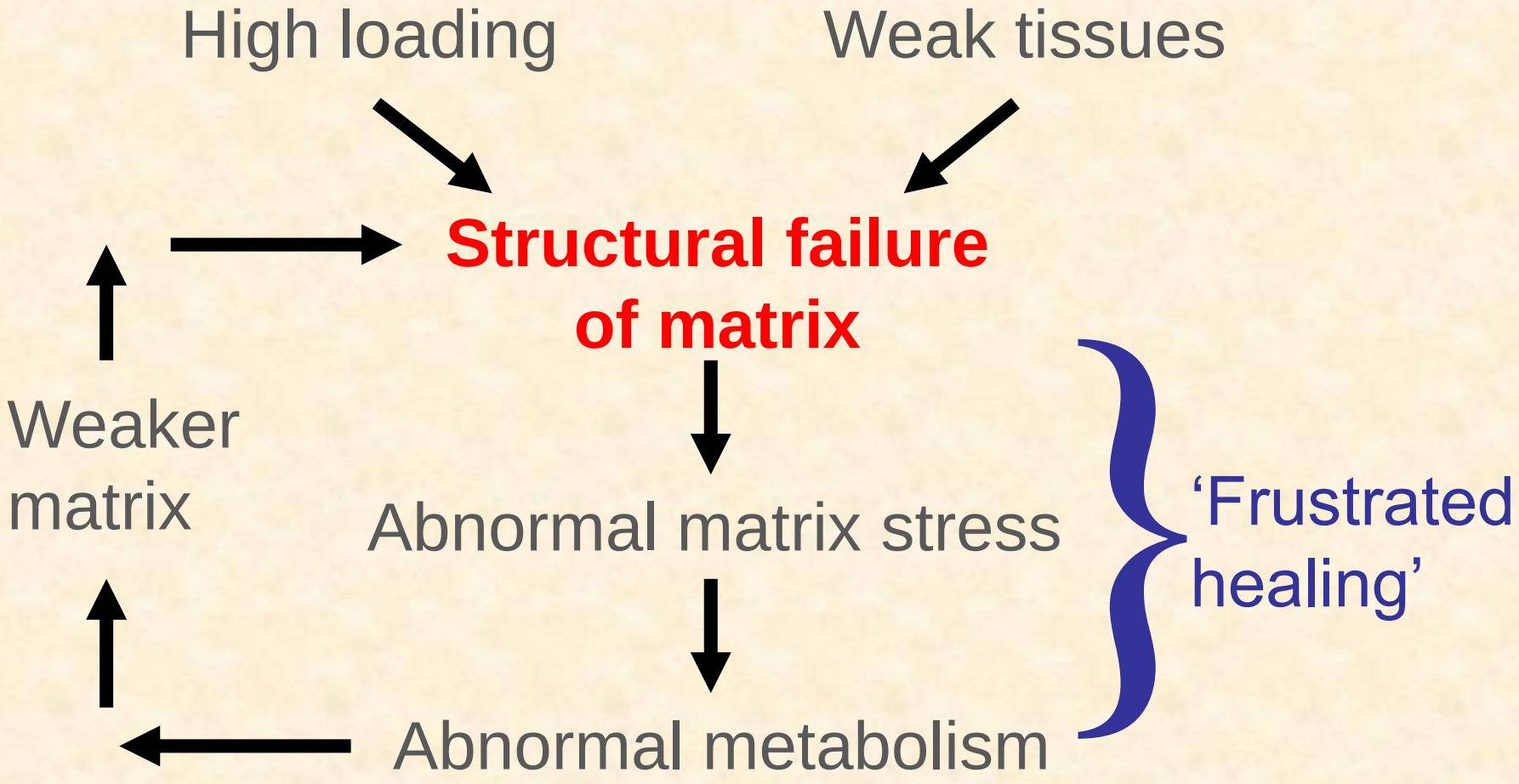
Minor damage to endplate: Major decompression of disc





Adams MA, Freeman BJC, Morrison HP, Nelson IW, Dolan P (2000). Mechanical initiation of intervertebral disc degeneration. Spine 25 1625-36.

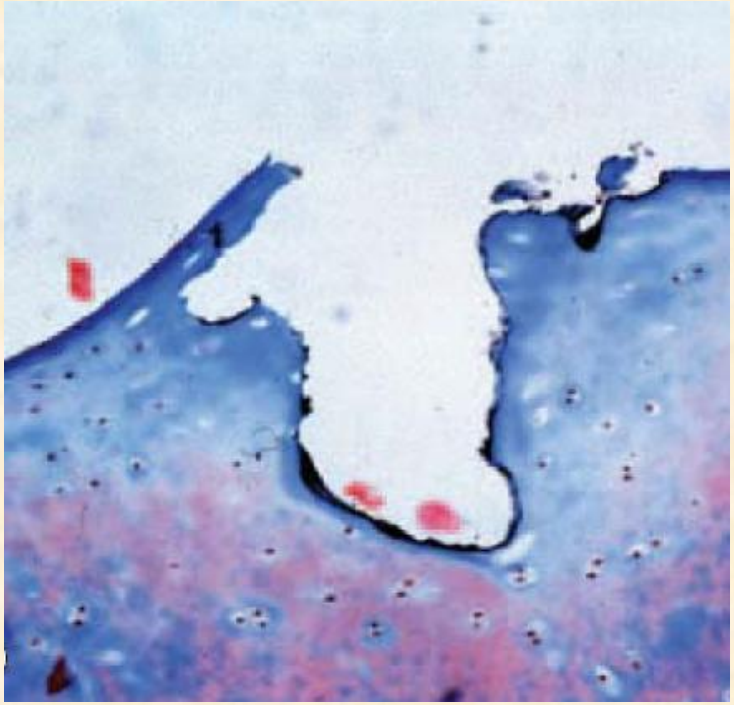
What exactly is disc degeneration?



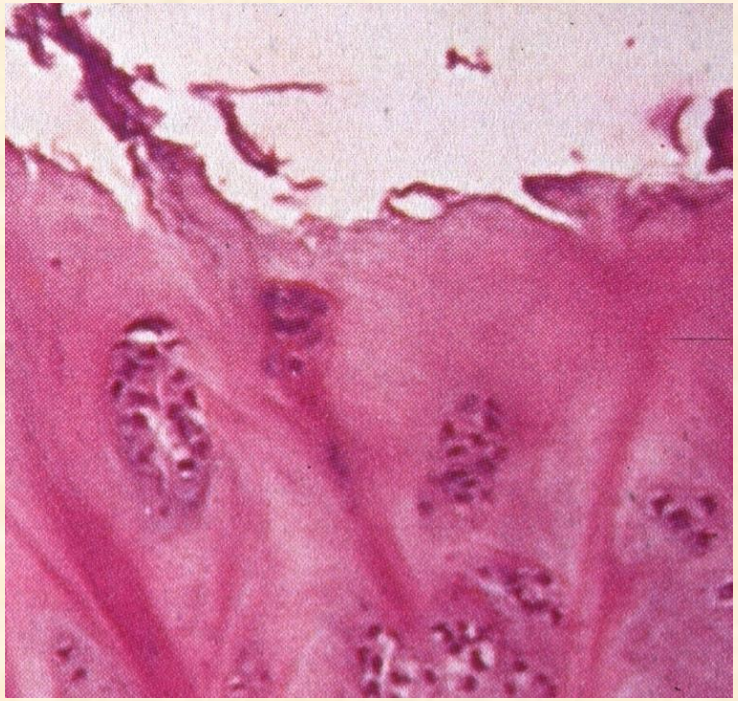
Adams MA, Roughley (2006). What is intervertebral disc degeneration, and what causes it? Spine 31 18 2151-61.

Cartilage degeneration and osteoarthritis

Compressive damage

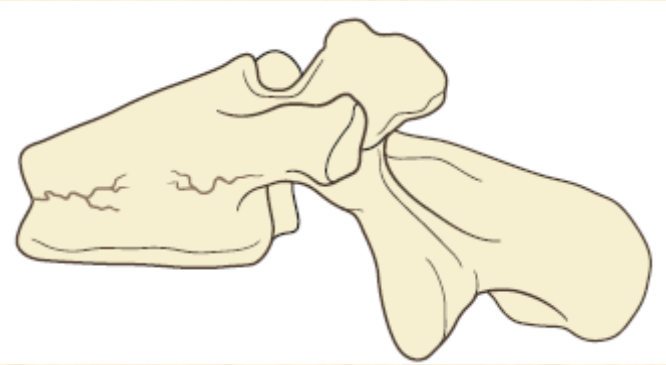


Osteoarthritis

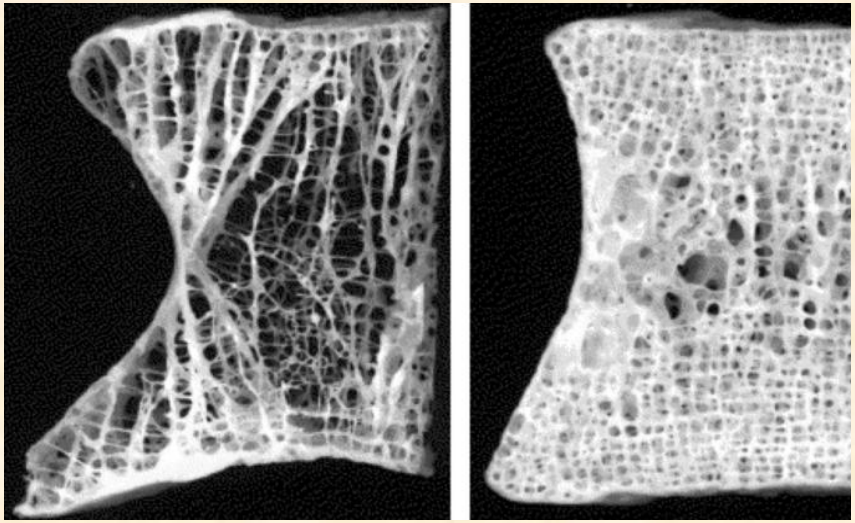


Kerin AJ, Wisnom MR, Adams MA (1998). The compressive strength of articular cartilage. Proc Inst Mech Eng [H] 212(4): 273-280.

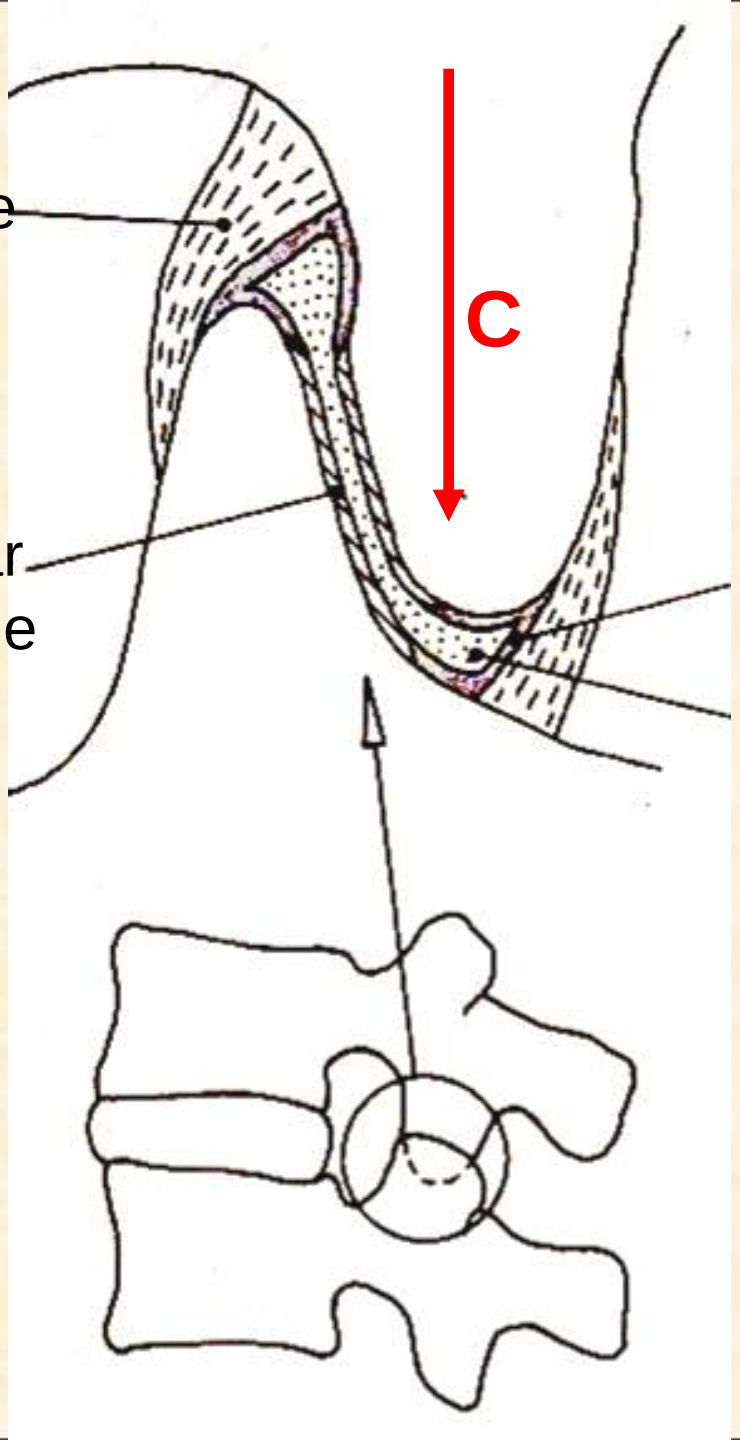
Osteoporosis and senile kyphosis



Rao & Singrakhia JBJS 85A 2010-22, 2003



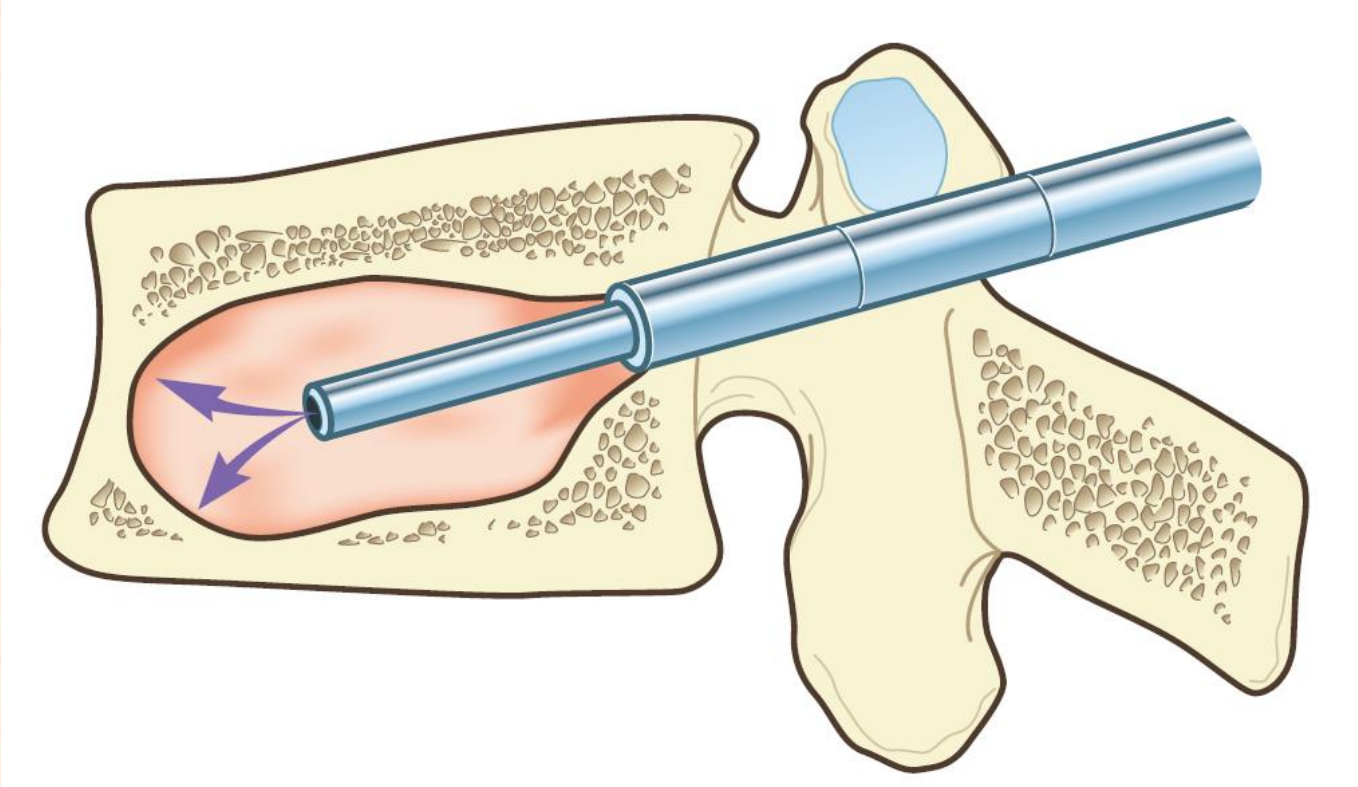
Rajapakse et al. J Biomech 2004 37:1241-9



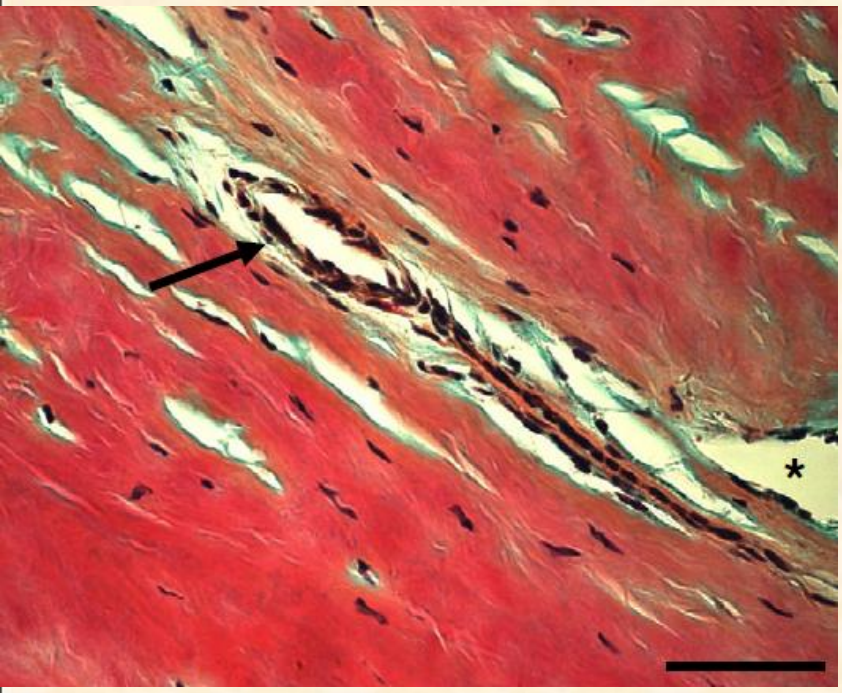
Adams, Pollintine, Tobias, Wakley, Dolan (2006). Disc degeneration can predispose to anterior vertebral fractures in the thoracolumbar spine. JBMR 21 9 1409-16.

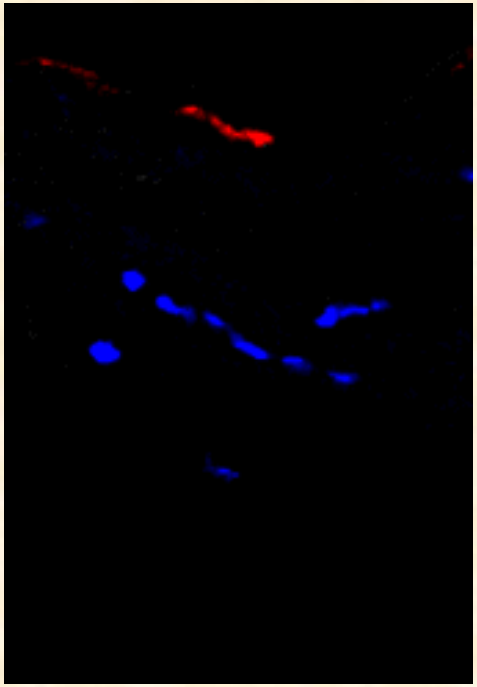
Vertebroplasty and kyphoplasty

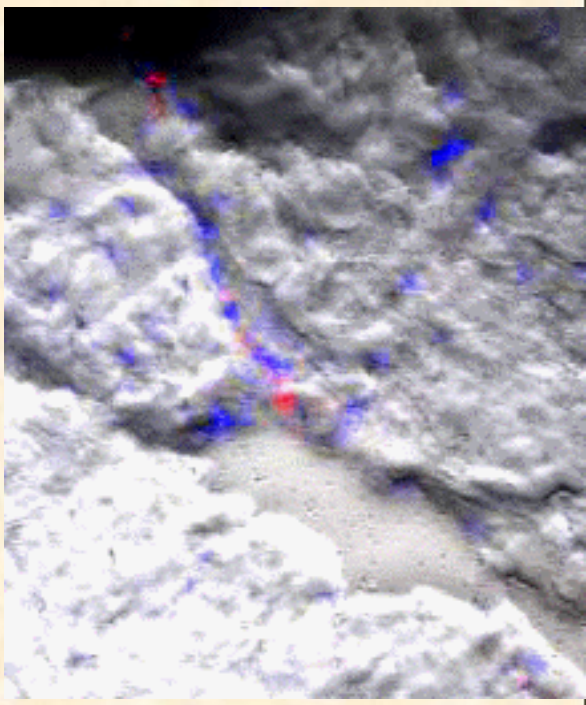
- injected cement can strengthen vertebrae and reduce deformity



Why is disc degeneration sometimes so painful?







Adams, Stefanakis, Dolan (2010). Healing of a painful intervertebral disc should not be equated with reversing disc degeneration. Clinical Biomechanics 25 961-71.

Stefanakis, Al-Abbasi, Harding, Pollintine, Dolan, Tarlton, Adams (2012). Annulus fissures are mechanically & chemically conducive to the ingrowth of nerves & blood vessels. Spine 37 1883-91

Polly Lama and Uruj Zehra: watch this space!

Good ‘bricks’? Right ‘wall’?

- 30 papers cited > 100 times (Google Scholar)
- prizes, invitations, medico-legal impact ….
- X career research grant income < £2m
- “has done well to survive so long in an unfashionable and underfunded area”

Relevance to “Growing old gracefully”?

- avoid <u>excessive</u> mechanical loading on your musculoskeletal system … by keeping it strong!

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Some problems in Academia

- **Managerialism**
  - career advancement requires innovation
  - innovation in academia has no natural predator!
- **Keeping your head down**
  - if you don't oppose bad decisions, your inertia adds to the problem
  - older academics *must* oppose bad decisions!
- **Research funding model inhibits creativity**
  - grant funding is now seen as an 'end' in itself
  - scramble for money encourages consensus rather than debate, followers rather than leaders

"Science progresses by funerals!"

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Growing old gracefully

- straight back?
- mobile joints?
- enough strength?
- lithe movements?
- well-shaped limbs?
- a spring in your step?
- **oomph!!**

What type of exercise, and how much?

Genetic influence in musculoskeletal disorders

	Heritability (%)
• osteoporosis	60-80%
• osteoarthritis	40-70%
• spinal degeneration	30-75%

- heritability depends on age, gender, lifestyle
- many genes exert a small effect

Inspect your family tree before deciding your priorities

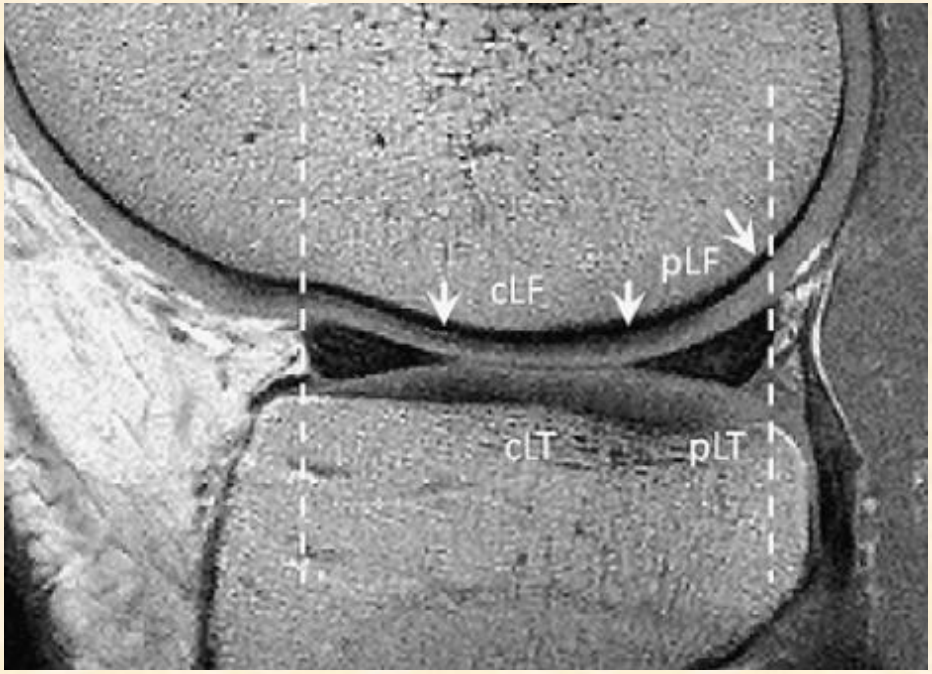
Strength training (pumping iron!)

- strong powerful muscles (security, independence)
- shapely limbs!
- strong tendons (good shock-absorption)
- stronger bones (less risk of fracture/deformity)

Cycling has similar effects

Aerobics, running, racquet sports, ...

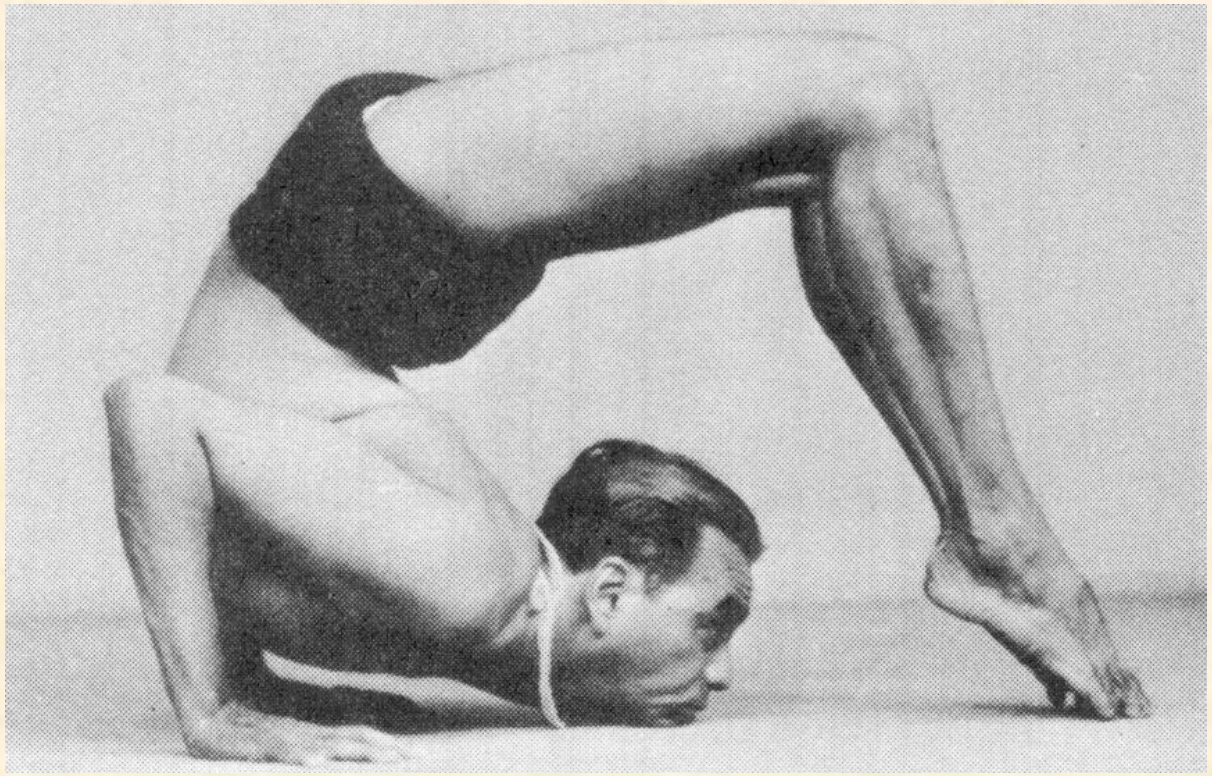
- good for bones and muscles (and endurance, fun etc!)
- not so good for strength, power and shape
- can have adverse effects on joints?



Surface zone of cartilage thinned after running (Mosher et al. OA & Cartilage, 18 358-64, 2010)

Yoga, swimming, walking …

- good for joints, mobility, and avoiding back pain
- improve muscles and tendons (but bones?)



Growing old gracefully

So what are you going to do!

- Check the family tree!
- Weight training - for strength, power, body shape
- Aerobics, racquet sports - for bones, fitness etc
- Yoga, swimming, walking – for mobility
- Build up slowly to avoid injury (esp. to cartilage)
- “Stand up for what you’re stood for!”

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- **Collaborators:** Ian Nelson, Mo Sharif, Allen Goodship, Jon Tobias, Kate Robson-Brown, Ian Harding, John Tarlton, John Hutchinson, Deborah Annesley-Williams …

and finally ….. Trish Dolan