

Section 21: Tendon / Ligament - Structure and Properties

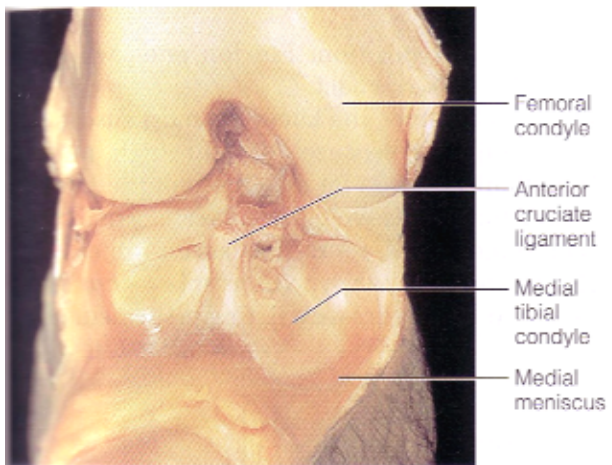
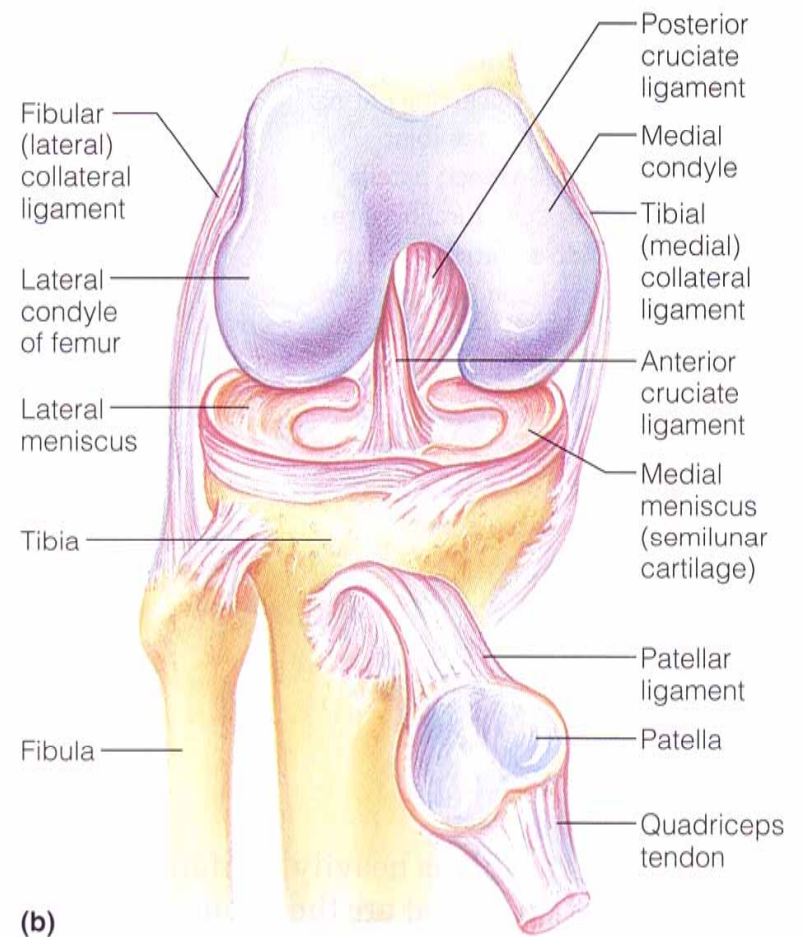
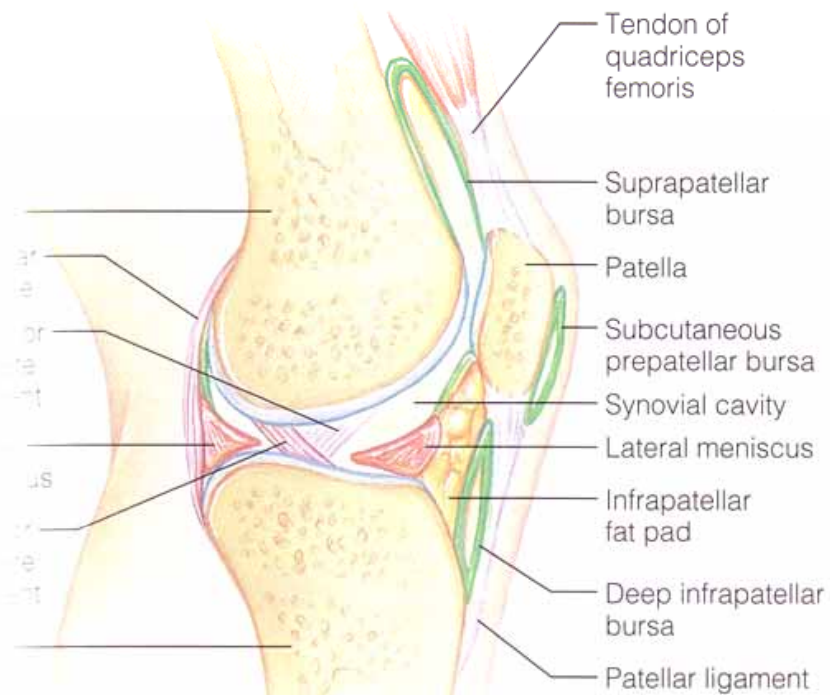
Why Ligaments?

- Important anatomical structures
 - Guide joint motion
 - Check rein
 - Proprioceptive feedback
- Relative simplicity
 - Biologically
- Everybody has them and hurts them
 - Anatomically
 - Mechanically
- Accessible (surgically)
- Easy to test (mechanically)
- Display typical soft tissue behavior

www.ratzrus.co.uk

Composition

- Tendons and ligaments are parallel-fibered collagenous tissues
- Low cellularity (fibroblasts, <20% of volume)
- Water = 70% of wet weight
- Solid matrix = 30% of wet weight
 - Collagen (>75% of dry weight)
 - Elastin
 - Ground substance



21-4

From: Garner

Ligament Hierarchy

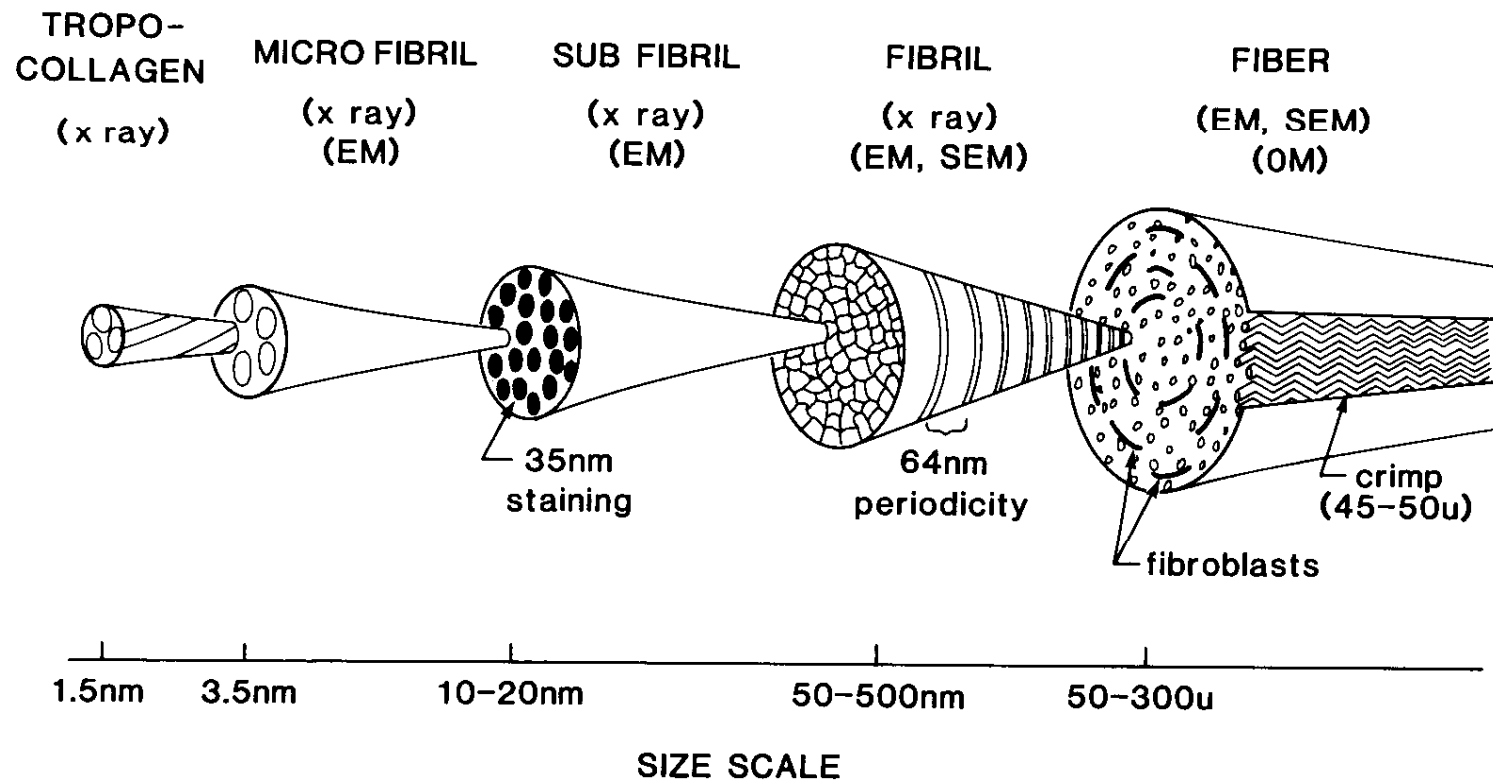
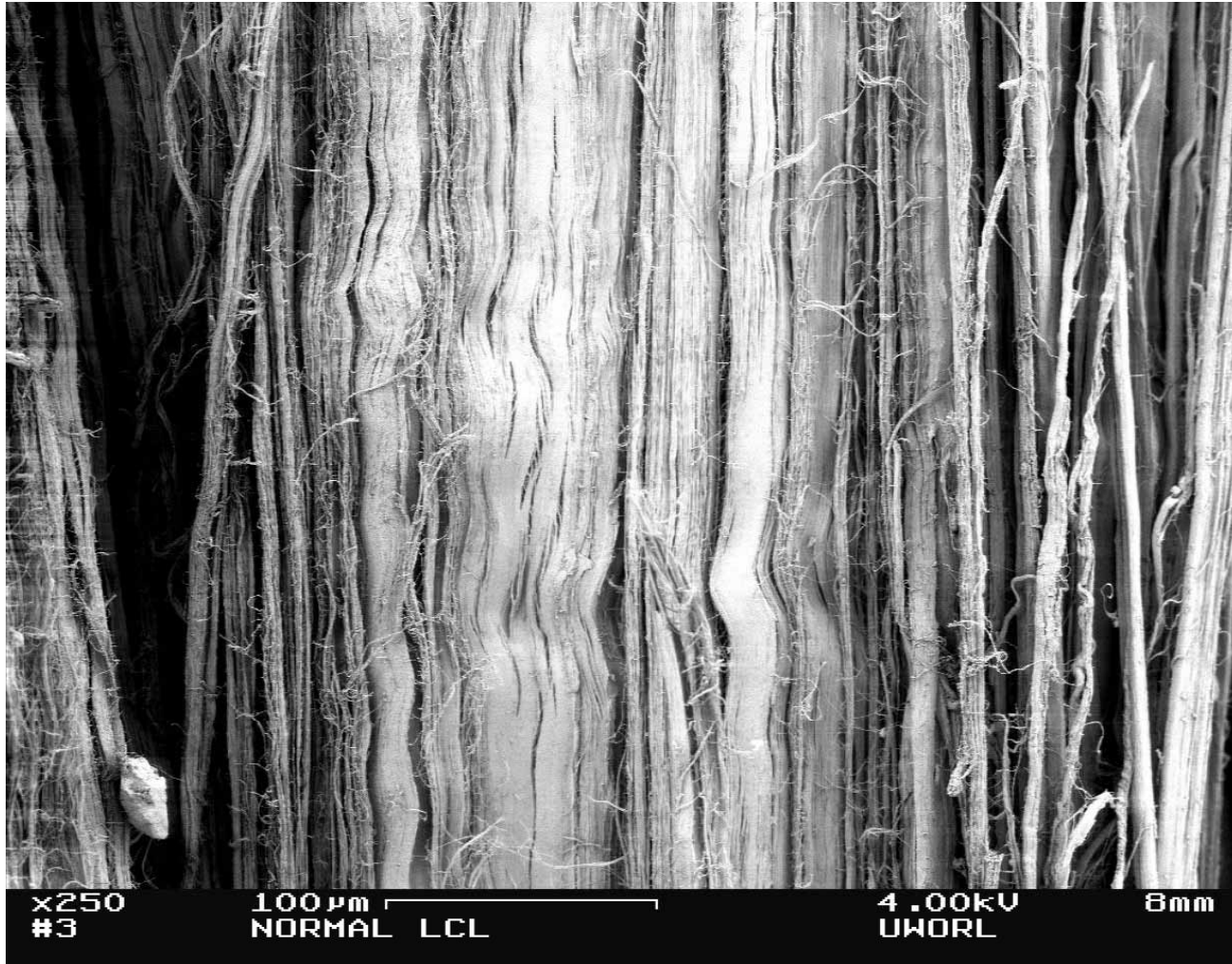


Fig. 2-29 Ligament architectural hierarchy. (Modified with permission from Kastelic J, Galeski A, Baer E: *The multicomposite structure of tendon*. Connect Tissue Res 1978;6:11-23.)

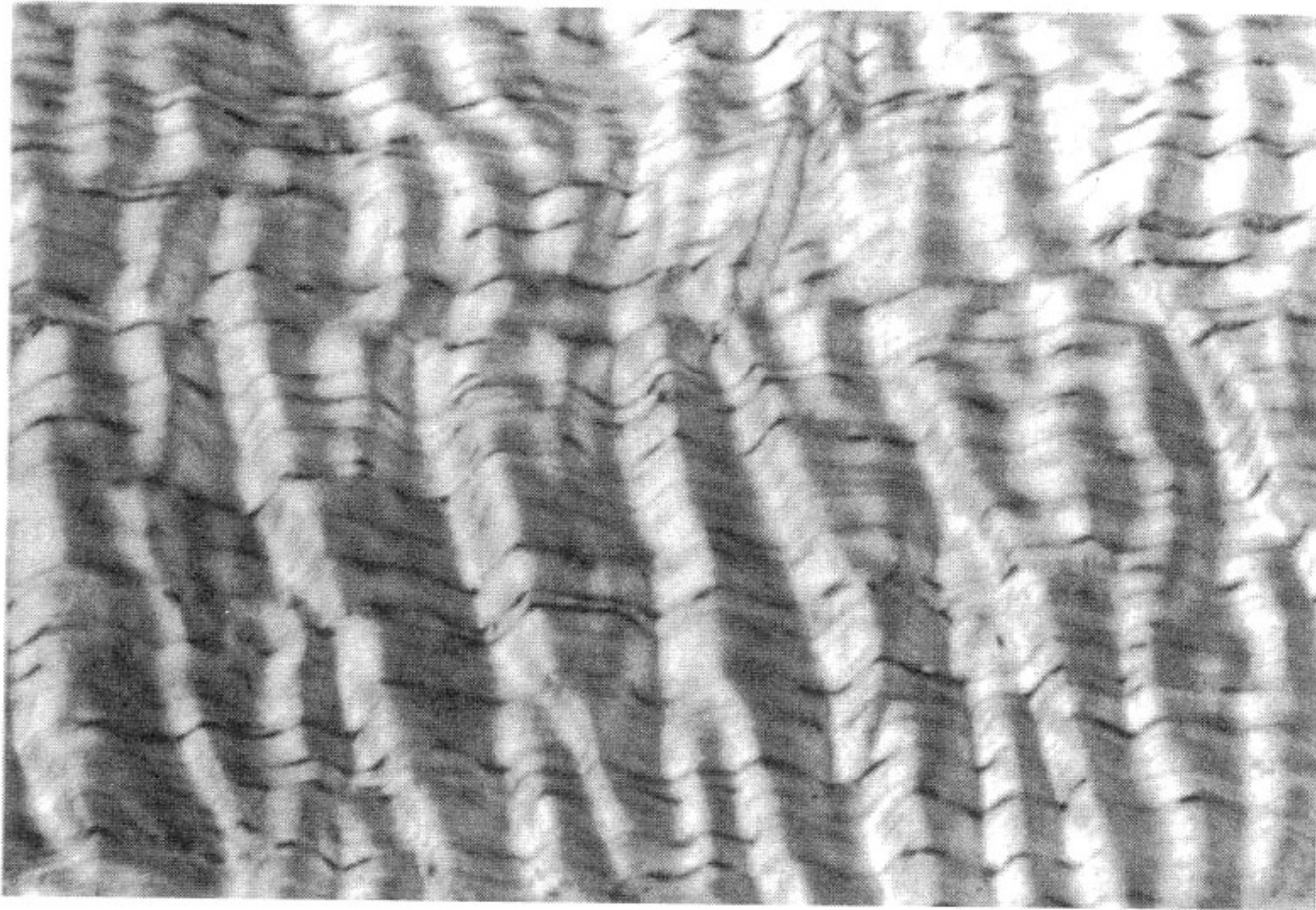
Frank et al., in Woo and Buckwalter, 1987

Ligament Fibers from SEM



21-6

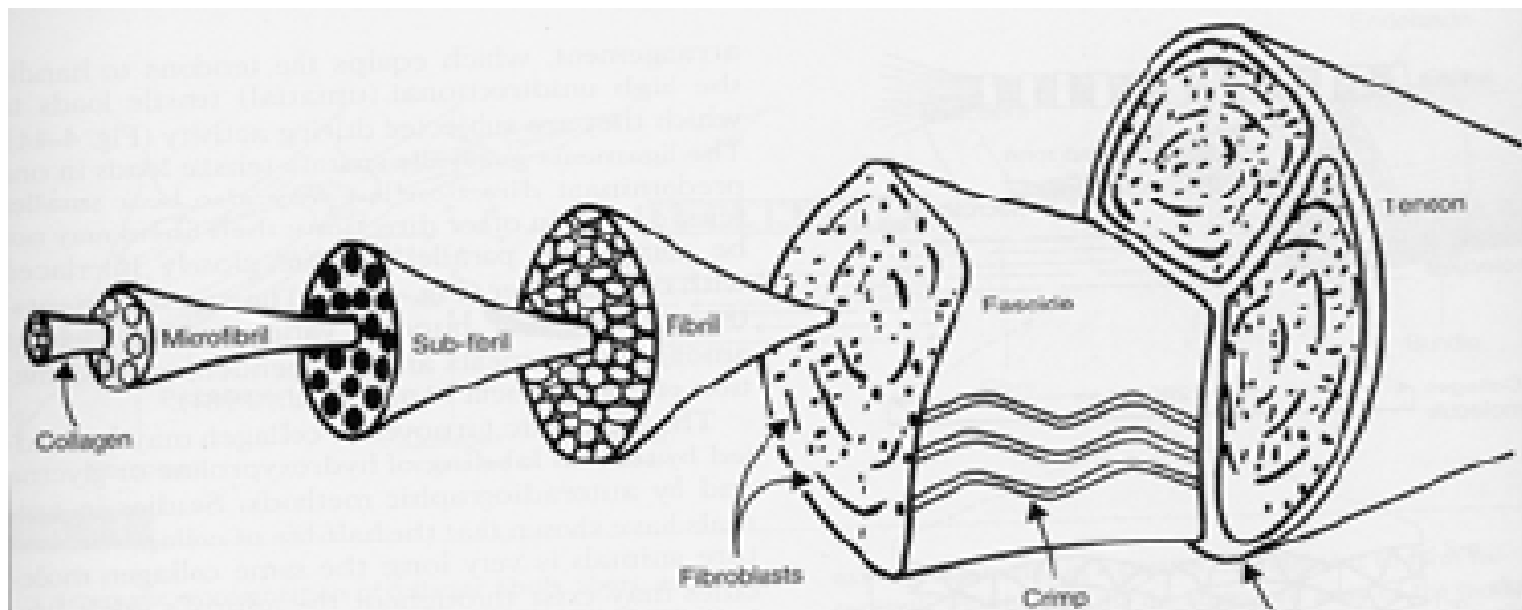
From: Vanderby



Photograph illustrating crimped pattern of collagen in ligament. Fibroblasts may be seen interspersed between the collagen fibres.

Tendon hierarchy

collagen molecule → microfibril → fibril → fascicle → tendon



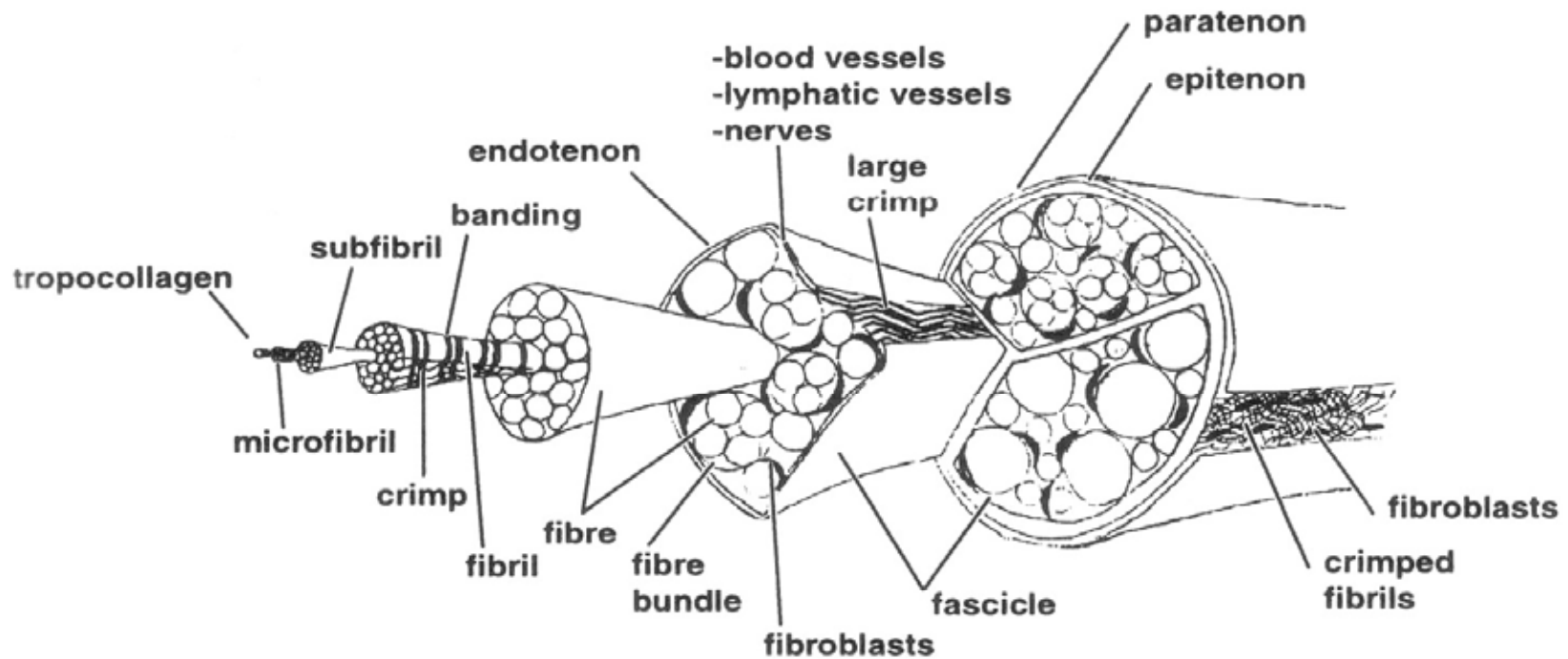
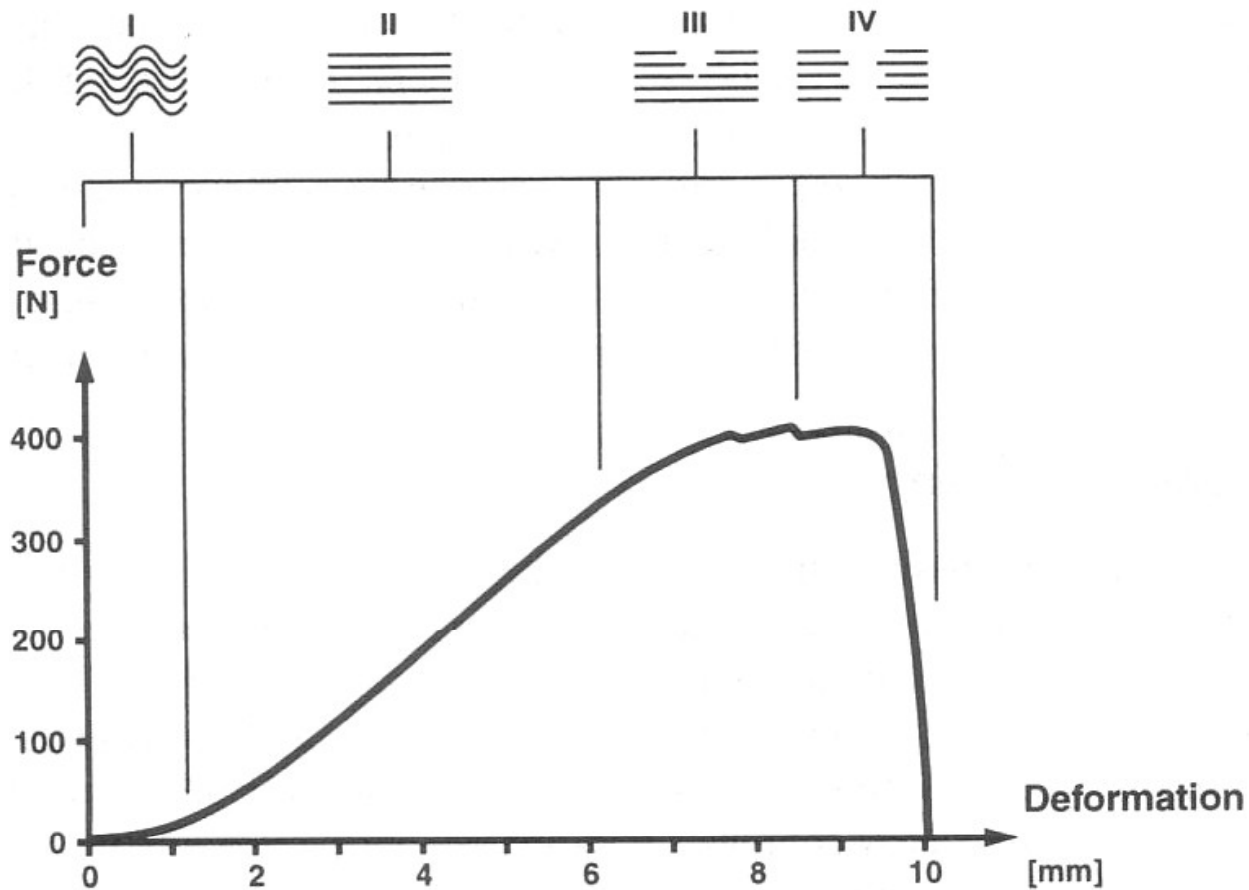


Figure 2.6.4

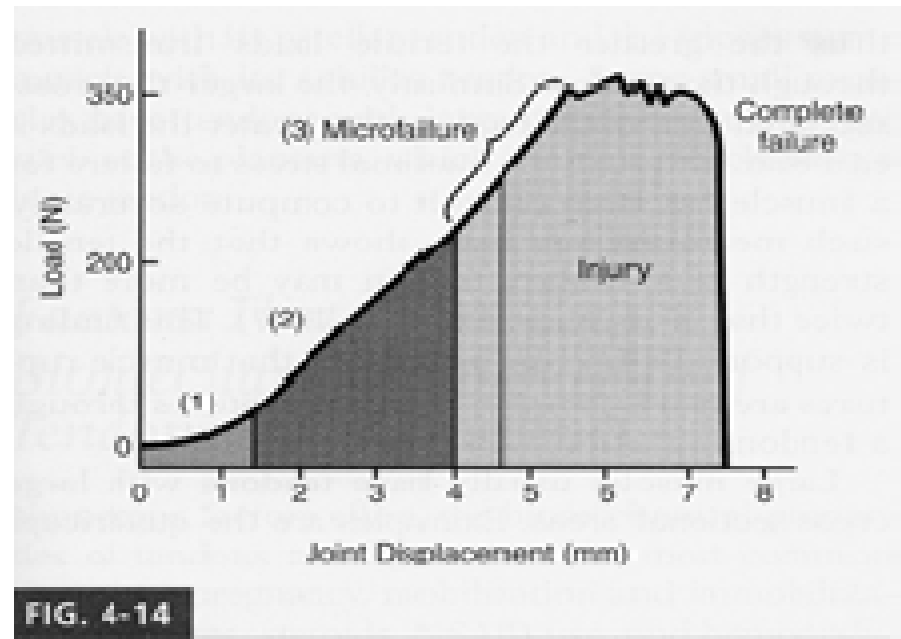
The structural hierarchy of a tendon, from the tropocollagen molecule to the entire tendon. Connective tissue layers or sheaths envelop the collagen fascicles (endotenon), bundles of fascicles (epitenon), and the entire tendon (paratenon). Note that blood and lymphatic vessels and nerves are cut in the cross-section within the endotenon (from Kastelic et al., 1978, with permission).



A typical force-deformation curve for a typical rabbit ligament under monotonic forcing. I = toe region; II = linear region; III = region of microfailure; IV = failure region. At top are schematic representations of fibres going from crimped (I) through recruitment (II) to progressive failure (III and IV).

In vitro load-deformation behaviors of ligaments

- Stage 1 – during anterior-drawer test
- Stage 2 – during physiological loading
- Stage 3 – during damage-inducing load leading to partial injury → complete rupture



Meniscus and Ligament Tears

Anterior cruciate ligament tear

Posterior cruciate ligament tear



Tackling can result in an "unhappy triad"

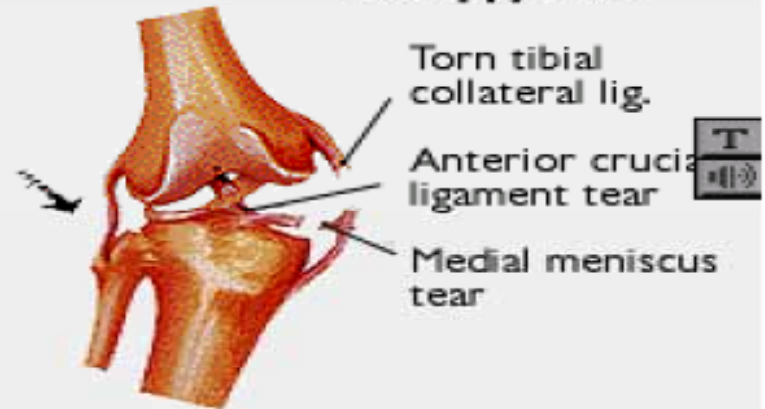
Fibular collateral ligament tear

Tibial collateral ligament tear

"Unhappy triad"



Twisting



Torn tibial collateral lig.
Anterior cruciate ligament tear
Medial meniscus tear

