FIBROUS CONNECTIVE TISSUES

Illustrations and Notes for

An Instructional Lecture

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FIBROUS CONNECTIVE TISSUES

The relative amounts of collagen and proteoglycans depend on the extent to which the tissue is subjected to tension and compression, respectively. The more it sustains tension but not compression, the more the tissue will consist of collagen. The more it is subjected to compression, the more it will consist of proteoglycans.

Tendons and ligaments essntially sustain only tension and so, will consist mainly of collagen. Subcutaneous fascia sustains both tension and compression in the skin and so, contains both collagen and proteoglycans. Cartialge is primarily concerned with resisting compression and is largely composed of proteglycans. Bone sustains compression but is modified by having its proteoglycans calcified. This increases its anticompression strength but limits its flexibility.

TENDON

Designed to sustain tension in a single direction

Mainly Type I collagen, highly orientated in a spiral fashion

LIGAMENTS

Designed to sustain tension, usually in a single plane but perhaps in several directions about the average longitudinal disposition of the ligament

Mainly Type I collagen, in parallel or woven sheets with slightly different orientations

WATER	COLLAGEN		ELASTIN	PROTEOGLYCANS	OTHER
	TYPE I	TYPE III			
60%	30%	3%	3%	0.5%	3.5%

IRREGULAR FIBROUS CONNECTIVE TISSUE

A bed of fibrous connective tissue designed to withstand both compression and tension in various directions

Accordingly it is well endowed with proteoglycans to withstand compression, and with a three-dimensional meshwork of collagen that on the one hand retains the proteoglycans, and on the other hand can resist tension in all directions

Examples include

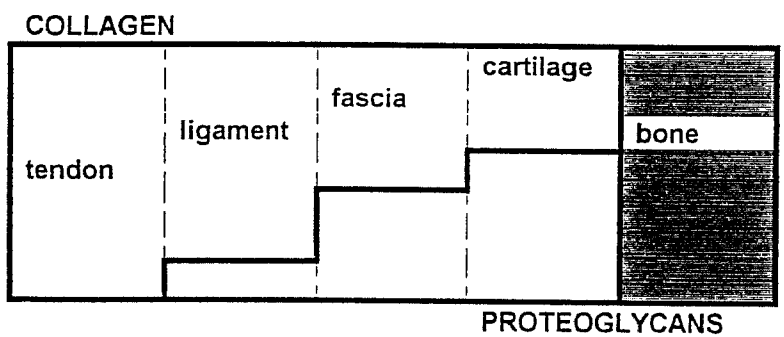
deep fascia	which is mainly tensile and therefore mainly collagenous
superficial fascia	which sustains both tension and compression and is therefore endowed with both collagen and proteoglycans. The latter is supplemented by fat which also contributes to sustaining compression
articular cartilage	is like a special fascia in which proteoglycans are the dominant consitutent

FIBROUS CONNECTIVE TISSUES

Tissues designed to withstand mechanical deformation -

TENSION	COMPRESSION
strings	fluid mush
COLLAGEN	PROTEOGLYCANS

TENSION



COMPRESSION

fibroblast

chondroblast

osteoblast

COLLAGEN STRUCTURE

Primary	polypeptide
Secondary	helix
Tertiary	triple helix
Quaternary	aggregated
	microfibril
	fibril
	fibre
	bundle
	fascicles

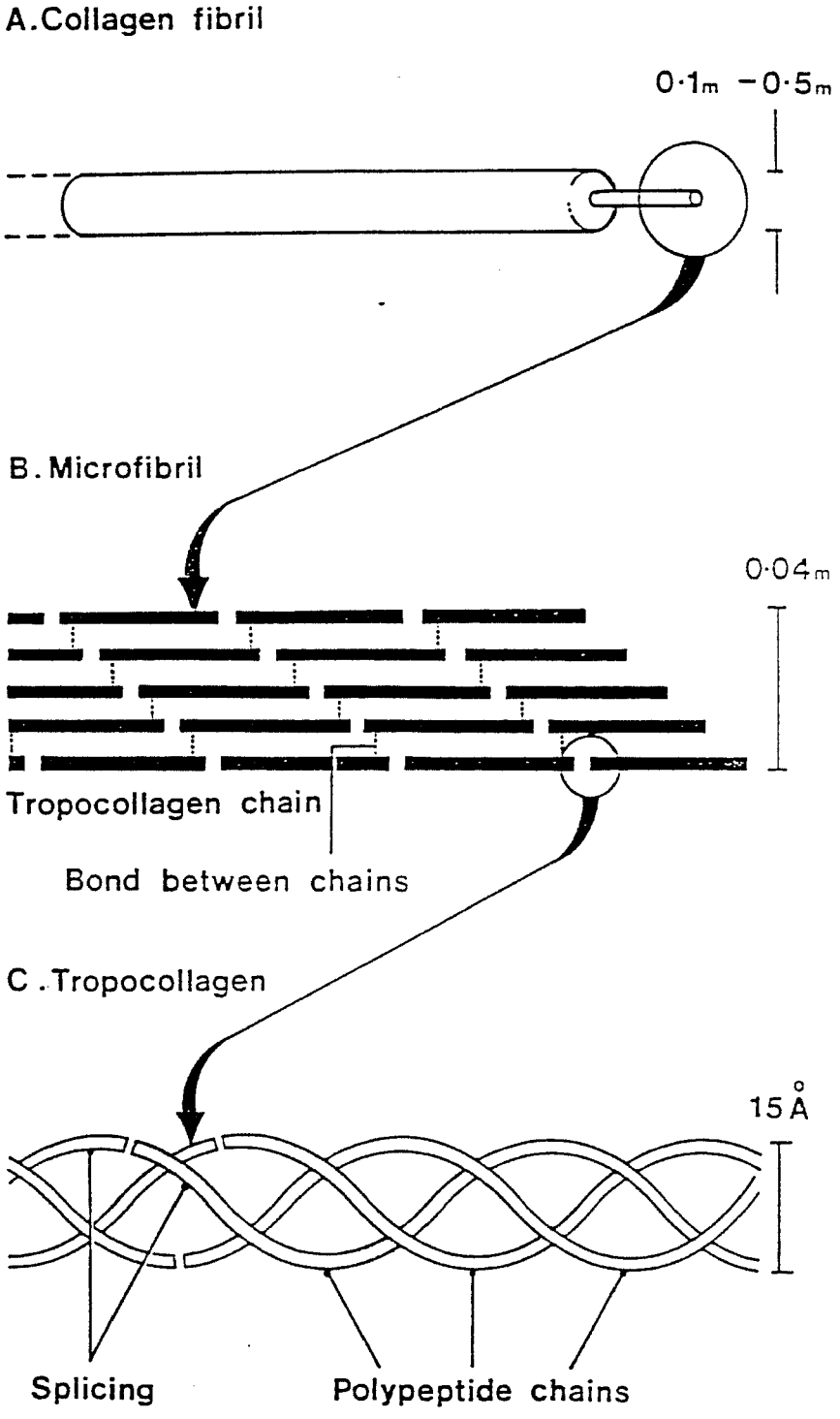


Fig. 2.9 The structure of collagen. A collagen fibril (**A**) is made up of several microfibrils (**B**). Each microfibril consists of several chains of tropocollagen (**C**) held together side-to-side by covalent bonds involving hydroxylysine molecules (⋮). Tropocollagen consists of three polypeptide chains wound around one another in a helical fashion. Tropocollagen chains are formed by the peptide chains in consecutive molecules splicing and being held together by electrostatic bonds between their ends.

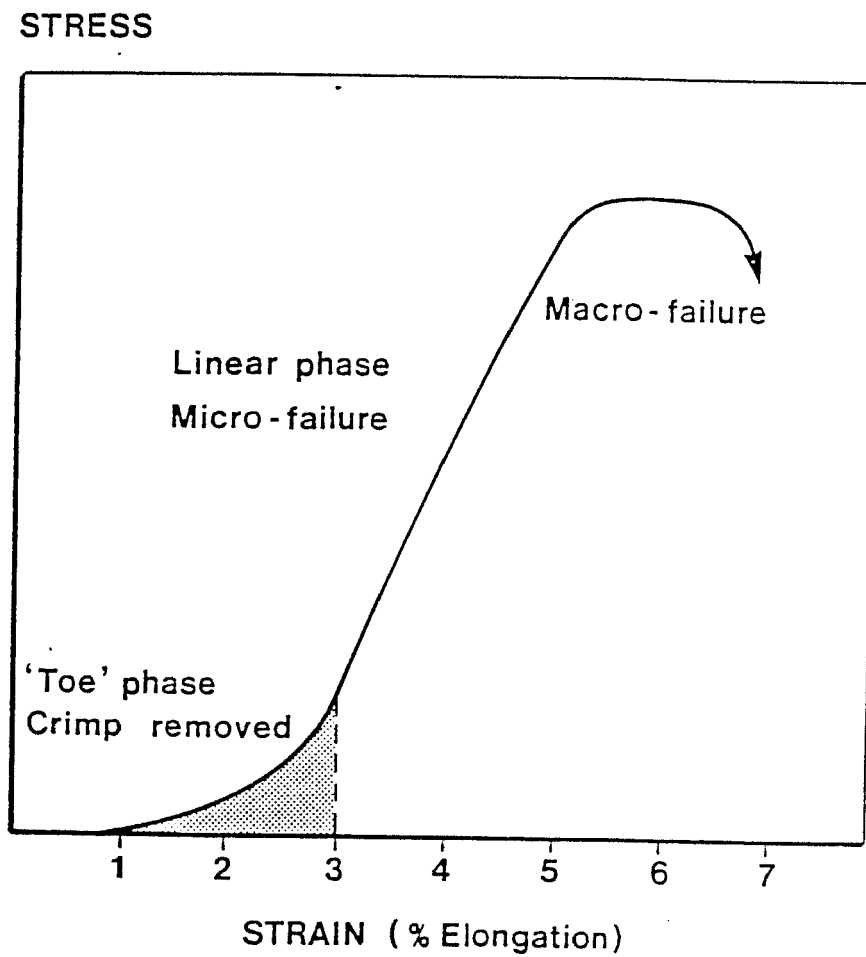


Fig. 6.6 Stress-strain curve of collagen. (Based on Abraham[1], and Shah et al.[482]).

PROTEOGLYCANS

Chains of glycosaminoglycans hanging from a core protein.

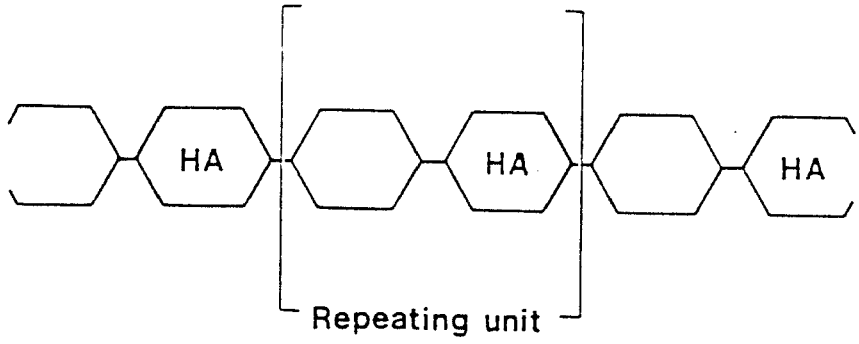
GLYCOSAMINOGLYCANS

Long chains of sugars, characterised by the nature of their

REPEATING UNIT

which is always a pair of molecules being

a hexose and a hexosamine



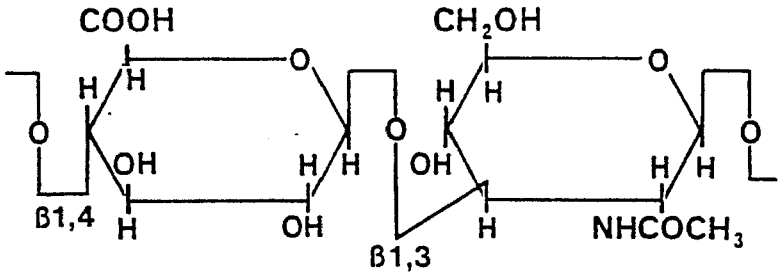
The glycosaminoglycans commonly encountered in fibrous connective tissues are

chondroitin-6-sulphate
chondroitin-4-sulphate
keratosulphate
dermatansulphate

and

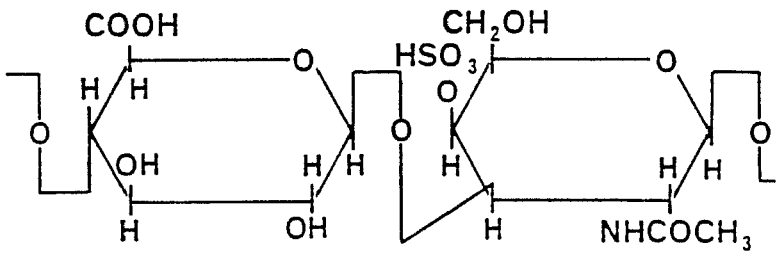
hyaluronic acid

HYALURONIC ACID



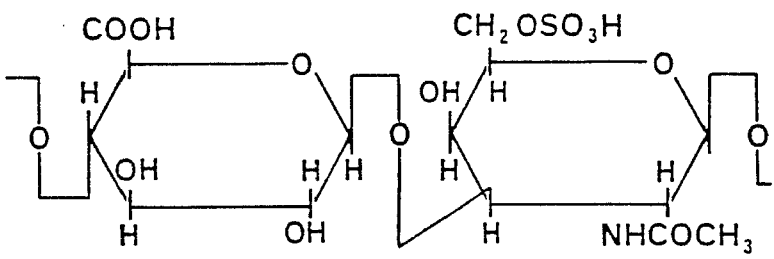
glucuronic acid N.acetyl glucosamine

CHONDROITIN 4 SULPHATE



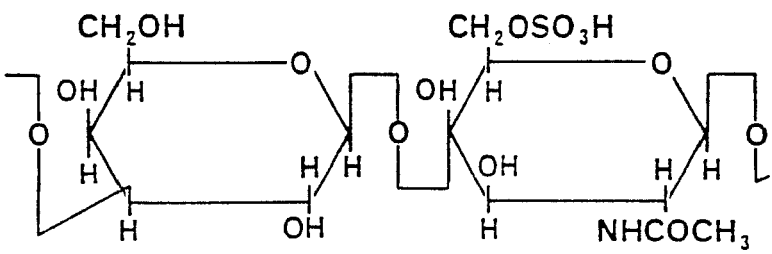
glucuronic acid N.acetyl galactosamine 4 sulphate

CHONDROITIN 6 SULPHATE



glucuronic acid N.acetyl galactosamine 6 sulphate

KERATOSULPHATE



galactose N.acetyl glucosamine 6 sulphate

Fig. 2.6 The chemical structure of the repeating units of the glycosaminoglycans.

PROTEOGLYCAN

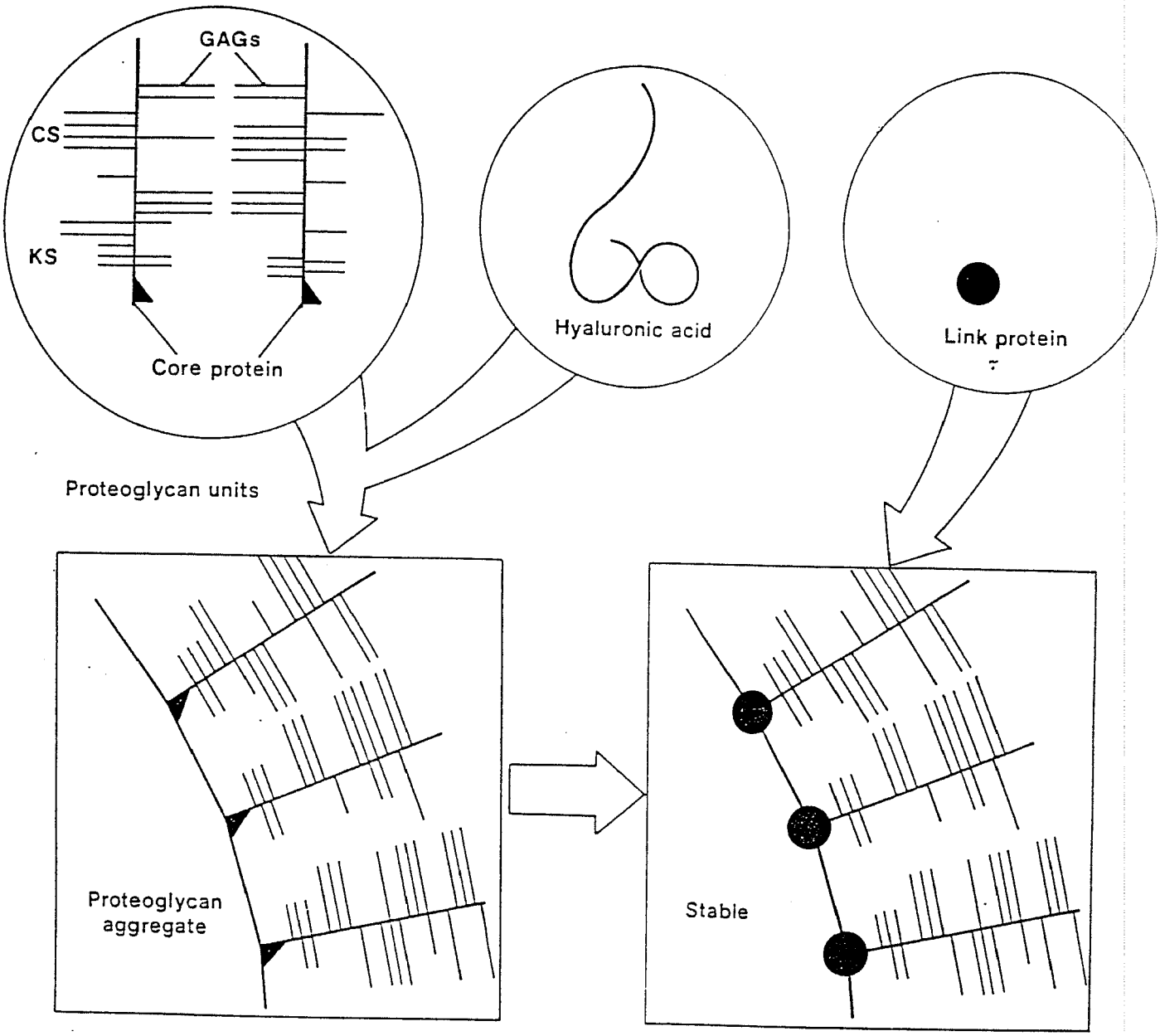


Fig. 2.7 The structure of proteoglycans. Proteoglycan units are formed by many GAGs linked to a core protein. Keratan sulphate chains (KS) tend to occur closer to the head of the core protein. Longer chains of chondroitin sulphate (CS) are attached along the entire length of the core protein. Proteoglycan aggregates are formed when several protein units are linked to a chain of hyaluronic acid. Their linkage is stabilised by a link protein.

AGGREGATED PROTEOGLYCAN

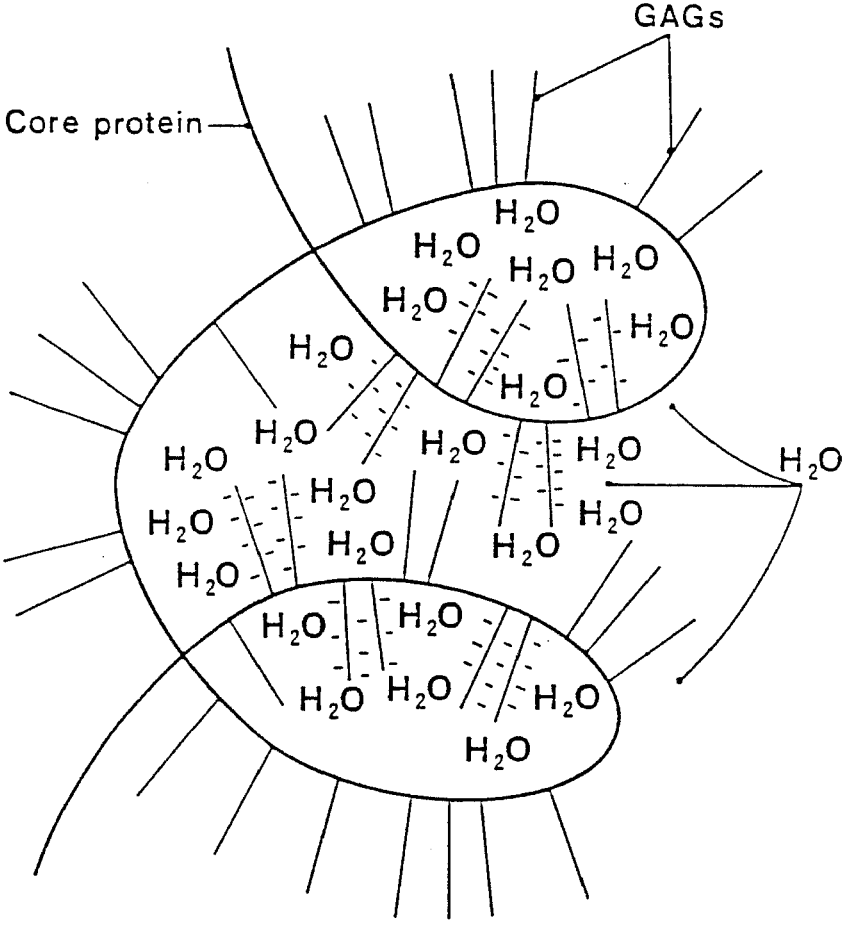
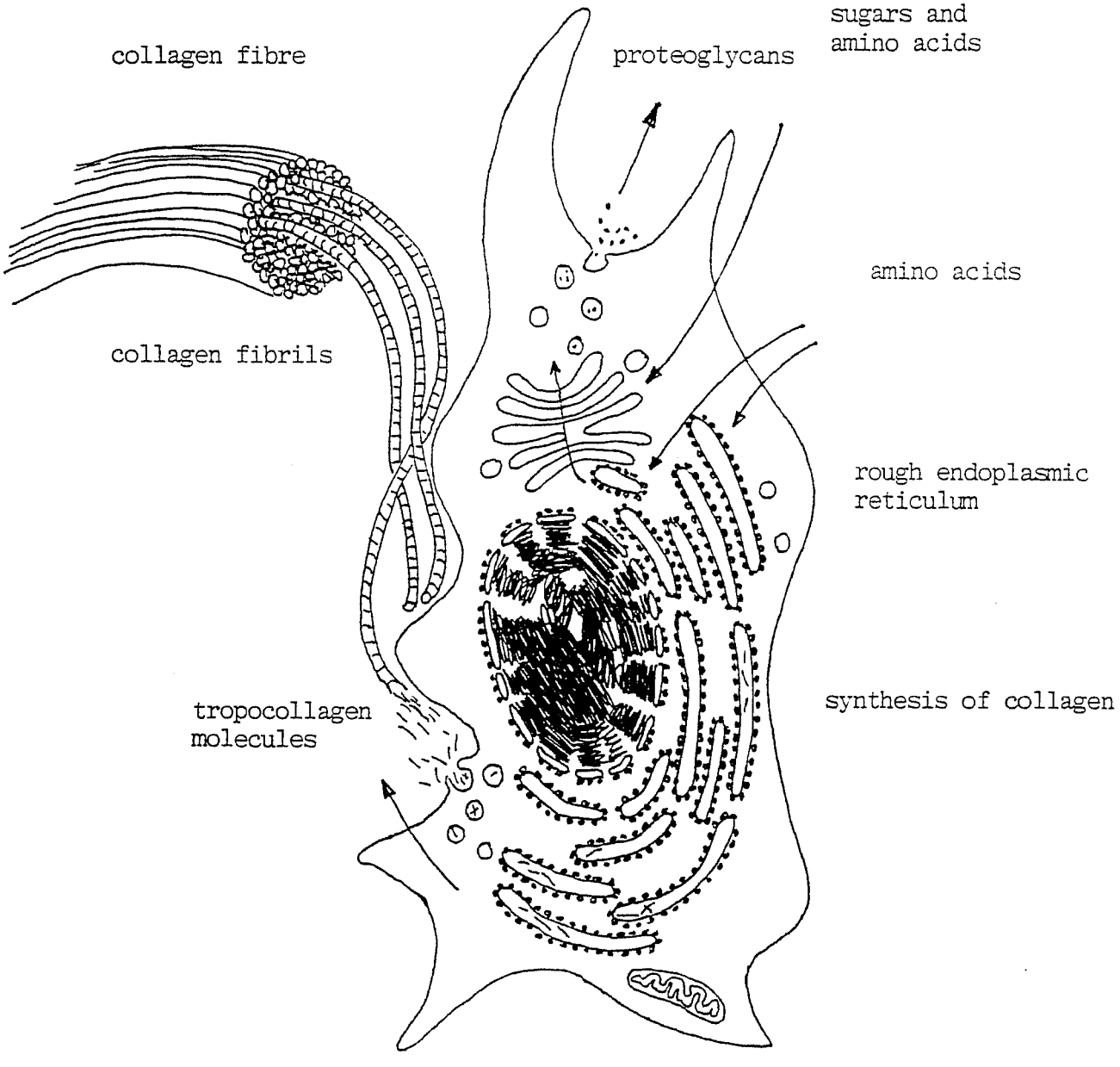
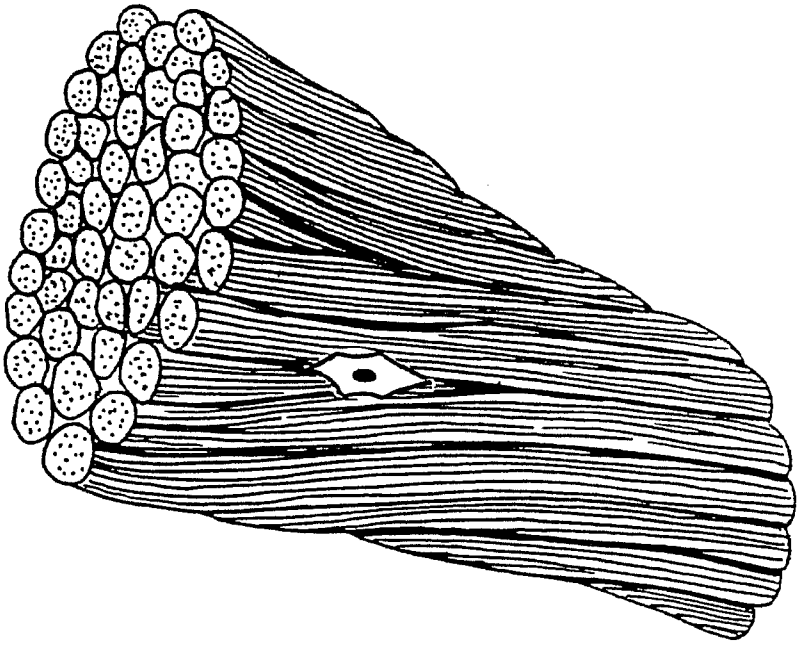


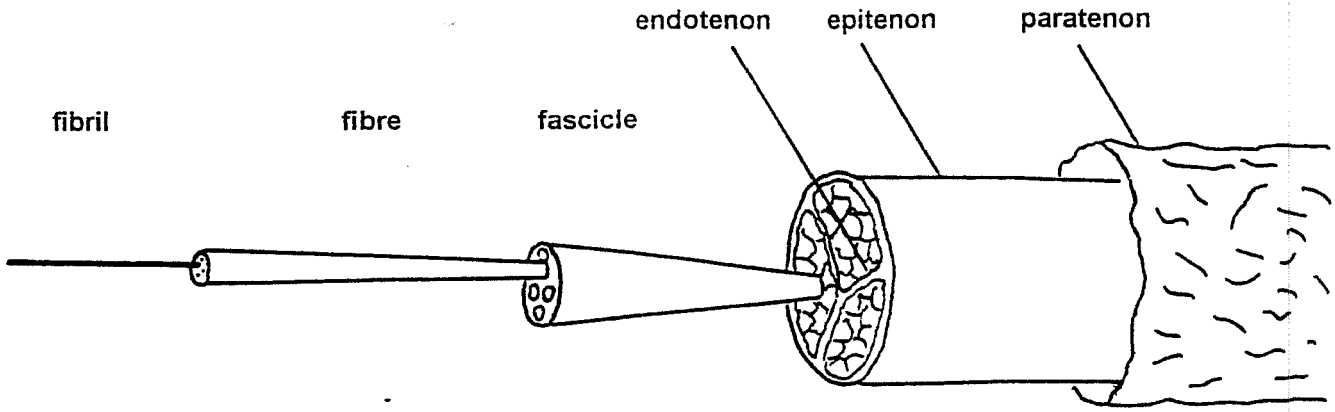
Fig. 2.8 A sketch of a coiled proteoglycan unit illustrating how the ionic radicals on its glycosaminoglycans (GAGs) attract water into its 'domain'.

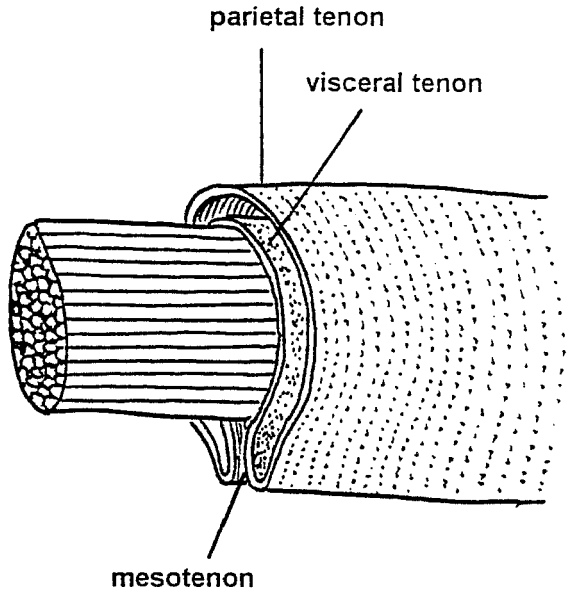
SYNTHESIS


collagen fibre
collagen fibrils
tropocollagen molecules
proteoglycans
sugars and amino acids
amino acids
rough endoplasmic reticulum
synthesis of collagen
FIBROBLAST

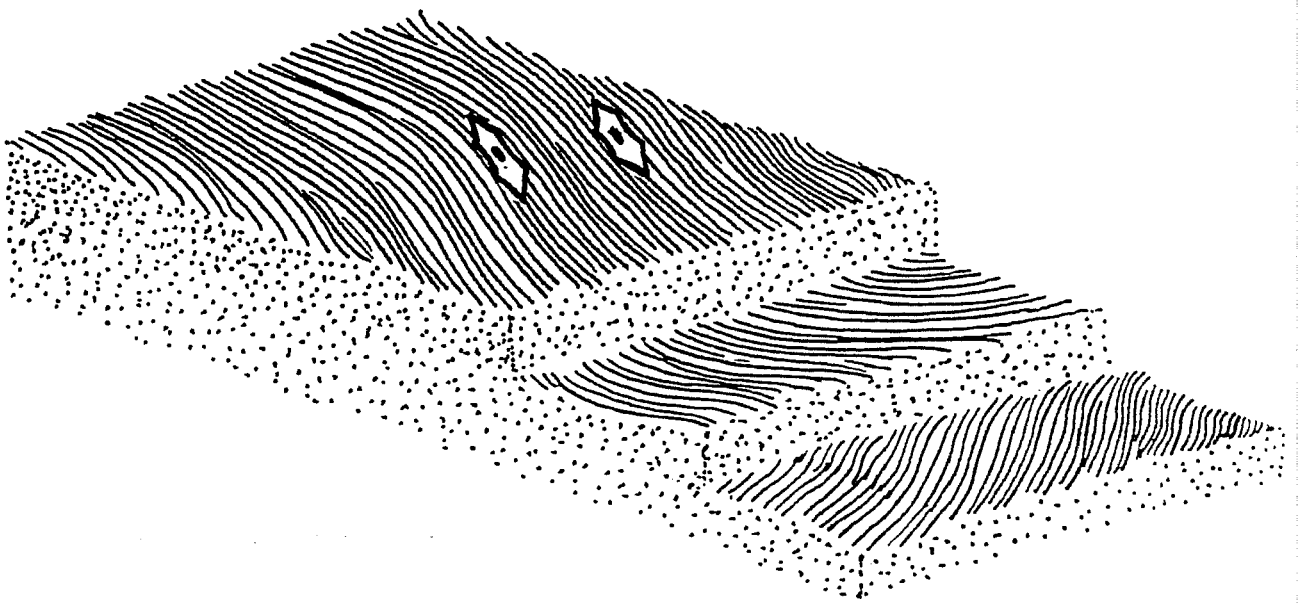
TENDON



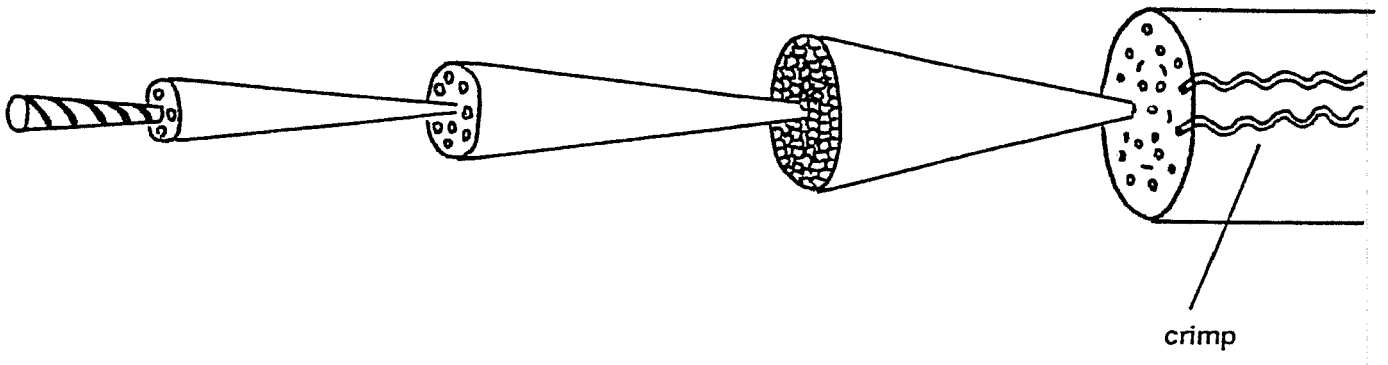

endotenon
epitenon
paratenon
fibril
fibre
fascicle


parietal tenon
visceral tenon
mesotenon

LIGAMENTS



tropo-collagen microfibril sub-fibril fibril fibre



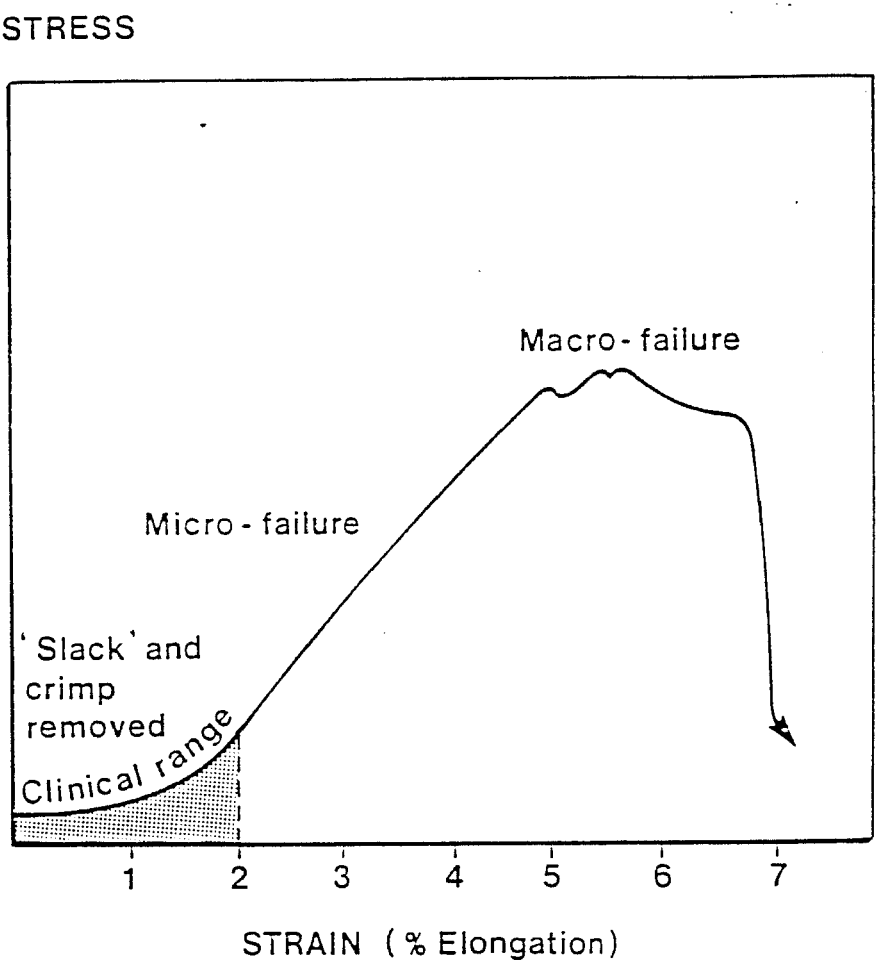
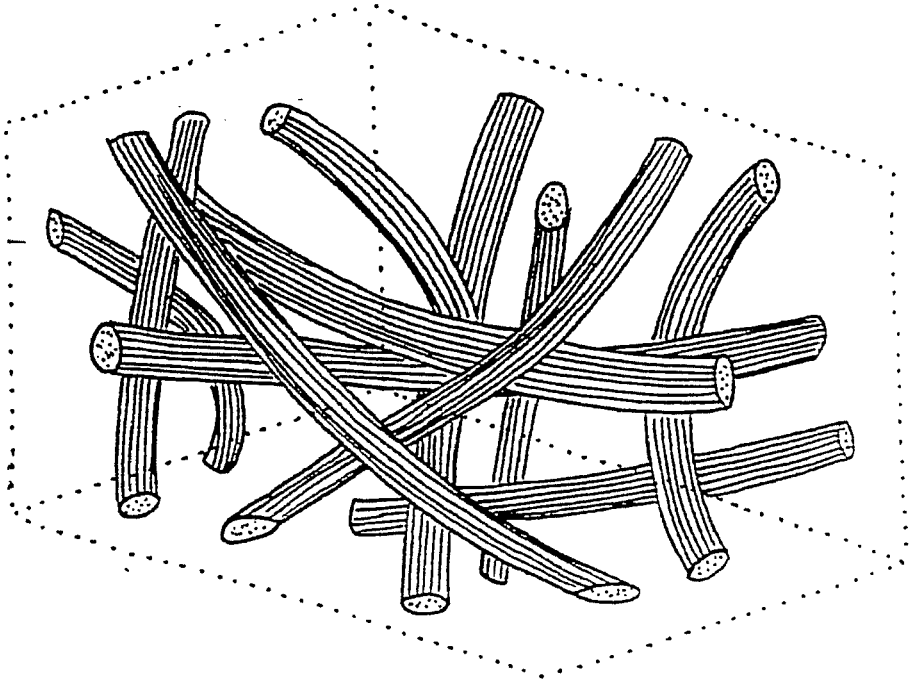
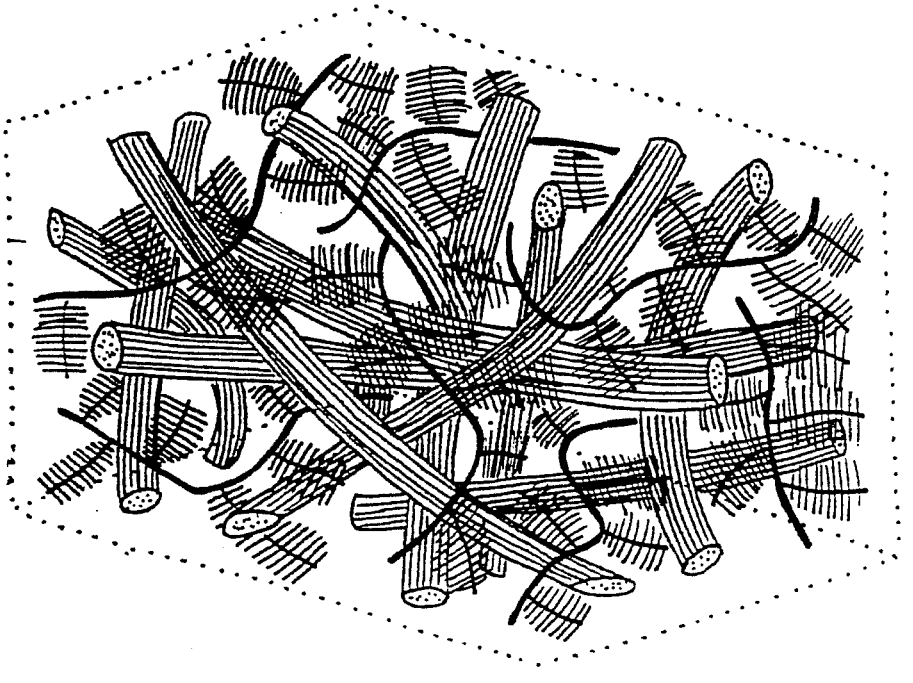


Fig. 6.7 Stress-strain curve for a ligament. (Based on Nordin and Frankel,[409] and Noyes.[411])

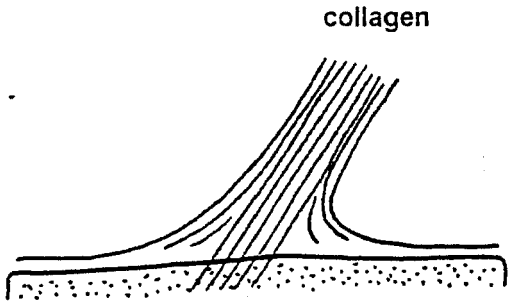
IRREGULAR FIBROUS CONNECTIVE TISSUE





ATTACHMENT SITES

TENDON



LIGAMENT (ENTHESIS)