Methods of examination

Classification of examination methods

- Examination of live-dead tissues: SUBJECT TO APPROVAL

(Hungary: Helth registration and training center)

- Examinations according to the method:
  - In vitro examination (examination on dead tissues)
  - In vivo examination (examination on live bodies)
- Examinations according to types:
  - Static
  - Dinamic

In vitro examination

- Goal:
  - Determination of tissue's (ligaments, muscles, bones and other) strength and deformation characteristic
- Methods:
  - Static (strength, deformation)
  - Dinamics (strength, numbers of repetitions, strength after given repetitions)

In vitro examinations

- Types:
  - Pulling (muscles, ligaments, rarely bones)
  - Pressure (bones)
  - Bending (pulling)
  - Others (eg, joint flexion)
- Size of sample
  - Full size (in compression buckling problem
  - Selected sections

Conduction of In vitro studies I.

Determination of target, chose:

- Modes: static or dynamic
- Type: pressure, pulling, bending, etc.
- Size: whole or cutted section
- number of pieces

Sampling

- In all cases pathologist (human or animal)
- Requirements has to be observed.
- Storage: Store in cool, chilling, freezing, ethyl alcohol, formaldehyde (prohibited)

Effects of storageing

- Cooling: There is no significant change in 5 hours
- Freezing: There is no significant change in 100 days
- Ethyl Alcohol:
  - dehydration and structural changes
  - Pressure strength loss,
  - bending strength and stiffness increase
  - m% depend on the storage time
- formaldehyde:
  - destroys collagen fibers, structural change
  - strength reduction

Conduction of In vitro studies II.

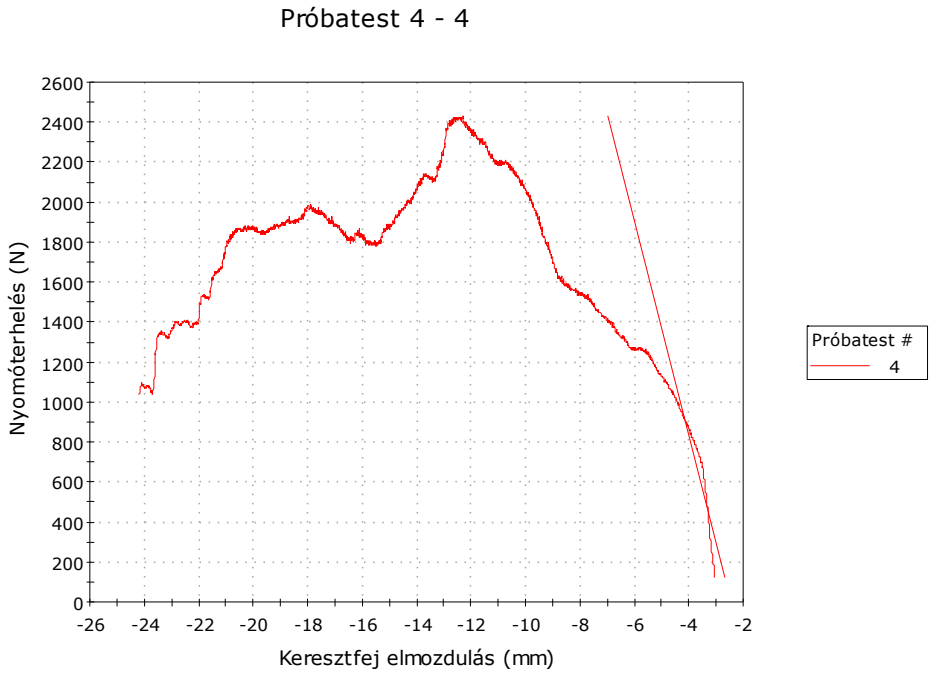
conducting experiments

- •loading rate
- •preload
- •Measured parameters (force, displacement)
- •Calculated parameters (stress, strain, Young modulus)

Conduction of in-vitro experiments

Conducting experiments

- loading rate
- preload
- Measured parameters (force, displacement)
- Calculated parameters (stress, strain, modulus of elasticity)

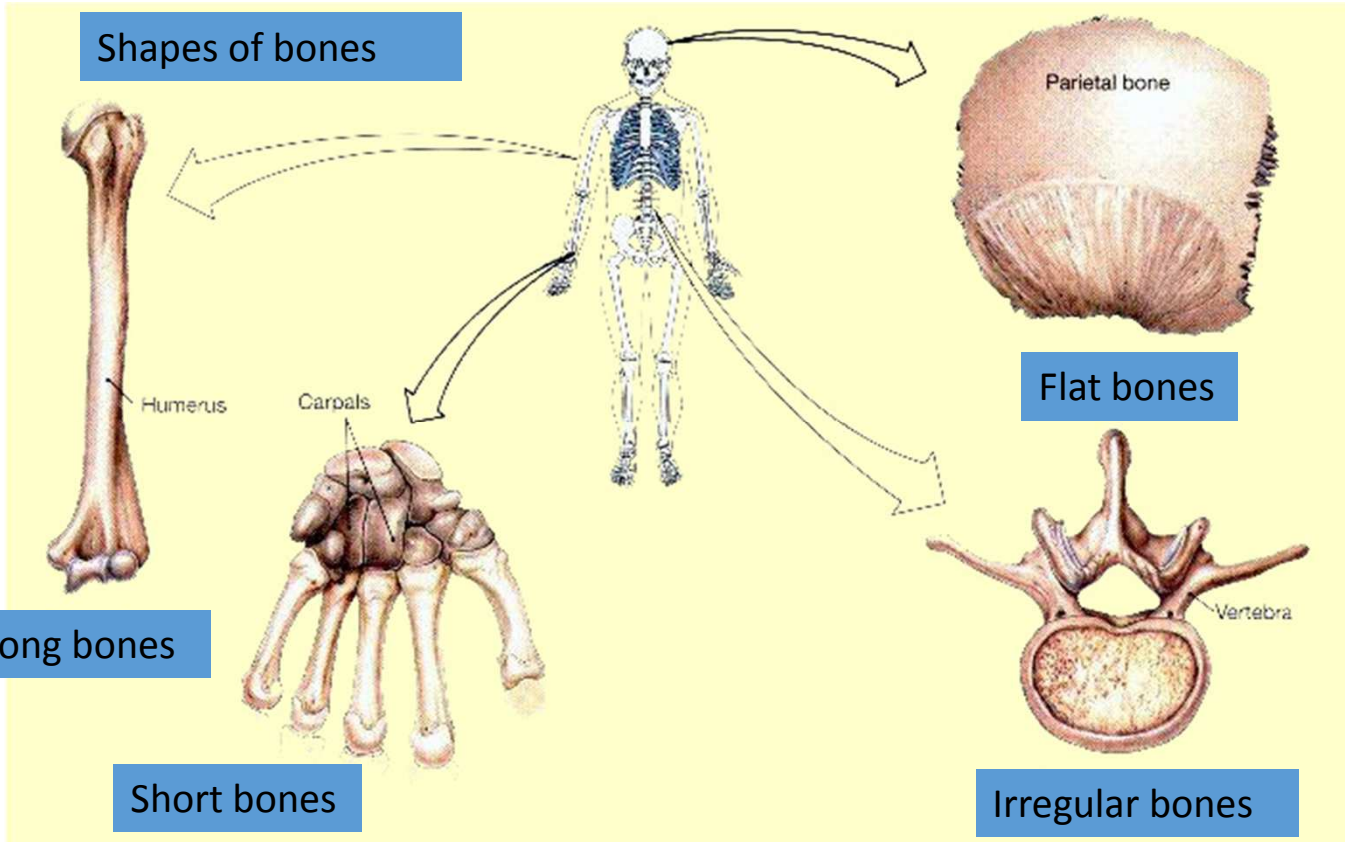


Conduction of In vitro studies III.

Analysis of the results of the experiments

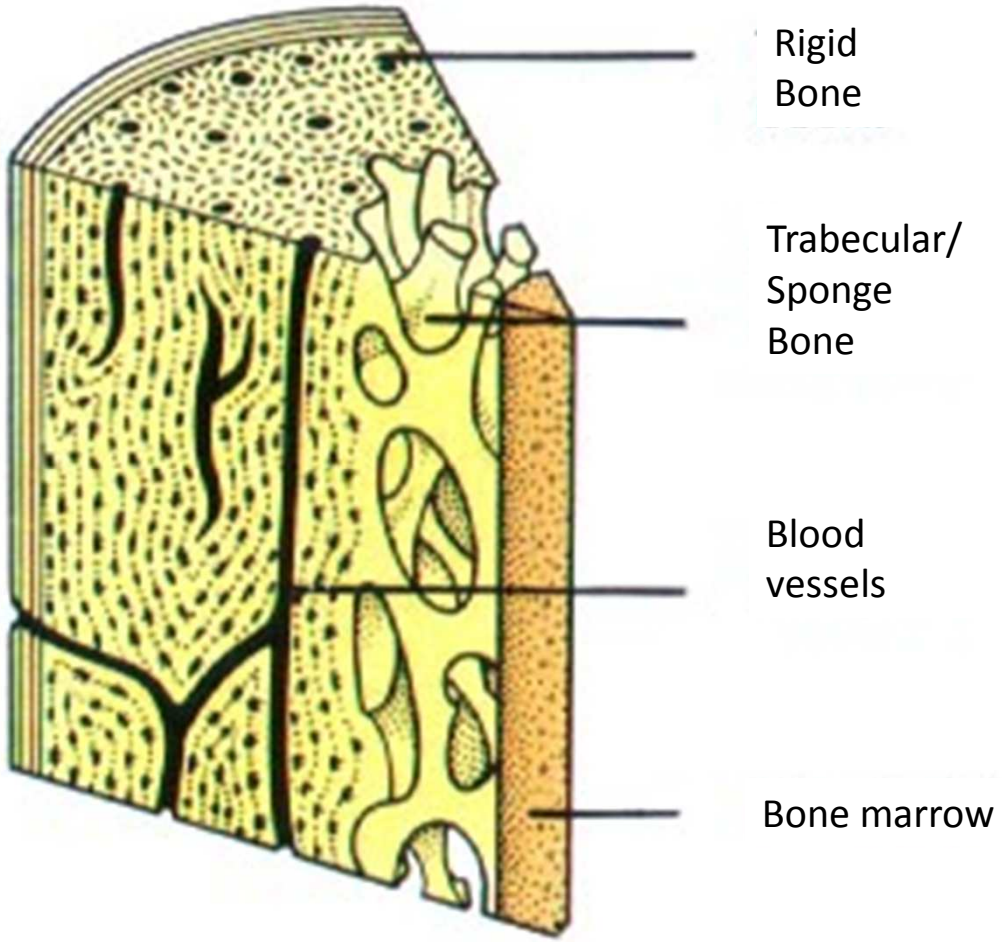
- Number of experiments
- Comparable parameters
- Statistical methods
- Findings, observations

Classification of bones

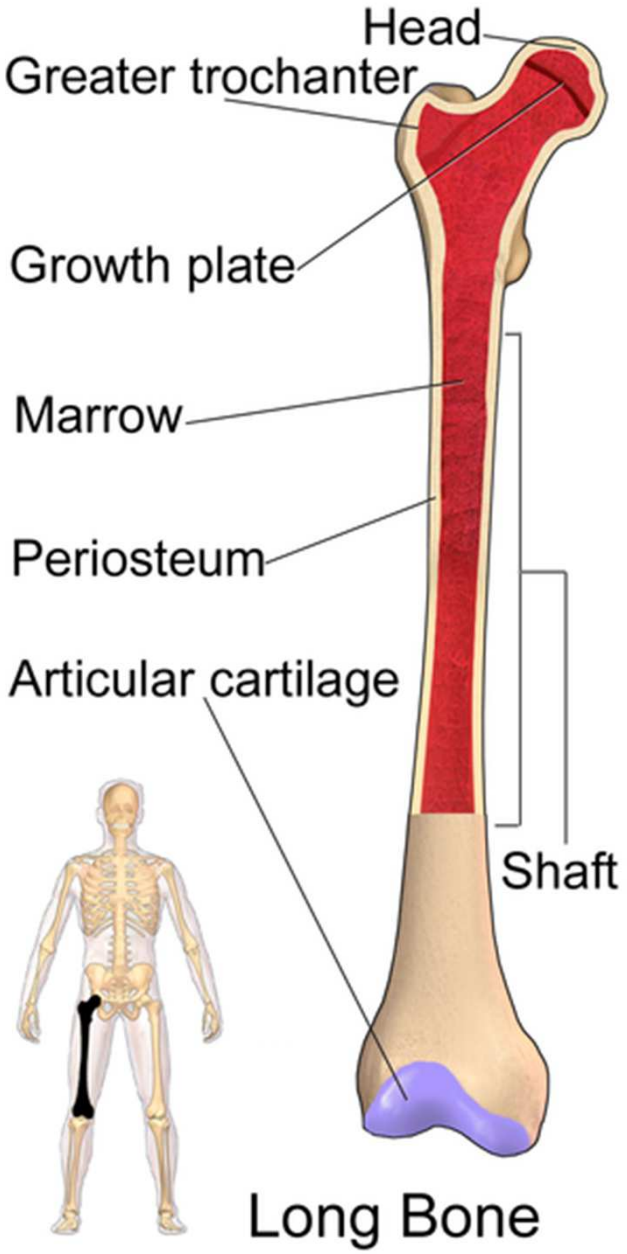


Structure of bones

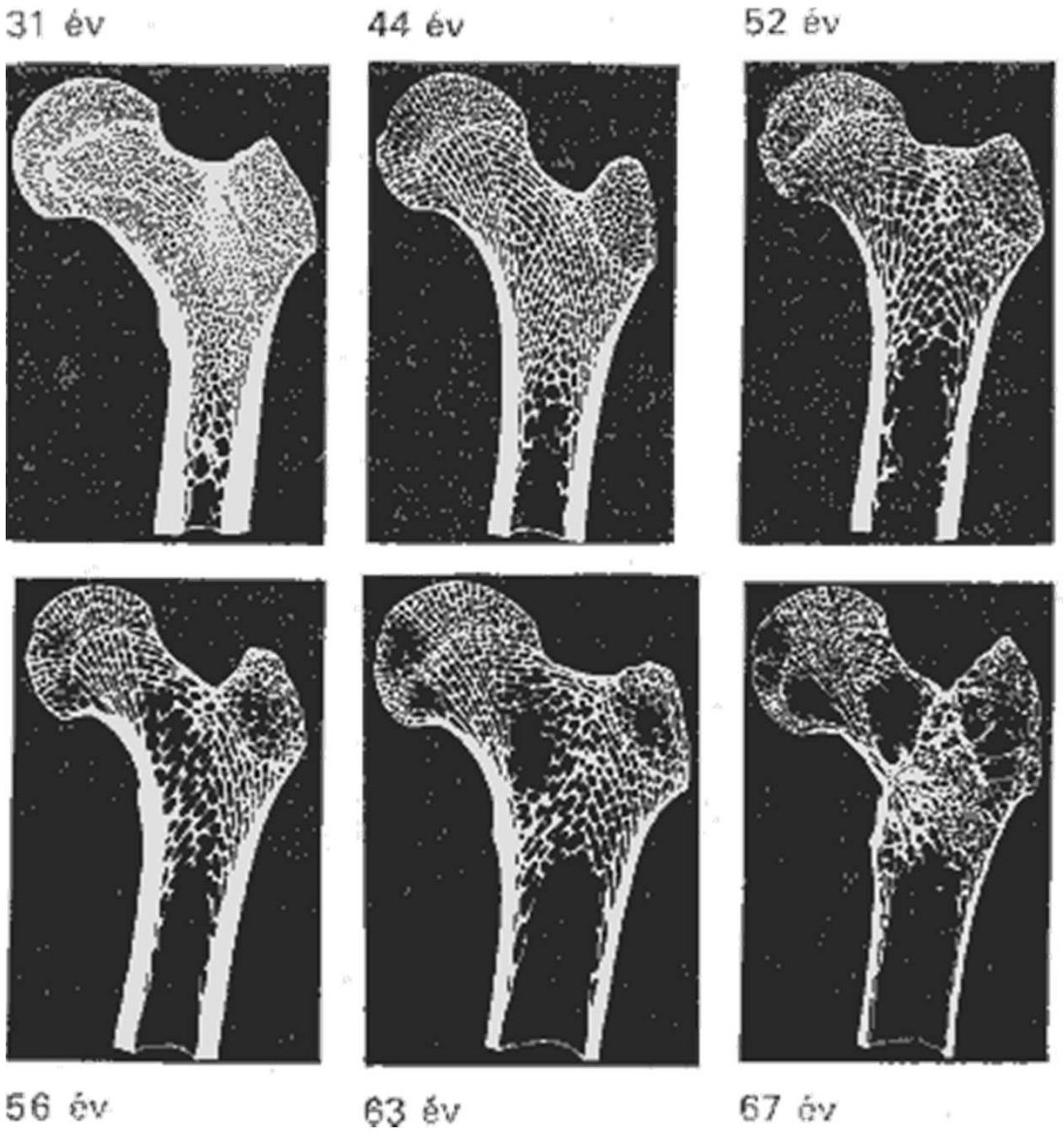
- The majority of bone is made of the bone matrix. It is composed primarily of inorganic hydroxyapatite and organic collagen the rate of the two stock are changing during the life
- osteoblasts (bone cell that resorbs bone tissue)
- osteoclasts (bone cell that forms the bone tissue)
- Periosteum (covers the bone),
- Compact (cortical) bone
- Trabecular (spongy) bone
- Bone marrow



Femur /tigh bone



Changing



Mechanical performanve of bones

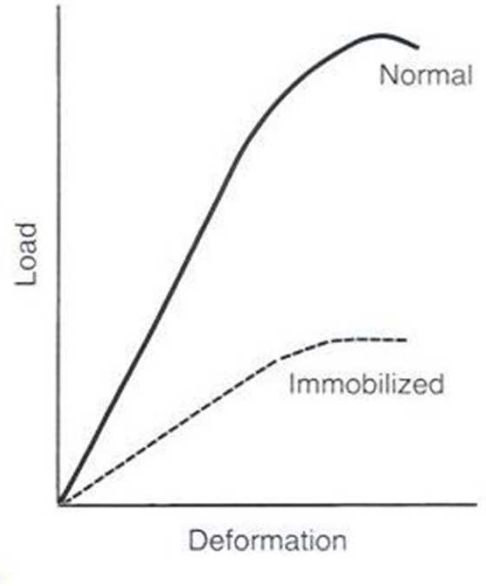
In general pressure test (in case of long bones bending tests)

The factors affecting the mechanical properties of bone formation and bone

- •Weight
- physical activity
- diets
- way of life
- Inherited properties

The differences in bone

- Bone hyperthropy
- Bone atrophy
- Osteoporosis
- Female athlete triad



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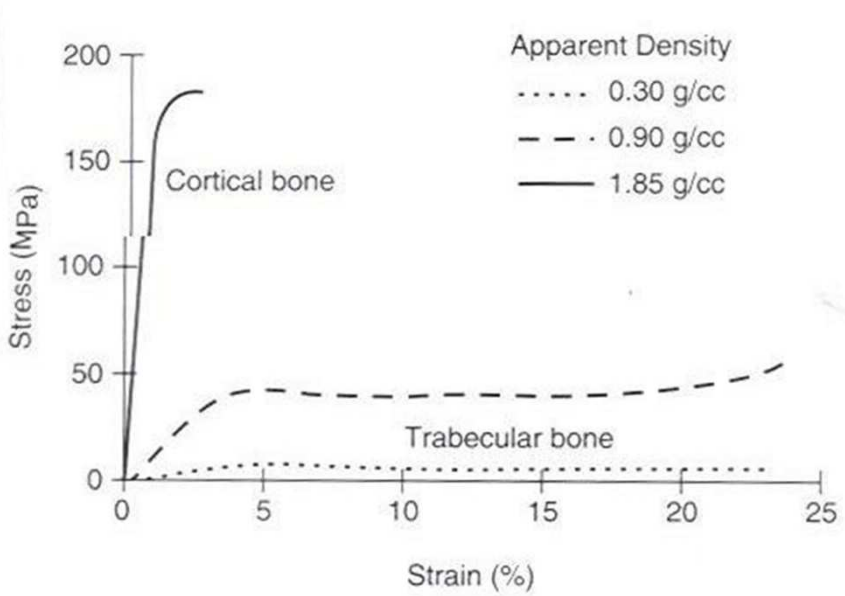
Mechanical performance

- In case of different bones



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Mechanical properties

	Ultimate Strength (MPa)	Modulus (GPa)	Elongation (%)
Metals			
Co-Cr alloy			
Cast	600	220	8
Forged	950	220	15
Stainless steel	850	210	10
Titanium	900	110	15
Polymers			
Bone cement	20	2.0	2–4
Ceramic			
Alumina	300	350	<2
Biological			
Cortical bone	100–150	10–15	1–3
Trabecular bone	8–50		2–4
Tendon, ligament	20–35	2.0–4.0	10–25

Adapted from Kummer, J.K. (1999). Implant biomaterials. In J.M. Spivak, P.E. DiCesare, D.S. Feldman, K.J. Koval, A.S. Rokito, & J.D. Zuckerman (Eds.). *Orthopaedics: A Study Guide* (pp. 45–48). New

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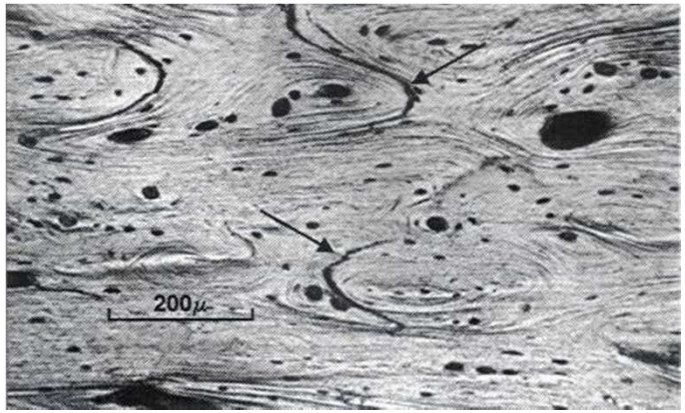
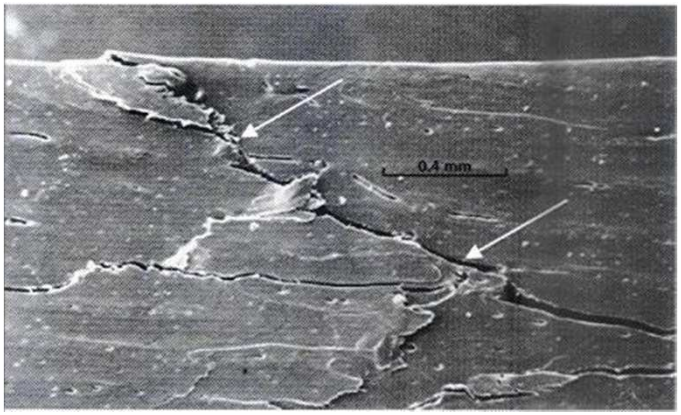
Types of fractures



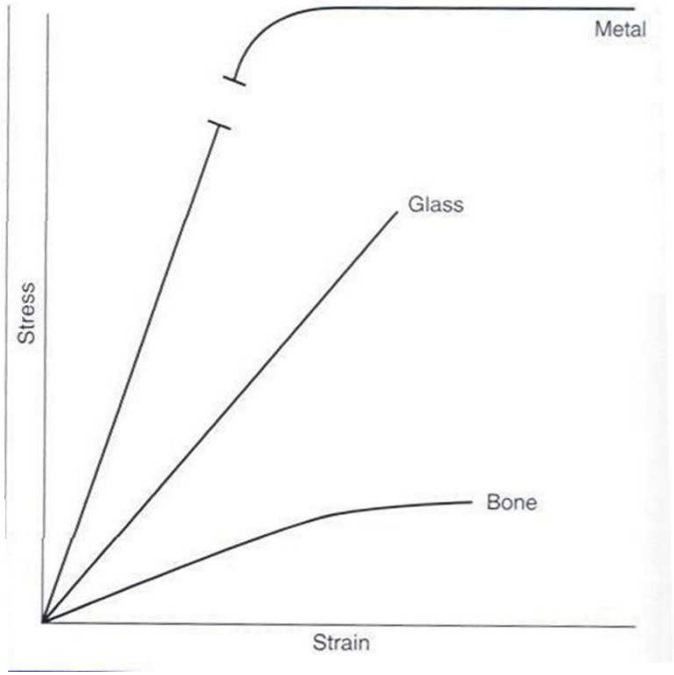
plastic



brittle

Mechanical properties

- Compared to other materials



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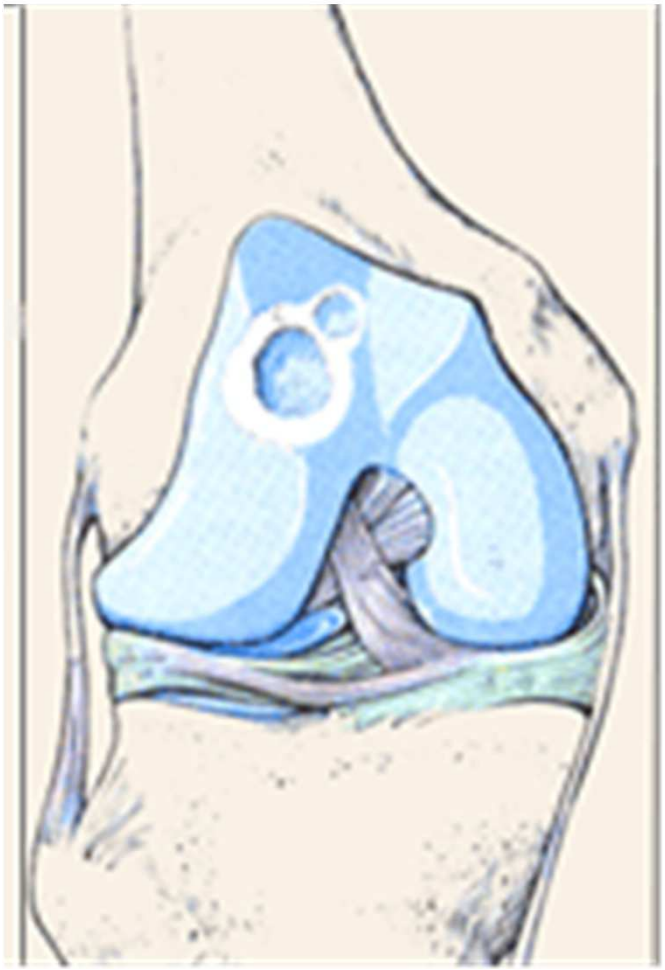
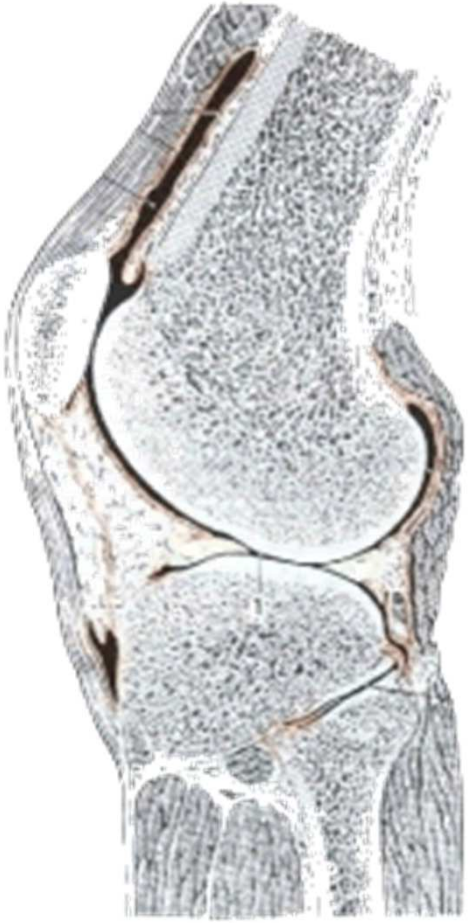
Cartilage



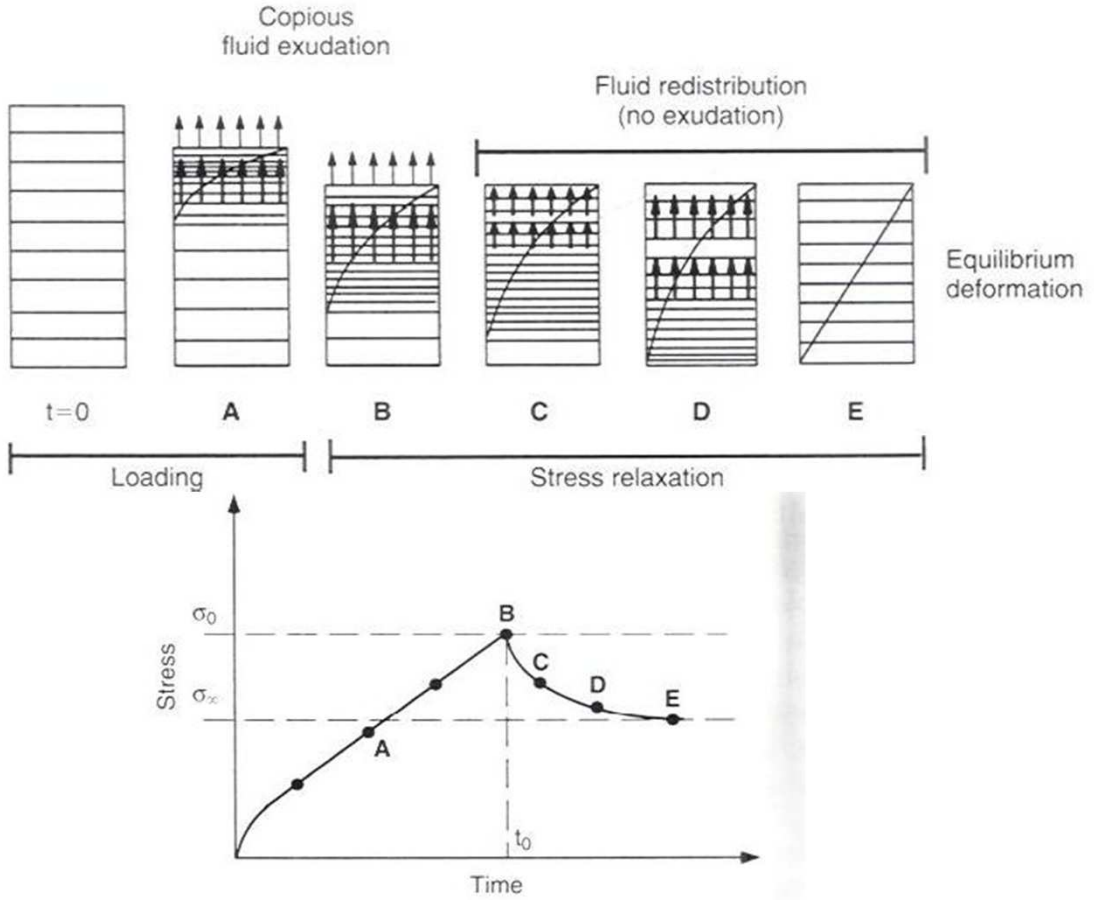


is a flexible connective tissue found in many areas in the bodies of humans and other animals, including the joints between bones, the rib cage, the ear, the nose, the bronchial tubes and the intervertebral discs. It is not as hard and rigid as bone but is stiffer and less flexible than muscle.

Properties of cartilages

- Types
- **Hyaline** - most common, found in the ribs, nose, larynx, trachea. Is a precursor of bone.
- **Fibro**- is found in invertebral discs, joint capsules, ligaments.
- **Elastic** - is found in the external ear, epiglottis and larynx.
- Role of fibrocartilage
  - Safe fit of joint surfaces
  - Regulate the sliding of bone surfaces on each other
  - Wetting of joint surfaces
  - Uniform load distribution
  - Damping of collisions

Behaviour of cartilage during load



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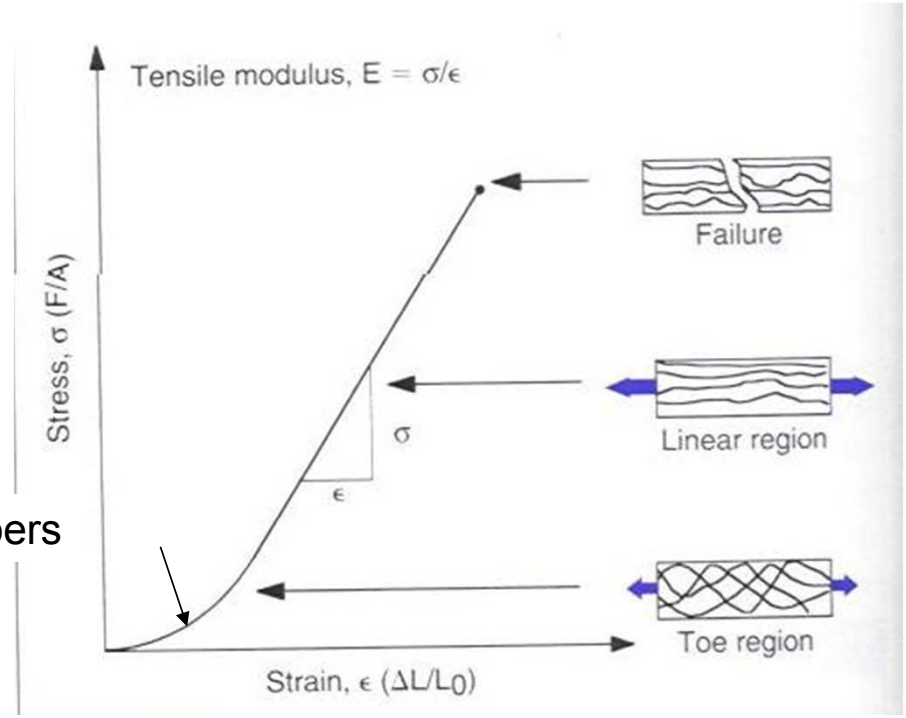
Mechanical properties of cartilage

Alignment of fibers



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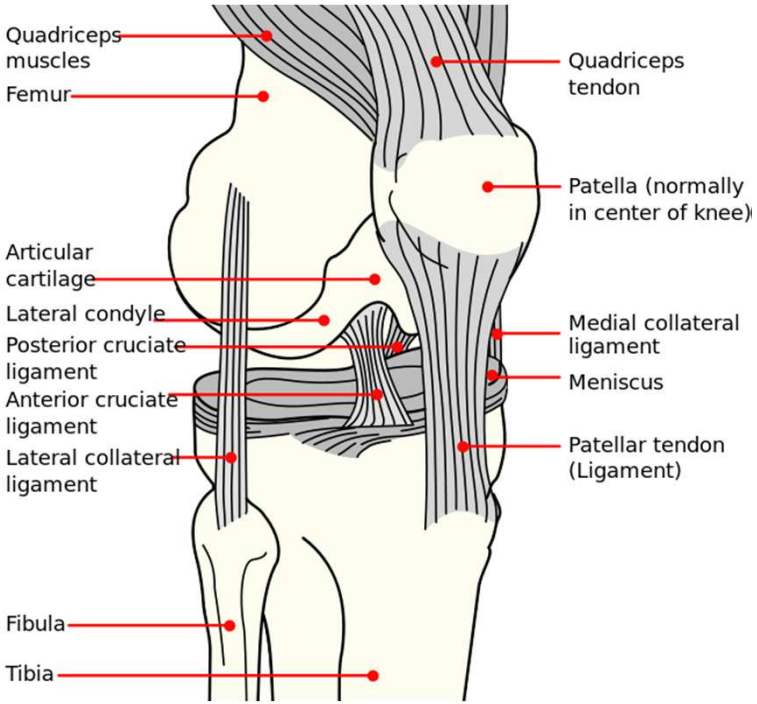
Ligaments

part of joint

Flexible connective tissue



Muscles

The muscle belly is the active part of the muscles which are able to contract. Theese transverse striped muscle tissue can function by the human will except heart muscle.

The passive part is composed by tendons, thees are less flexible and built up by collagen cells.

Classification of muscles

Based on the shape

long (biceps)

short (on the palm between the fingers)

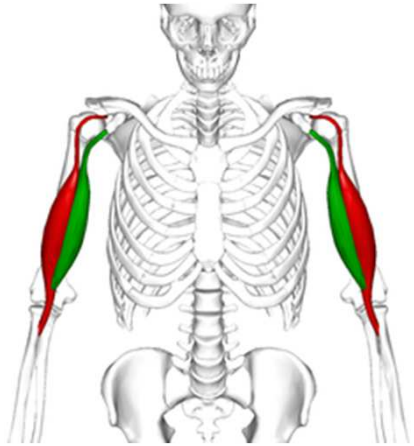
flat (abdominal muscle)

Circular (= closing muslce/sphincter)

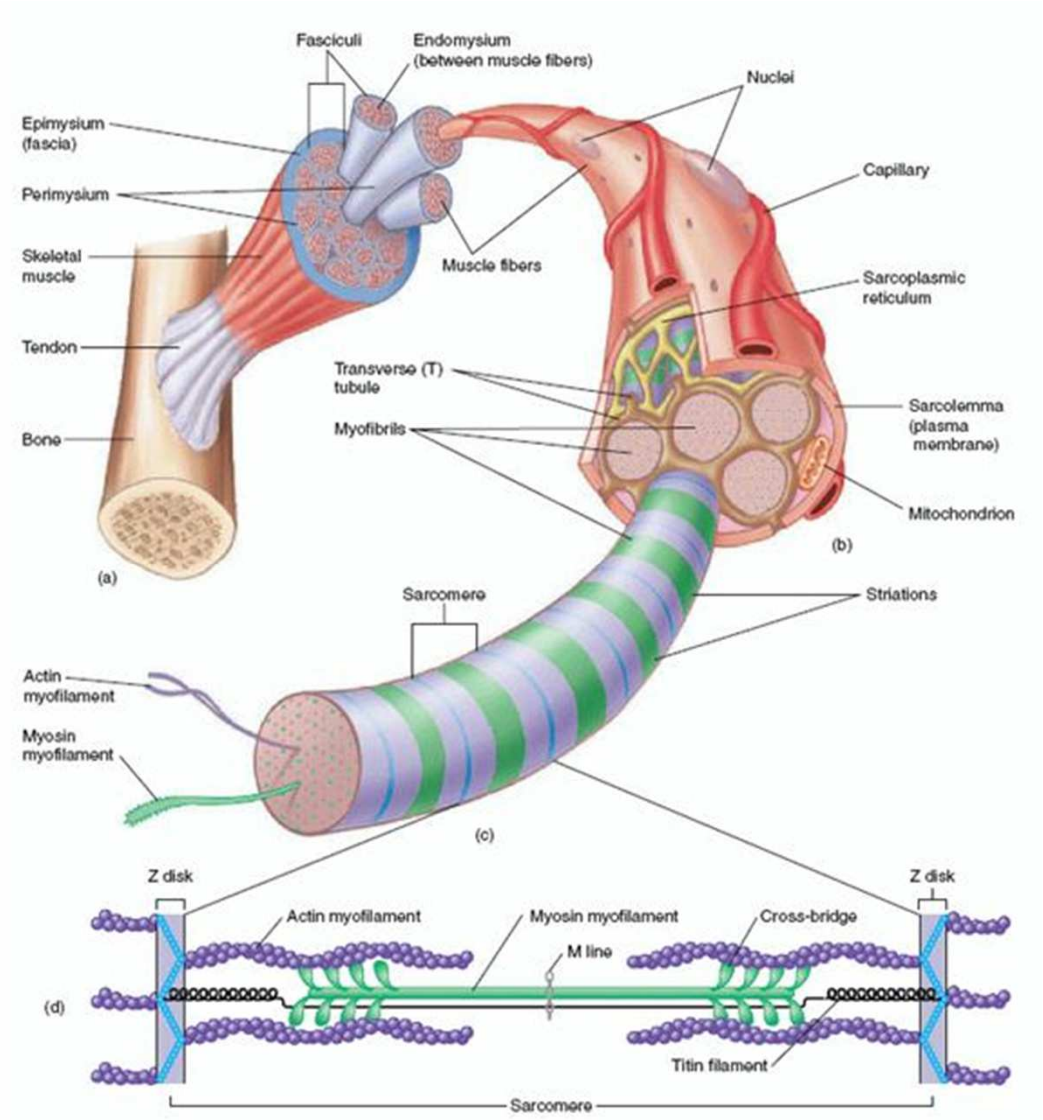
Based on the origin

1-, 2-, 3-, 4- headed

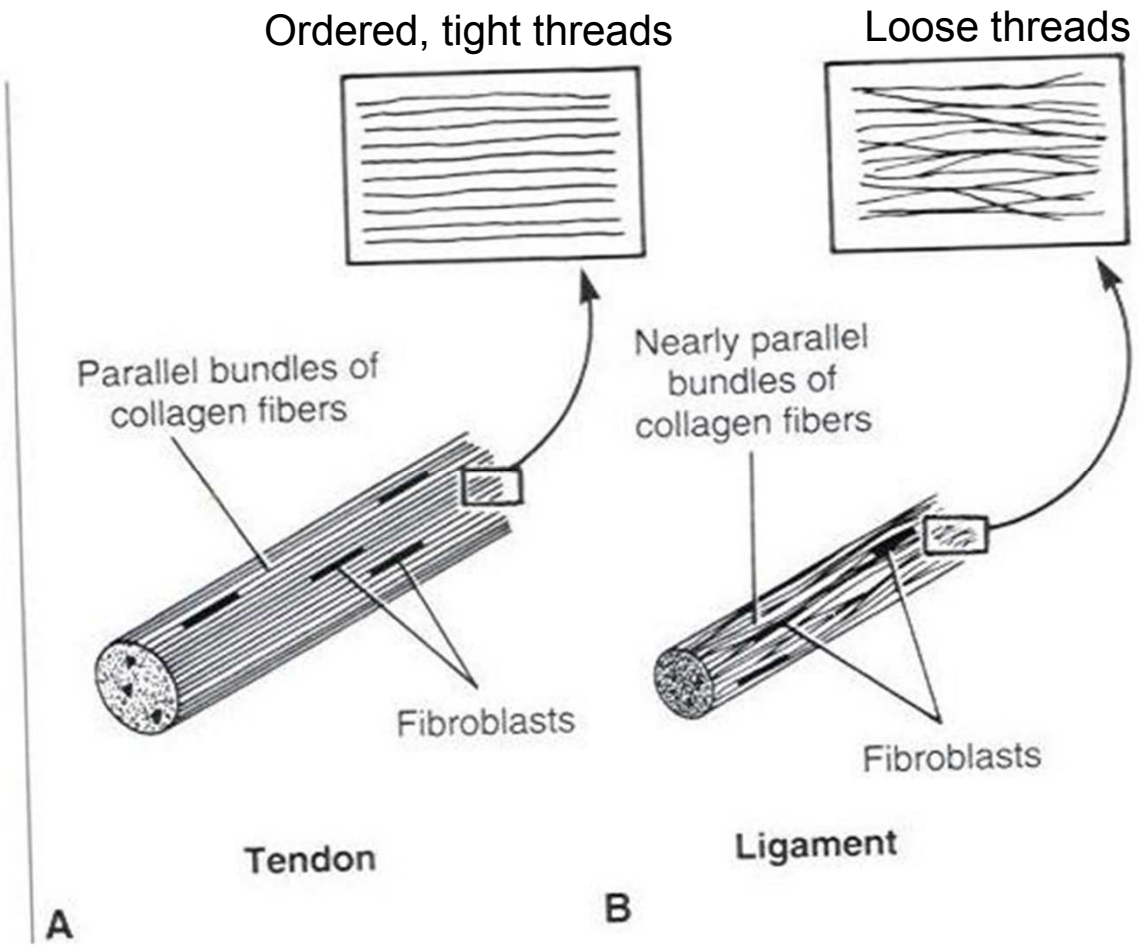
Double headed (biceps)



Structure of the muscle



Structure ligament-tendon



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Tendons

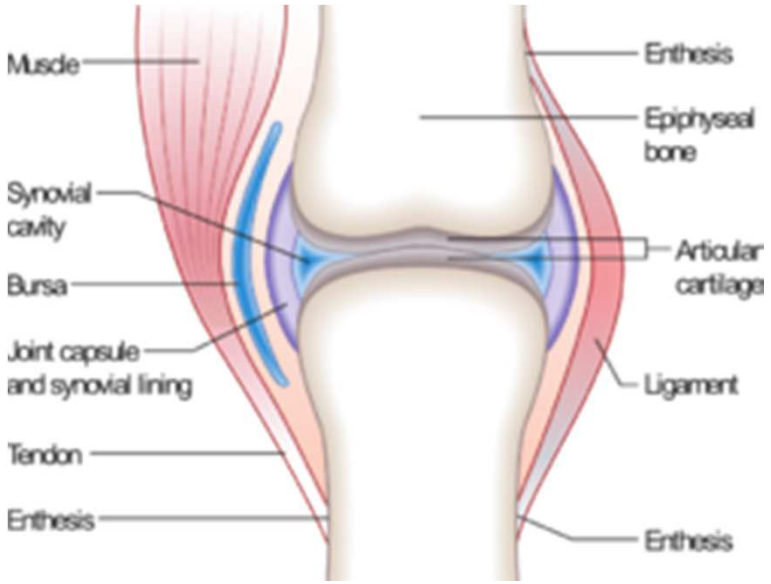
Tendon: fix the muscles to the skeleton, and prevent the passive overtension

Additional parts: bursa

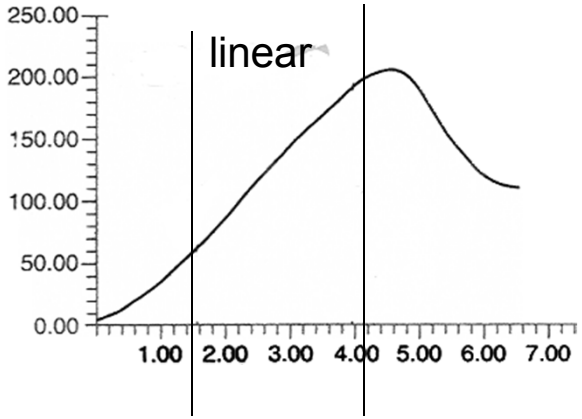
vagina tendinis

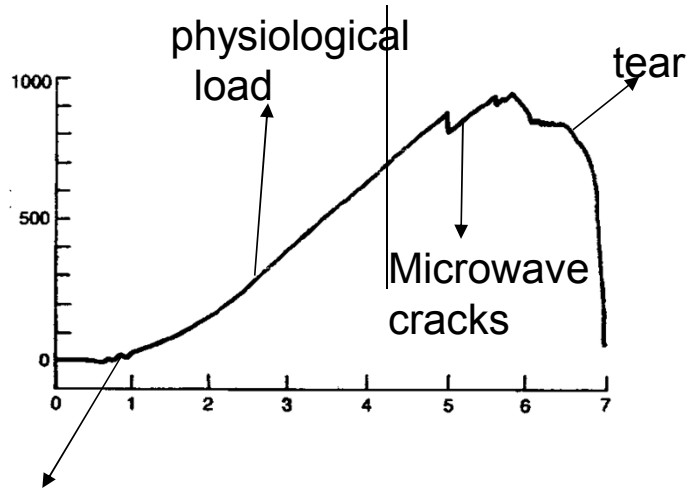
fascia=

layer of fibrous tissue



Mechanical properties of tendons ligaments





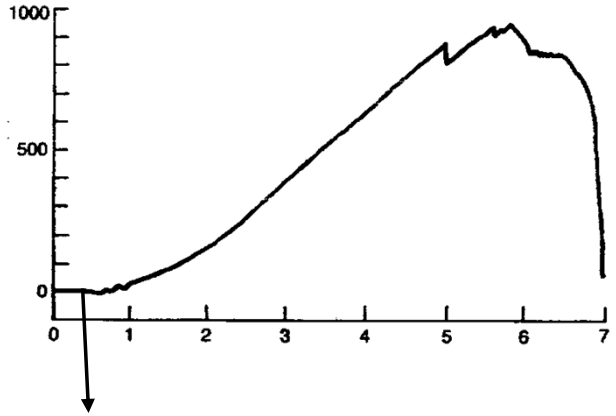
Flattening of the fibers

Tendon **Ligament**

Planning of the examination

chucking

Preload



Preload is needed? How much?

Mechanical proerties of ligament and tendons

Component	Ligament	Tendon
Cellular Material:	20%	20%
Fibroblast		
Extracellular Matrix:	80%	80%
Water	60–80%	60–80%
Solids:	20–40%	20–40%
Collagen:	70–80%	slightly higher
Type 1	90%	95–99%
Type 3	10%	1–5%
Ground substance	20–30%	slightly lesser

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Influencing factors

- pregnancy
- age
- Movement (mobilization)
- diabetes
- steroids
- Anti-inflammatory drugs (NSAF)
- Kidney problems (dialysis)
- Graft type of connection