BIOM3003 Study Notes

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This sample contains a page from each module.

Carl's Module

Selection

Natural selection is a mechanism for evolutionary change that favours survival and reproduction of some organisms over others because of their biological characteristics. Sexual selection is a mechanism for evolutionary change that favours increased progeny production of some organisms as a consequence of mate choice for certain biological characteristics (long tails, hard to maintain).

Simple Genetic Traits: select for dominant alleles, recessive alleles or heterozygotes. Complex Genetic Traits: directional selection (want particular direction), stabilising selection (want middle) or disruptive selection (want extreme ends).

Evolution is change in genetic composition of population over time. Driving forces:

- Mutation: changes in nucleotide sequence
- Genetic drift: random change in small populations
- Selection (natural and sexual): filters variation and leads to adaptation
- Gene flow: movement of alleles between populations

Microevolution is short term change in species. Macroevolution is long term change.

H&E

Hematoxylin: basic dye, blue colour, stains basophilic structures - acid (nucleus and RNA rich areas of cytoplasm like ribosomes and rER)

Eosin: acid dye, red colour, stains acidophilic structures - basic (collagen, mitochondria, membranes)

Cartilage

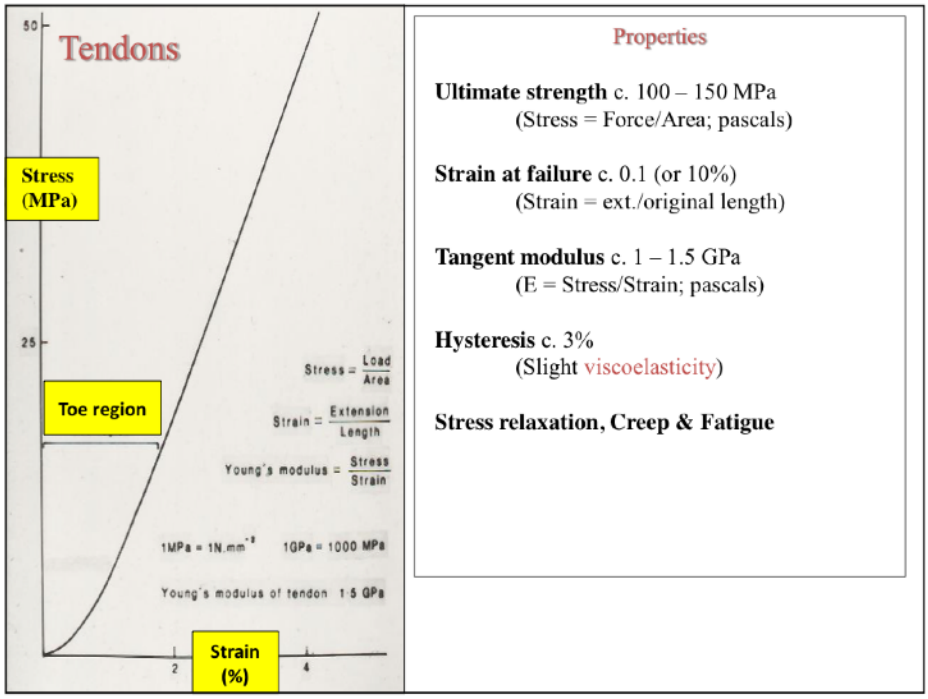
- blue
- if pink, it is becoming more ossified
- avascular
- has perichondrium which is membrane with dark dots (precursors to cartilage)
- Eburnation - worn off cartilage, polished bone

Mike's Module

3-5cm above calcaneus is point of lowest vascularisation, this is where overheating occurs and is likely to break.

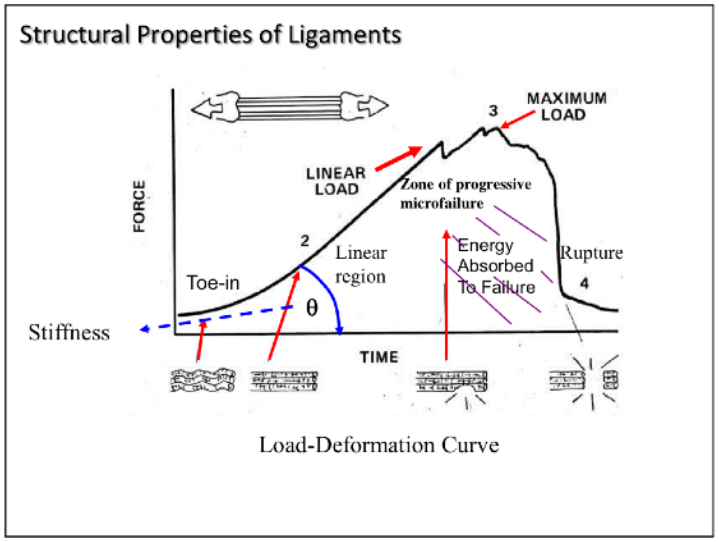
All tendons have similar characteristics.

There is limited effect of age (maturity of collagen). Age effect is mainly during early development. Increasing the strain has a minor effect on properties (slight increase in modulus).



Elastic - immediately get stress in response to constant load. With collagen, a constant load results in increased stretch (strain goes up) and overtime deformation increases [creep].

If you apply 100MPa, tendons busts immediately. If you apply half the load, you need to wait a bit before it fails. If you apply 12MPa, it ruptures in 5.5 hours. Achilles tendon has high area ratio and can load 30-50MPa. Is likely to suffer from fatigue form of creep. May have repair mechanisms. Can't distinguish between flexors and extensors on on stress-strain curve but can on fatigue test. Will show flexor is more resistant to fatigue than extensors. Have similar gradient but flexor is shifted higher.



Achilles tendon rupture more likely in males, recreational athletes and from frequent eccentric (force extends muscle) loading.

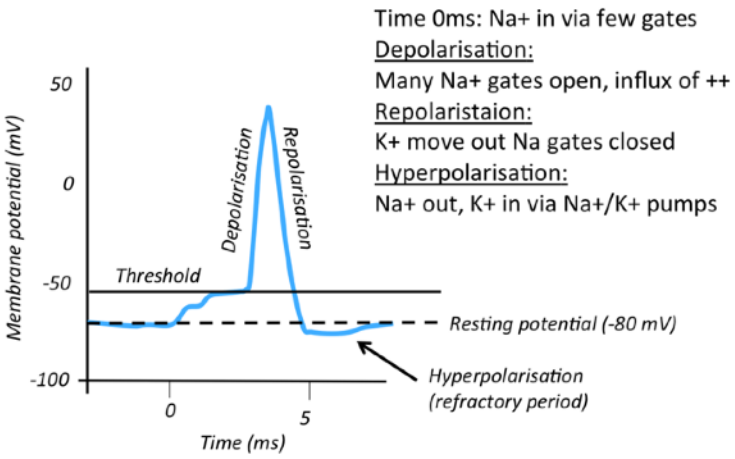
Unlike tendon that breaks at one point, ligament will have a microfracture. The rest will continue to support the load. After many minor damages, the whole thing fails = graded failure. When you load ligament and pull on bone at each end, the short fibres are strained more than the longer fibres.

Kylie's Module

Using EMG to measure the activity of muscles

Physiology of motor unit and AP generation

Motor unit is the motoneuron (in spinal cord), motor axon and all the muscle fibres it innervates. They range in size to allow graded, sustained and controlled force. It receives input from descending pathways, spinal interneurons and afferent fibres. The force is altered by number and discharge rate of motor units and contractile properties of the muscle fibres. Measuring electrical activity generated by the muscle AP provides information about complex changes in motor excitability (timing of activity, strength of neural drive), fibre types (conduction velocity), muscle fatigue…



Repolarisation restricts maximum discharge rate

Motor neuron terminates on motor end plate/motor point/neuromuscular junction and releases neurotransmitter ACh. If postsynaptic cleft reaches threshold, AP runs along muscle fibre.

AP propagation is 2-5m/s (conduction velocity) along muscle fibre.

Record AP with surface EMG or fine-wire EMG

Surface electromyography:

- recording is a complex summation of overlapping asynchronous AP
- the change in ions as it flows through muscle tissue is picked up by electrodes (in the recording zone)
- Use bipolar (+ and -) electrode to reduce noise

Intramuscular electromyography:

- recording from a small region, can selectively record single or a collection of multiple MUs
- Distance between electrode and muscle fibre affects size and shape. Summation of many muscle fibres different shape compared to MU with few muscle fibres.

Olga's Module

Locomotor Gaits

Changes in gait are associated with movement at different speeds, acceleration and manoeuvrability, energetic efficiency (oxygen consumption), stability and typically involve a discontinuous change in limb kinematics.

Symmetrical gait = left and right limbs of a pair alternate

Asymmetrical gait = limbs move together

Duty factor: % of total cycle which a given foot is on the ground (measure of stance phase)

- >50% is walk
- <50% is run

Stride Length and Frequency

How quick you change and how large it is.

With cheetah and greyhound, increased speed increases the stride length. However the frequency doesn't change in the greyhound.

Gait Mechanics

Walking	Running
Inverted pendulum (stiff-legged gait)	Pogo sticks
less compliant	more compliant
stability, limited manouvrability	manoeuvrability requires dynamic stability
muscles and tendons support strut-like limb in walking	muscle and tendons are used more to provide elastic energy storage in running

Walking is cheaper than moderate speed running, then running becomes cheaper. We switch gaits at around the speed (and stride length-frequency combination) that optimises our metabolic cost of locomotion. Energy is conserved via passive mechanisms in both gaits via pendular motion of CoM in walking vs. elastic strain energy storage/recovery in running.

Walking	Running
CoM vaults up after heelstrike	CoM falls down after heelstrike
Reaches highest point at midstance	Reaches lowest point at midstance
Then swings down	Then springs back up
No whole-body aerial phase	Whole-body aerial phase

Marc and Claire's Module

Dorsal Column / Medial Lemniscal Pathway

- Sensation: fine touch, vibration, proprioception
- nerve fibres are large, myelinated axons
- ascend spinal cord ipsilaterally
- are some synapses in spinal cord grey matter (nucleus proprius) for ipsilateral and contralateral reflexes
- Gracile fascicle: fibres from lower body. Cuneate fascicle: fibres from upper body. [lumbar - see only GF. Cervical - see both]
- 1st order: contact receptors in periphery, cell body in root ganglion, axon goes through spinal cord ipsilaterally to medulla. Can also send collateral branches
- 2nd order: 1st order synapses with cell body in medulla. Decussates at pyramids.
- 3rd order: 2nd order synapses in thalamus. Sends to cortex to become aware of sensation.