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*Bachelor of Physiotherapy
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Repairing connective tissue

How the right diet can help



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Mechanotherapy

- Mechanical perturbations lead to structural adaptation
- Davis' law (described 1867)
 - Tendon
 - Muscle
 - Articular cartilage
- Wolffs' law (described 1892)
 - Bone



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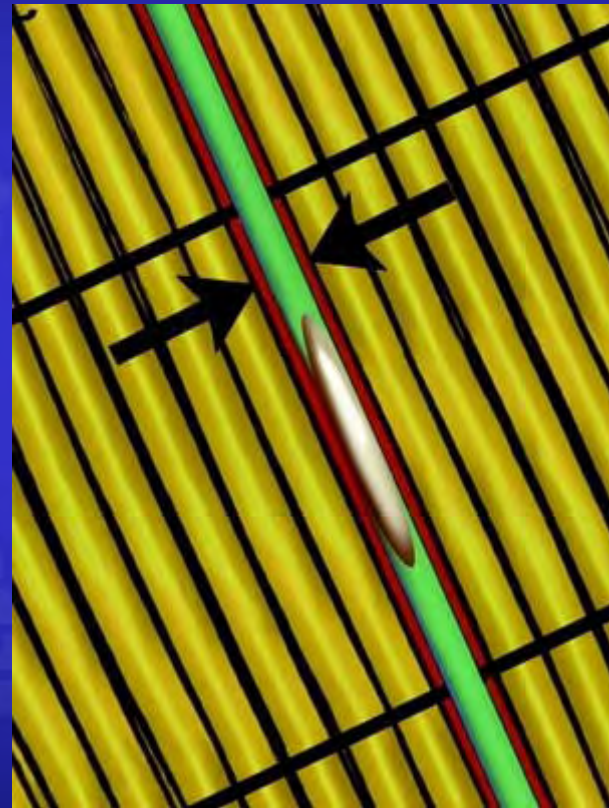


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Mechanotherapy

- 1) mechanical stimulus
 - Direct or indirect



K M Khan and A Scott Br J Sports Med 2009;43:247-252

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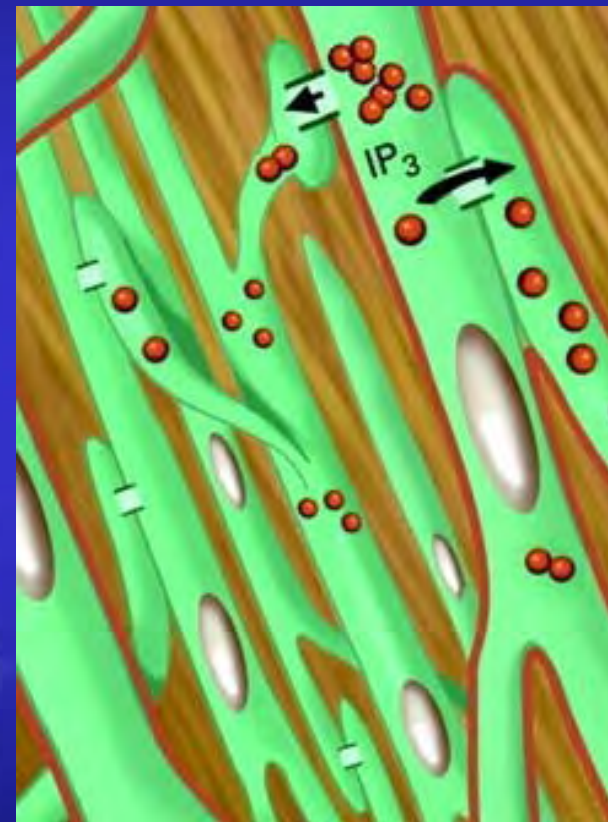
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Mechanotherapy

2) chemical signals

- Within and between cells
 - Messenger proteins
 - Ion channels



K M Khan, and A Scott Br J Sports Med 2009;43:247-252

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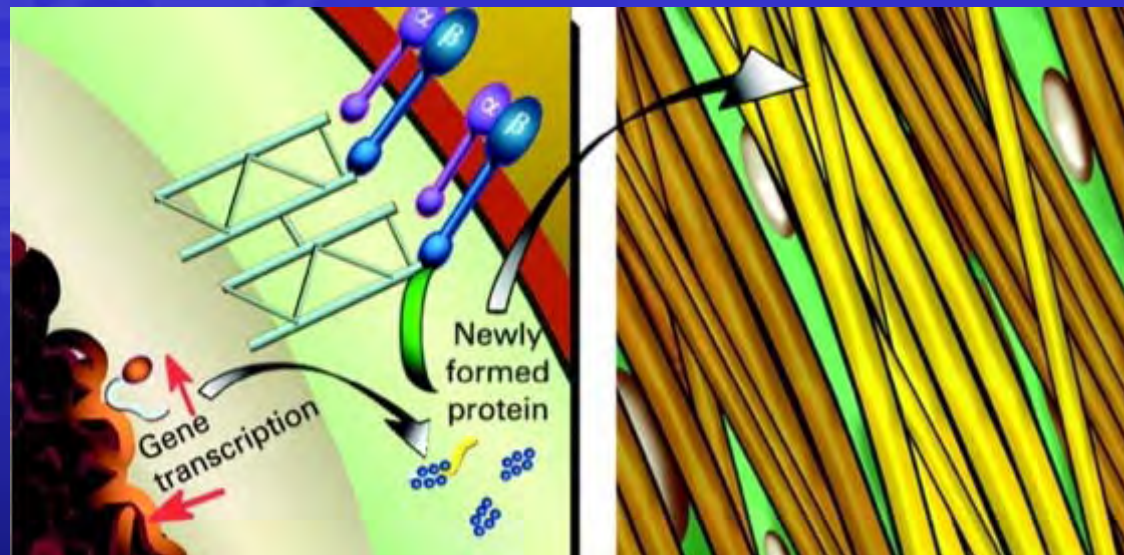
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Mechanotherapy

3) cellular response

- Increased extra-cellular matrix protein synthesis



K M Khan, and A Scott Br J Sports Med 2009;43:247-252

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Can we influence the balance between anabolism and catabolism?

- Catabolism followed by anabolism
- Net balance determines overall effect



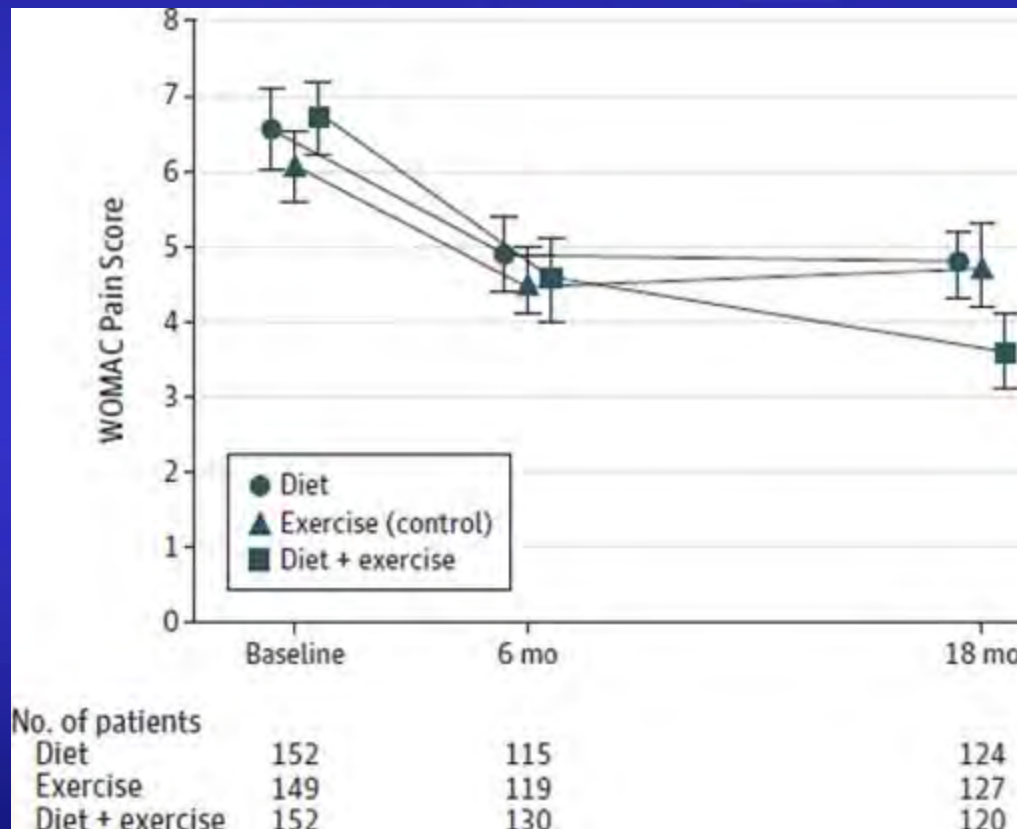
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How does 10% weight loss = 50% pain reduction?



Effects of Intensive Diet and Exercise on Knee Joint Loads, Inflammation, and Clinical Outcomes Among Overweight and Obese Adults With Knee Osteoarthritis. Messier et al. JAMA 2013.



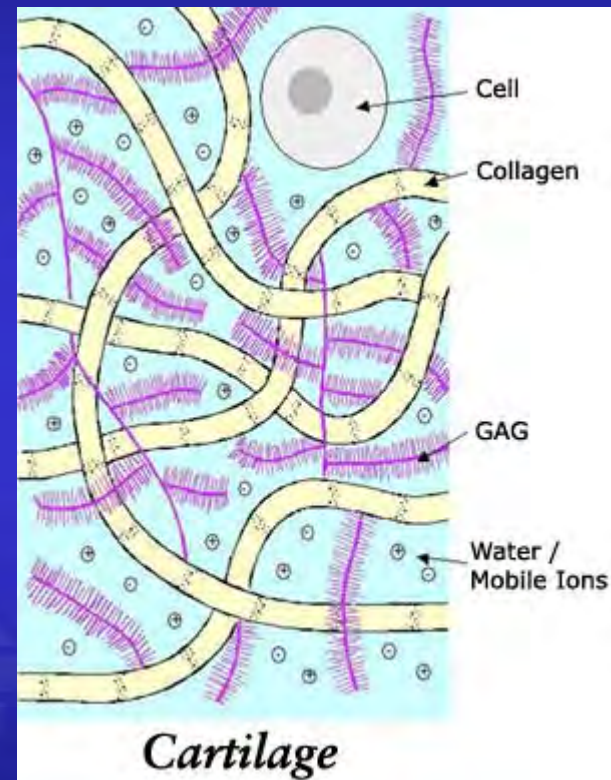
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Articular cartilage

- Chondrocytes maintain extra-cellular matrix
- Extra-cellular matrix
 - Structural support
 - Supports cell functions
 - Constantly remodelled
 - MMPs
 - TIMPs



<http://www.bidmc.org/Research/Departments/Radiology/Laboratories/Cartilage.aspx>



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Matrix Metallo Proteinases (MMPs)

- 24 MMPs in humans
- Degrade extra-cellular matrix
- Constitutive secretion by the liver
 - Secretion increases with liver disease
 - Increases catabolic breakdown of extra-cellular matrix



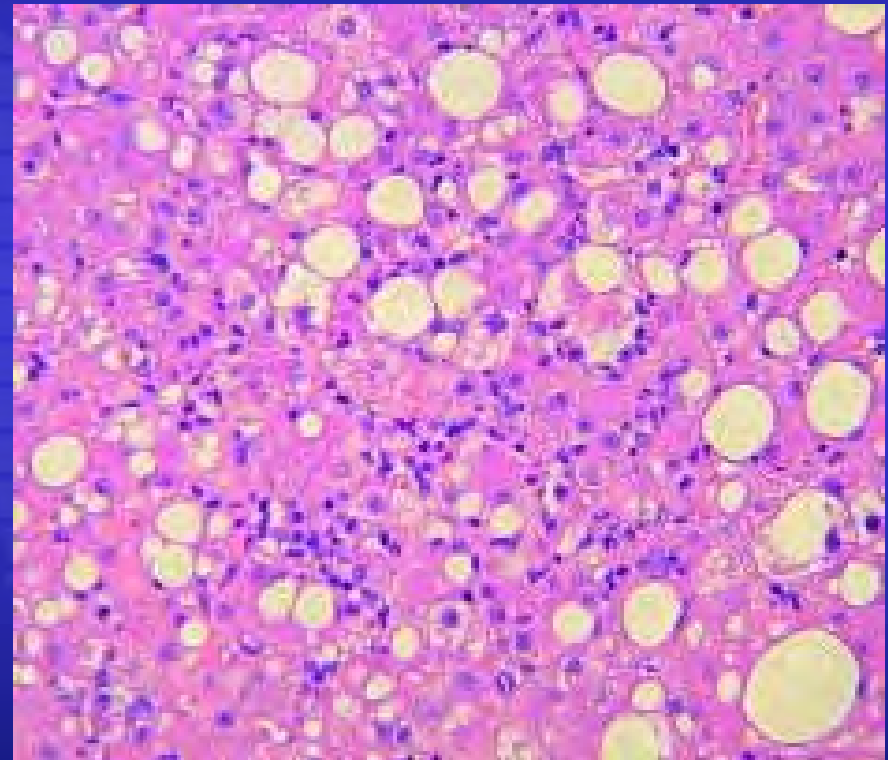
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Non-Alcoholic Fatty Liver Disease (NAFLD)

- De Novo lipogenesis
 - Collagenases (break down collagen)
 - MMP 1*
 - MMP 8*
 - MMP 13*#
 - MMP 18
- *up regulated in NAFLD
#implicated in OA



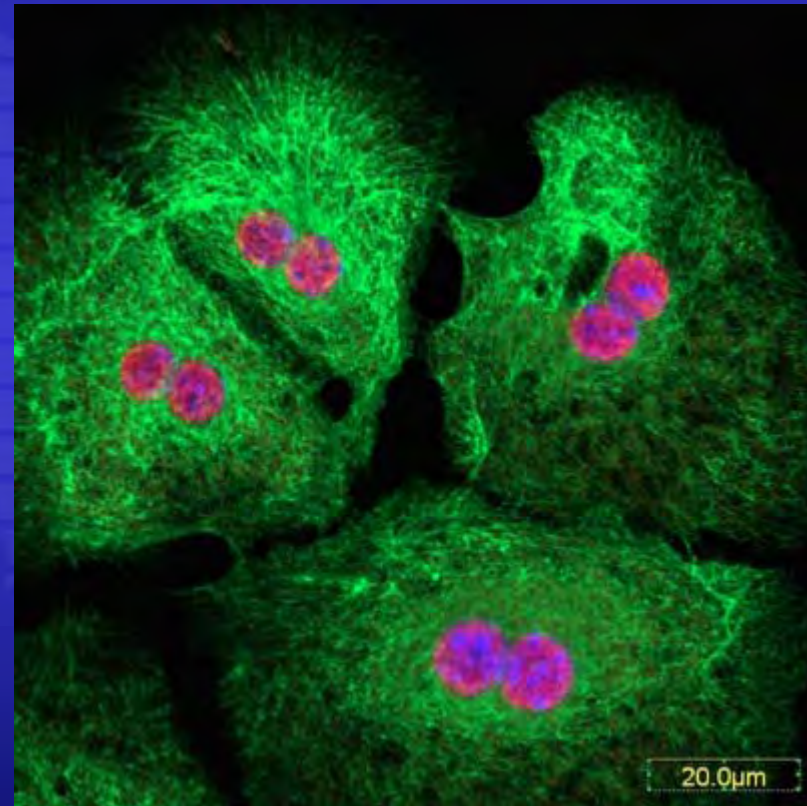
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Serological evidence of NAFLD

- Amino-transferases are chemicals mainly found in liver cells



<http://www.carolinascientific.org/blog/2016/3/29/im-a-liver-not-a-fighter>

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Serological evidence of NAFLD

- Damaged liver cells release amino-transferases into circulation



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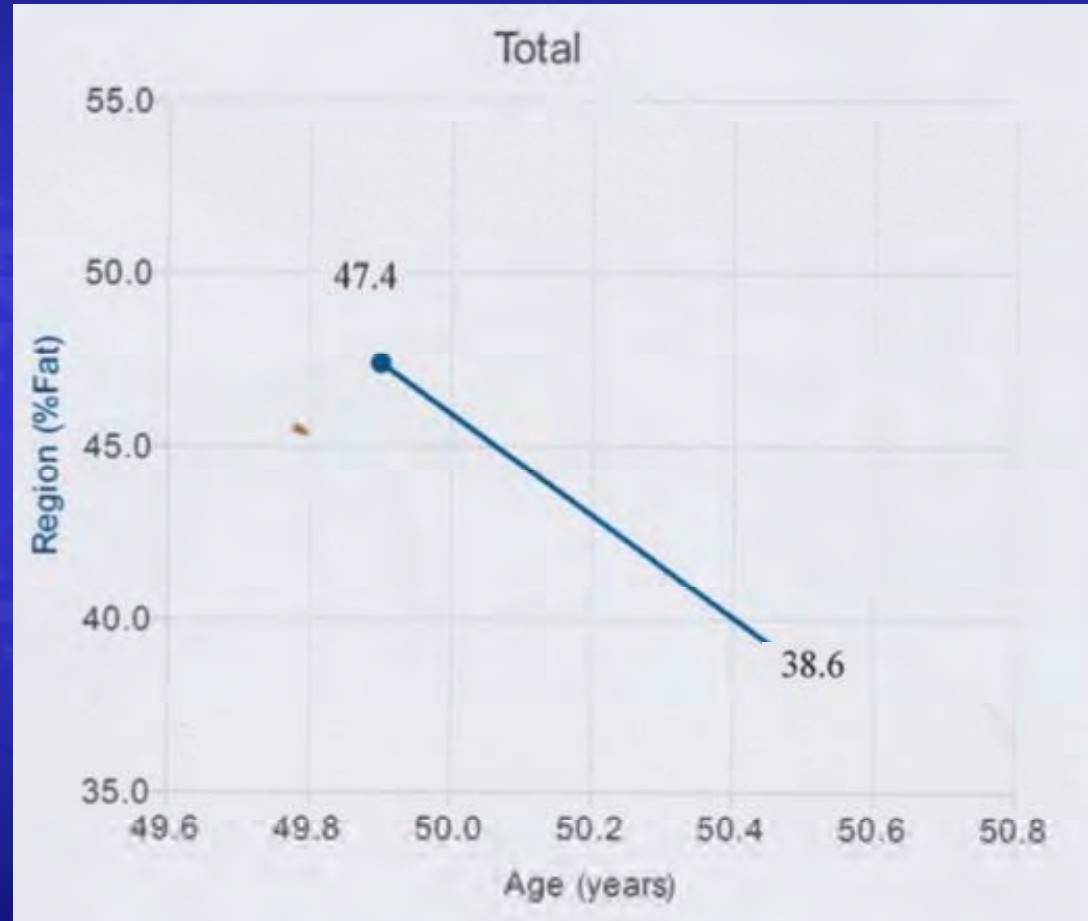
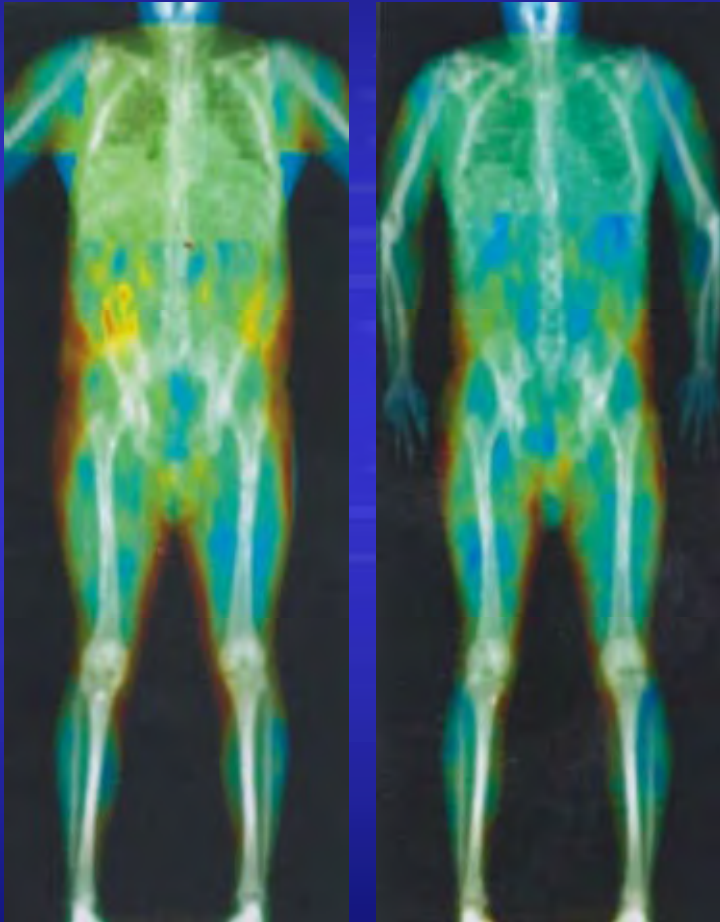
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<http://www.skidmore.edu/academics/music/aholland/Microphotos2.htm>

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Medically supervised low carbohydrate diet



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Improved liver health with weight loss

BIOCHEMISTRY	262758416 19/11/2016 08:36 AEDT	Latest Result 288660067 08/09/2017 08:22 AEST
Bili.Total	11	8
ALP	36	47
GGT	45	26
LD	173	154
AST	27	19
ALT	52 H	19



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Low Carb Doctors Clinic Results

- Average weight loss 15kg
- Significant reductions in joint pain
- ~50% of patients defer joint replacement surgery



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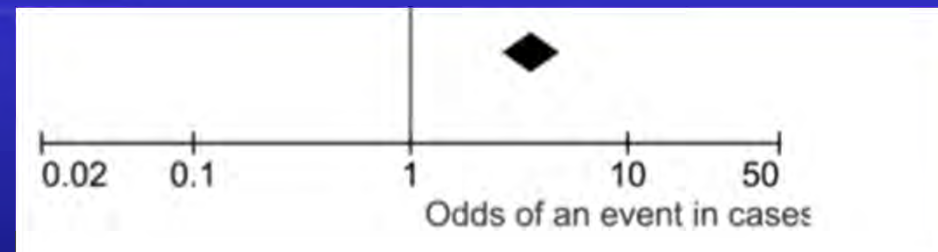


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Why do diabetics have triple the rate of tendinopathies?

- Tendinopathy more prevalent with diabetes
 - odds ratio 3.67
- Increased rates of:
 - Dupuytren's contracture
 - Stenosing tenosynovitis
 - Adhesive capsulitis
 - Plantar fasciopathy



Is there an association between tendinopathy and diabetes mellitus? A systematic review with meta-analysis. Ranger, Wong, Cook, et al. BJSM, 2016.



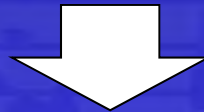
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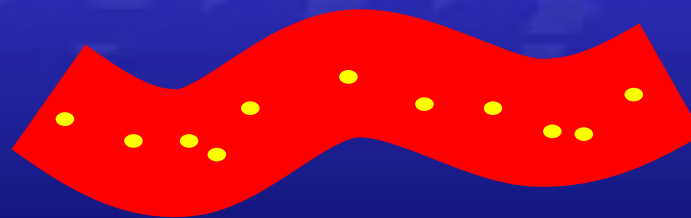
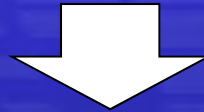
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Dietary carbohydrates

Complex carbohydrate



Glucose + Glucose + Glucose + Glucose

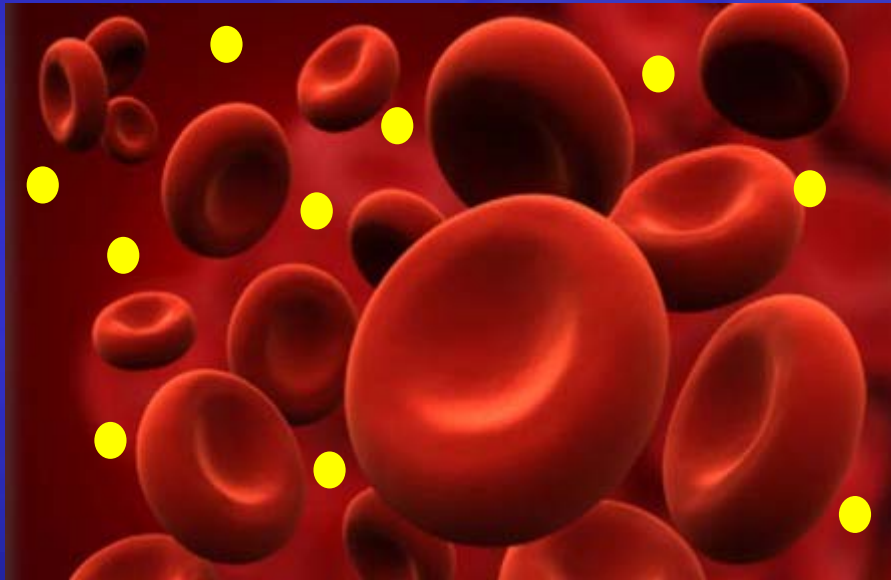


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Blood Glucose Levels

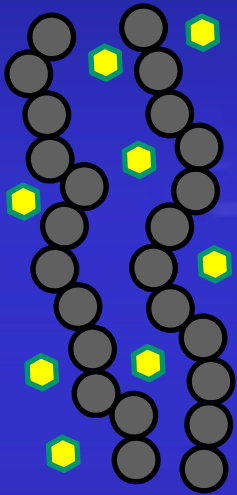


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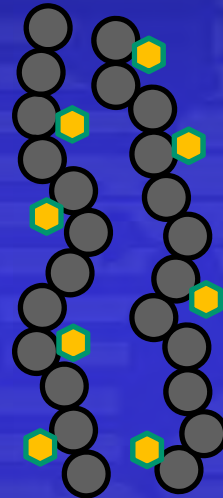
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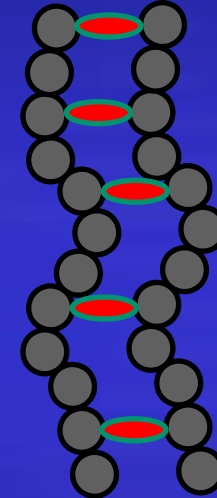
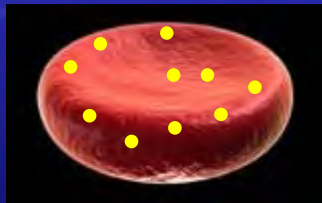
Advanced Glycosylated End Products (AGEs)



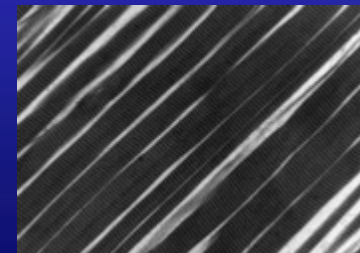
Circulating glucose



Glycation



Advanced glycosylated end products (AGEs)



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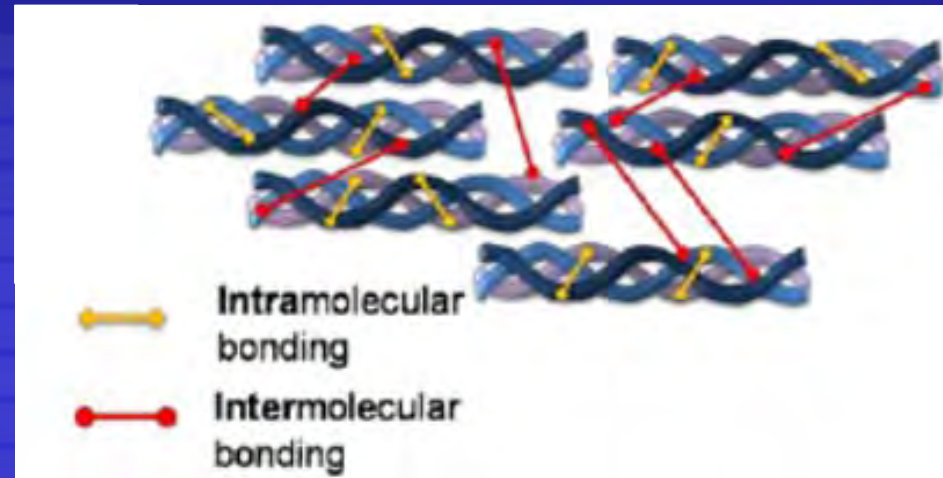
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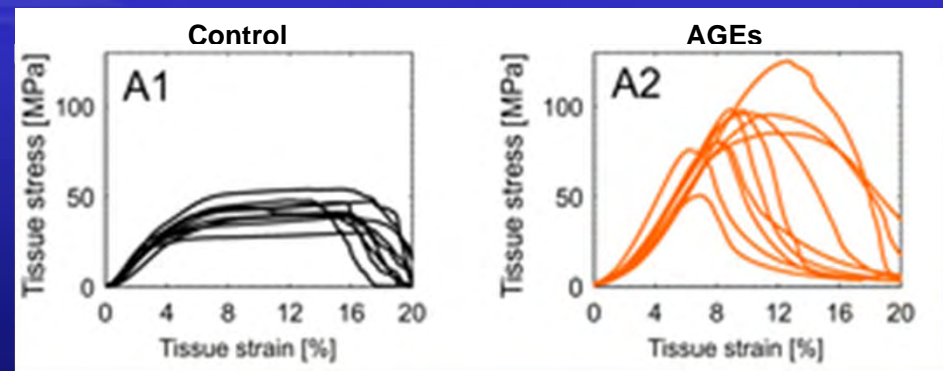
'AGEs' and collagen

- Altered mechanical properties
 - increased brittleness
 - less elastic
 - weaker
- Reduced tissue remodelling
- Prone to oxidation

Robins, S. P. (2007). Biochemistry and functional significance of collagen cross-linking. *Biochem. Soc. Trans.* 35, 849-852.



Wilson et al. (2012). The effect of collagen ageing on its structure and cellular behavior. *Proceedings of SPIE*.



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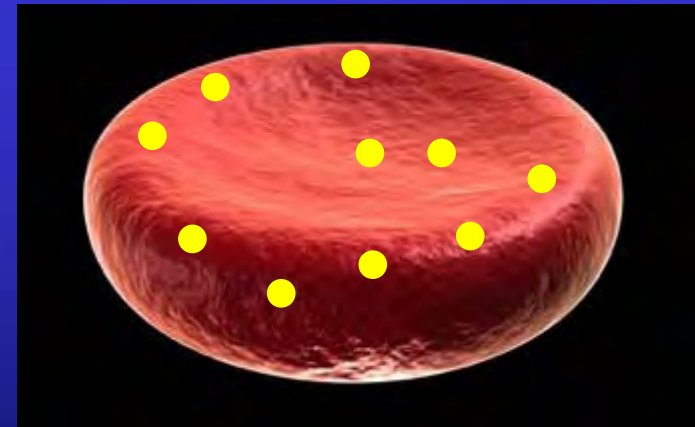
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Changes in HbA1c on Low Carb diet

HbA1c	258012101 16/05/2016 16:14 AEST	274653948 29/08/2016 08:13 AEST	Reference
HbA1c (IFCC)	74 H	51 H	(20-38)
HbA1c	8.9 H	6.8 H	(4.0-5.6)

- Improved remodelling of extra-cellular matrix
- Improved tissue mechanics



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Inflammation

- Eicosanoids
 - Chemicals which regulate many functions of inflammation
 - Swelling
 - Temperature
 - Clotting
 - Derived from omega 3 + 6 fats

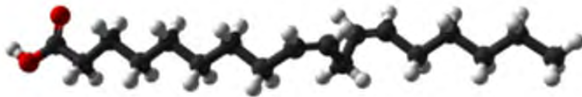


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OMEGA 6 PATHWAY



Linoleic acid

↓
gamma-linolenic acid

↓
Dihomo gamma linolenic acid

↓
Arachidonic acid

lipoxygenase

COX 2

COX 1

Series 4
leukotrienes
LBT-4

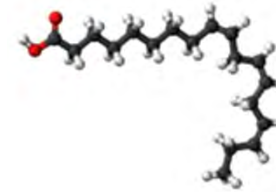
Series 2
prostaglandins
PGE-2

thromboxanes

← Delta 6 desaturase →

← Delta 5 desaturase →

OMEGA 3 PATHWAY



Alpha Linoleic acid

↓
Stearidonic acid

↓
Eicosatetraenoic acid

↓
Eicosapentaenoic acid
Docosahexanic acid

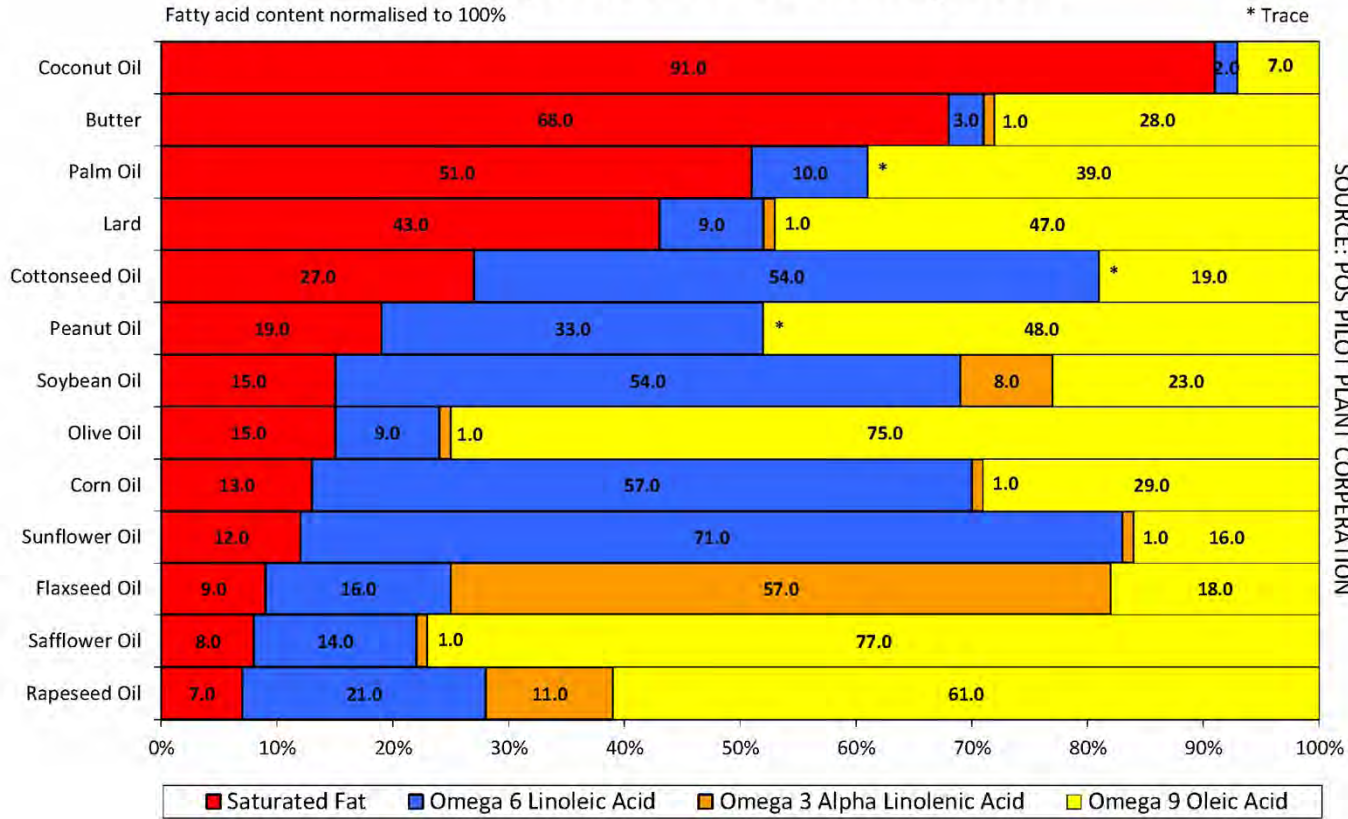
lipoxygenase

COX 1

Series 5
leukotrienes
LBT-5

Series 3
prostaglandins
PGE-3

Comparison of Dietary Fats



<5% plant sourced omega 3 converted to more active forms

Changing the omega 6:3 ratio

OMEGA 6:3 RATIO						
	Mon	Wed	Thu	Thu		
	04/01	02/03	01/09	15/12		
	2016	2016	2016	2016		
	2015	1250	0854	0820	Units	Ref Range
OMEGA 6	28.4	27.5	24.2	24.1	% of Total FA	
OMEGA 3	8.9	12.9	14.5	15.2	% of Total FA	
OMEGA 6:3 RAT	3.2	2.1	1.7	1.6	: 1	(1 - 4)



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Benefits of reduced inflammation

C REACTIVE PROTEIN	249646349 20/07/2016 07:42 AEST	Latest Result 288854740 13/10/2017 08:12 AEDT	Reference
CRP	20.6 H	1.5	(0.0-5.0)

- Reduced need for medications
 - Reduced side effects
- Improved recovery
- Cardiovascular benefit



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How would medically supervised weight loss help your patients?

- Reduced MMPs
 - 10% weight loss = 50% pain reduction
 - Defer or cancel surgery
 - Enhanced response to loading
- Reduced BGL
 - Less glycation improves tissue mechanics
 - Enhanced response to loading
- Reduced inflammation
 - Reduced medication use
 - Improved exercise capacity
 - Improved recovery



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Thankyou!



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- Leucine rich diet shown to stimulate tendon collagen synthesis in response to exercise.
-



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Summary

- Low carbohydrate diet to improve liver health and reduce tissue glycation
- Leucine rich diet to stimulate anabolism
- Diet rich in Omega 3's and low in Omega 6's
- Combining a medical approach to optimising health can enhance the results of your practice.

*Mechanotherapy
respecting recovery time
frames



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Protein

- Substrate for tissues (need building blocks)
- Some individual amino acids may have greater stimulant effect
 - Arginine
 - BCAA's
 - leucine
- Overview of mTOR pathway
- Role of beta-hydroxybutyrate in increasing leucine levels (metabolised preferentially)



BIOCHEMISTRY	242600456 24/08/2017 13:55 AEST	Latest Result 286531383 18/10/2017 11:15 AEDT
Creatinine		65
eGFR		>90
Bili.Total	11	8
ALP	52	49
GGT	53 H	24
LD	162	158
AST	17	17
ALT	31 H	23



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BIOCHEMISTRY	287587420 19/07/2017 10:00 AEST	Latest Result 287440904 14/10/2017 08:26 AEDT
Bili.Total	11	15
ALP	58	54
GGT	35	30
LD	165	145
AST	24	22
ALT	43 H	31



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Improved liver health with weight loss

BIOCHEMISTRY	262477346 20/07/2017 08:54 AEST	Latest Result 288192331 16/10/2017 08:35 AEDT
Bili.Total	10	9
ALP	72	71
GGT	19	17
LD	189	225
AST	33	25
ALT	41 H	19



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MAILLARD (BROWNING) REACTION



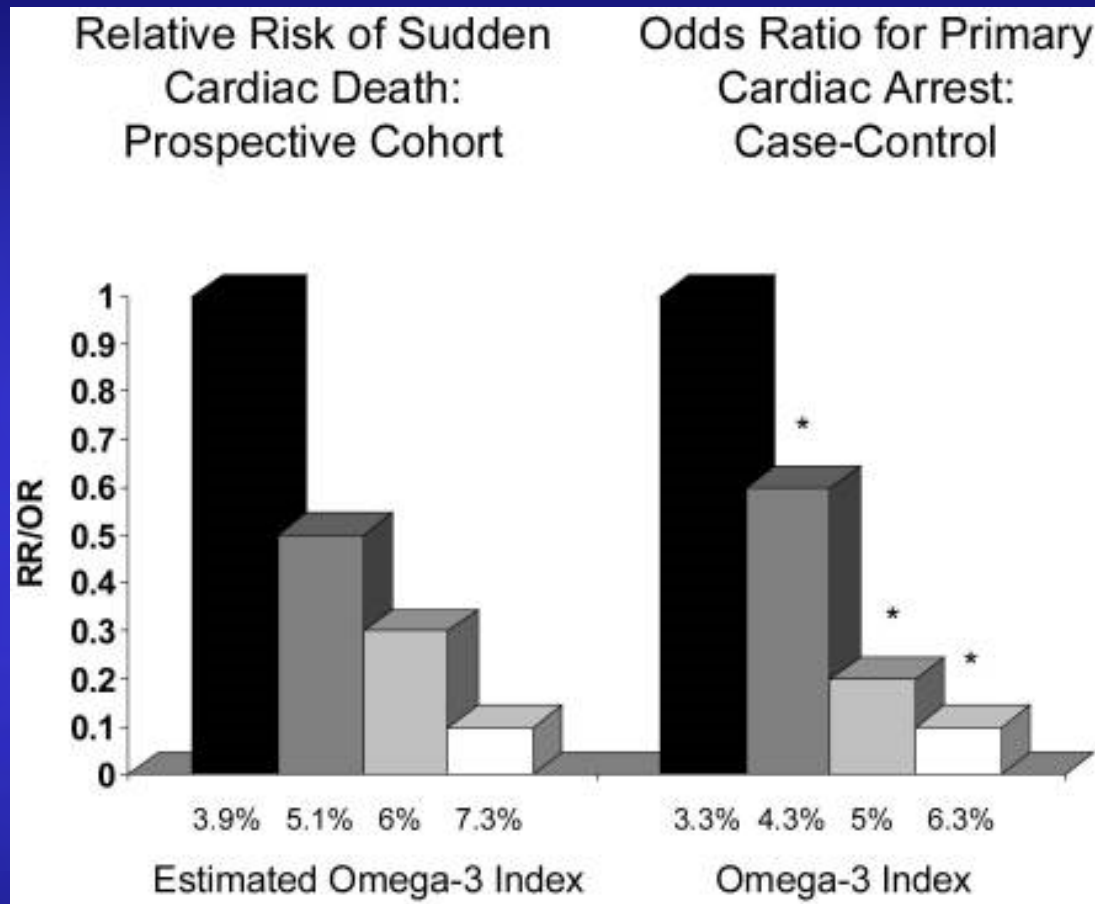
John W. Baynes <http://doctorlib.info/medical/biochemistry/46.html>



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Siscovick DS, Raghunathan TE, King I, et al. Dietary intake and cell membrane levels of long-chain n-3 polyunsaturated fatty acids and the risk of primary cardiac arrest. *JAMA* 1995;274:1363-7.

Albert CM, Campos H, Stampfer MJ, et al. Blood levels of long-chain n-3 fatty acids and the risk of sudden death. *N Engl J Med* 2002;346:1113-8.

William S Harris *Am J Clin Nutr* 2008;87:1997S-2002S



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Once significant collagen degradation has occurred, it is felt that repair of the damaged matrix is not possible and progression of matrix loss is likely.




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Green tea and Doxycycline

Influence of Tea Polyphenols on the Formation of Advanced Glycation End Products (AGEs) *in vitro* and *in vivo*

Shanli Peng¹, Genyi Zhang^{1, 2}, 

¹School of Food Science and Technology, Jiangnan University, Wuxi, China

²State Key Laboratory of Food Science and Technology, Jiangnan University, Wuxi, China



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