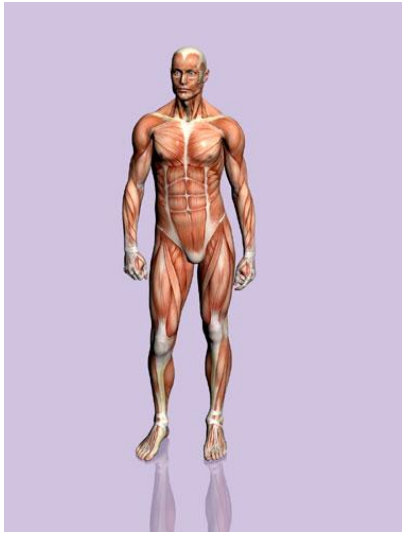
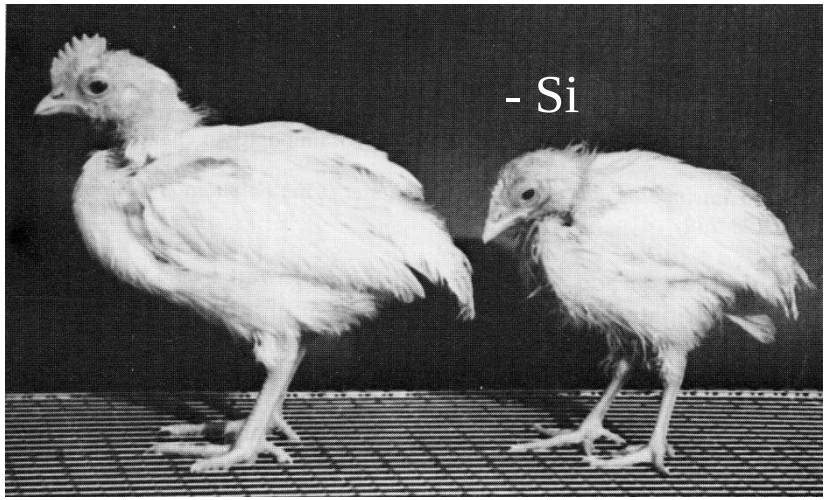
Silicon, Ethanol and Connective Tissue health:

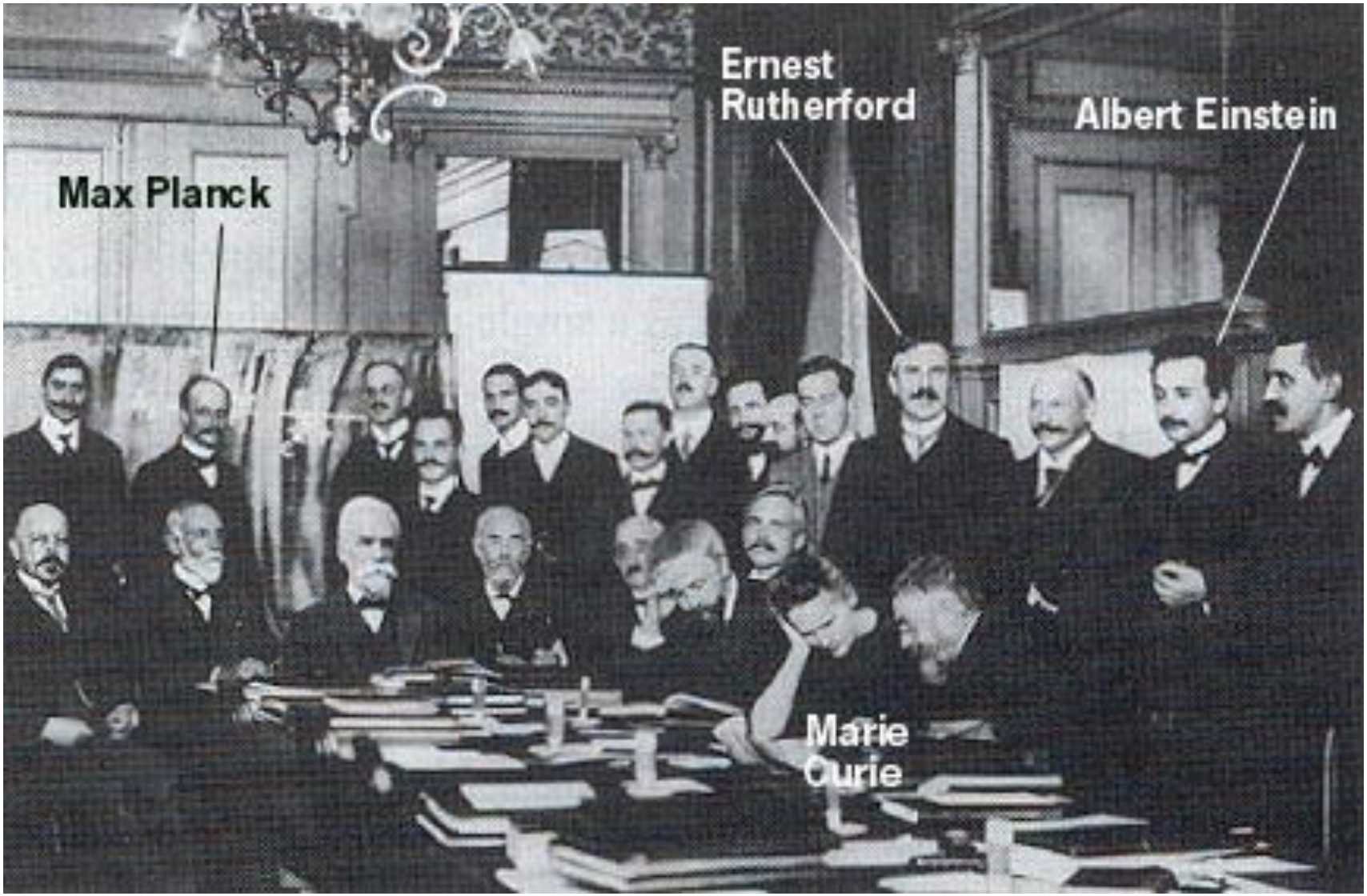
A Case for Moderate Beer Consumption?

Professor Jonathan J Powell
MRC HNR, Elsie Widdowson Laboratory:
Fellow, Hughes Hall College, University of Cambridge.
Cambridge (UK).

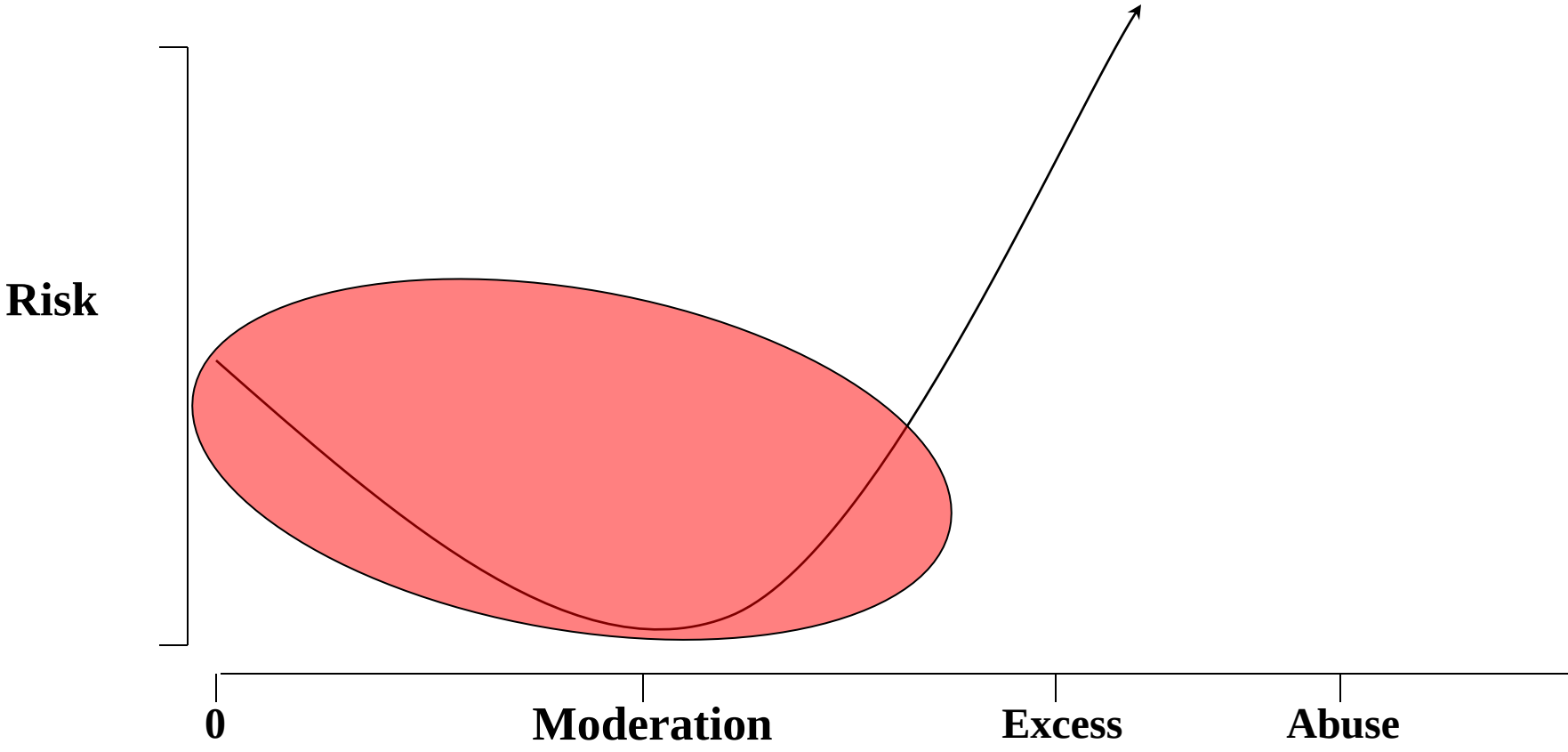




The First Solvay Congress 1911
Hotel Metropole



Cardiovascular or Bone Mortality and Alcohol



Nutritional Aspects of Beer

Orthosilicic Acid (Silicon)

Moderate Ethanol Content

Anti-oxidants

B Vitamins

Other Minerals

Calories

Nutritional Aspects of Beer

Orthosilicic Acid (Silicon)

Moderate Ethanol Content

Anti-oxidants

B Vitamins

Other Minerals

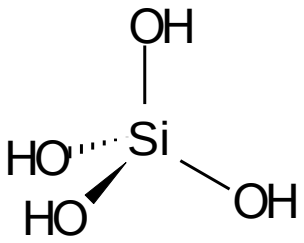
Calories

Dietary Silicon

Dietary intake of Si is 15-40 mg Si/day

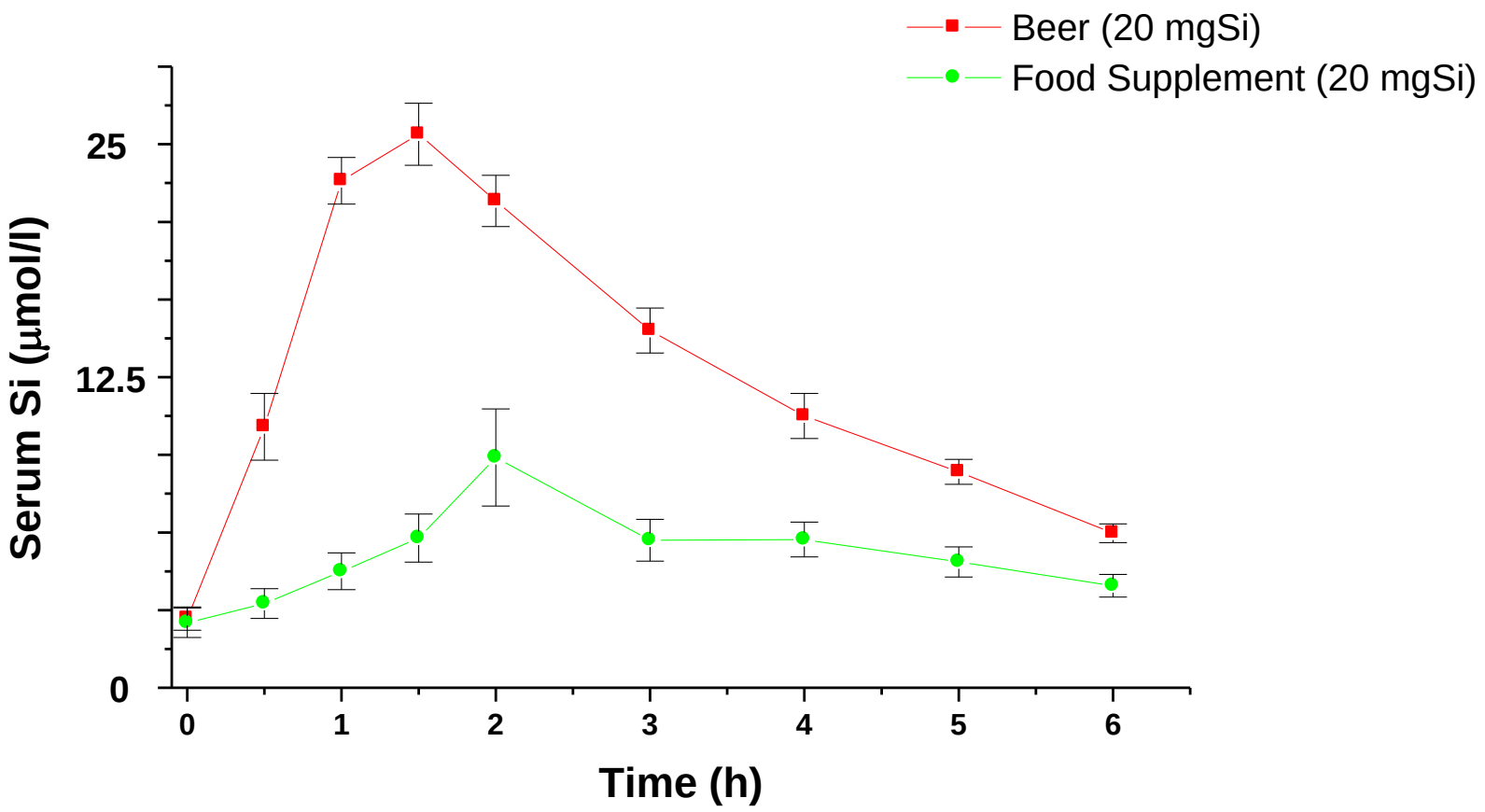
Silicon Values in Beer

	Mean±SD (mg/l)	Range (mg/l)
Lager	22.1 ± 8.3	11.7 - 39.4
Bitter	19.8 ± 5.7	12.6 - 29.8
Mild		16.7 - 30.1
Stout		9.6 - 19.7

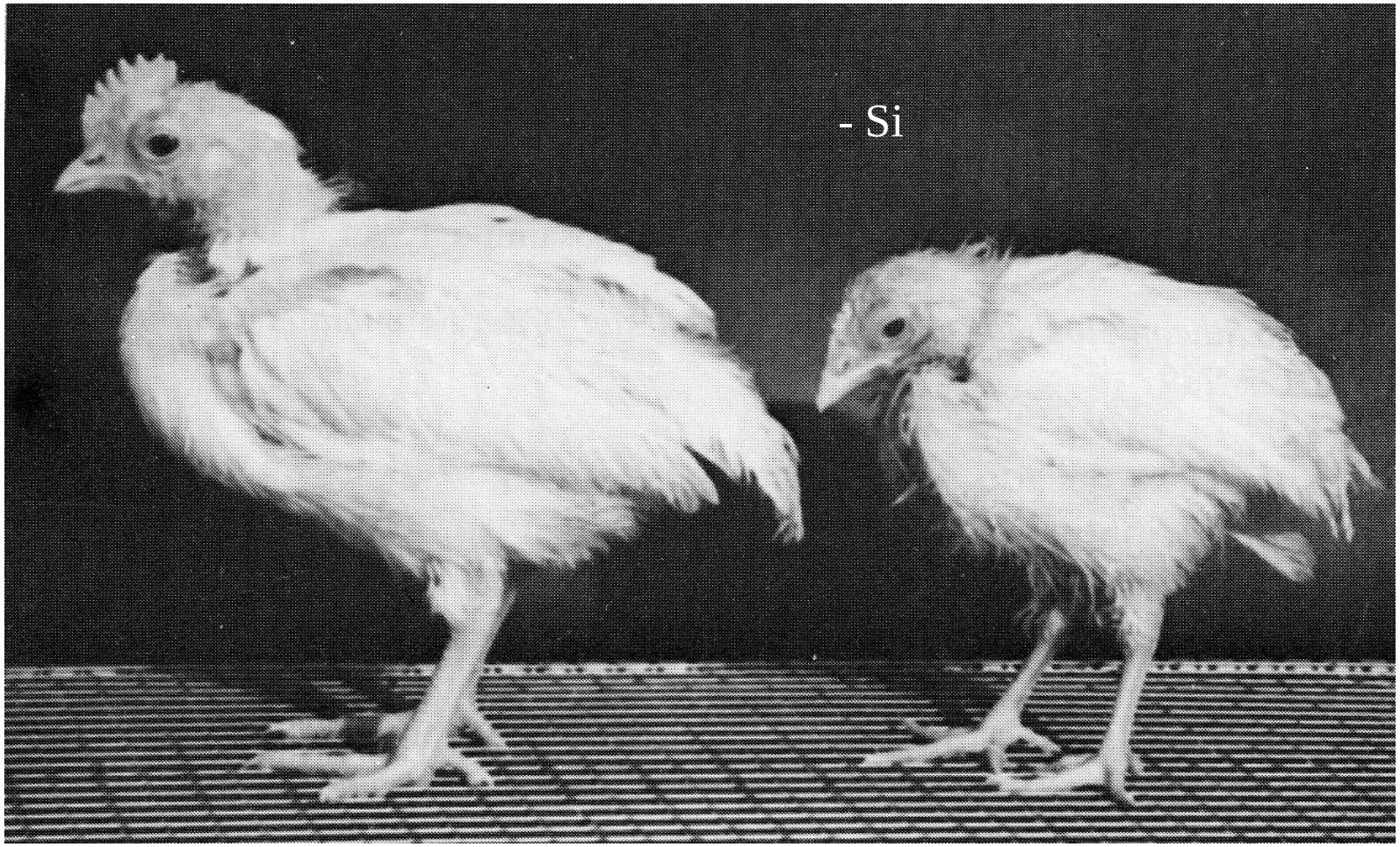


Br J Nutr. 2004;91(3):403-9.

Silicon Absorption

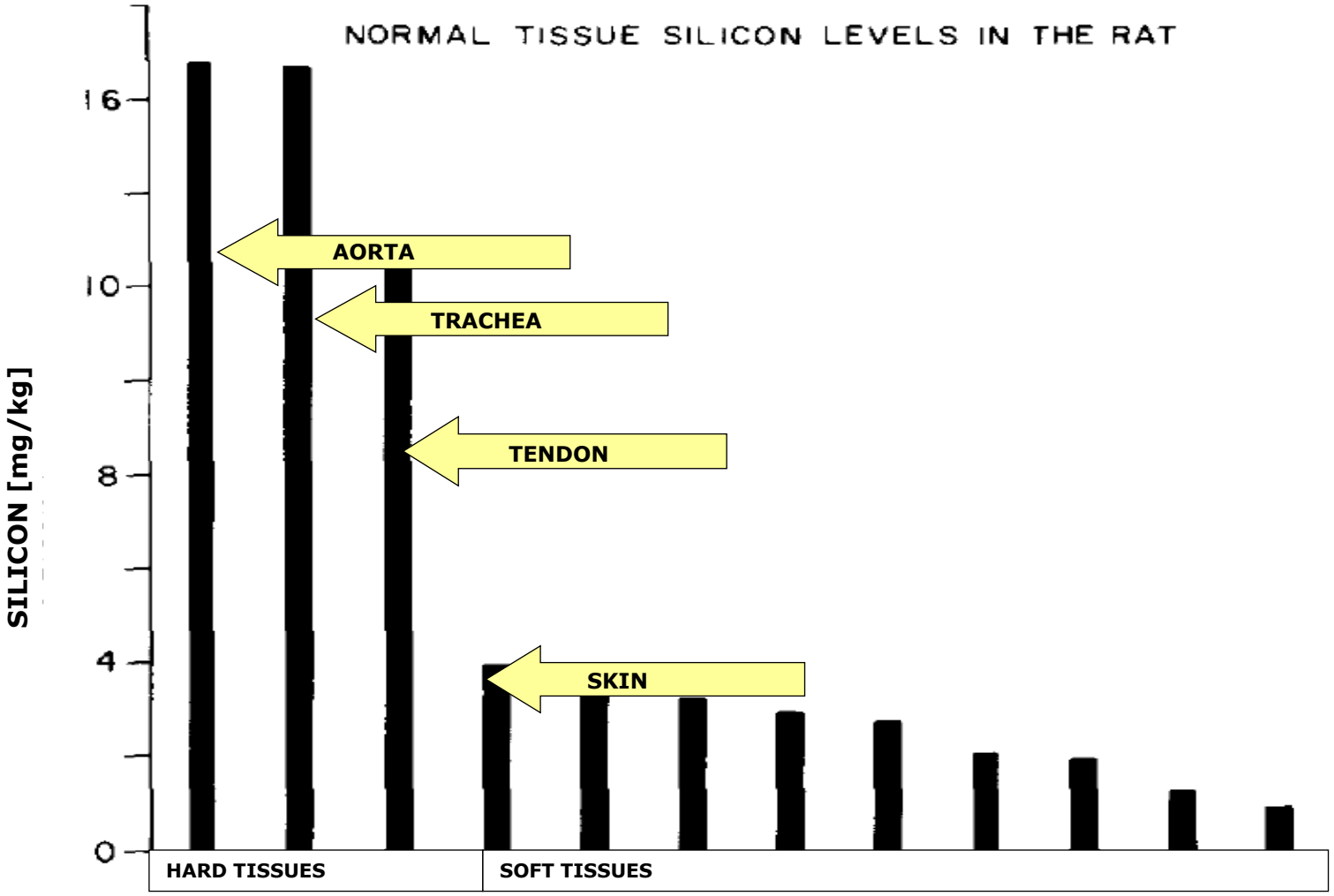


Br J Nutr. 2004;91(3):403-9.



Four-week-old chicks on silicon-supplemented diet (left) and low-silicon basal diet (right) (Carlisle, 1972).

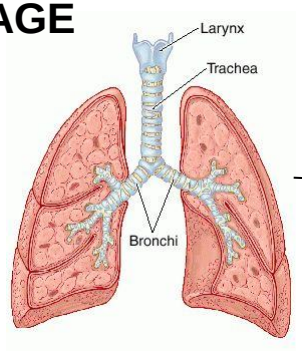
Body level of Si is 140-700 mg

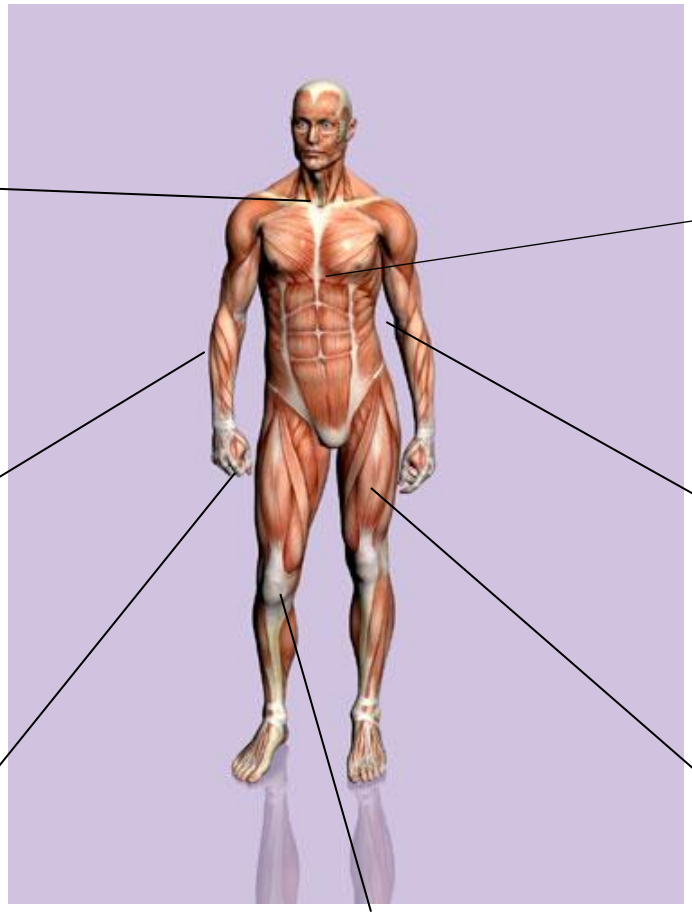


Carlisle, E.M., *Proceedings: Silicon as an essential element.* Fed Proc, 1974

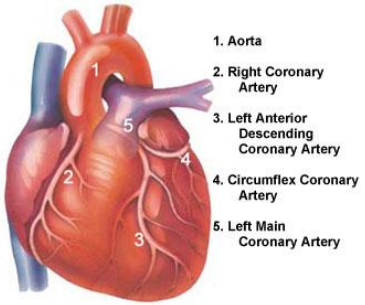
Collagenous Tissues

CARTILAGE

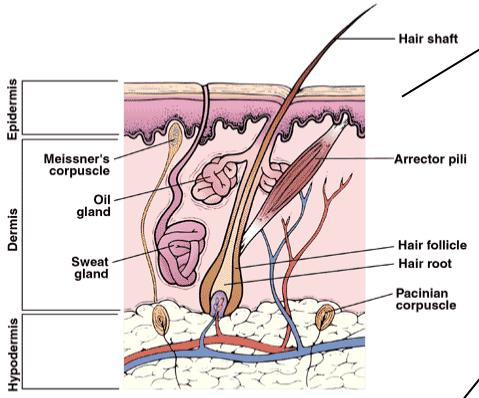


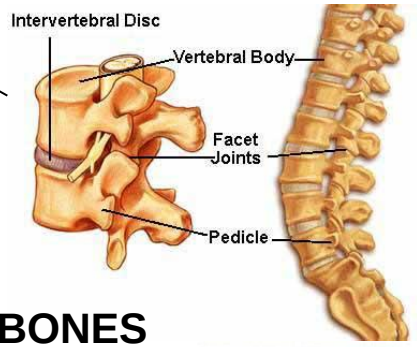


VASCULATURE

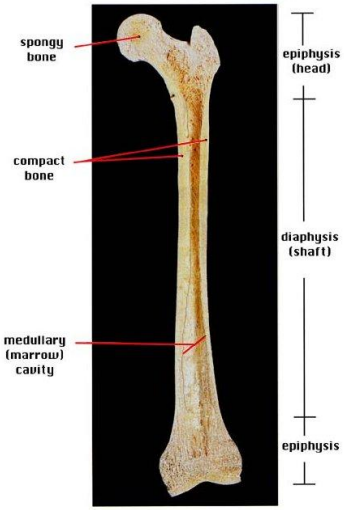


HAIR & SKIN

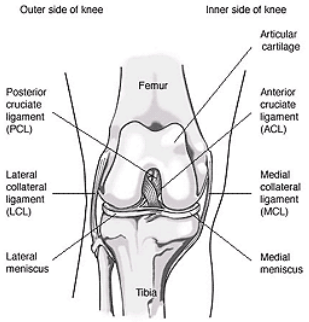




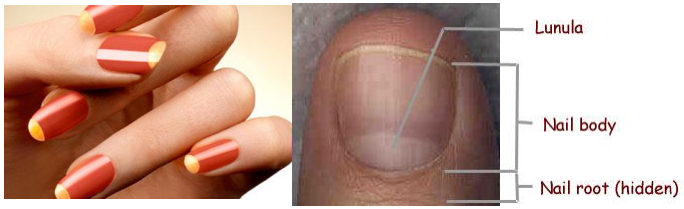
BONES



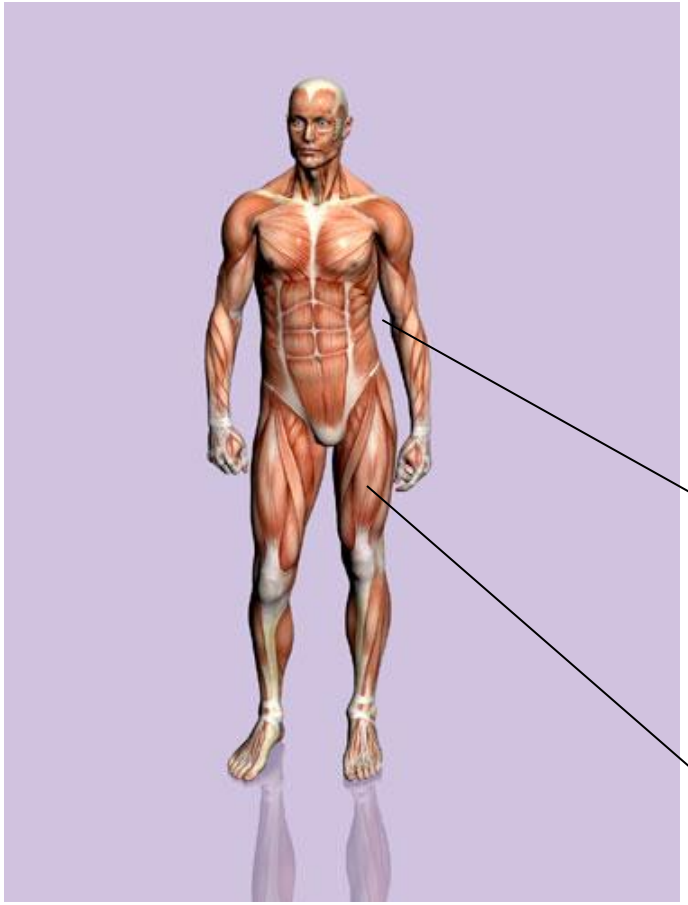
JOINTS

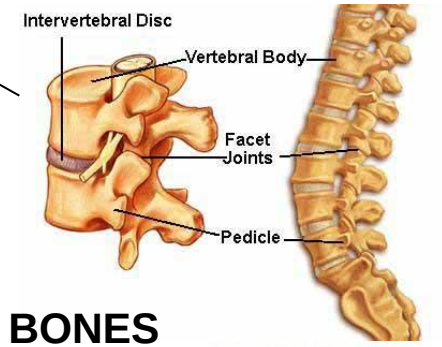


NAILS

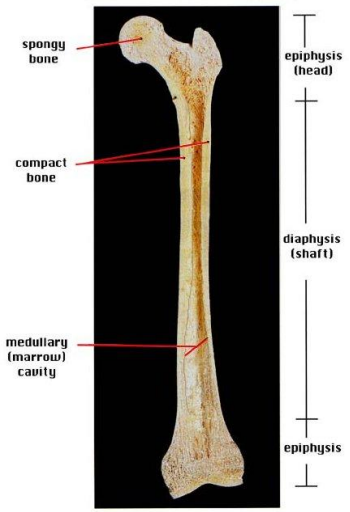


BONE

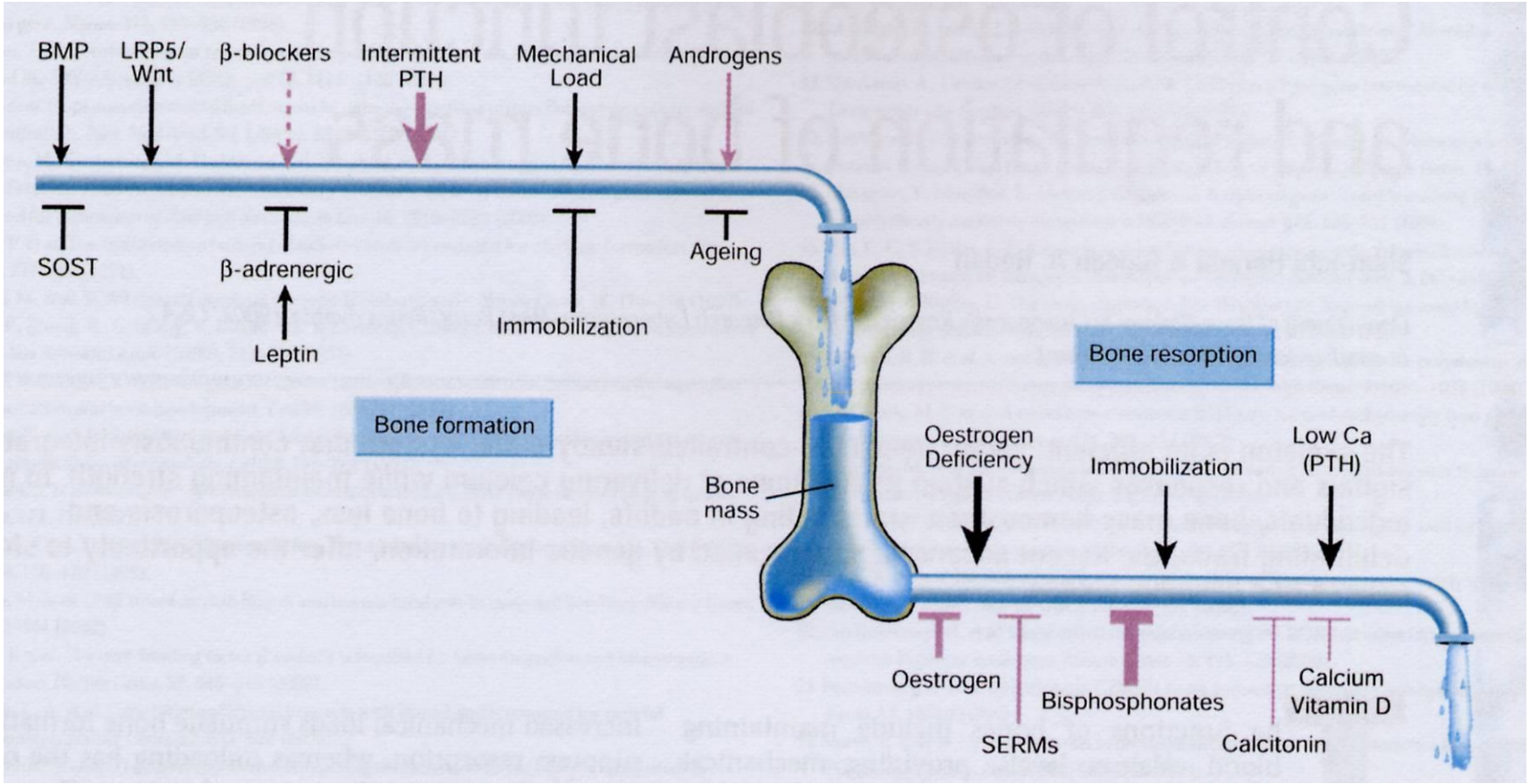



Intervertebral Disc
Vertebral Body
Facet Joints
Pedicle

BONES

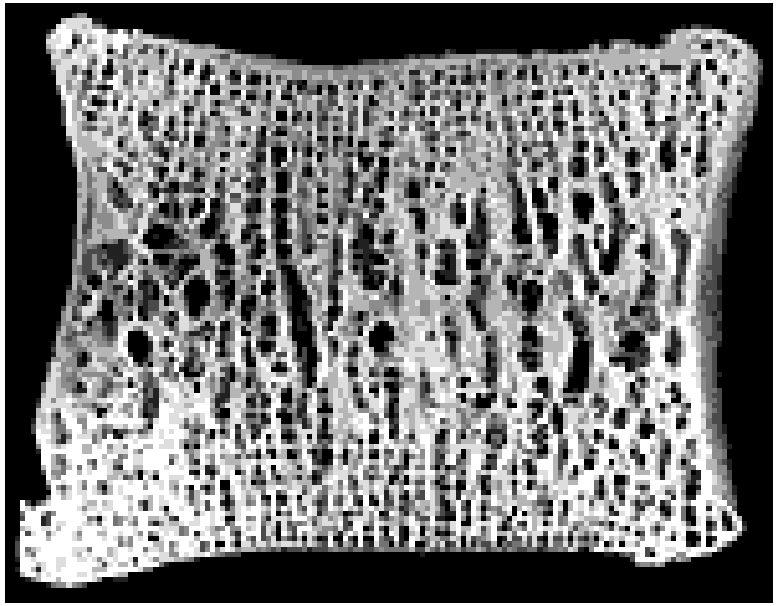

spongy bone
compact bone
medullary (marrow) cavity
epiphysis (head)
diaphysis (shaft)
epiphysis

Bone Homeostasis

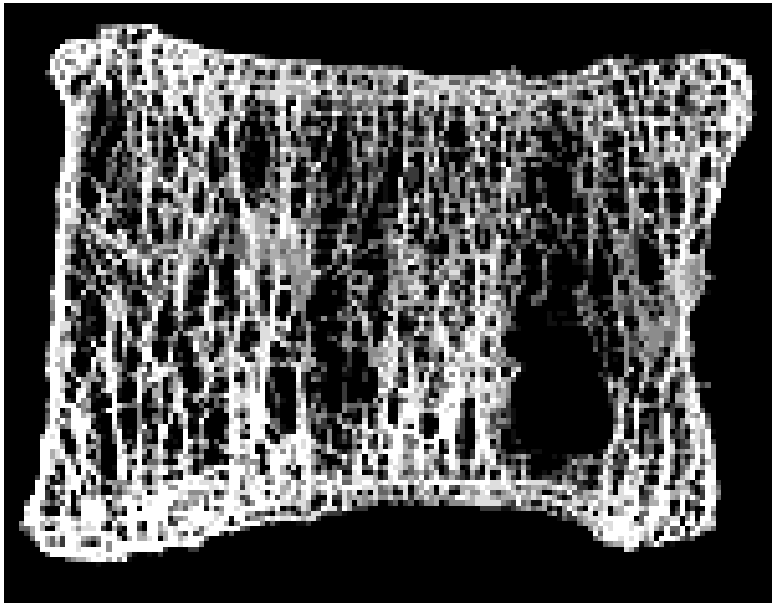


(Adapted from Harada & Rodan *Nature 2003.*)

Osteoporosis



Normal Bone

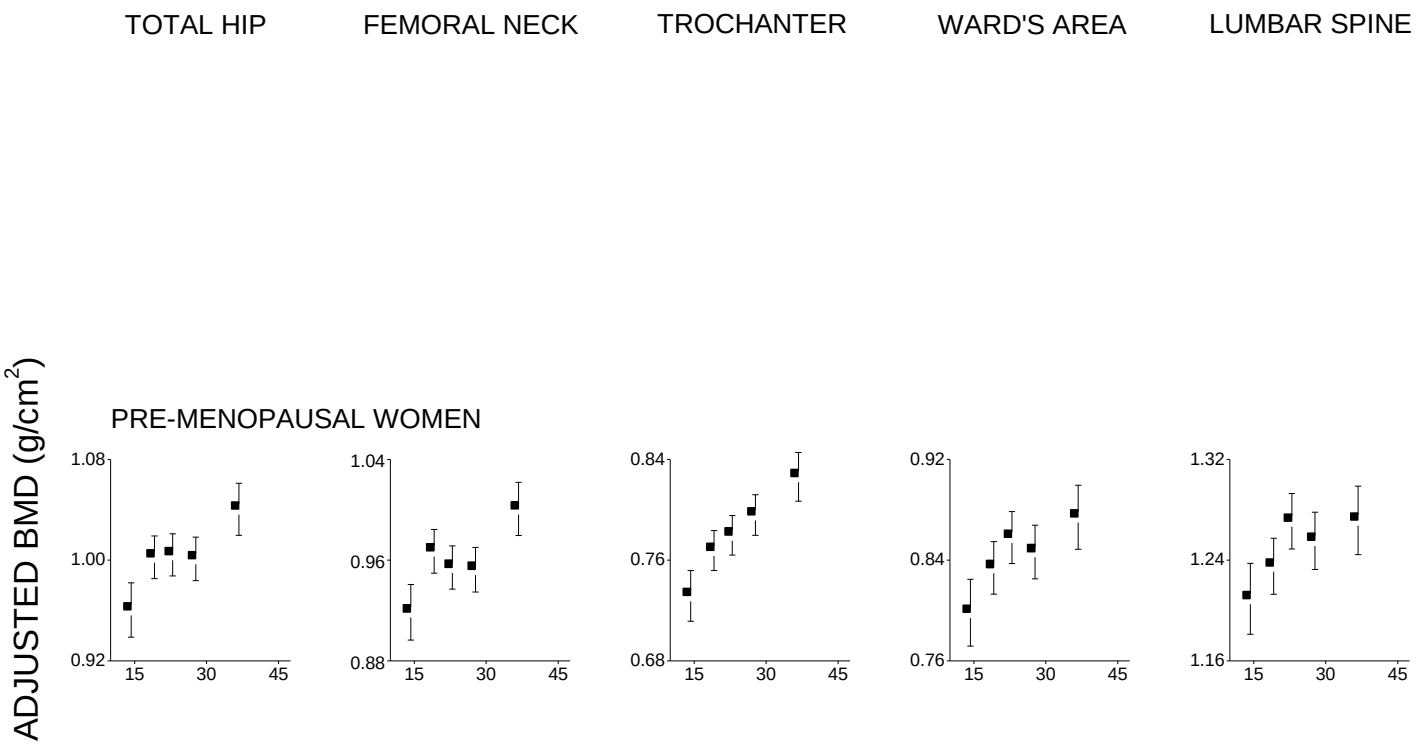


Osteoporotic Bone

UK Osteoporosis costs: 1 billion pounds per annum.

Dietary silicon intake and BMD

Framingham Offspring cohort (USA)
1251 men and 1596 women (306 pre-menopausal)



Jugdaohsingh *et al.*, *J Bone Miner Res* 2004;19:297–307.

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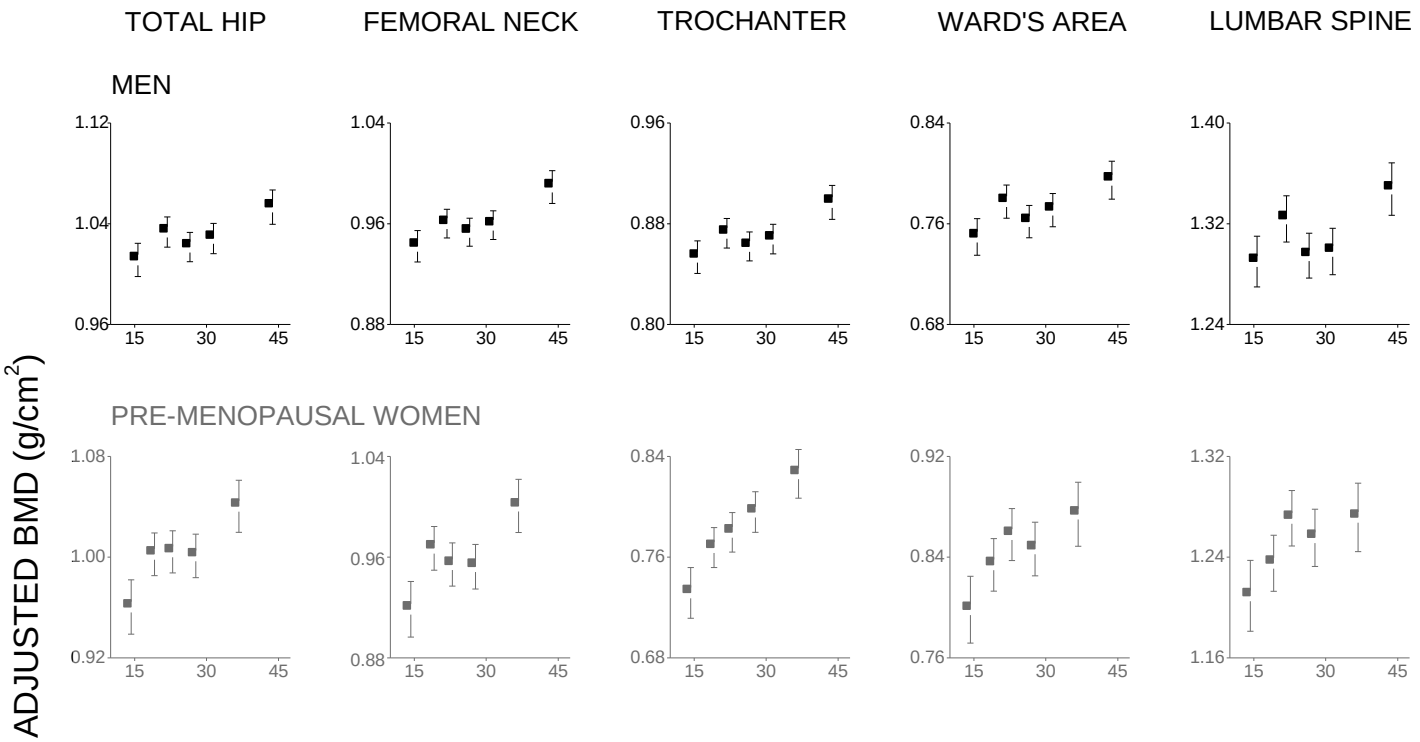

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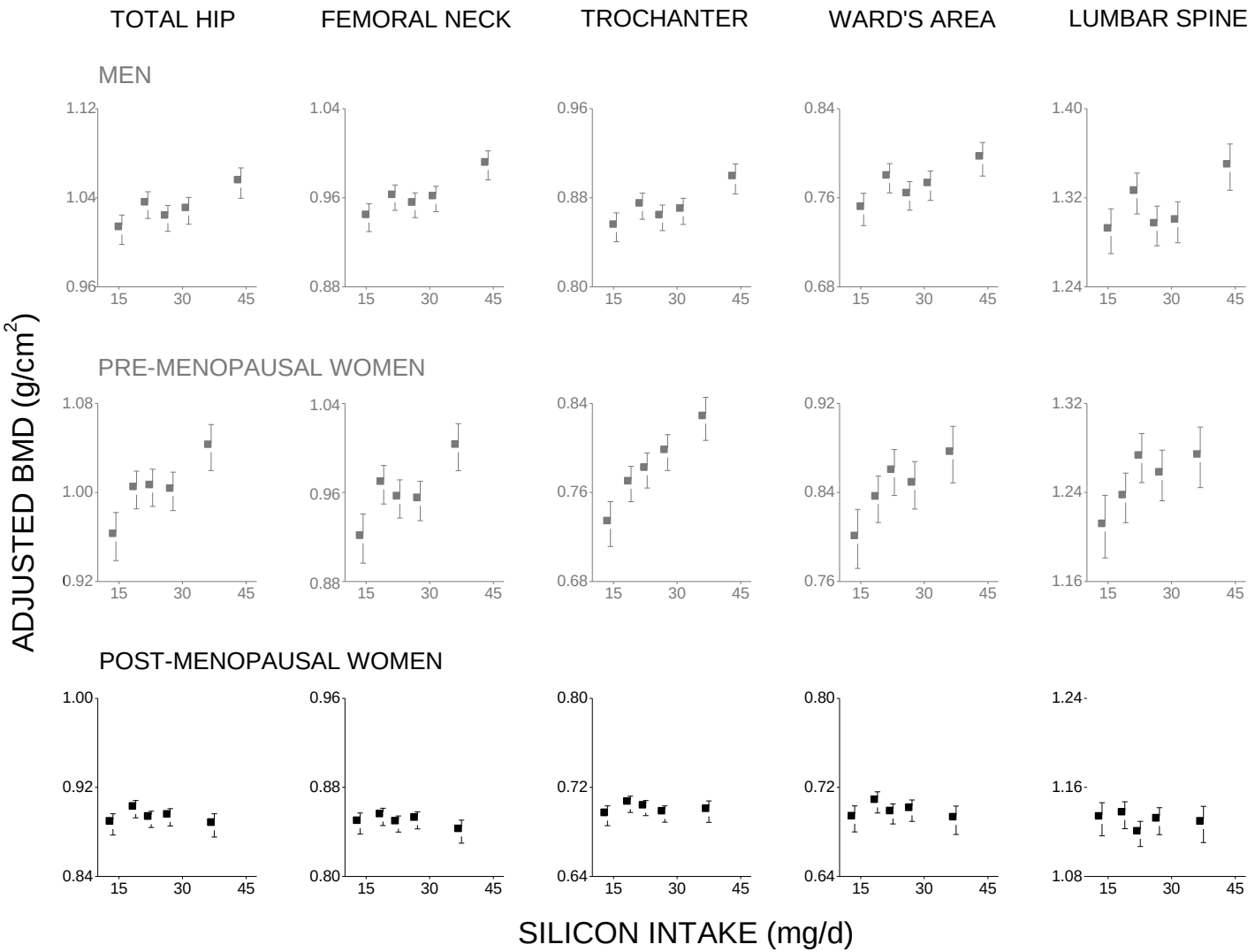

Jugdaohsingh *et al.*, *J Bone Miner Res* 2004;19:297–307.

Aberdeen Prospective Osteoporosis Screening Study (APOSS)

Silicon Intake & BMD: separate menopausal status, HRT use

Menopausal Group	FN BMD		LS BMD	
	r	*P*	*r*	*P*
Pre-menopausal (*n*=109)	0.206	0.03	0.152	0.12
Pre- & Peri-menopausal (*n*=333)	0.098	0.07	0.083	0.13
Post-menopausal				
no-HRT (*n*=1018)	-0.025	**0.43**	0.010	0.74
past-HRT (*n*=664)	0.076	**0.05**	0.066	0.09
current-HRT (*n*=1170)	0.086	**<0.01**	0.019	0.52

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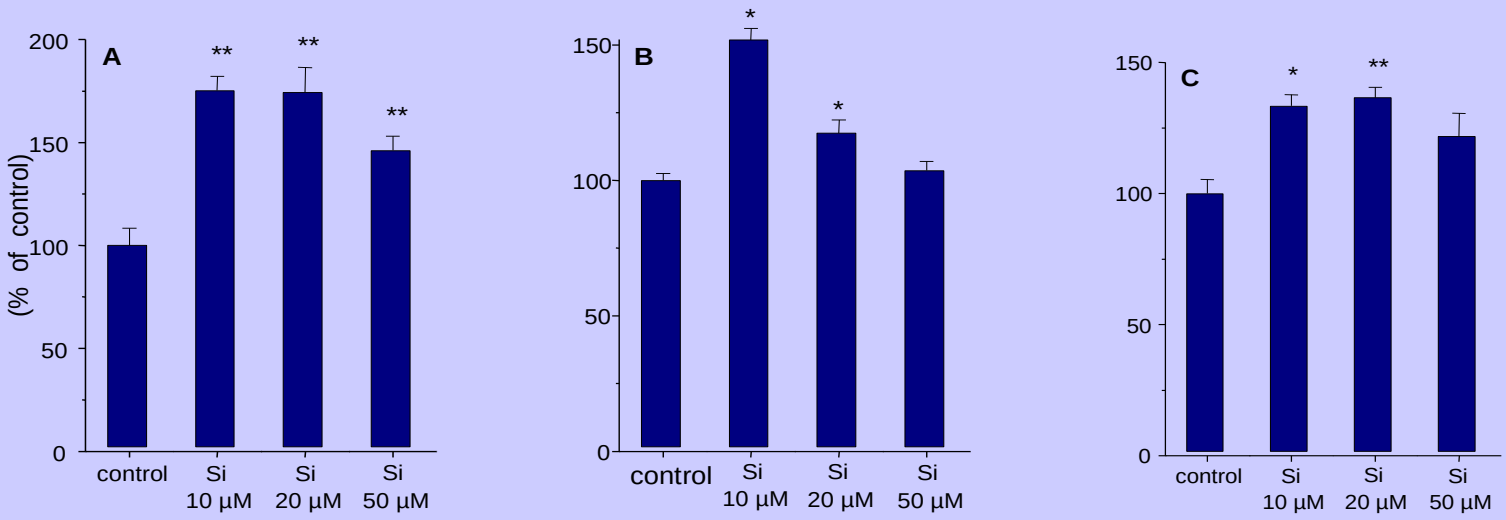
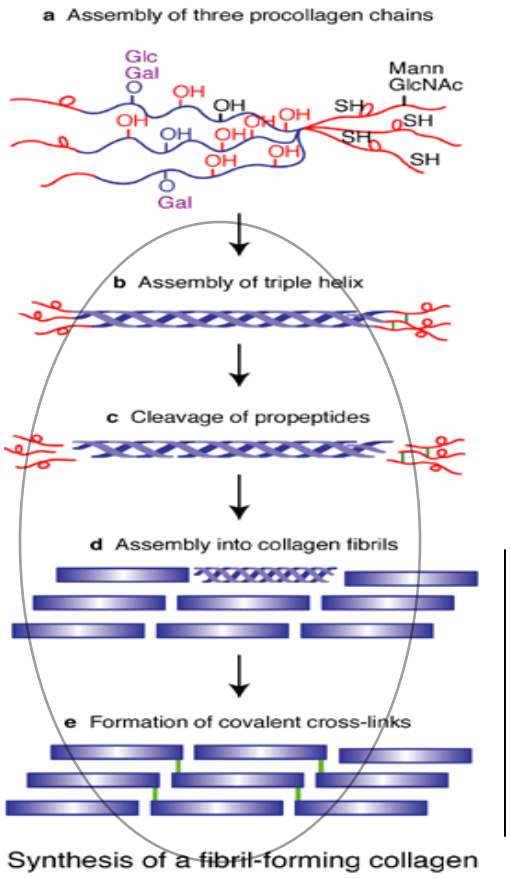
Macdonald *et al*., *J Bone Min Res* 2005;20 (S1):S393-S393.



A, Pro-collagen 1 C-terminal polypeptide synthesis (ng/µg protein).
B, Osteocalcin synthesis (ng/µg protein).
C, TGF-β1 synthesis (pg/µg protein).
* $p < 0.01$, ** $p < 0.005$; (paired *t*-test) control *vs* Si.

Reffitt et al - *Bone* - 2003; 32(2):127-35.

Collagen type 1 synthesis in cell lysates by Western blot



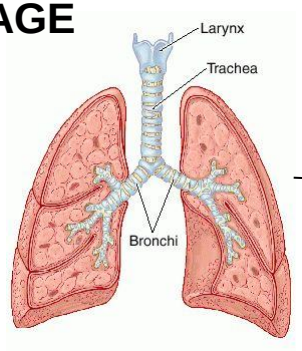
Synthesis of a fibril-forming collagen

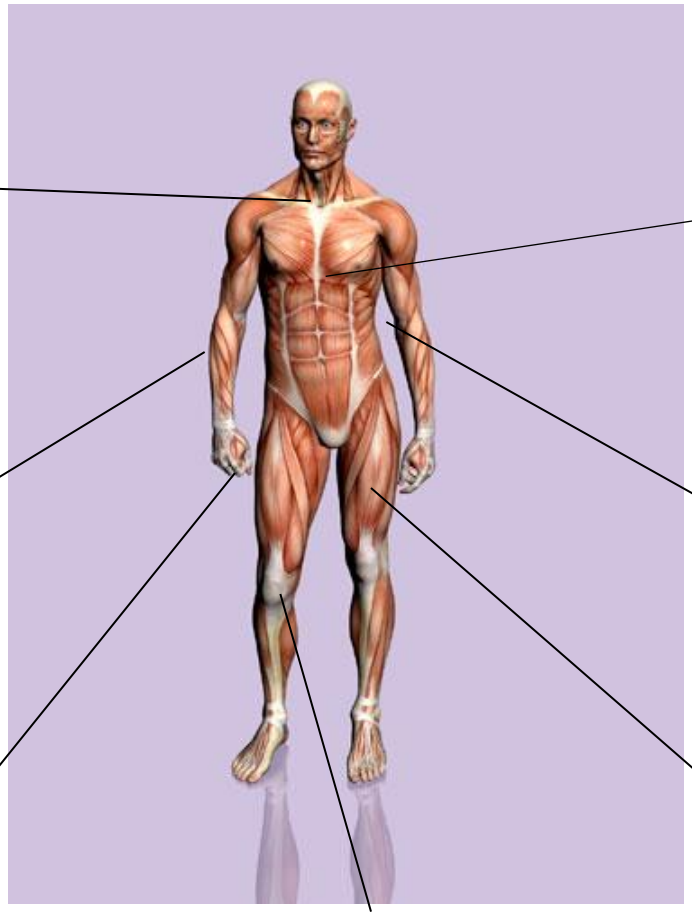
(Unpublished results.) A graph showing an increase collagen in the extracellular matrix and cell lysate of human skin fibroblast cells exposed to different concentrations of orthosilicic acid ($Si(OH_4)$).

Silicon may facilitate matrix formation through collagen deposition.

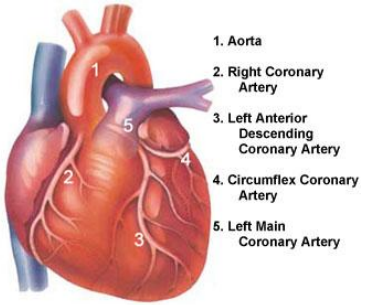
Collagenous Tissues

CARTILAGE

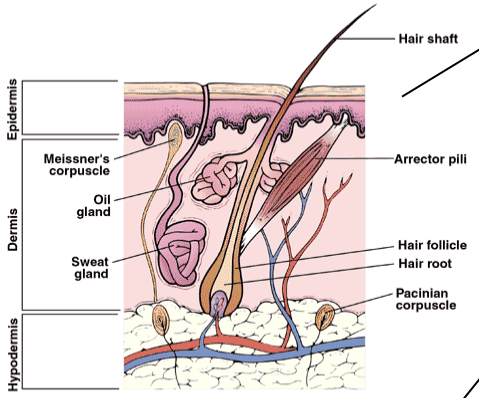


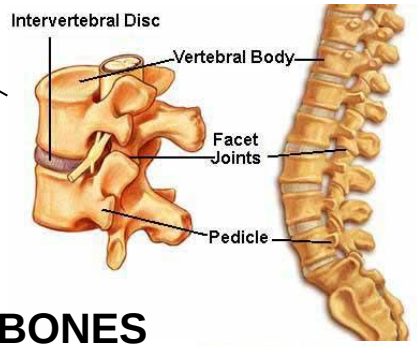


VASCULATURE

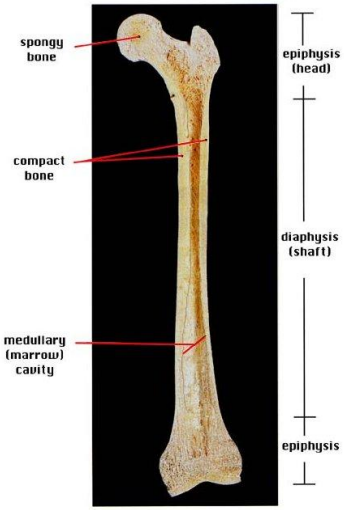


HAIR & SKIN

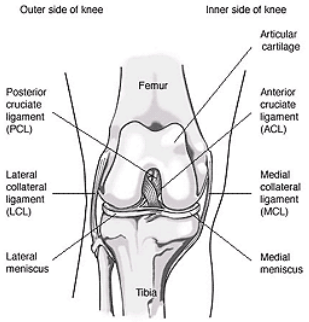




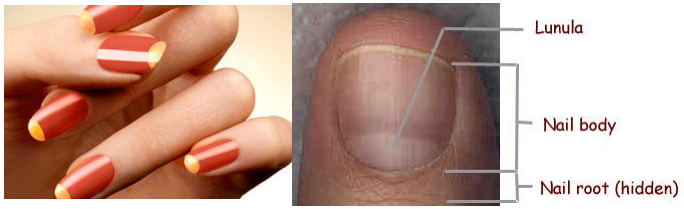
BONES



JOINTS



NAILS



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Nutrition Research 31 (2011) 147–156

Nutrition Research

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Soluble silica and coral sand suppress high blood pressure and improve the related aortic gene expressions in spontaneously hypertensive rats

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Silicon reduces hypertension

Vessel Circumference

Circumference (diameter) is greater in the silicon treated mice which would allow lower pressures for equivalent blood flow

(Unpublished results.) Preliminary findings from a study (in collaboration with the Medical University of Vienna) investigating the effect of silicon supplementation on atherosclerosis and aortic health. A significant increase in aortic circumference was found in the silicon supplemented groups, compared to the control group.

Nutritional Aspects of Beer

Orthosilicic Acid (Silicon)

Moderate Ethanol Content

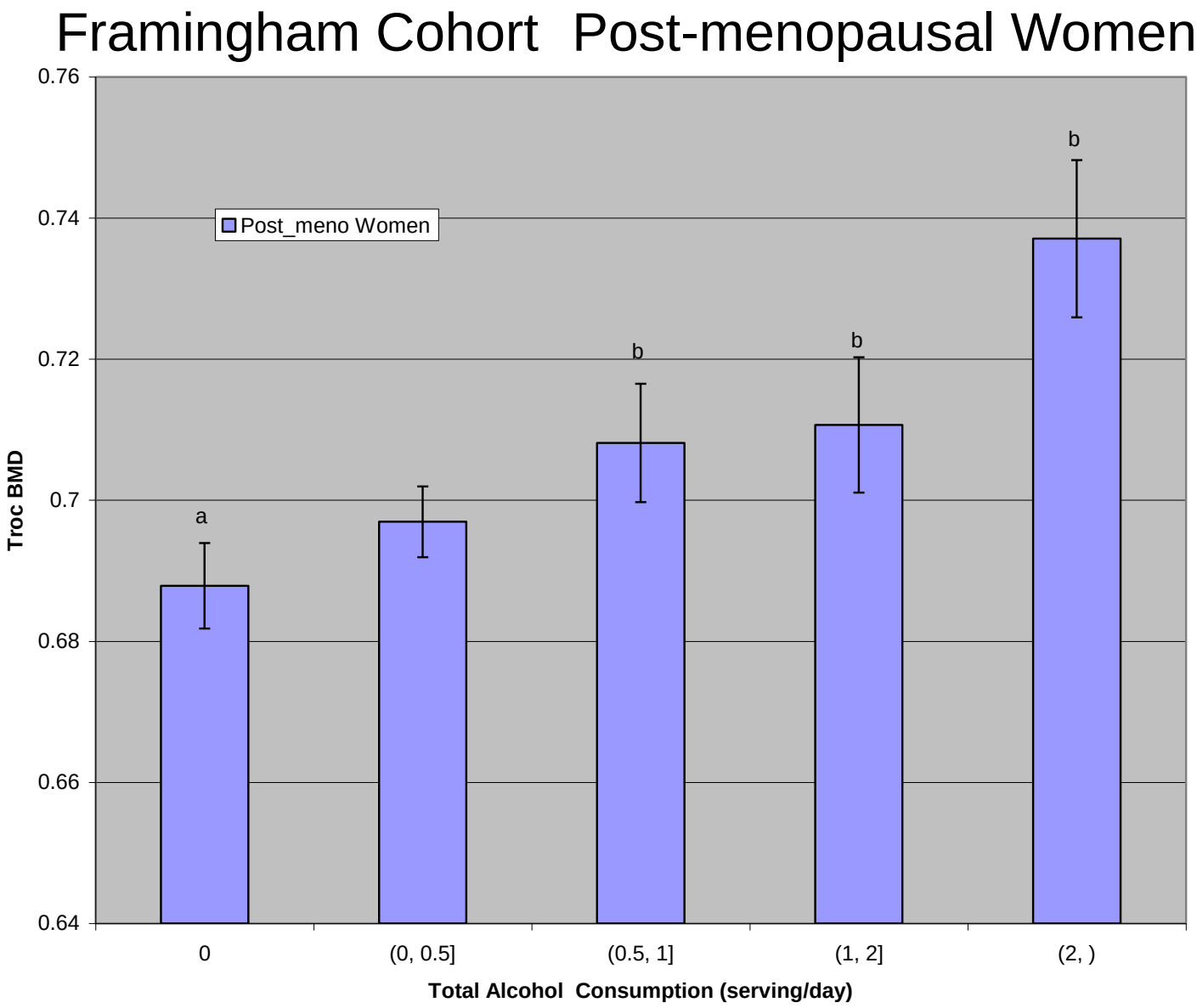
Anti-oxidants

B Vitamins

Other Minerals

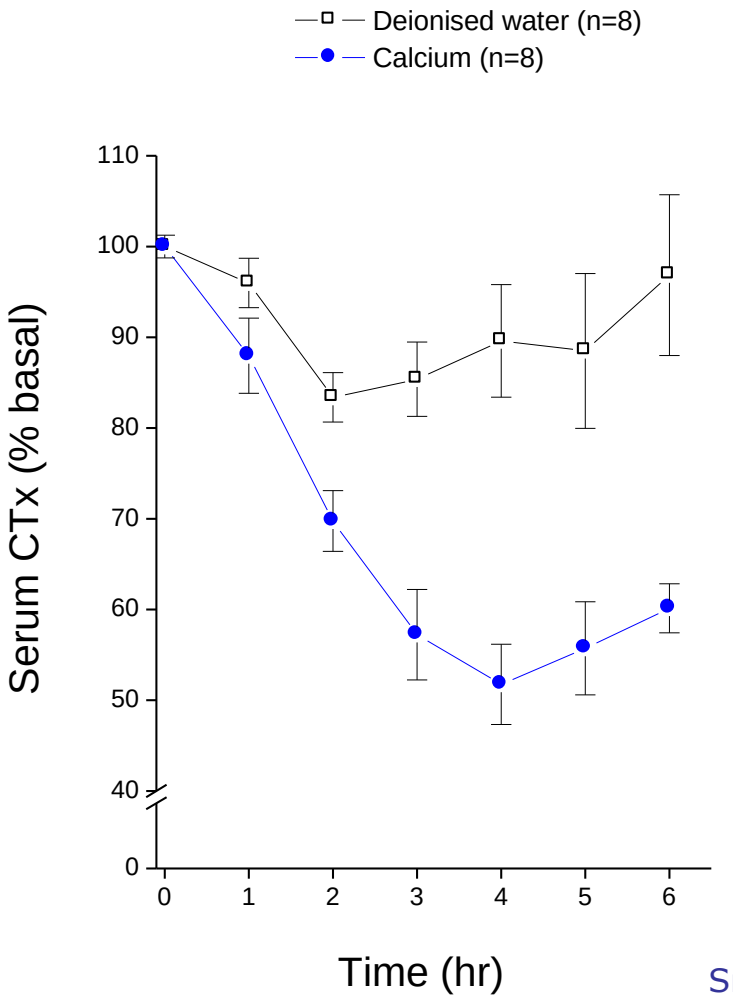
Calories

Moderate Alcohol Intake and Bone Mineral Density



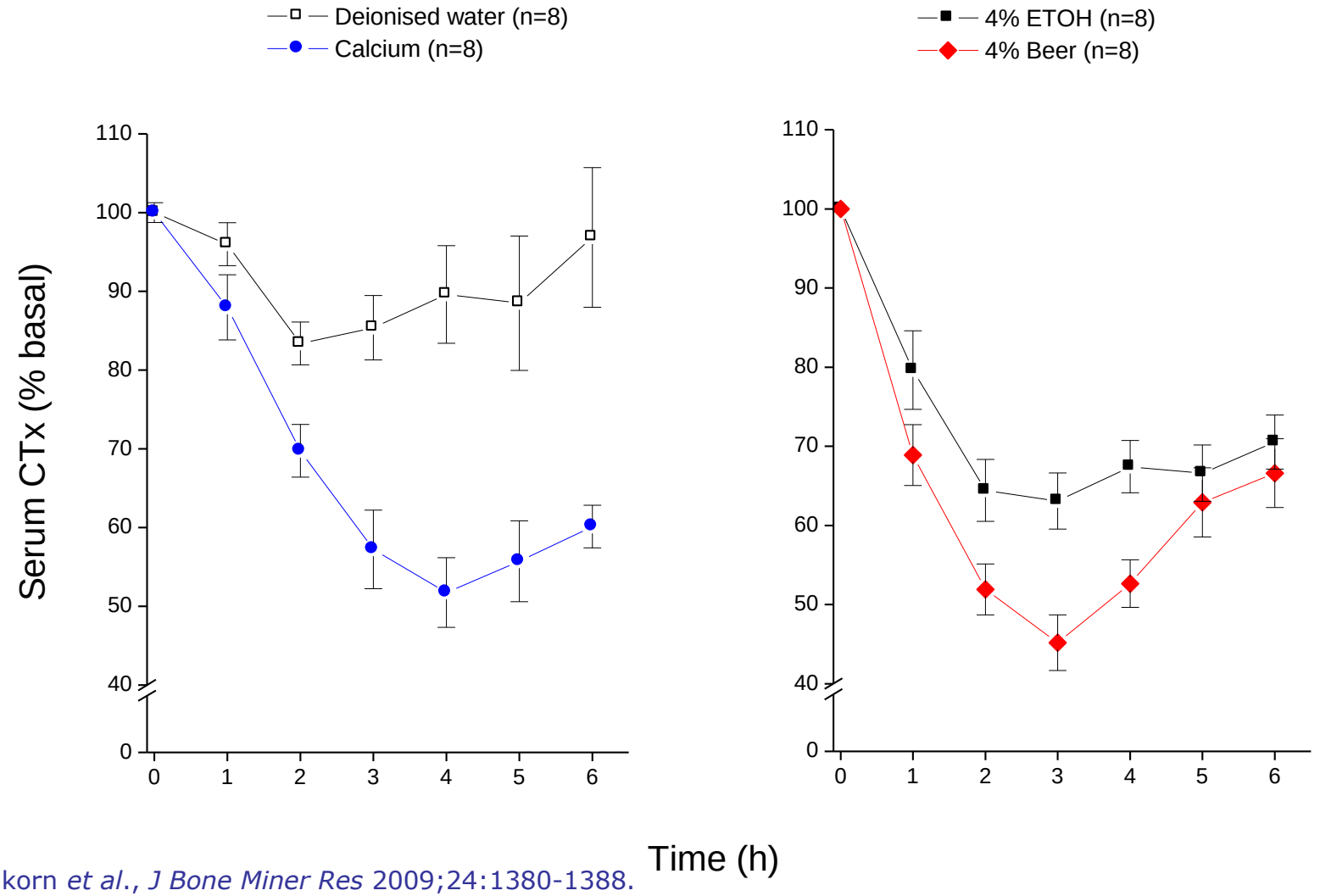
Tucker *et al*., *Amer J Clin Nutr* 2009; 89:1188-96.

Serum CTx following Ca Ingestion



Sripanyakorn *et al*., *J Bone Miner Res* 2009;24:1380-1388.

Serum CTx following Ca or Alcohol Ingestion



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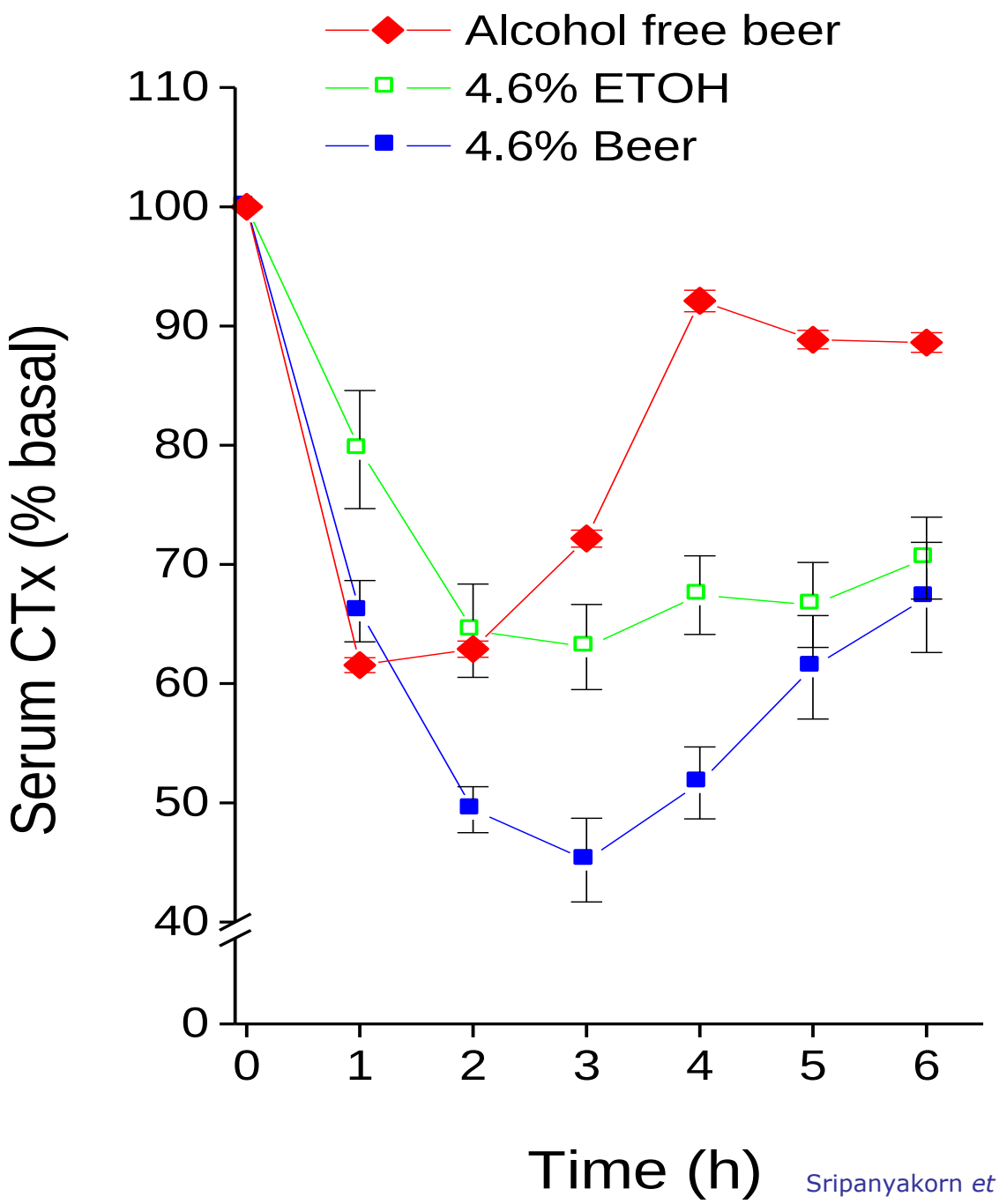

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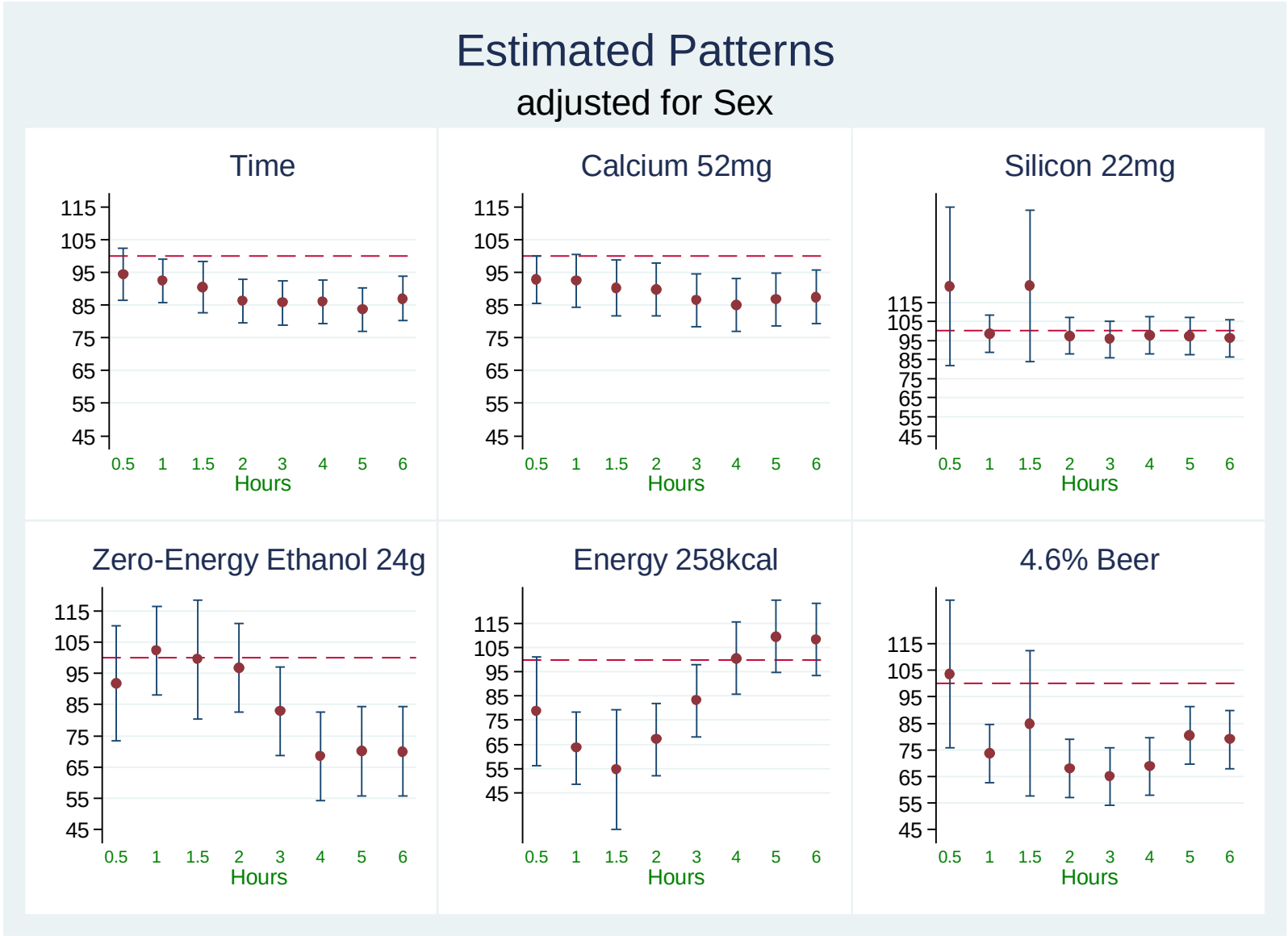
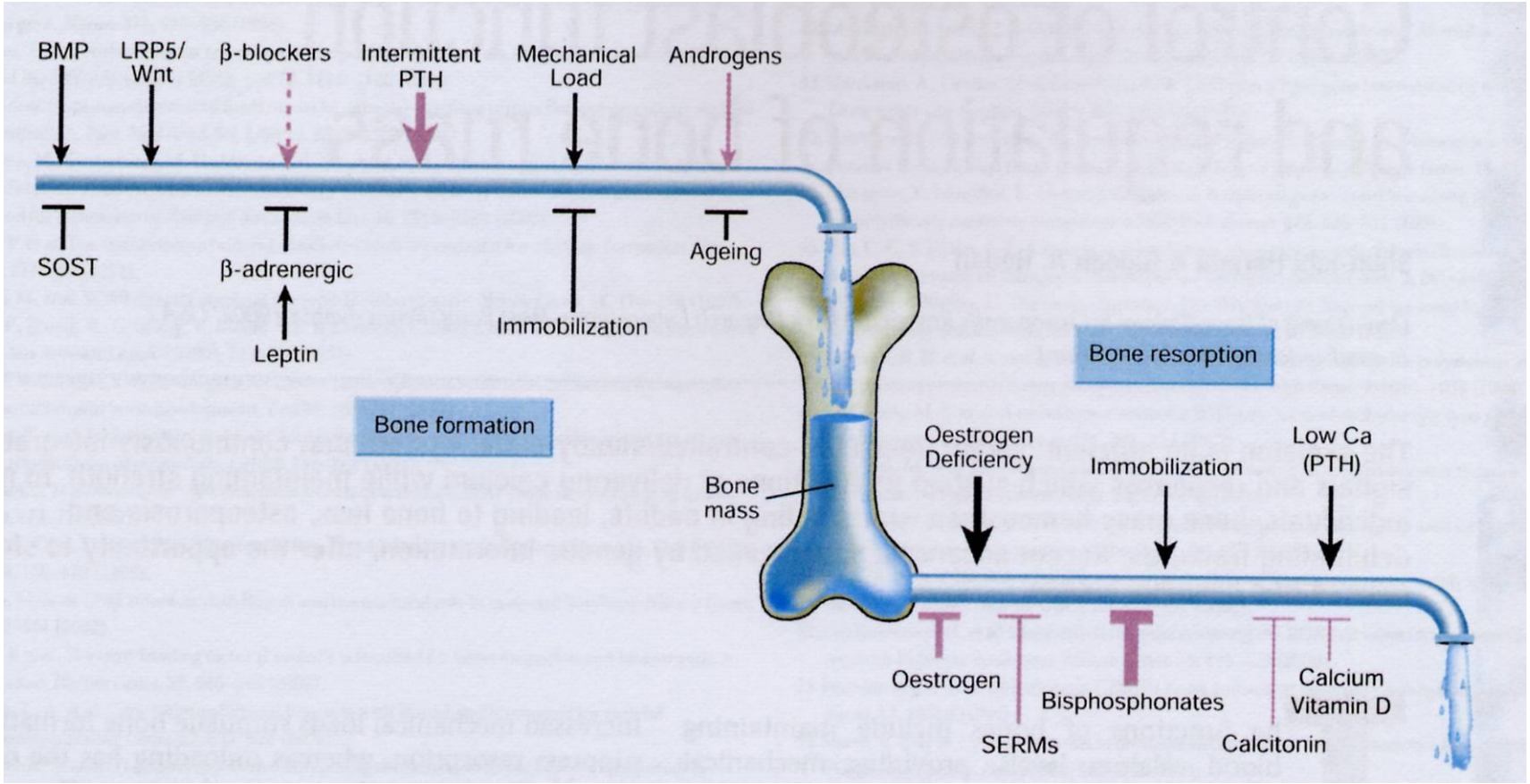
Sripanyakorn *et al.*, *J Bone Miner Res* 2009;24:1380-1388.

Final Model of Moderate Beer Consumption on Inhibition of Bone Resorption



Sripanyakorn *et al.*, *J Bone Miner Res* 2009;24:1380-1388.

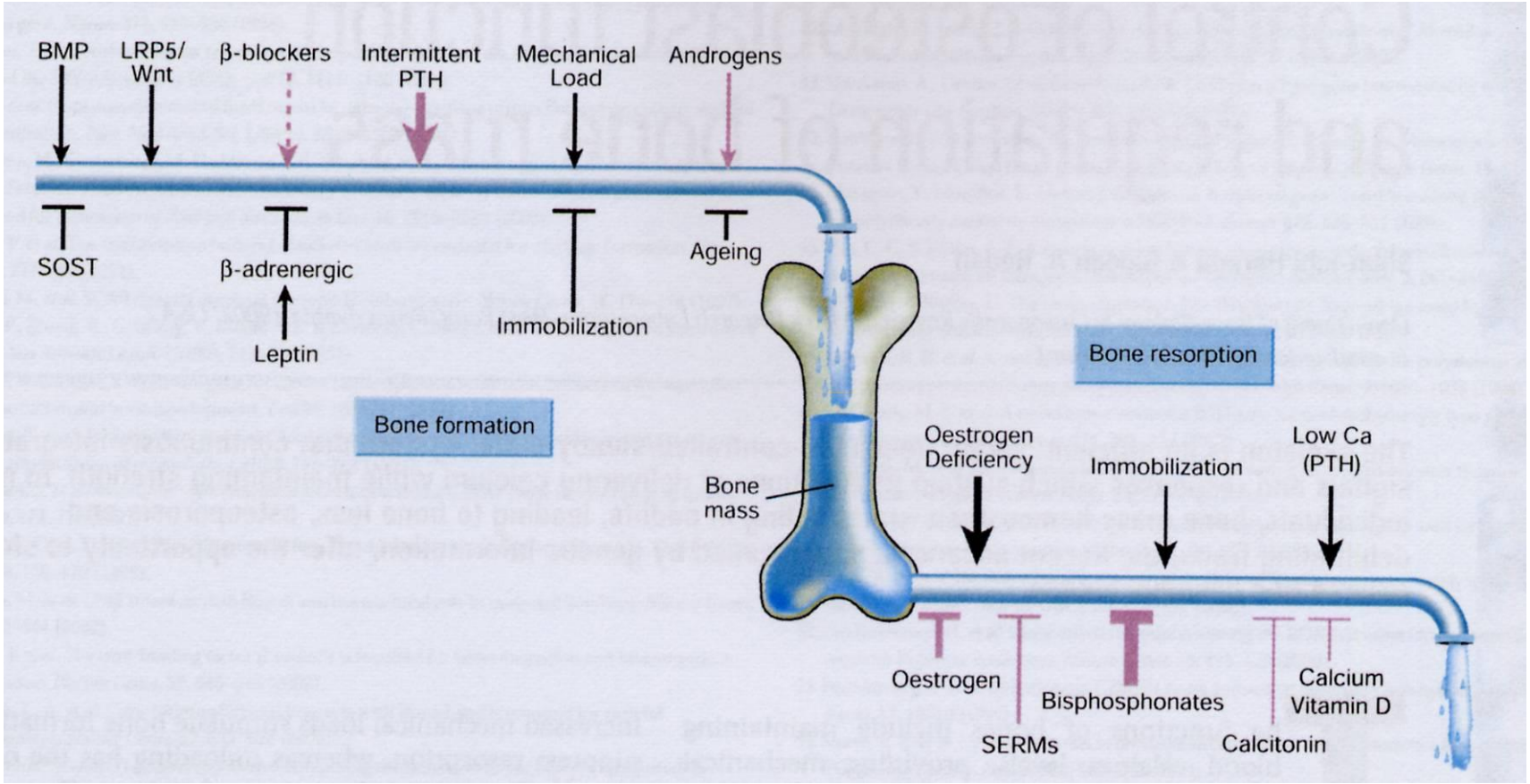
Bone Homeostasis



(Adapted from Harada & Rodan *Nature 2003.*)

Ethanol (moderate)

Bone Homeostasis



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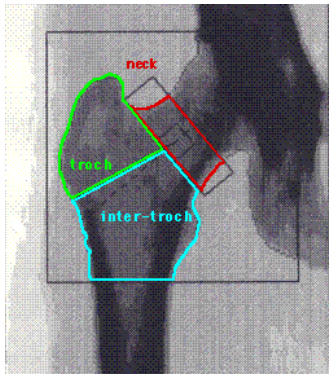
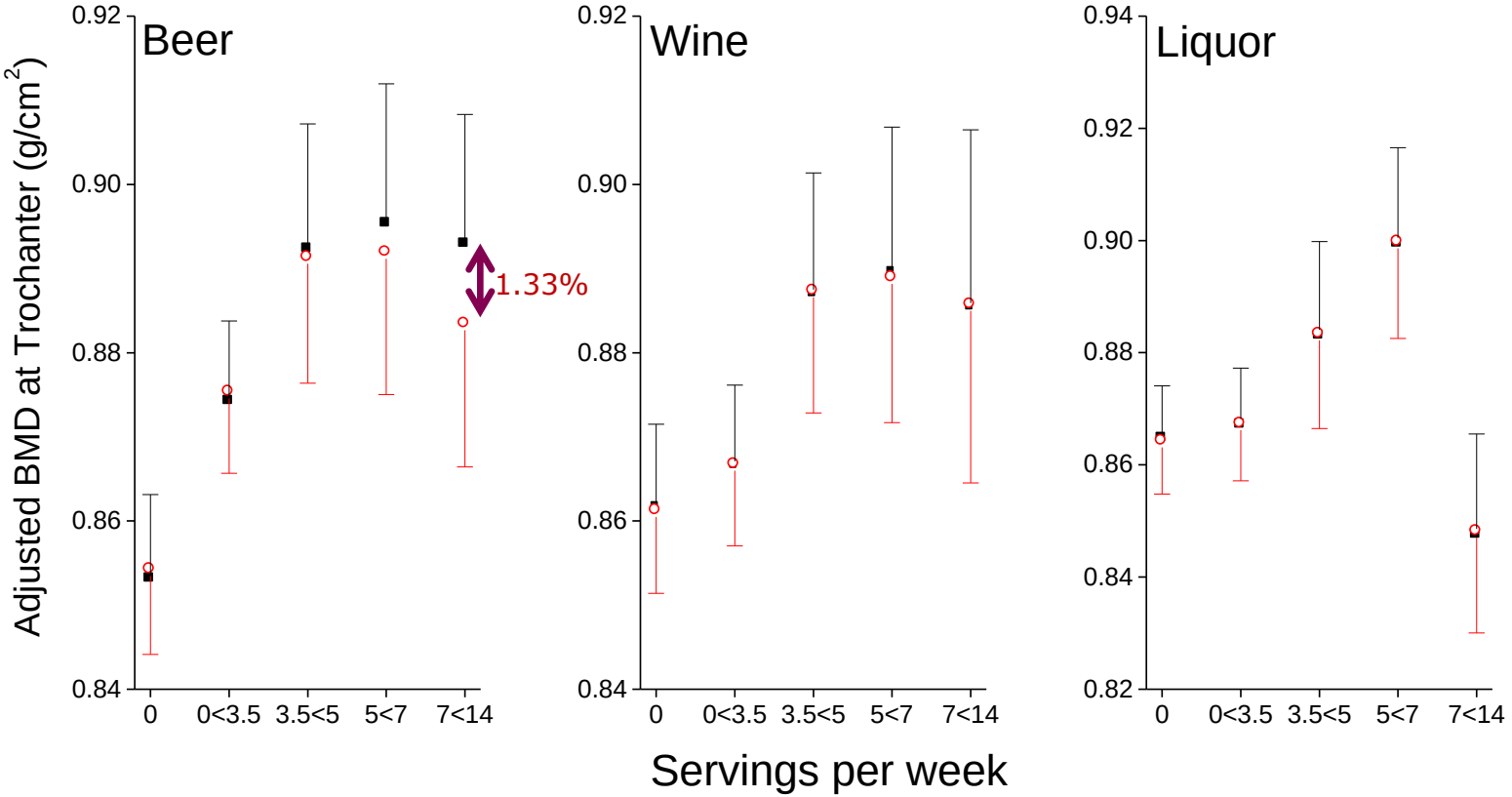


Associations between alcohol intake and BMD in men (in the Framingham Cohort): dissecting out the contribution from silicon



with (*circles*) and without *(squares)* adjustment for silicon intake.

Tucker *et al*., *Am J Clin Nutr* 2009;89:1188-1196.

BUT: CONFOUNDERS!!!!!!

Moderate drinkers are moderate people eating moderately and exercising moderately…….

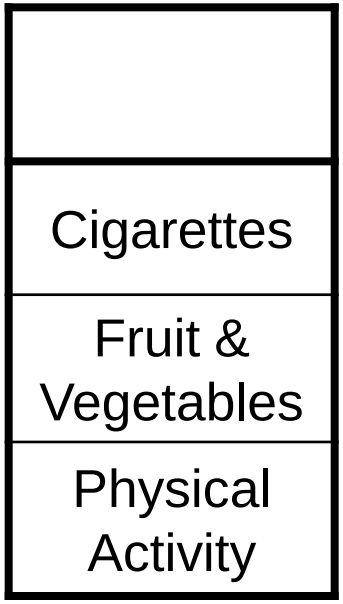
APOSS Cohort:

- Lifestyle, Moderate Alcohol Intake & Bone Mineral Density

N = 3883 women

50-62 years old

Two-Step cluster analysis



APOSS Cohort:

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Two-Step cluster analysis

	"Good" 27%
Cigarettes	↓
Fruit & Vegetables	↑
Physical Activity	↑

APOSS Cohort:

- Lifestyle, Moderate Alcohol Intake & Bone Mineral Density

N = 3883 women

50-62 years old

Two-Step cluster analysis

	"Good" 27%	"Bad" 50%
Cigarettes	↓	↓
Fruit & Vegetables	↑	↓
Physical Activity	↑	↓

APOSS Cohort:

- Lifestyle, Moderate Alcohol Intake & Bone Mineral Density

N = 3883 women

50-62 years old

Two-Step cluster analysis

	"Good" 27%	"Bad" 50%	"Ugly" 23%
Cigarettes	↓	↓	↑
Fruit & Vegetables	↑	↓	↓
Physical Activity	↑	↓	↔

(Unpublished results.) Our findings confirm that the positive impact of moderate alcohol (beer) ingestion on bone health cannot be explained by confounding factors and is a real phenomenon.

Conclusions

•Beer is a potential major source of dietary silicon as absorbable orthosilicic acid.

• Silicon (orthosilicic acid or precursor forms such as MMST) is involved in bone **Formation** and other aspects of connective tissue health .

• ***Moderate*** Alcohol intake is associated with acute suppression of bone **Resorption**.

•Ingestion of high levels of dietary silicon and *moderate* alcohol consumption is postively associated with bone health in humans

• Moderate beer consumption appears to address bone health from two sides: promotion of bone formation (silicon) and inhibition of bone resorption (ethanol).

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