CA:MG RATIO IN HUMAN HEALTH

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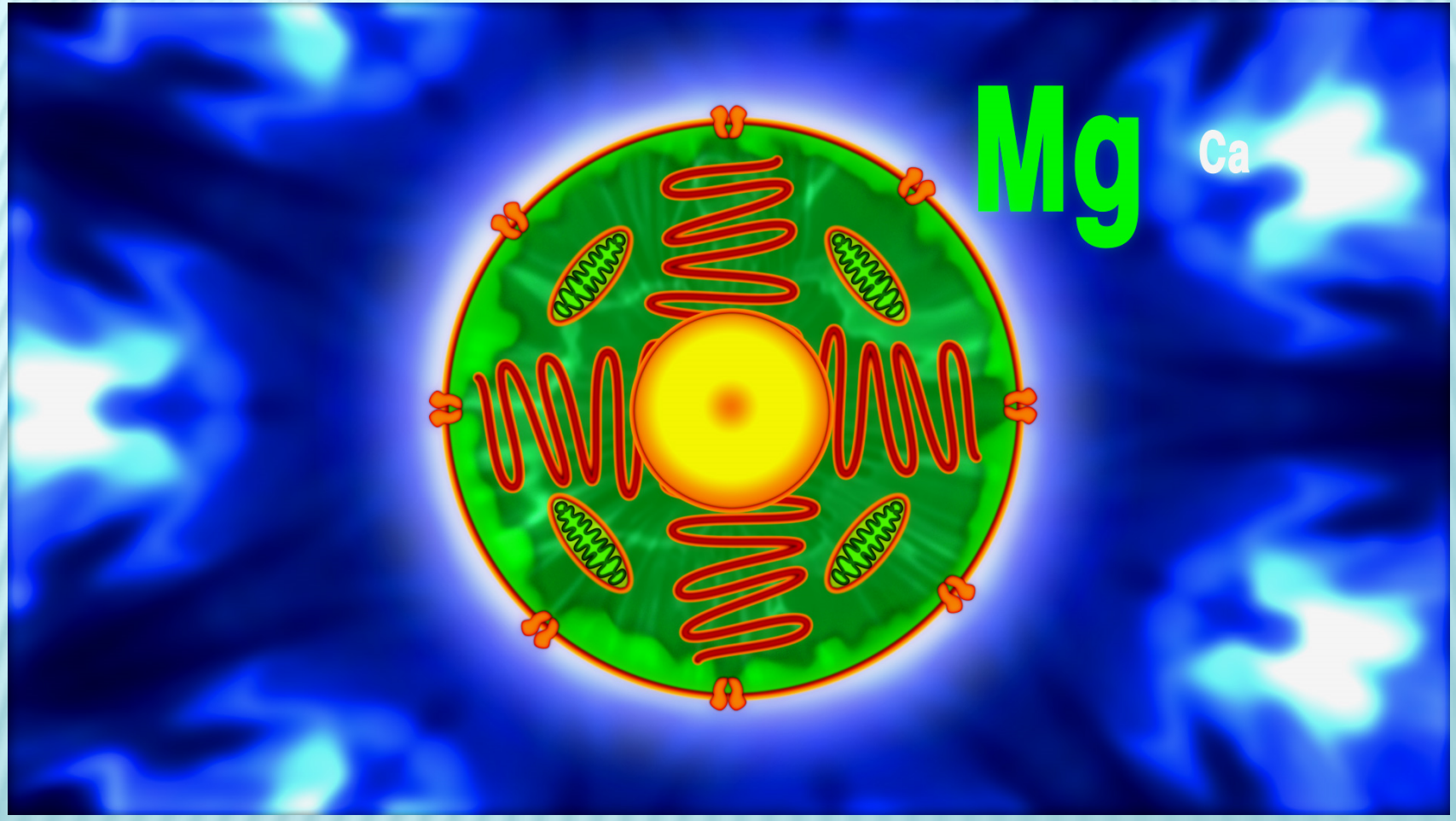
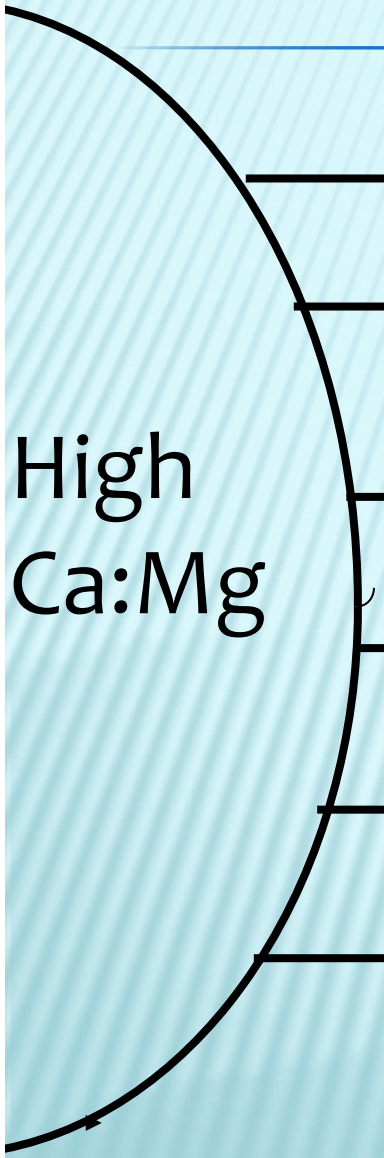
CA:MG IN ANIMAL CELL FUNCTION



CELLULAR EFFECTS IN HUMANS OF HIGH CA:MG



Cell Type/Function	Effect	Clinical
Heart muscle	Over-contracts cannot relax	Heart Disease
Blood Platelet	Stickiness – prone to clot	Blood clots – Heart Attack Stroke
Vascular smooth muscle cells	constriction/stiffness hypertension	HD Risk Factor
Cholesterol Biosynthesis	Over-production dyslipidemia	HD Risk Factor
Liver	High glucose prodn.	High blood glucose
Muscle cell	Poor response to insulin	Insulin Resistance
Pancreas, beta cell	High insulin prodn.	Hyperinsulinemia

See: Resnick, et al articles, 1993 – 1999
and Seelig & Rosanoff, 2003

CA:MG IN HUMAN HEALTH

- **Historical – "Do not exceed 2:1 intake of Ca:Mg"**
  - **Durlach, 1989**
- **2012 – Ca:Mg < 2.68 intake shows less risk of cancer**
  - Dietary Ca:Mg < 2.6 can lower occurrence of colorectal adenoma with polymorphism
    - **Dai et al., 2012**
  - In general, risk of colorectal cancer decreases with rising Mg intakes
    - **Larsson et al., 2005, Folsom & Hong, 2006**
  - especially at low Ca:Mg intake ratios
    - **Dai et al., 2012; Ma et al., 2010**

CHANGING CA:MG INTAKE RATIOS IN HUMAN POPULATIONS

Population – year	Ca:Mg Dietary	Ref.
Traditional		
Rural India, underprivileged – 1998	0.50	Kapil, 1998
Bedouin traditional, 2009	0.87	Abu-Saad, 2009
Transitional		
Upper Class Young Chinese – 1941	1.12	Chu et al., 1941
Ceylon Med Students – 1950	1.35	Cullumbine, 1950
*Bedouin transitional, 2009	1.49	Abu-Saad, 2009
Modern Developed		
Japan	1.6 –1.9	Ma et al., 2010
China – 2004 (1997)	1.75	Cai et al., 2004
Canadian adults, 2004	2.63	HealthCanada, 2004
European adults, 2009	2.73	Welch, 2009
Turkish teens, 2008	2.89	Garipagaoglu, 2008
UK adults, 2008/9	3.1	Bates, et al., 2010
USA adults, 2007/8	3.17	Rosanoff, 2010

INFLUENCE OF CA:MG INTAKE RATIO

- **China study, Ca:Mg intake ratio = 1.7**
  - **increased** mortality from cardiovascular and colorectal cancer diseases
    - At 320+ mg Mg/day

      Dai et al., 2013

- **USA studies, Ca:Mg intake ratio = 3.3** **(2009-10 USDA NHANES data. With supplements it is 3.6)**
  - **decreased** mortality from cardiovascular diseases
    - At increase of dietary Mg of 200 to 375 mg/day
      - **Chiuve 2011, 2013; Zhang 2012; Del Gobbo 2013**
  - **decreased** mortality from colorectal cancer
    - At increased Mg intakes of >106 mg/day
      - **Folsom & Hong, 2006**

EFFECT OF SOIL CA:MG RATIOS ON YIELD AND PLANT CA:MG IN ALFALFA
(WISCONSIN SOILS, 1979)

Soil Ca:Mg*	Yield t/a	Plant Ca:Mg	% Exchange sat - Mg	% Exchange sat - Ca
Theresa silt loam*				
2.28	3.31	2.15	35	34
3.40	3.31	2.36	22	45
4.06	3.40	2.53	19	46
4.76	3.40	2.87	17	49
5.25	3.50	2.97	16	52
8.44	3.22	3.29	12	62
Plainfield loamy sand*				
2.64	4.14	2.48	20	32
2.92	4.28	2.70	20	35
3.48	4.35	3.32	18	38
4.81	4.12	3.35	15	43
7.58	4.30	4.14	13	65
8.13	4.35	3.64	15	68

*Variations in exchangeable Ca and Mg achieved by adding gypsum and/or Epsom salt.
**Exchangeable Ca range = 1,640 - 3,040 lb/a; Exchangeable Mg range = 380 - 744 lb/a.
***Exchangeable Ca range = 950 – 2,050 lb/a; Exchangeable Mg range = 240 - 390 lb/a.

SUMMARY

- Ca:Mg ratios:
  - Human Diet – rising; has health consequences
  - Soil - may not alter yield, but may alter crop Ca:Mg; differs with soil type.
  - Crop - taken together with overall diet, impacting human health?
- Other mineral ratios that may have human health impact:
  - Zn:Cu
  - Na:K
  - P:Ca and P:Mg – poorly studied in human health so far