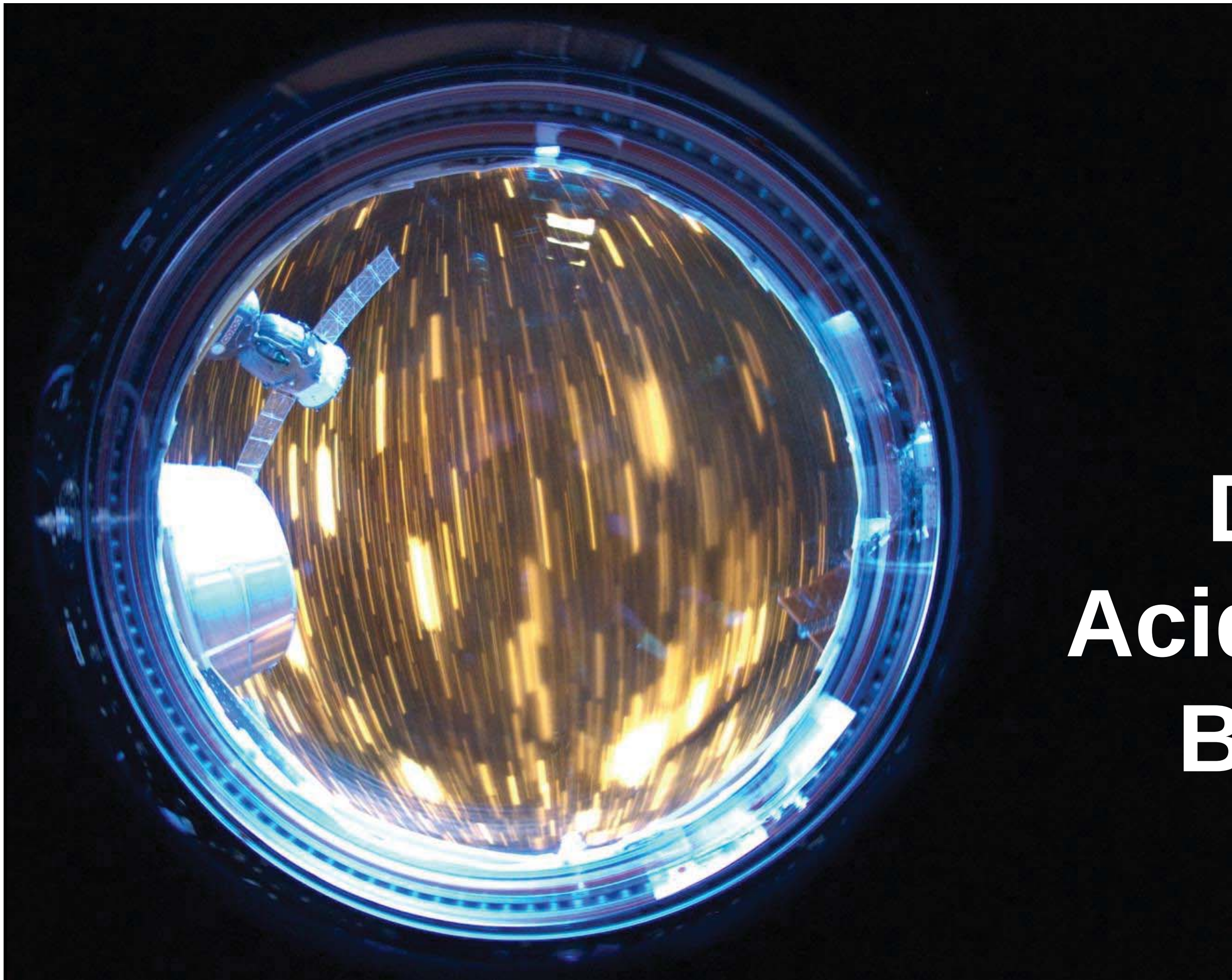


Diet
Acid/Base
Bone

Scott M. Smith, Ph.D.
Sara R. Zwart, Ph.D.

Forward Work

Bone Strength?

Fracture risk?

↑ resorption

↑ formation

Optimization

Exercise

Diet

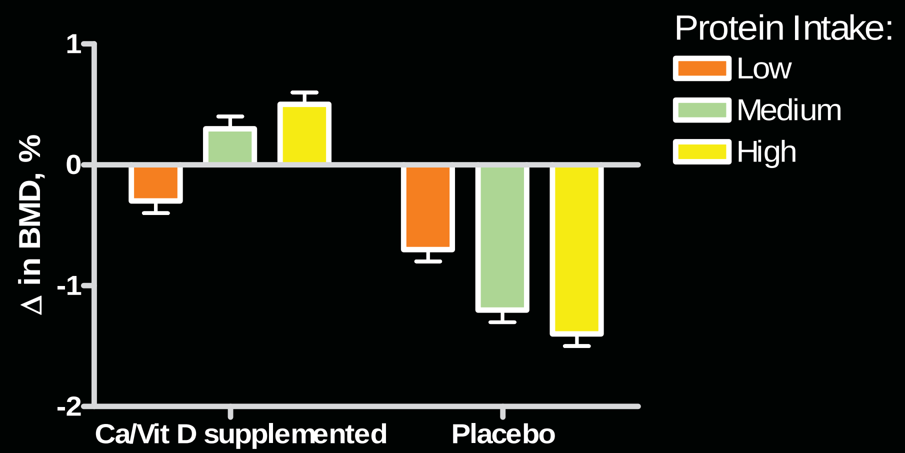
Dietary Protein

Excess protein: beneficial or harmful to bone?

- Oxidation of excess protein yields H^+ corresponding to H_2SO_4
- Bone: reservoir of base
- Osteoclasts are more active at lower pH

Other factors

- Calcium
- Base-components
- Type of protein



Dawson-Hughes et al. 2002

Animal vs. Vegetable

Animal protein

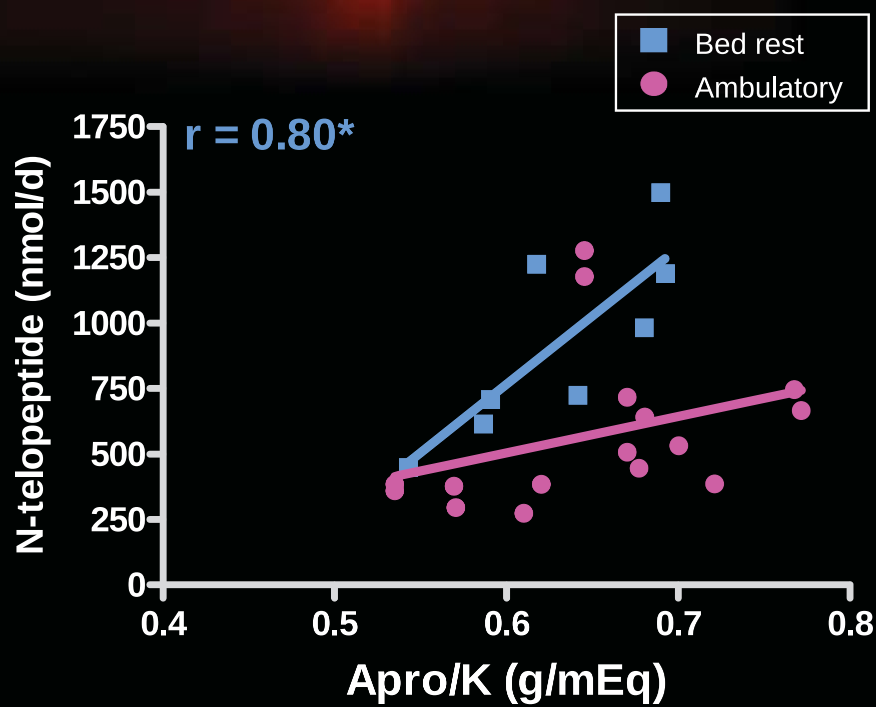
- Diets rich in animal protein tend to have greater overall acid potential

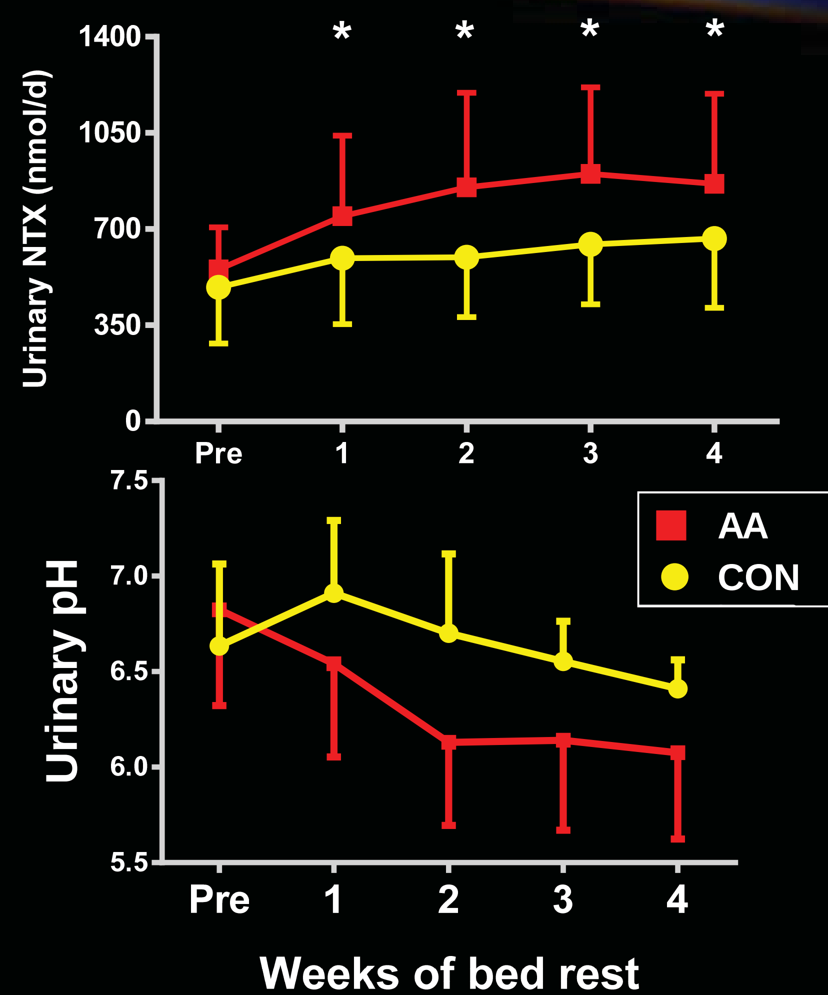
Vegetables/fruits

- Contain substantial amounts of base precursors (and K)

APro/K provides an estimation of acid/alkali load

Bed Rest

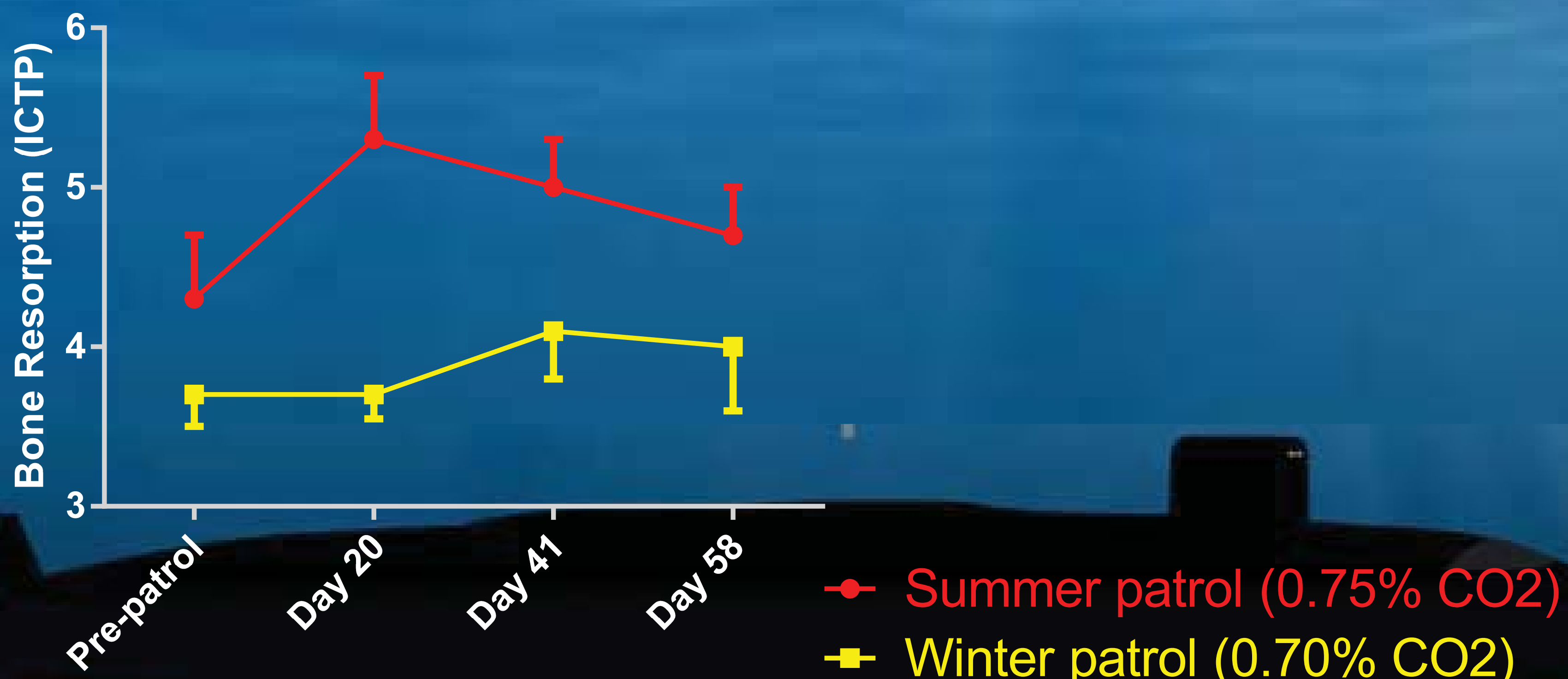




Zwart et al., *Am J Clin Nutr*, 2004

Zwart et al., *J Appl Physiol* 2005

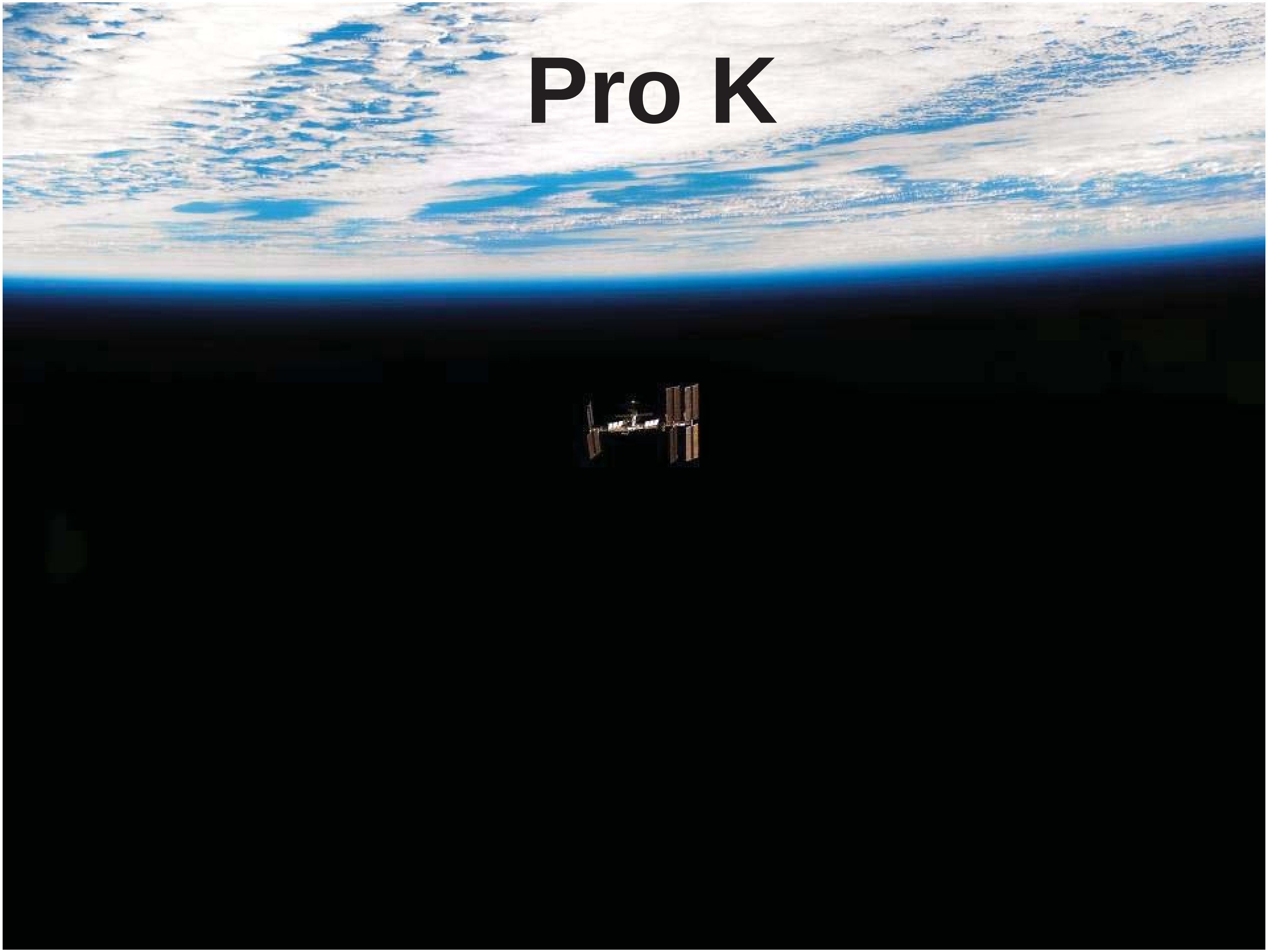
Submariners



Serum carboxy-terminal cross linked telopeptide of type 1 collagen (ICTP)

J Appl Physiol 112:587-596, 2012

Pro K

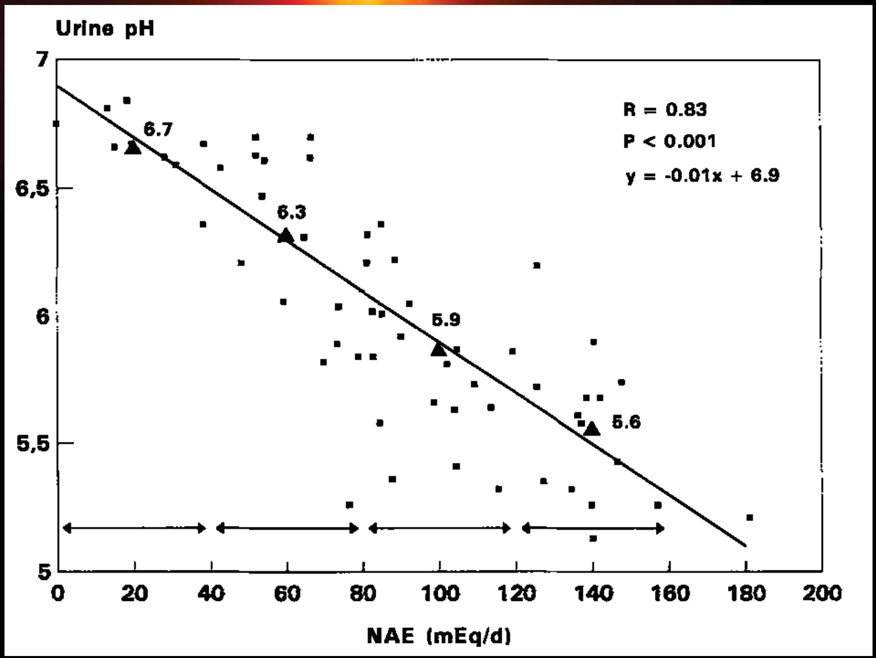


Pro K

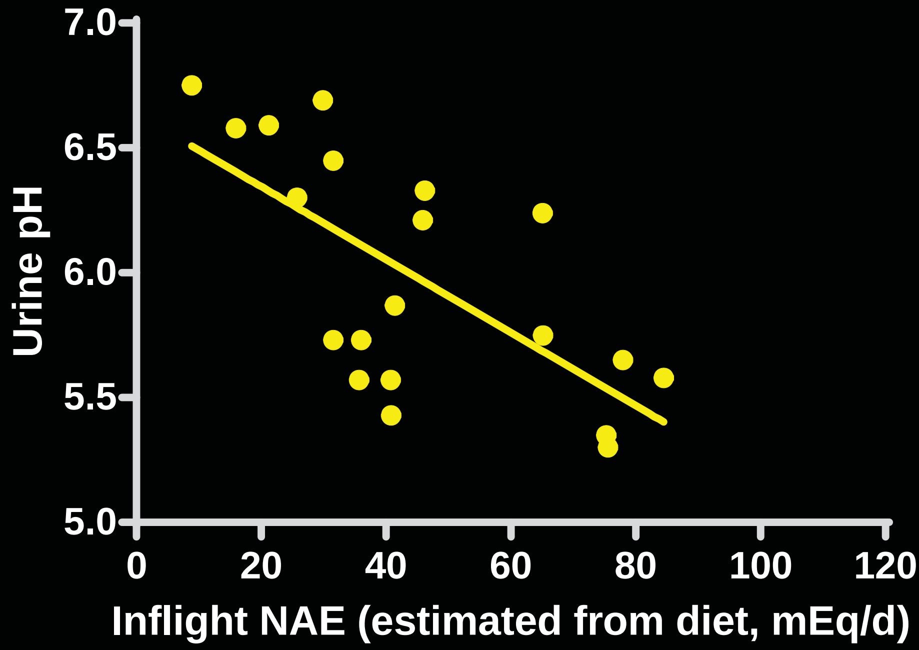
- 4-d controlled diets 2x before and 4x during flight
    - High Apro/K: 1.0-1.3 g/mEq
    - Low Apro/K: 0.3-0.6 g/mEq
- Blood/urine samples collected at end of session

L-180	L-45	FD15	FD30	FD60	FD120	FD180
4-d High APro:K	**4-d Low APro:K**	**4-d Low APro:K**	***4-d Monitored Diet***	**4-d Low APro:K**	**4-d High APro:K**	**4-d High APro:K**

Pro K



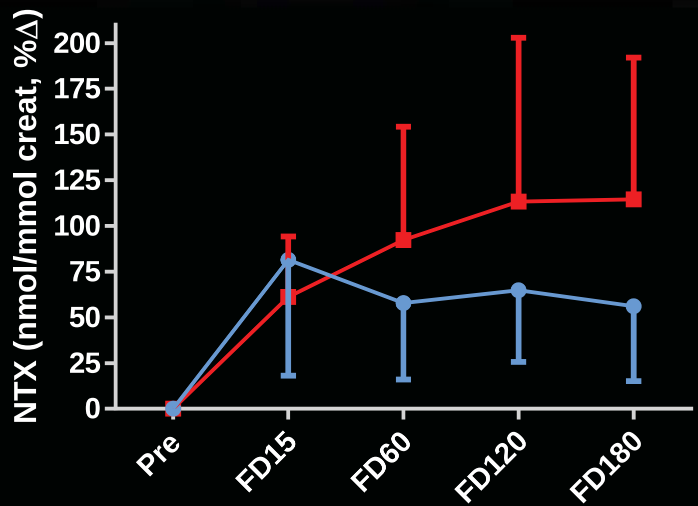
Remer & Manz 1995



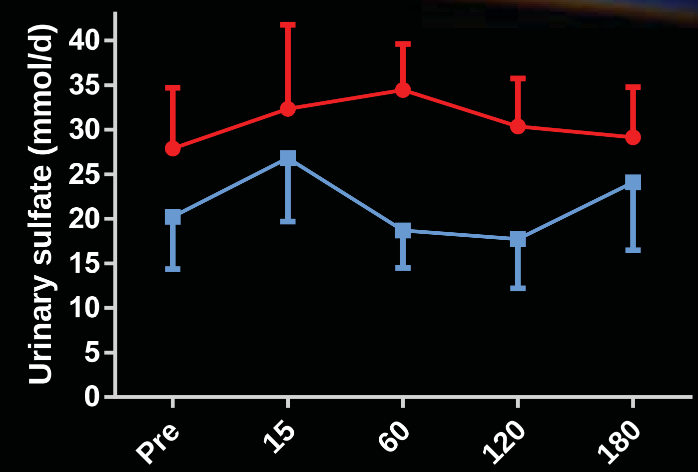
NAE= PRAL + Organic acids

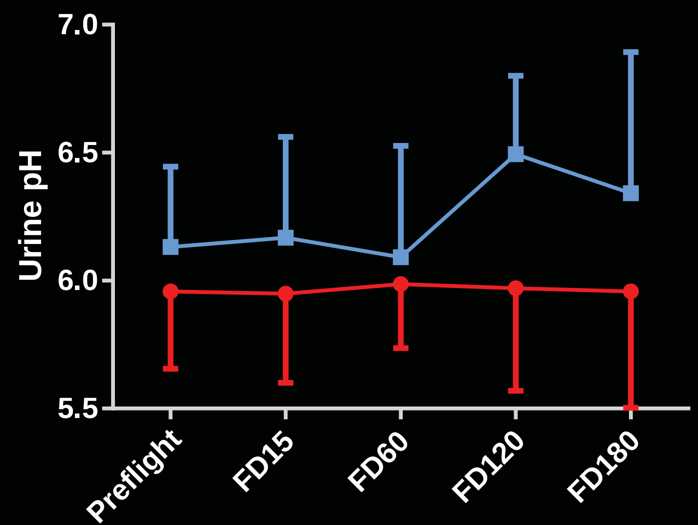
PRAL = 2 x [(0.00503 x mg met/d) + (0.0062 x mg cys/d)] + (0.037 x mg P/d) – (0.021 x mg K/d) – (0.026 x mg Mg/d) – (0.013 x mg Ca/d)

PRELIMINARY Results

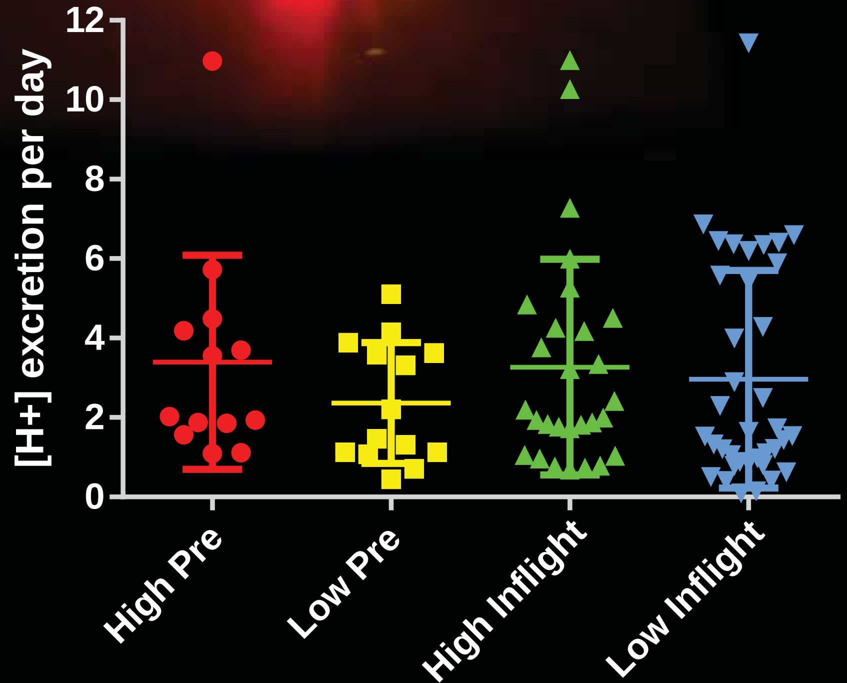


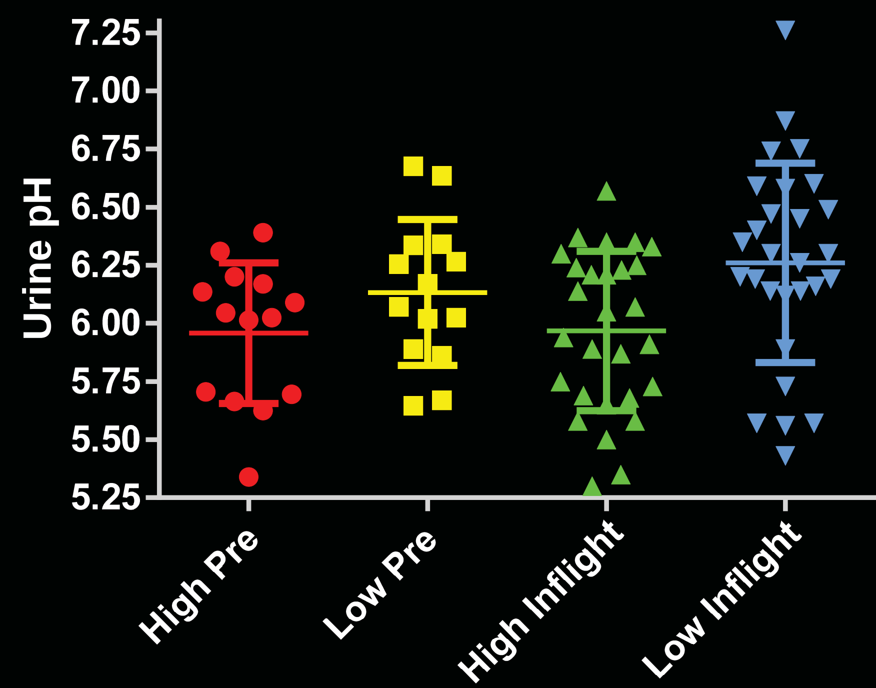
High Apro/K
Low Apro/K





PRELIMINARY Results

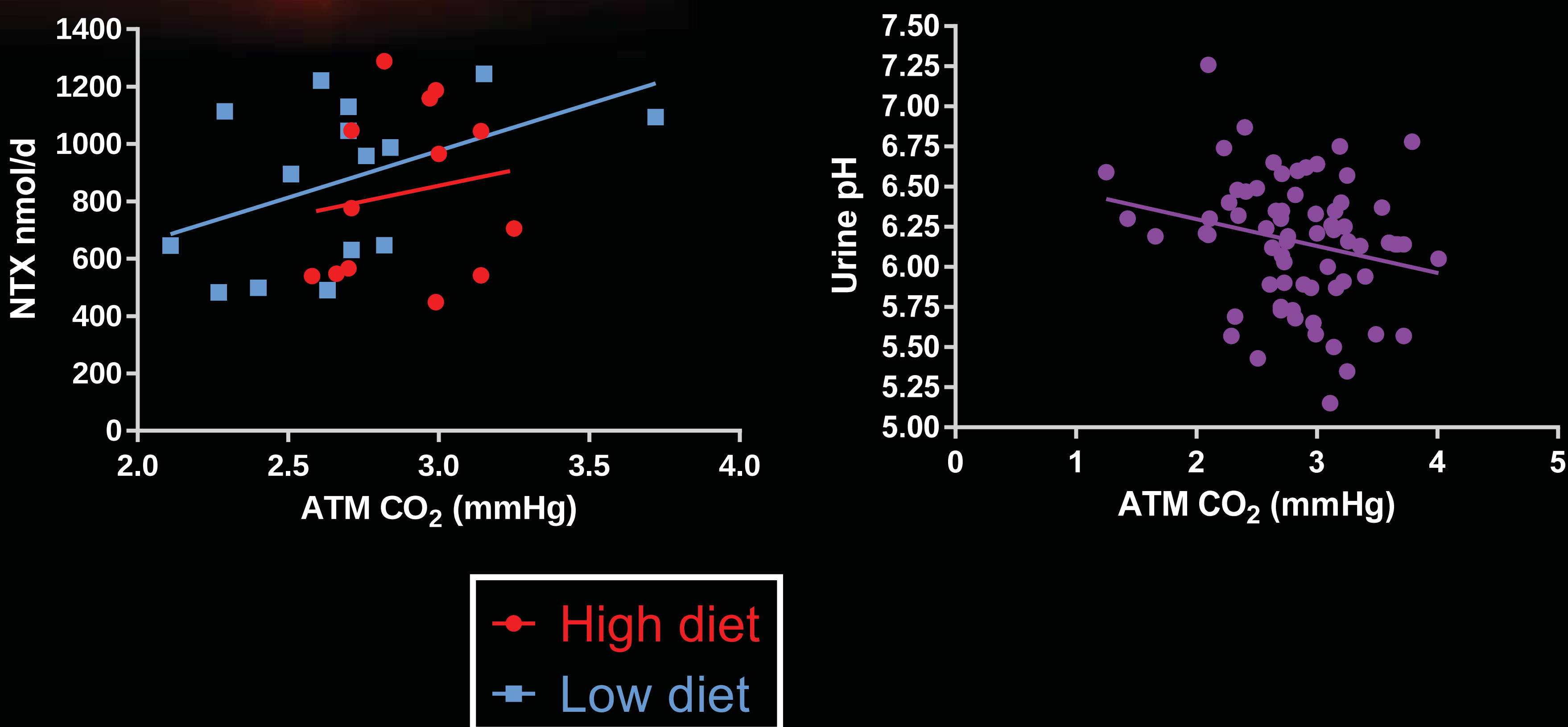




Variability between subjects – confounding factors?

Energy (i.e., kcal, % requirement, metabolic rate), Protein (% of kcal), CO2, Exercise, Inflammation, Gender, Exercise, Other (?)

PRELIMINARY Results



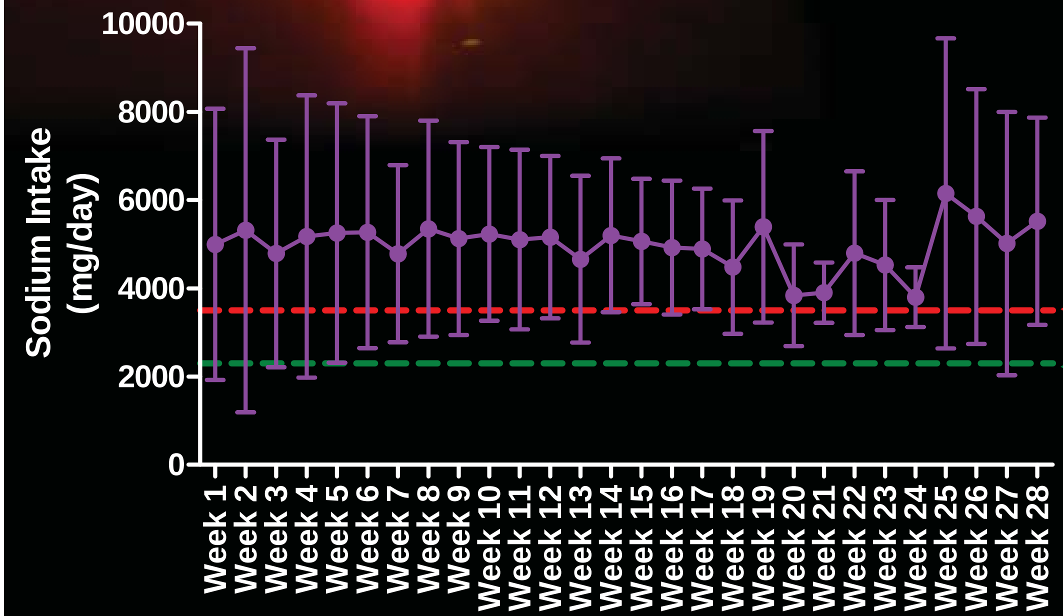
Sodium

Excess sodium intake (and related effects on acid/base physiology) is associated with a number of health issues

- Bone loss
- Increased renal stone risk
- Impaired muscle performance/protein catabolism
- Altered glucose metabolism
- Hypertension

With the exception of hypertension, all of these other factors have been raised as concerns for space travelers.

Sodium



3500 mg/d = ISS requirement; and the “old” RDA)

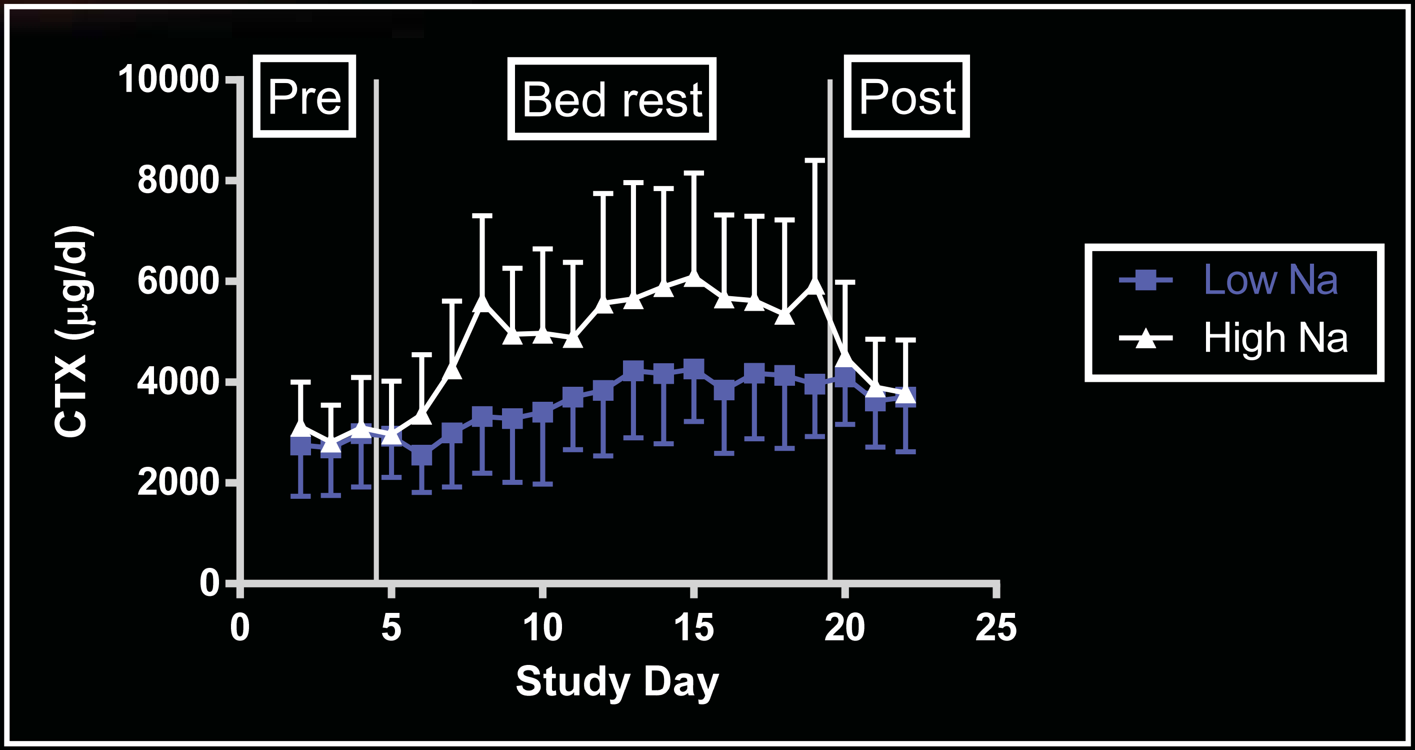
2300 mg/d = US Dietary Reference Intake Tolerable Upper Intake Level (UL)**, and NASA exploration requirement

In 2005-2006, the average US intake of Na was estimated at 3,436 mg Na/d*
In 1990-1999, the average US intake of Na was estimated at: 3,377 mg for 31-50 yo M**
3,539 mg for 31-50 yo F

*** http://www.cdc.gov/media/pressrel/2009/r090326.htm**
**** IOM, Dietary Reference Intakes, 2004**

Sodium and Bone

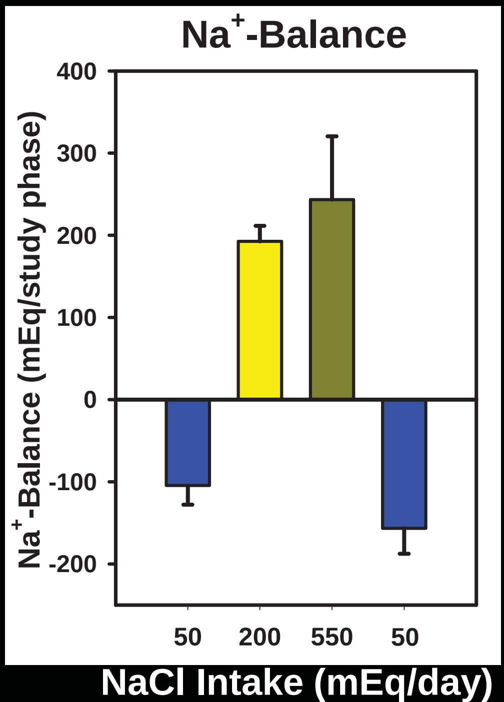
SOLO



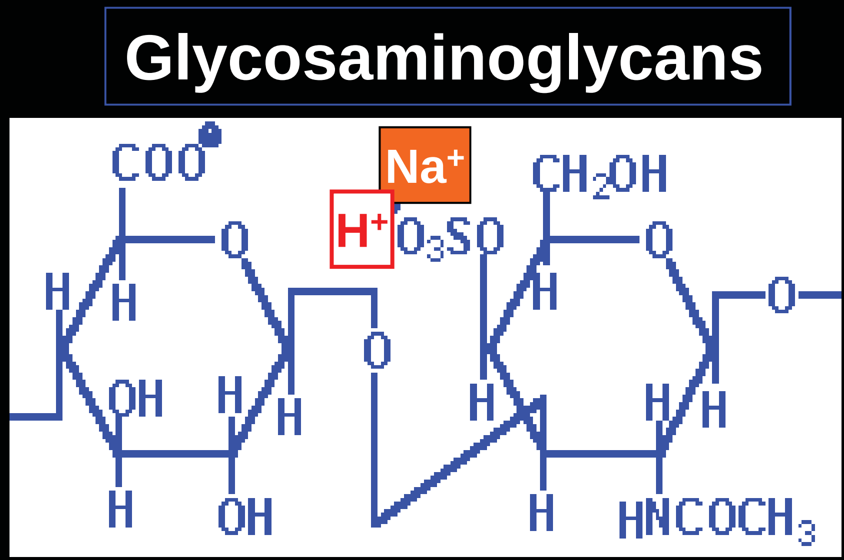
Frings-Meuthen et al., JAP, 2011

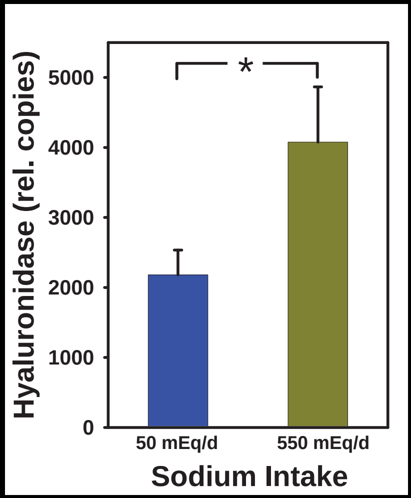
Sodium and pH

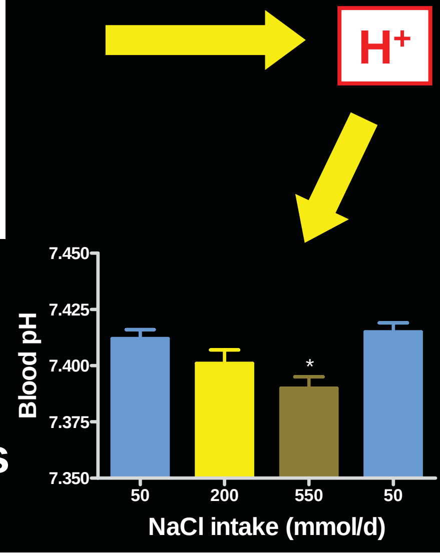
Excess sodium intake leads to non-osmotic (i.e., non-fluid retaining) storage of sodium



The excess sodium is bound to glycosaminoglycans in skin, exchanging with a hydrogen ion.







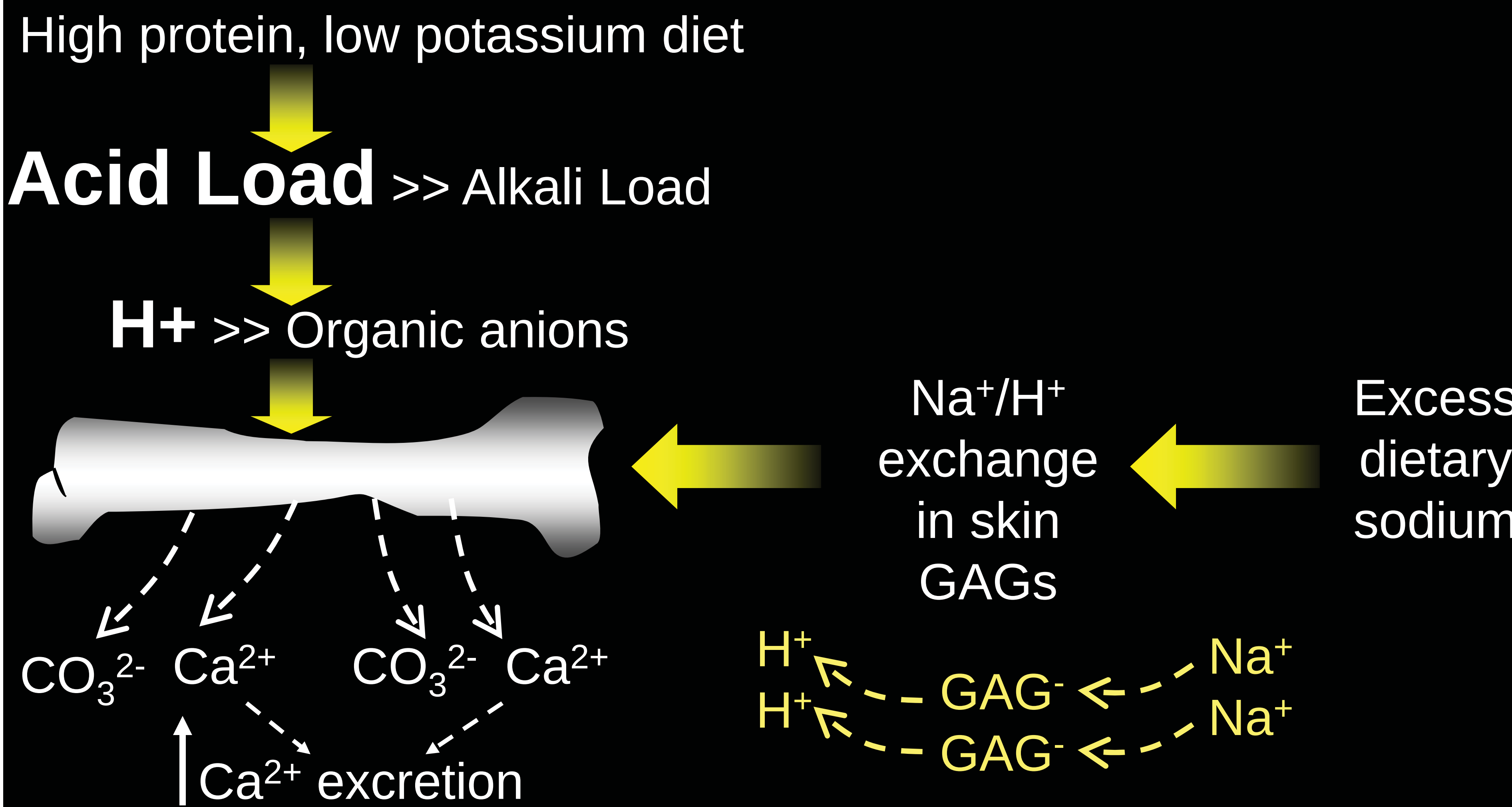
50 mEq = 1150 mg
200 mEq = 4600 mg
550 mEq = 12,650 mg

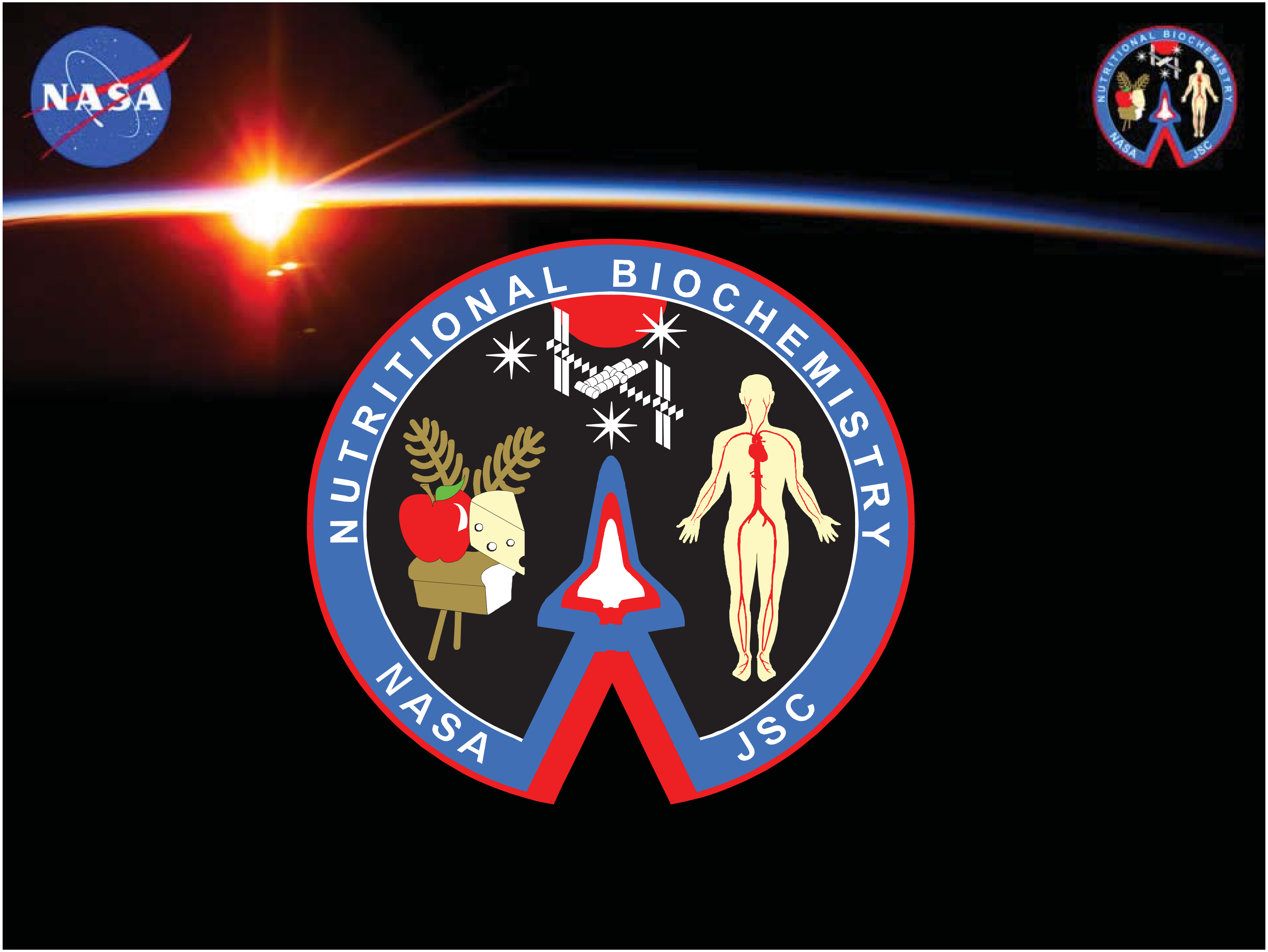
H+ release contributes to acid load

Heer, et al., *BJN*, 2009
Frings-Meuthen et al, 2011


SOLO

Acid/Base and Bone

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