Mineral and vitamin nutrition

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MacroMinerals

Macrominerals -- generally required at 0.2% of the diet or more

Calcium (Ca^{+2}) **Phosphorus (PO_4^{-3})**

Potassium (K^{+}) **Sodium (Na^{+})** **Chlorine (Cl^{-})**

Magnesium (Mg^{+2}) **Sulfur (S^{-})**

Minerals

Microminerals or Trace Minerals -- required in ppm range

Copper ($Cu^{+1,+2}$) **Iron ($Fe^{+2,+3}$)**

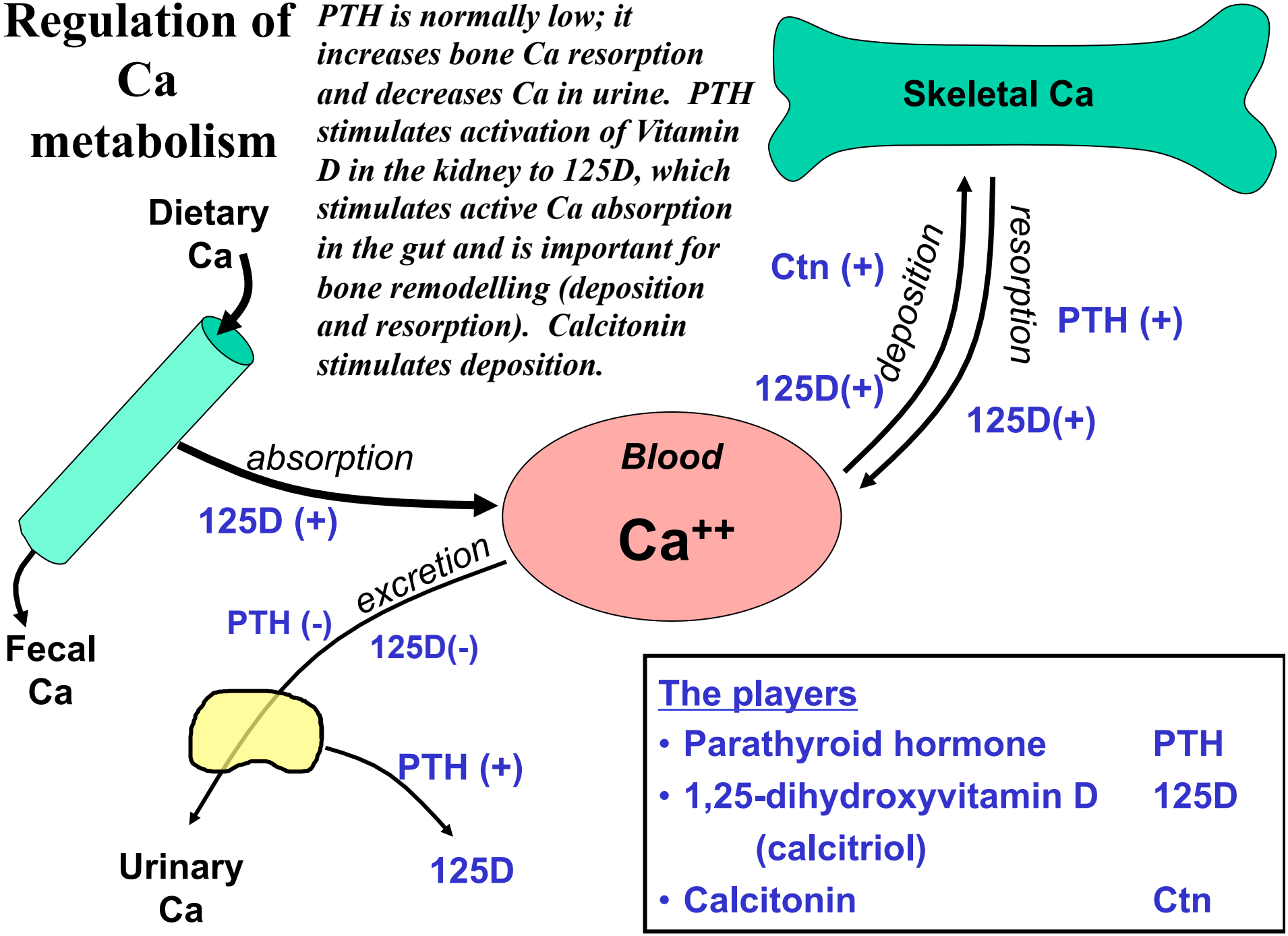
Manganese (Mn^{+2}) **Zinc (Zn^{+2})**

Cobalt (Co^{+2}) **Iodine (I^{-})** **Selenium (Se^{+2})**

Chromium (Cr) ??

Regulation of Ca metabolism

PTH is normally low; it increases bone Ca resorption and decreases Ca in urine. PTH stimulates activation of Vitamin D in the kidney to 125D, which stimulates active Ca absorption in the gut and is important for bone remodelling (deposition and resorption). Calcitonin stimulates deposition.



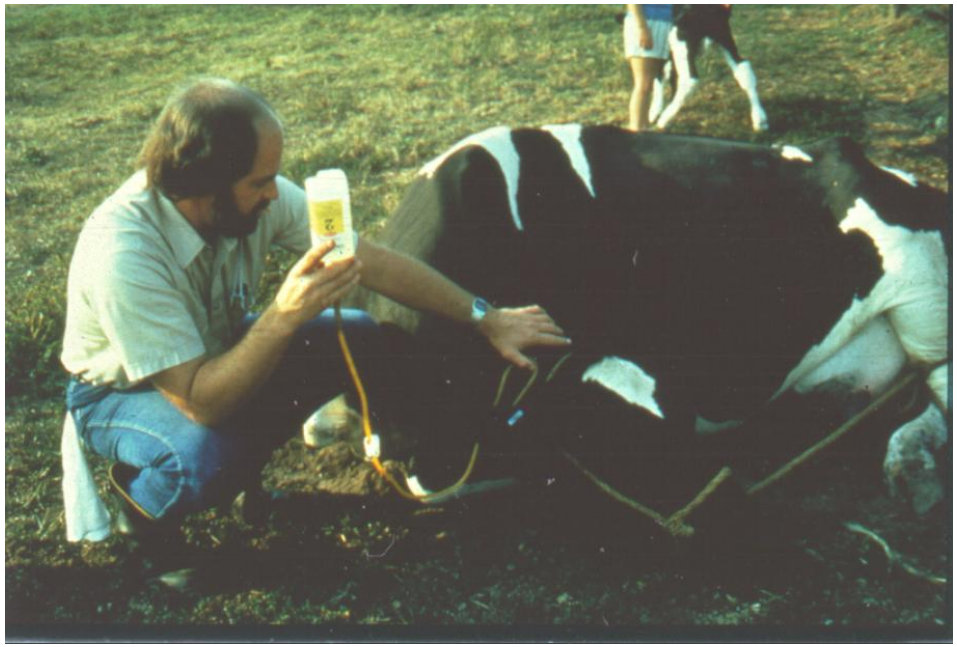
The players

- Parathyroid hormone — PTH
- 1,25-dihydroxyvitamin D (calcitriol) — 125D
- Calcitonin — Ctn

Acute hypocalcemia

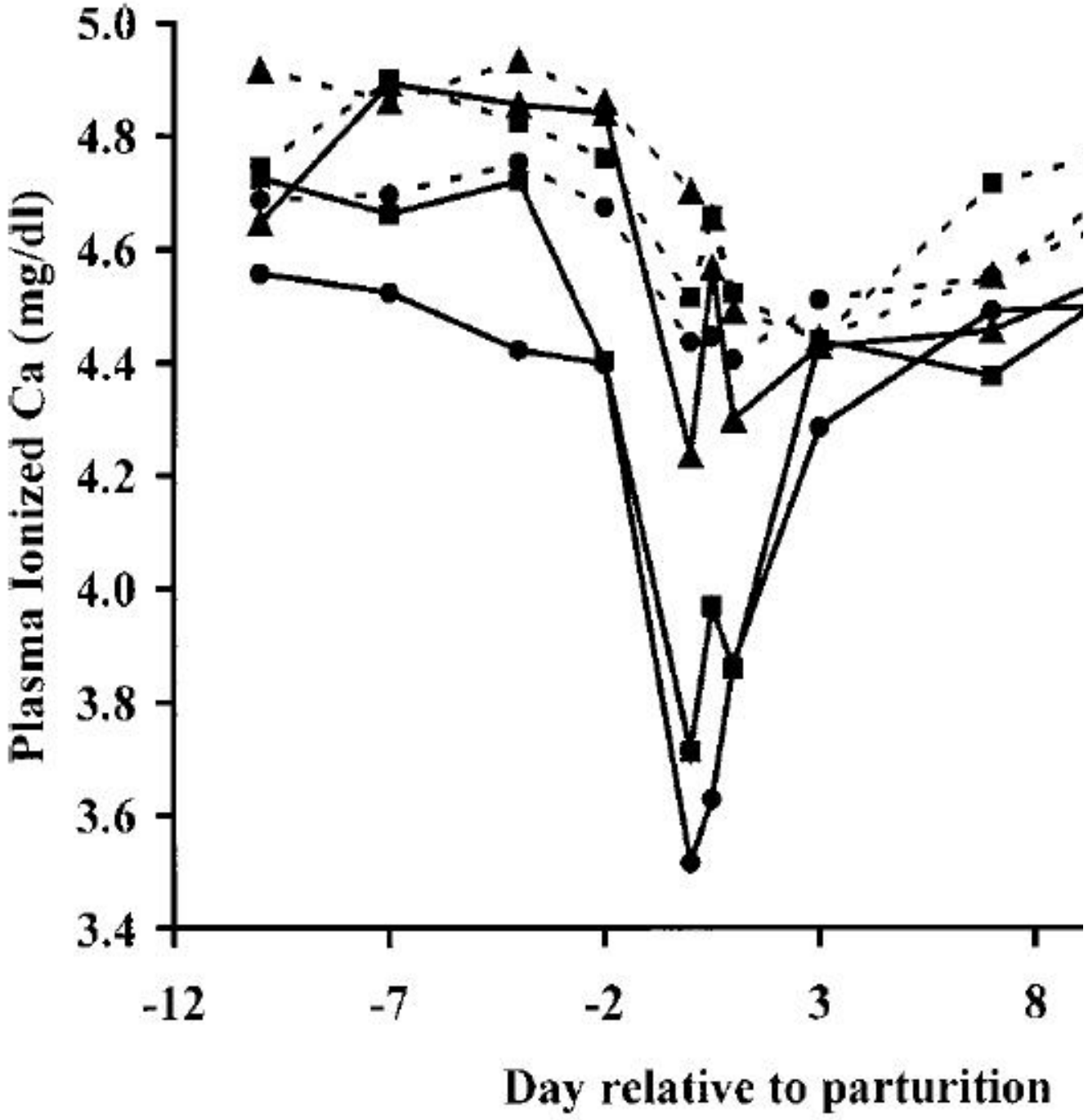
Maintaining calcium homeostasis is a challenge at calving. Feeding high Ca before calving may be counterproductive as it turns off mechanisms that enable rapid mobilization of bone Ca. Instead, close-up dry cows should be fed a diet with a Dietary Cation-Anion Difference (DCAD; Na + K - Cl - S) of about -10 mEq/100 g DM. This slightly acidifies blood and turns on Ca mobilization mechanisms to prevent hypocalcemia at calving.

Lower **potassium (K)** as much as possible and/or feed hydrochloric acid-treated products or "anionic salts", such as $CaCl_2$, along with slightly elevated Ca (1.2% Ca). Urine pH should drop below 6.



Prepartum DCAD and parturient hypocalcemia

Plasma ionized Ca of cows (—) and heifers (- -) fed a control diet (●) or a diet with dietary cation-anion difference (DCAD) of 0 (■) or -15 (▲) meq/100 g dietary DM. From Moore et al., 2000.



Practical Considerations for macrominerals

A. When is supplementation needed?

1. Macrominerals

   a. Generally does not depend on soil

   b. When to supplement?

   - Calcium: **usually, unless diet is high in alfalfa**
   - Phosphorus: **usually**
   - Magnesium: **high grain diets, lush spring grass**
   - Potassium: **high grain diets, generally not needed in diets with lots of forages from northern climates**
   - Sodium: **almost always**
   - Chloride: **almost always but seldom needed**
   - Sulfur: **when feeding nonprotein N, maybe**

Practical Considerations for macrominerals

Macrominerals – most common supplements

- Calcium: **limestone (calcium carbonate)**
- Phosphorus: **dicalcium phosphate, monosodium phosphate**
- Magnesium: **magnesium oxide, magnesium sulfate**
- Potassium: **potassium chloride**
- Sodium: **salt**
- Chloride: **salt**
- Sulfur: **gypsum (calcium sulfate)**

Free choice salt/mineral block

Practical Considerations: trace minerals

a. Depends on soil type/levels (muck soils hold minerals tightly)

b. The TM composition of feeds varies considerably

c. More often a problem with high grain than high forage diets

d. When to supplement?

- Copper: **usually added, esp. in southern MI**
- Iron: **usually not needed once solid feed is consumed**
- Manganese: **high corn diets, but seldom a problem**
- Zinc: **high grain diets**
- Cobalt: **must add to ruminant diets in northern half of MI**
- Iodine: **always**
- Selenium: **always in Great Lakes region**

Practical Considerations: trace minerals

Trace minerals – most common supplements

- Copper: **copper sulfate, cupric oxide**
- Iron: **iron oxide**
- Manganese: **manganese oxide or sulfate**
- Zinc: **zinc sulfate or oxide, zinc methionine**
- Cobalt: **cobalt chloride**
- Iodine: **potassium iodide, EDDI**
- Selenium: **sodium selenate, selenite**

Practical Considerations; vitamins

- Not affected by soil type
- Deteriorate during feed storage
- Usually supplement only A, D, and E to ruminants

Philosophies of supplementation

1. Meet the difference
   a. Usually how we feed most macrominerals
   b. Amount supplemented will be dependent on how much diet already supplies
2. Supplement at 50-100% of requirement, regardless of diet
   a. Usually how we feed trace minerals and vitamins
   b. Amount supplemented is not dependent on diet.

TM Salt evaluation

Case example: Are the trace minerals in a TM salt reasonable? Assume intake at 0.5% of diet DM.

Take each required final concentration times 200 (100 / 0.5).

		ppm
<u>Concentration in supplement</u>		req'd
Copper	0.03%	10
Iron	0.2%	50
Manganese	0.2%	40
Zinc	0.35%	40
Cobalt	0.005%	0.1
Iodine	0.007%	0.6
Selenium	0.003%	0.3

TM Salt Evaluation

Are the trace minerals in a TM salt reasonable? Assume intake at 0.5% of diet DM.

Concentration in supplement			ppm supplied	ppm reqd	% supplied
Cu	0.03% =	300 ppm	1.5	10	15
Fe	0.20% =	2000 ppm	10	50	20
Mn	0.20% =	2000 ppm	10	40	25
Zn	0.35% =	3500 ppm	17.5	40	44
Co	0.005% =	50 ppm	0.25	0.1	250
I	0.007% =	70 ppm	0.35	0.6	58
Se	0.003% =	30 ppm	0.15	0.3	50

Practical Considerations

Case example: Make a supplement that meets all the TM and vitamin needs of a cow when fed at 0.5% of diet DM.

Take each required final concentration times 200 (100 / 0.5).

	Required final concentration	Concentration in supplement	
Copper	10 ppm	2000 ppm	= 0.2%
Iron	50 ppm	10,000 ppm	= 1.0%
Manganese	40 ppm	8000 ppm	= 0.8%
Zinc	40 ppm	8000 ppm	= 0.8%
Cobalt	0.1 ppm	20 ppm	= 0.002%
Iodine	0.6 ppm	120 ppm	= 0.012%
Selenium	0.3 ppm	60 ppm	= 0.006%
Vitamin A	2000 IU/lb	400,000 IU/lb	= 400 kIU/lb
Vitamin D	500 IU/lb	100,000 IU/lb	= 100 kIU/lb
Vitamin E	20 IU/lb	4,000 IU/lb	

Practical considerations in supplementing vitamins

Are the vitamins in this vitamin pack reasonable?

	Pack Concentrations	Required in total diet
Vit A	2000 kIU/lb	2000 IU/lb
Vit D	500 kIU/lb	450 IU/lb
Vit E	70 IU/lb	8 IU/lb

Are these concentrations reasonable?

a. Yes

b. No, seems short on vitamin D

c. No, seems short on vitamin E

d. No, they are all too high

Practical considerations in supplementing vitamins

Case example: Are the vitamins in a vitamin pack reasonable?

	Concentration in supplement	Concentration required	Inclusion required
Vit A	2000 kIU/lb	2000 IU/lb	0.10%
Vit D	500 kIU/lb	450 IU/lb	0.09%
Vit E	70 IU/lb	8 IU/lb	11 %

A and D are both ~1000 times reqt but E is only 10 times reqt.
What inclusion rate is needed to meet 100% of each reqt?

Vit A: 2000 IU A/lb diet ÷ 2,000,000 IU A/lb pack = 0.10 lb pack/ lb diet
= 0.10% inclusion rate

Vit D needs 0.09% inclusion rate.

Vit E needs 11.4% inclusion rate.

This pack is only an effective supplement for A and D. The added vit E is insignificant relative to requirements and is a marketing gimmick!