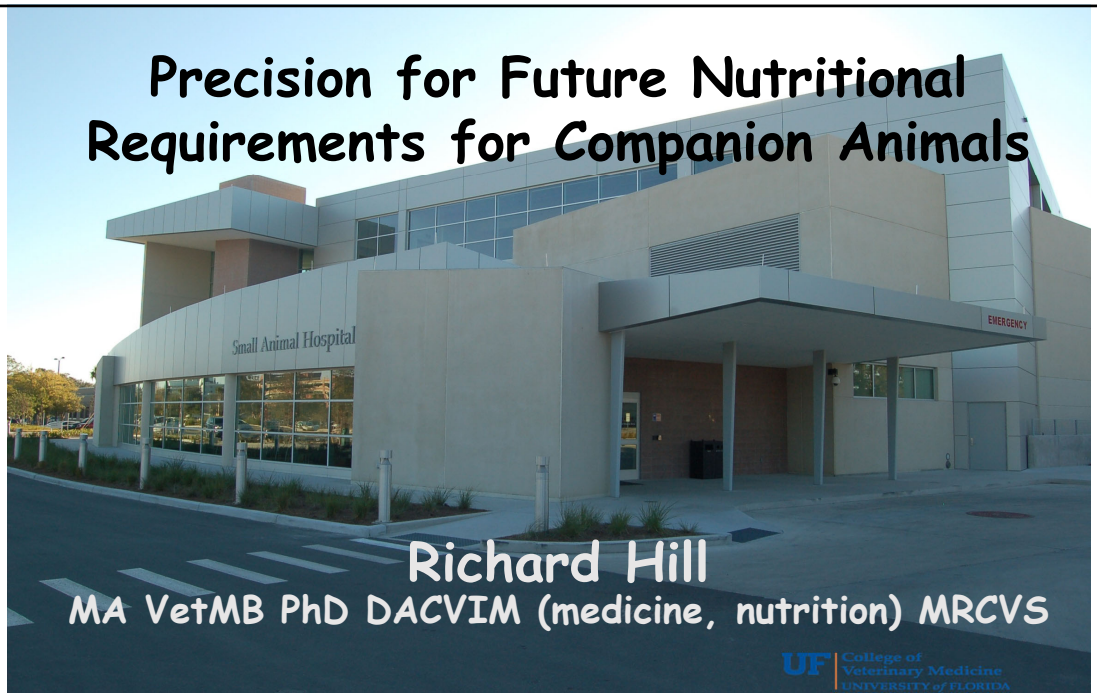

Precision for Future Nutritional Requirements for Companion Animals

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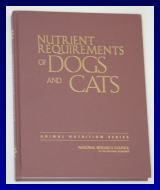
Overview

- Precision nutrition in companion animals
- Basis for National Research Council Nutrient requirements of dogs and cats (2006)
  - Allometry of nutrient requirements vs size
  - Minimal and maximum requirements
  - Variation of energy needs with activity
- A canine example
- Future prospects and need



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Precision Nutrition in Companion Animals

- Dietary habits/feeding behavior
  - Pet owners as well as animal behavior
- Genetics
  - Pro-opiomelanocortin gene defect and obesity
  - SLC2A9 gene for urate transporter
- Physical activity/energy requirements
  - Metanalyses: Birmingham et al Cats BJN 2009 Dogs PLOS 2014
- Obesity and metabolic disease/metabolomics
  - Obesity increasing, metabolic disease risk differs
- Microbiome:
  - Colon smaller than in people

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Many Types of Diet

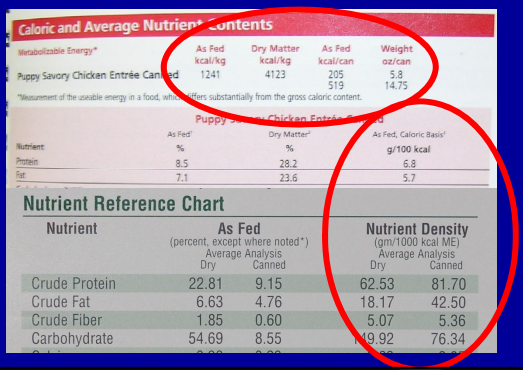
Age specific

Breed specific

Therapeutic

Energy Terminology

- 1 kcal on pet food label = 1 Calories on a human label
- 1 Mcal = 1000 kcal; Values are Metabolizable Energy (ME)
- ME in pet foods calculated using 'Modified Atwater Factors' (3.5 kcal/g protein or carb; 8.5 kcal/g fat) or feeding trial



Caloric and Average Nutrient Contents

	As Fed kcal/kg	Dry Matter kcal/kg	As Fed kcal/can	Weight oz/can
Puppy Savory Chicken Entrée Canned	1241	4123	205 519	5.8 14.75

"Measurement of the useable energy in a food, which differs substantially from the gross caloric content.

Nutrient	As Fed' %	Dry Matter' %	As Fed, Caloric Basis' g/100 kcal
Protein	8.5	28.2	6.8
Fat	7.1	23.6	5.7

Nutrient Reference Chart

Nutrient	As Fed (percent, except where noted*) Average Analysis Dry	As Fed Canned	Nutrient Density (gm/1000 kcal ME) Average Analysis Dry	Nutrient Density Canned
Crude Protein	22.81	9.15	62.53	81.70
Crude Fat	6.63	4.76	18.17	42.50
Crude Fiber	1.85	0.60	5.07	5.36
Carbohydrate	54.69	8.55	149.92	76.34

Nutrition Facts

Serving Size 1/2 cup (115g)
Servings Per Container About 4

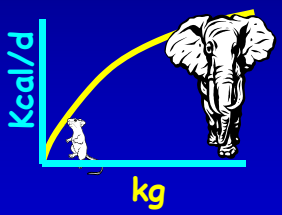
Amount Per Serving	
Calories 250	Calories from Fat 130
	% Daily Value*
Total Fat 14g	22%
Saturated Fat 7g	45%
Cholesterol 55mg	18%
Sodium 75mg	3%
Total Carbohydrate 26g	9%
Dietary Fiber 0g	0%
Sugars 26g	
Protein 4g	
Vitamin A 10%	Vitamin C 0%
Calcium 10%	Iron 0%

* Percent Daily Values are based on a 2,000 calorie diet

The Allometry Issue:

- Species and dog breeds vary greatly in size and energy requirements
- Pets fed fixed formula diets so nutrient intake proportional to calories
- Nitrogen excretion proportional to metabolic body size
- Vitamin and trace mineral requirements similar across species relative to metabolic body size and energy requirements
- (Rucker and Steinberg 2002, Rucker and Storms 2002)

Vitamin	Mouse	Rat	Chick	Cat	Human
Thiamin	2	2	1	2-3	1-2
Riboflavin	1	1	0.5	1-2	1
Niacin	8	8	6-8	20-30	5
Pyridoxine	2	2	1-2	2-4	1
Kcal/d	9/20g	46/300g		200/5kg	2000/70kg



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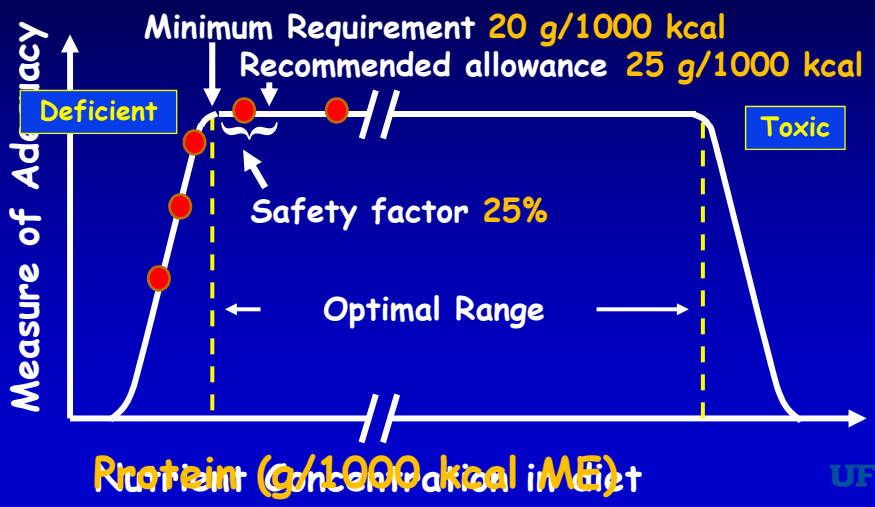
Nutrient Requirements

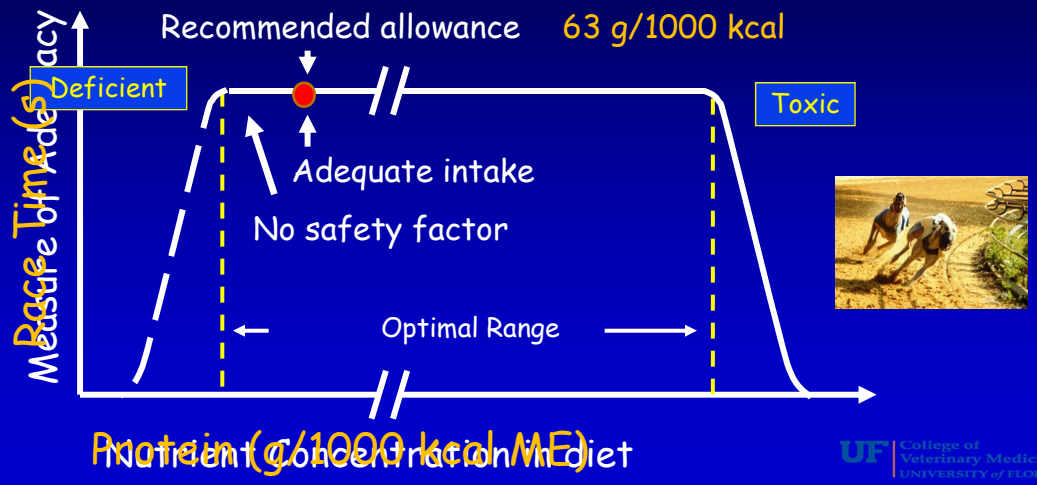
- 'Recommended Allowance' based on 'Minimum Requirement' or 'Adequate Intake' +/- Safe Upper Limit
- Tables for growth, adult, pregnant/lactating dogs + cats
- Essentiol nutrients (not fiber)
- Allometry issue
  - Fix animal size
  - Assume 4 kcal/g diet
- /kg diet ➡ /1000 kcal ➡ /kgBW$^{0.75}$
  - Keep amount/1000 kcal constant

Establishing Recommended Allowance (RA) from Minimum Requirement (MR) of an Essential Nutrient



Adequate Intake (AI) where less Information

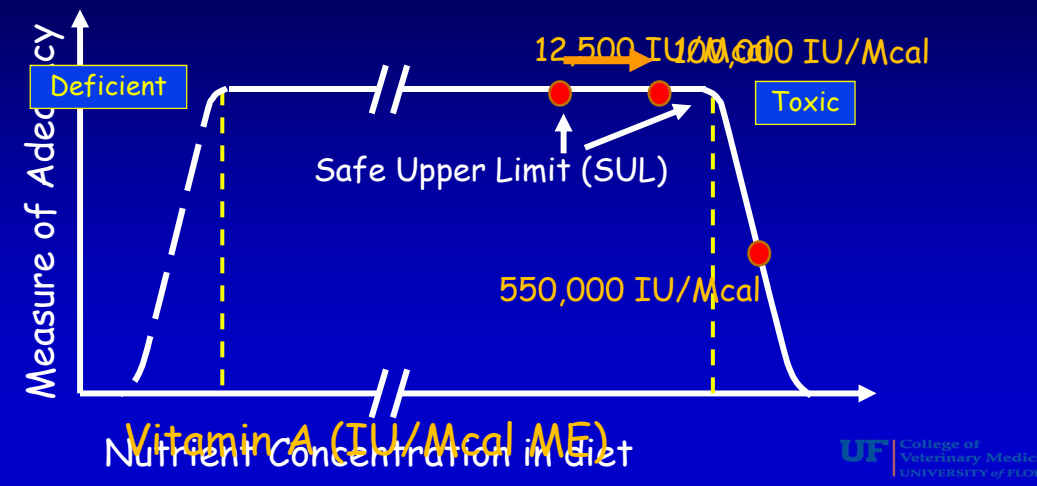
e.g. Racing greyhounds consuming 140 kcal/kg $BW^{0.75}$ daily)



Safe Upper Limit (SUL) of a Nutrient

(assumes dogs consuming mean of 130 kcal/kg $BW^{0.75}$ daily)

(Growing pups: Morris et al 2012)



NRC (2006) recommendations

ME requirements of exercising dogs	Kcal/kg $BW^{0.75}$	
Types of activity	Mean	Range
Basal metabolic rate	76	48-114
Resting fed metabolic rate	84	51-127
Maintenance (laboratory dogs)	130	87-173
Racing Greyhounds	140	120-160
Working Collies	184	80-380
Hunting dogs	240	200-280
Sled dogs pulling heavy loads 32 km/d	270	250-290
Racing sled dogs 168 km/d in extreme cold	1050	860-1240

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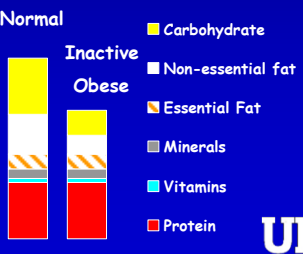
The Activity Issue

- NRC/AAFCO recommendations are based on studies in laboratory animals undertaking more activity than pets (130 kcal/$kg^{0.75}$ daily)
- Pets are mostly couch potatoes whereas sled dogs need much more
- Energy requirements can vary up to 15x in dogs, 2x in cats?
- Recommendation: Estimate nutrient requirements for metabolic body weight but maintain nutrient intake as energy intake decreases by increasing nutrient/kcal eg in obese animals



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'Lucky' 10 yo Male Dalmatian

- 78 lbs Normal body condition score (5/9)
- Urate urolithiasis (SLC2A9 defect)
  - Recommend low purine diet, alkaline urine
- Chronic kidney disease IRIS stage 2, normotensive
  - Creatinine 2.8 g/dL (normal <1.2)
  - Urine specific gravity 1.011 (isosthenuric), no urine protein
  - Recommend low phosphorus, alkaline urine
- Previous diet: Total ~1442 kcal ≈ 100 kcal/kg $BW^{0.75}$

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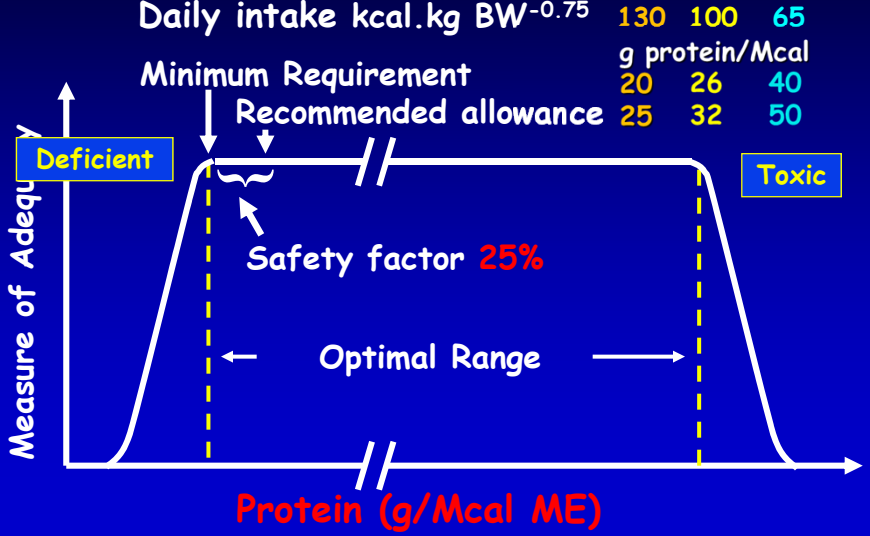
Adjusting Nutrient Intake in Pets Requiring Less Calories!

MR assumes lab dogs consume mean of 130 kcal.kg $BW^{-0.75}$ daily



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Protein (g/Mcal ME) in Canine Renal Diets

Manufacturer	Brand name	Dry	Can
Hill's	g/d	47	48
	k/d	33	33
	u/d	23	27
Purina	NF	36	36
Royal Canin	Renal MP	41	46
	Renal LP	35	30

American College of Veterinary Nutrition has long recommended an iterative process

- Assess (animal and environment)
- Energy Requirement
  - Diet history or calculation
- Nutrient composition
  - Key nutrients?
- Introduce changes slowly
- Reassess and adjust

Plea for additional minimum reporting nutritional studies involving companion animals

- Animal factors
  - Age, sex/neutered?, weight and body condition score
- Environment
  - Cage size. Ambient temperature, activity
- Food and ME intake ideally relative to metabolic body weight
- More complete diet analysis
- Ingredient source and recipe

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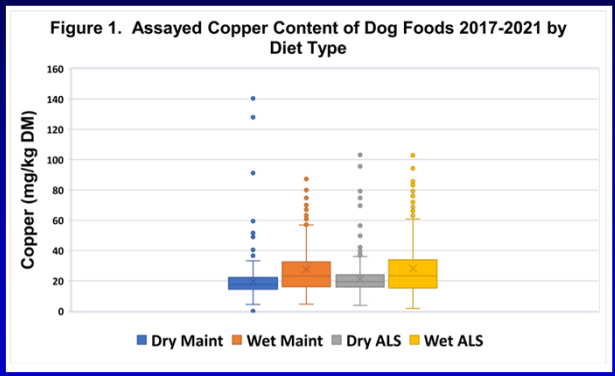
The Copper Issue

- No MR for trace minerals
- Variable absorption
- NRC assumed 30% Cu absorption
- Concern for copper-associated hepatopathy in dogs
- Cardiomyopathy in cats when copper oxide used
- Many foods contain more than the UL (20 g/kg DM) in person consuming 2000 kcal daily of diet containing 4 kcal/g DM)



AAFCO PFC Copper in Dog Foods Expert Panel Final Report 2022

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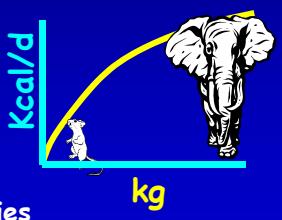
Why Consider Companion Animals?

- Advantages
  - Will consume standard diet for long periods
  - Large number of pets consume similar diets (sentinel for disease)
  - Intermediate life-span so rapid resolution
  - Out-bred animals in which some diseases are common
  - Shorter route to establish genetic basis (Ostrander)
- Limitations:
  - Diets poorly described because mostly proprietary
  - Food intake usually not reported
  - Few prospective RCTs
  - Small sample sizes, no population data
  - Limited finance for research mostly from pet food companies



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- Many funding sources: UF, Royal Canin, Department of Defense

- Questions?