

Nutrient sufficiency through a dog's lifetime: Implications for development and learning

A. Kate Shoveller, PhD

Center for Nutrition Modeling

Department of Animal Biosciences



Agenda

- Proper nutrient supply starts before conception
- Breeding bitch to puppy how to feed to produce an optimum development and learning
- Transition to the senior or geriatric period that we focus on learning or cognition

Management of the brood bitch starts prior to breeding

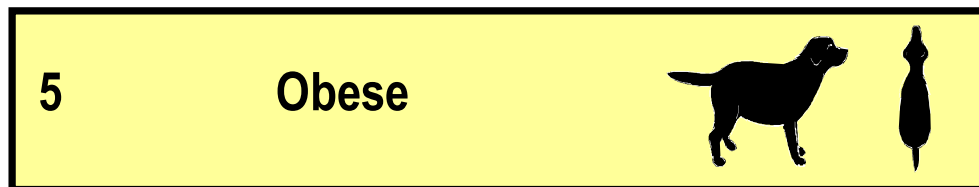
Health Status

- Physical examination
- Vaccinations
- Clear of parasites

Body Condition

- Ideal body score*
- Ideal or maximum muscle condition score
- Daily exercise*

Body condition score

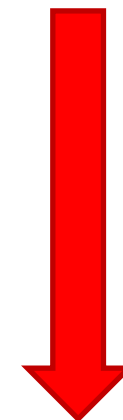


Under-conditioning before or during pregnancy may result in:

- Poor puppy development
- Difficulty with weight during lactation and being prepared for next litter



- Slight fat covering over the ribs and pelvis
- Good muscling that is maintained through exercise

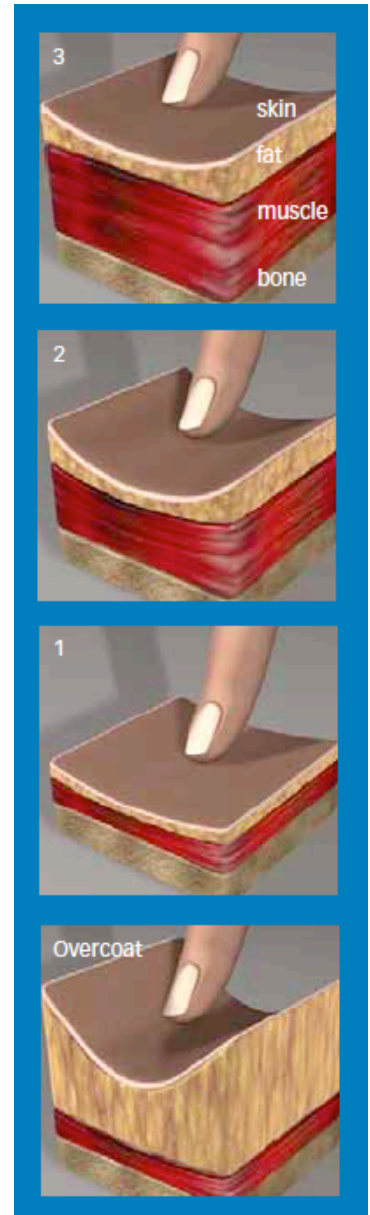


Over conditioning before or during pregnancy may result in:

- Difficulty whelping
- Reduced feed intake during lactation resulting in poor milk production and difficulty being prepared for next litter
- Potentially long term deficits in the puppies

Muscle condition scoring

- Important to evaluate muscle over the spine, scapulae, skull, wings of the ilia, triceps and thigh muscle
 - Muscle loss of sarcopenia is seen with aging
 - Bones should be slightly more palpable but good muscle surrounding them
 - Normal for joints to deteriorate
- Cumulatively results in sarcopenia and is characterized by the progressive and general loss of skeletal muscle mass and strength with a risk of adverse clinical outcomes



Populations are variable!

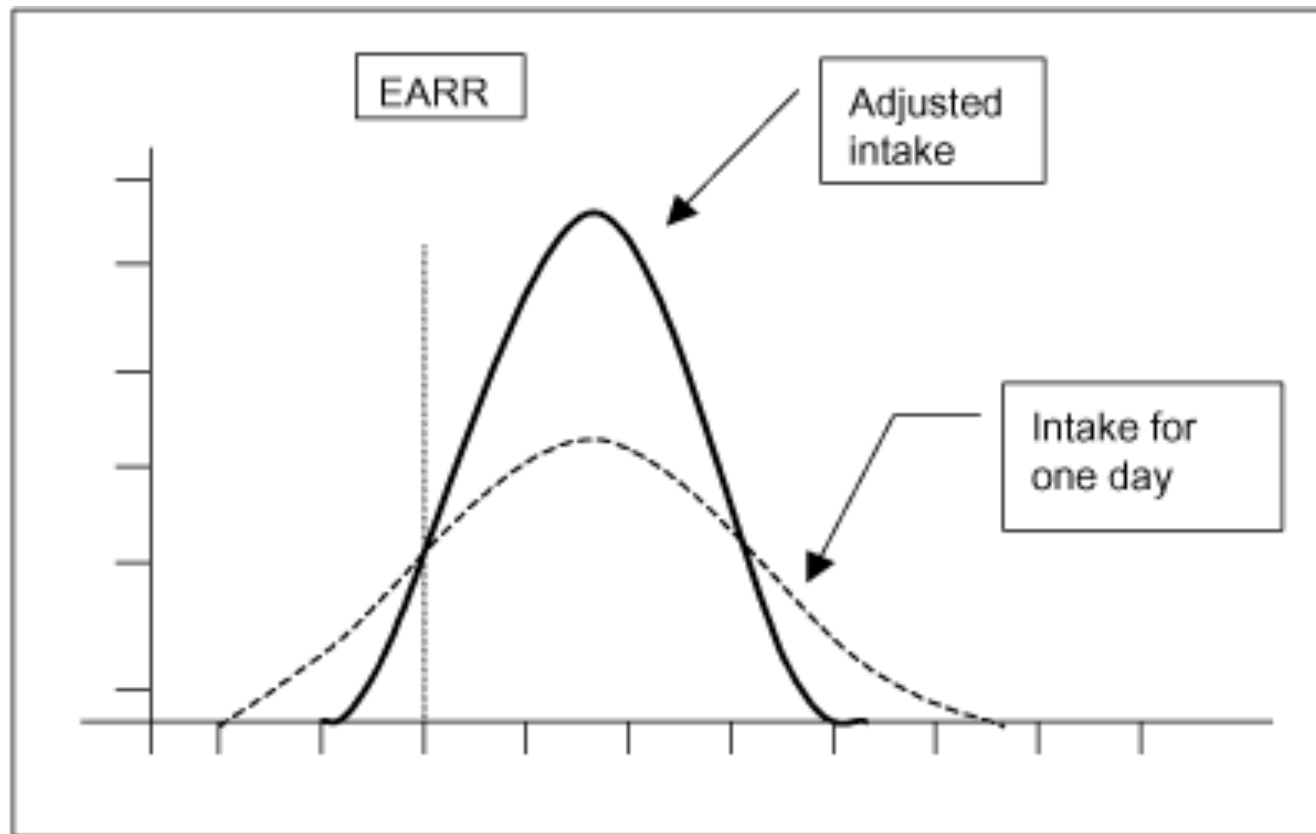
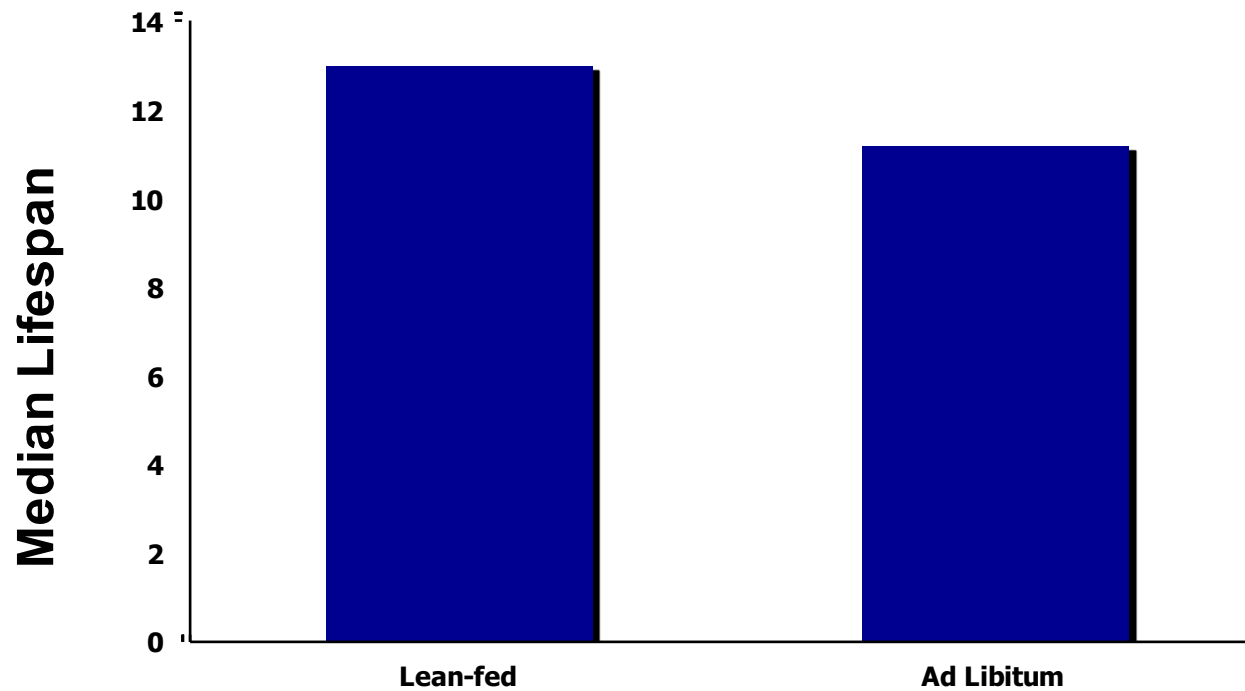


Figure 1 - Effect of within-person variation in the distribution of the frequency of intake values.

Do not feed in excess, feed to ideal body condition

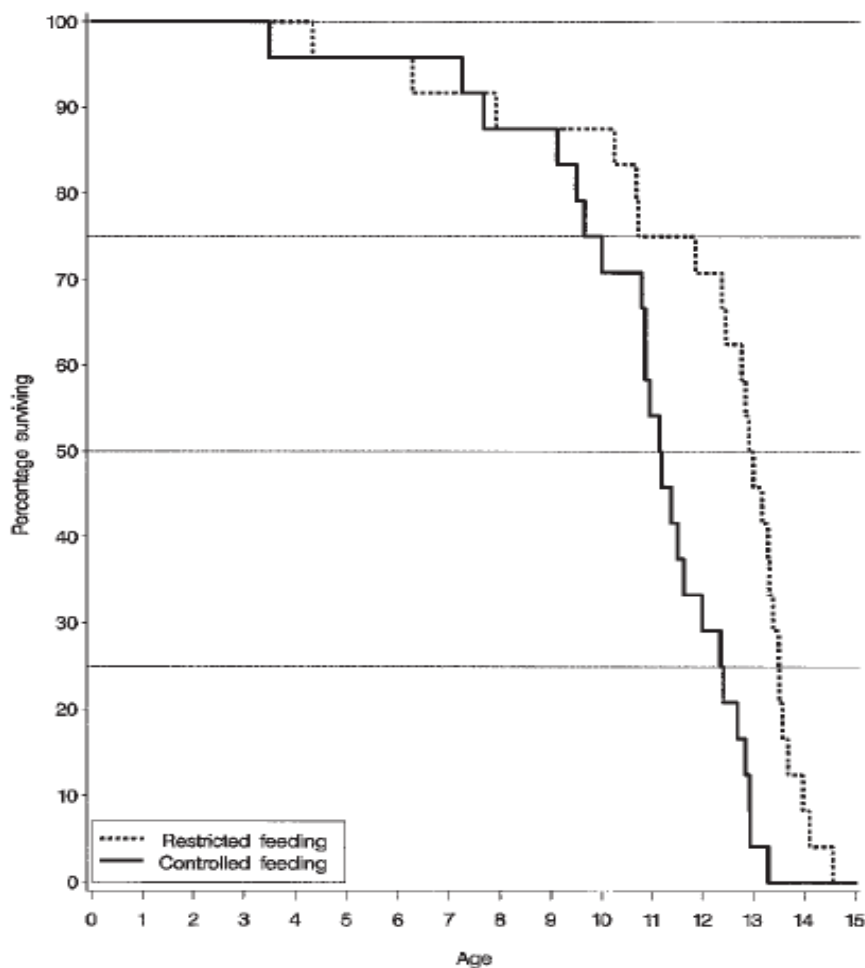
1 year study:

- 4 littermate-paired Labrador Retrievers
- Controls fed as much as they want
- Lean-fed pair-mates fed 25% less
 - *Median lifespan 1.8 years longer*



JAVMA, May 1, 2002

Aging cannot be stopped, but it can be delayed



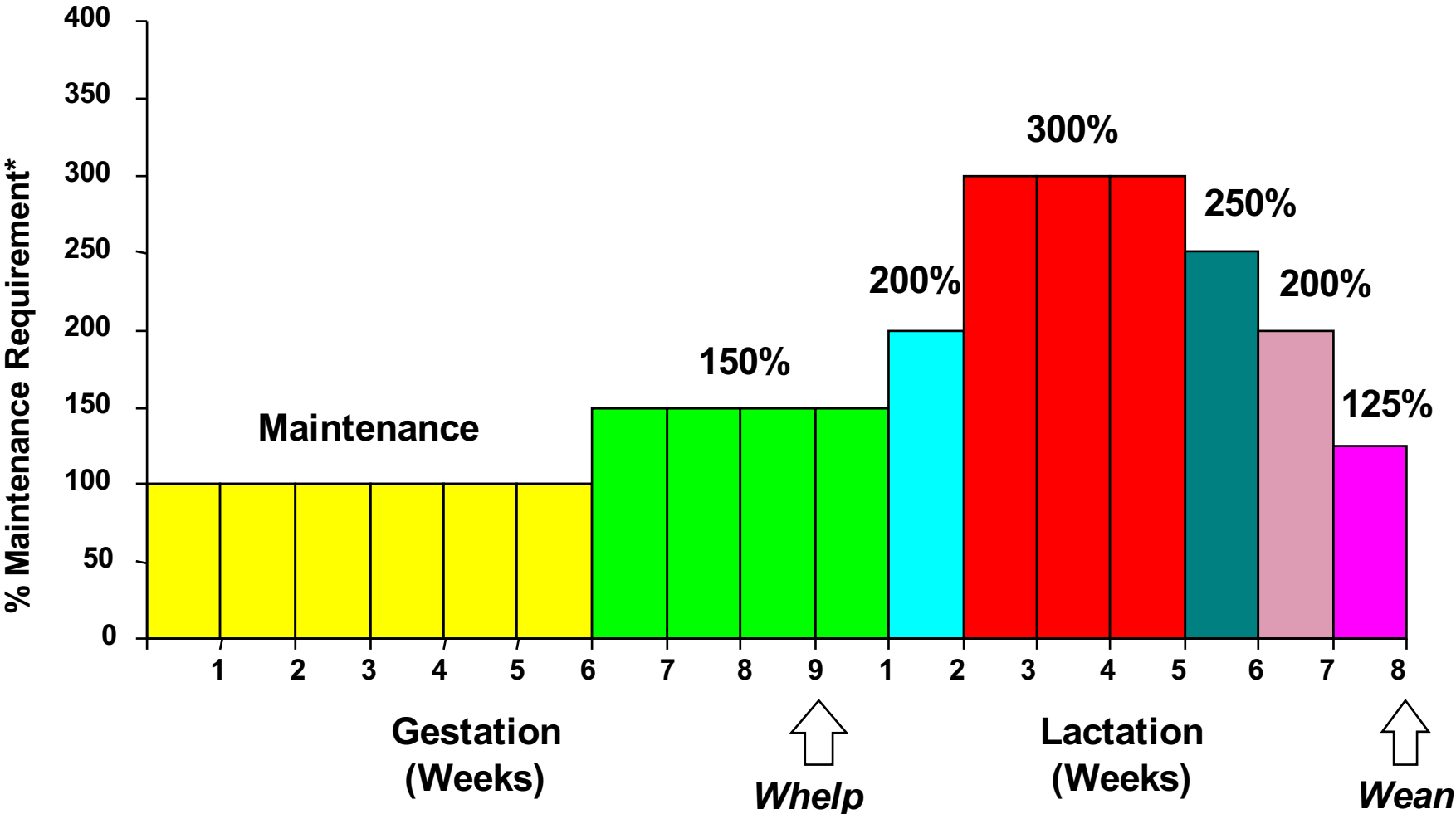
Variable	Group	
	Controlled-feeding	Restricted-feeding
Triglyceride (mg/dl)*	49.9 (3.4)	41.5 (3.3)†
Cholesterol (mg/dl)*	209 (10)	202 (10)
Triiodothyronine (nmol/L)‡	1.16 (0.03)	0.98 (0.03)†
IV glucose tolerance test		
Baseline insulin (pmol/L)§	70.8 (9.2)	48.4 (8.7)†
Baseline glucose (mg/dl)*	100.7 (1.2)	93.5 (1.2)†
Peak glucose (mg/dl)§	578 (15)	493 (13)†
Delta G (mg/dl)§	478 (15)	401 (13)†
Rate of glucose decline (mg/dl/min)§	6.5 (0.77)	11.3 (0.75)†
Time to baseline (min)§	91.2 (2.7)	41.4 (2.7)†

- Restricted feeding group was fed 25% of ad libitum

Should the nutrient density change if I need to restrict food intake?

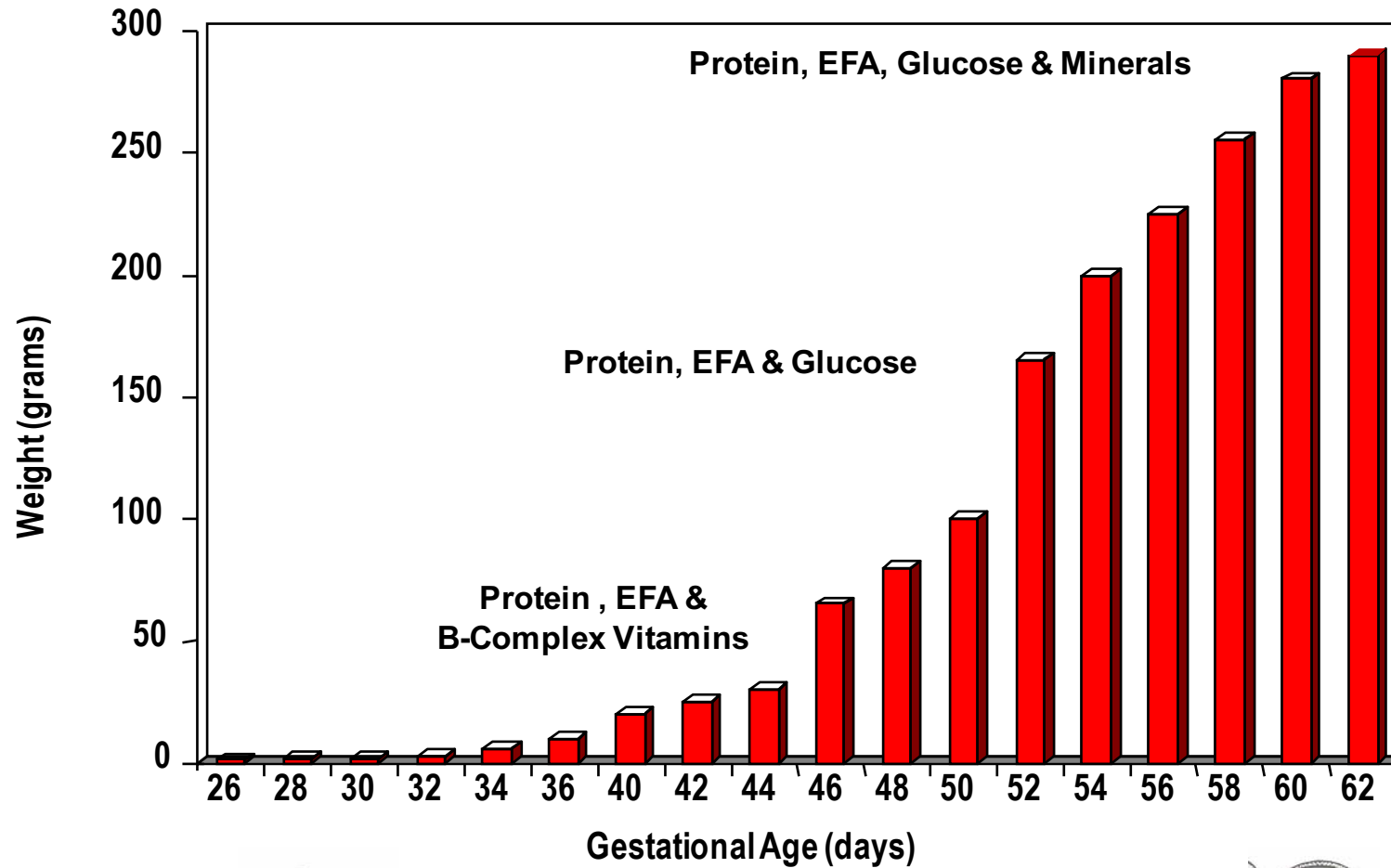
- Protein (amino acid) requirements are a function of lean body mass, not dietary energy
 - If reducing feed intake you need to ensure that you still meet the amino acid and fatty acid requirements
 - Look for foods with a higher protein as a function of dietary energy (% calories from protein)

How much to feed?



* Expressed on an energy basis

Fetal growth

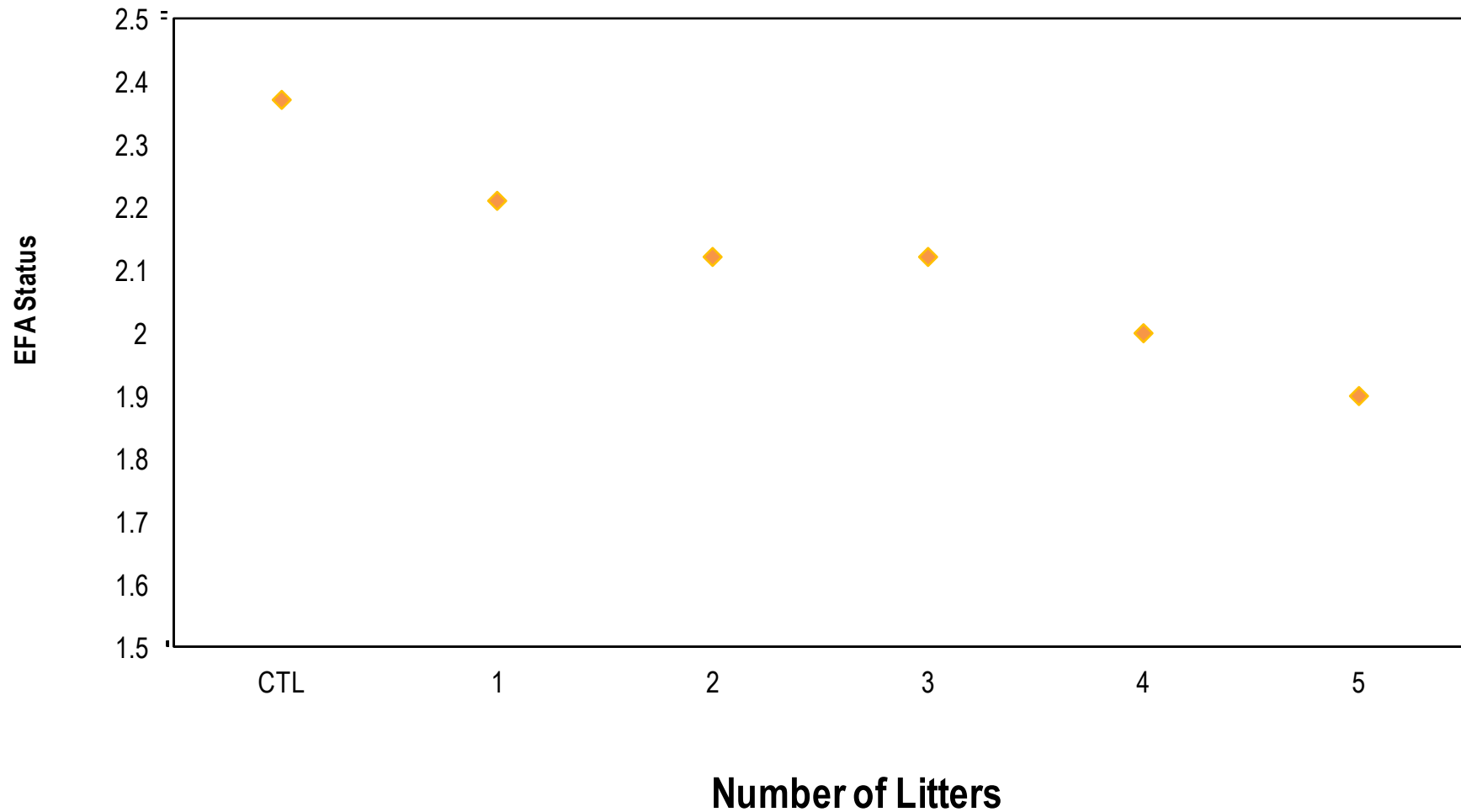


Sources of Fatty Acids

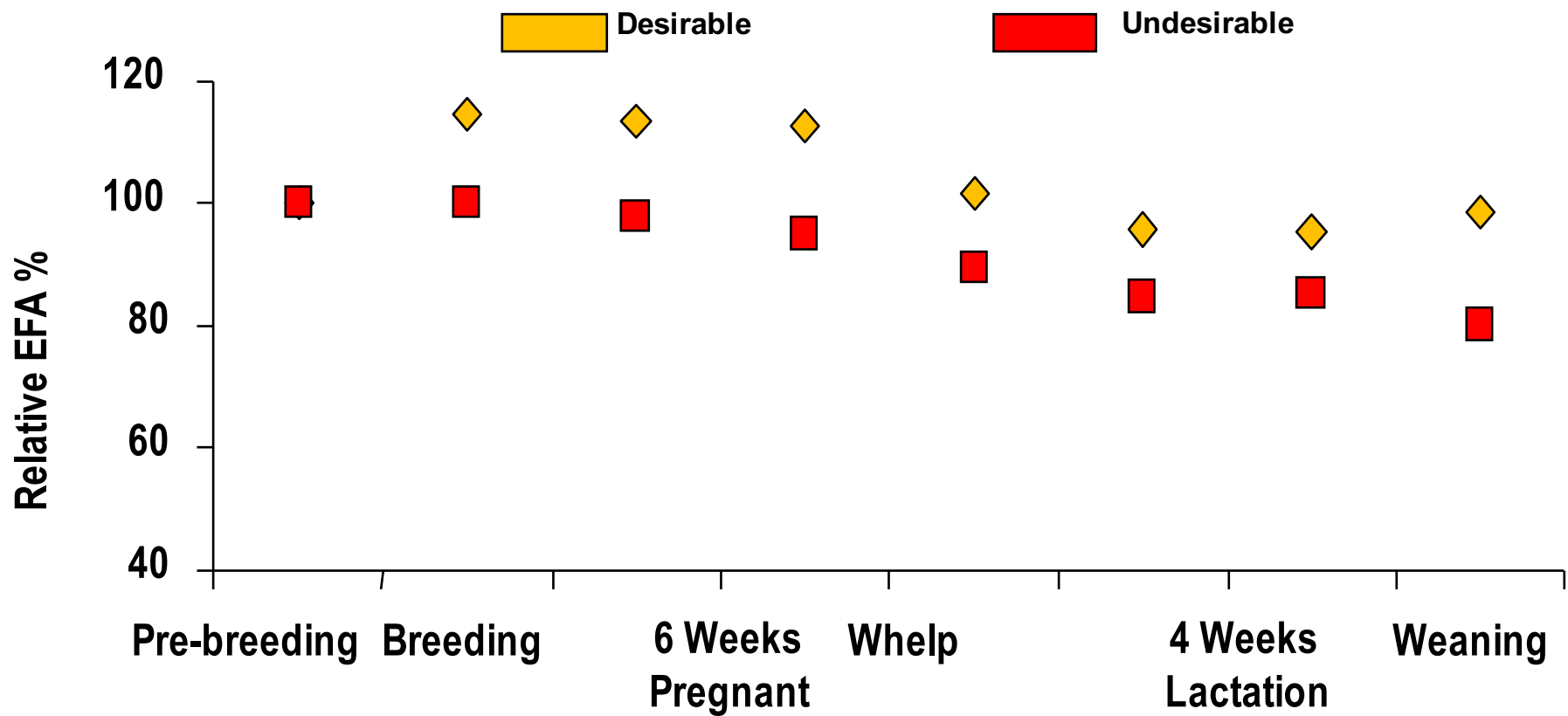
- Linolenic acid (18:3n-3)
 - Flaxseed oil
 - Soybean oil
 - Canola oil
- Linoleic acid (18:2n-6)
 - Safflower oil
 - Sunflower oil
 - Corn oil
 - Flaxseed oil
 - Also called linseed oil
- Long-chain PUFA
 - EPA (20:5n-3)
 - DPA (22:5n-3)
 - DHA (22:6n-3)
 - Fish/marine oils
 - Can be highly



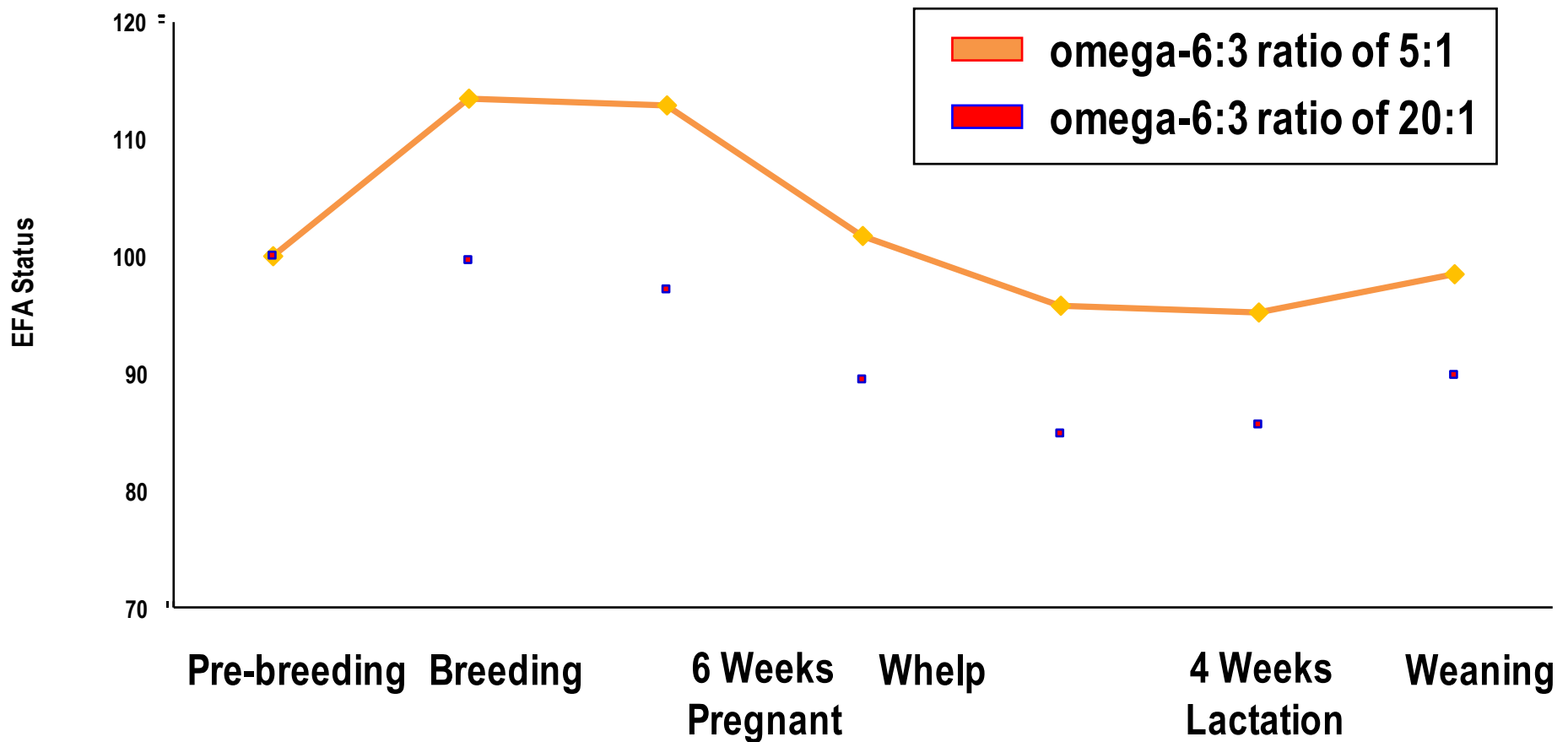
Effect of maternal essential fatty acid depletion on number of litters



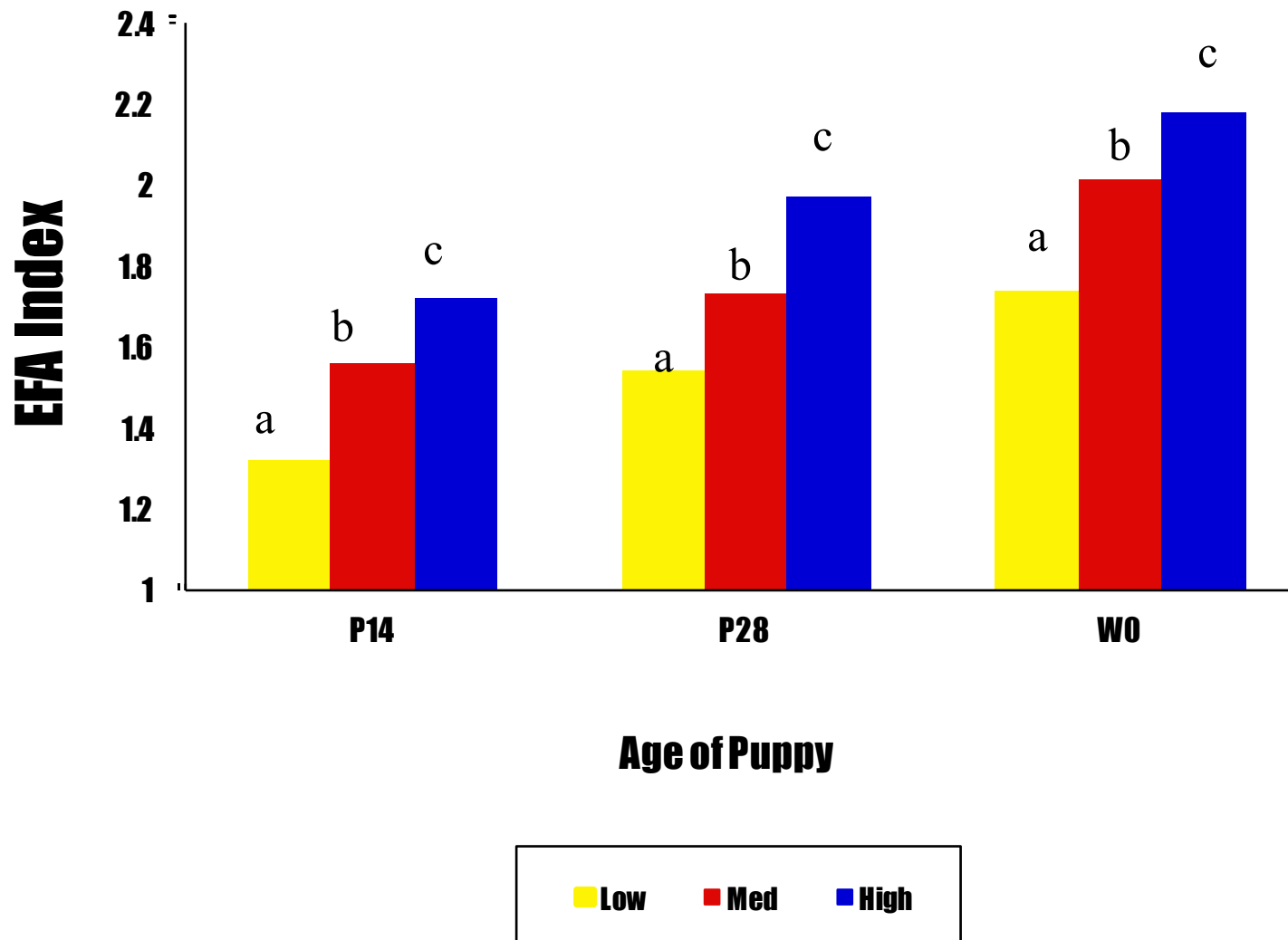
Effect of reproduction on maternal EFA



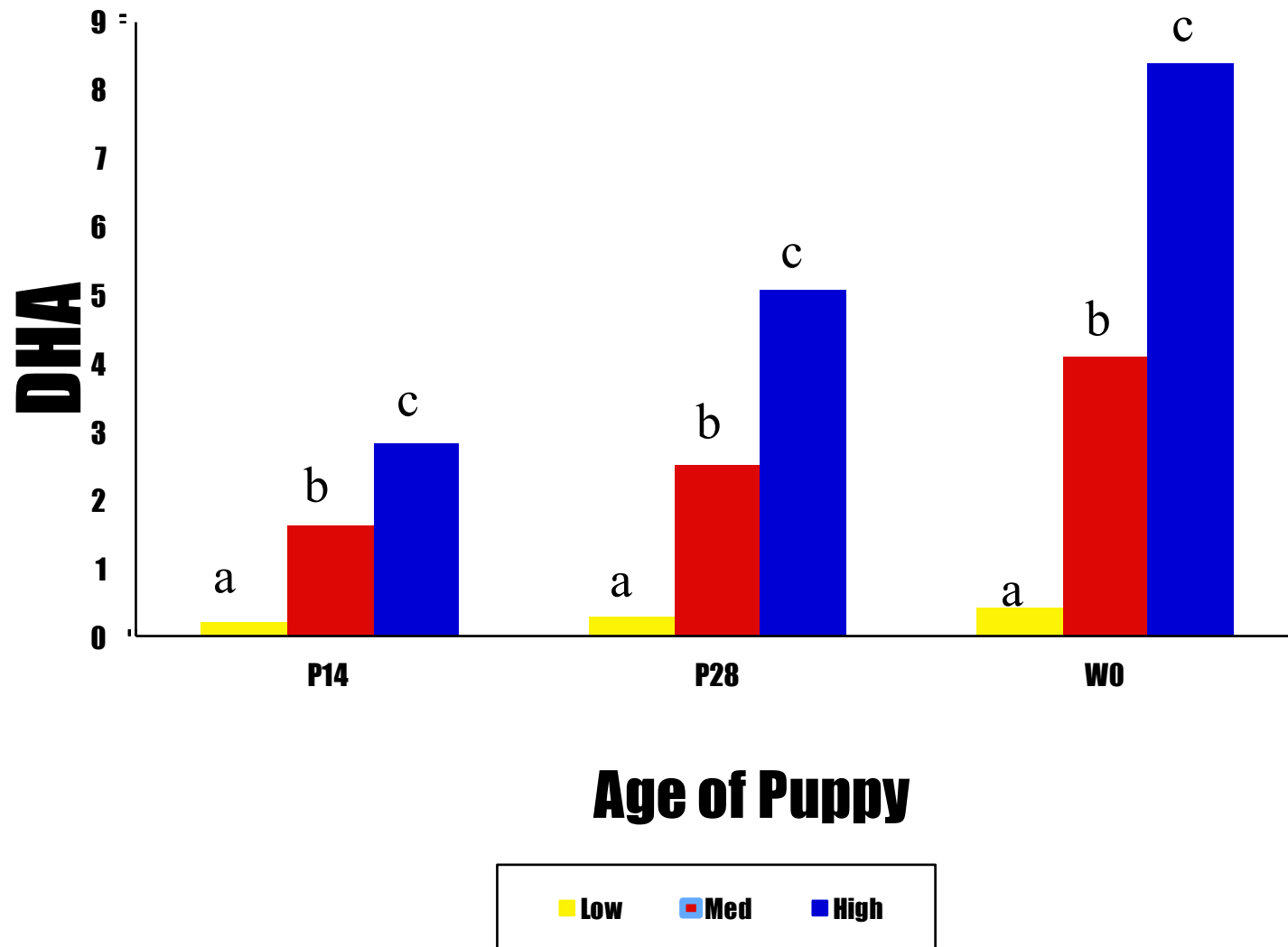
Positive benefits of optimal n-6: n-3 ratio on maternal EFA status



Effect of maternal dietary fatty acids on neonatal EFA status



Effect of maternal dietary fatty acids on neonatal DHA



DHA improved brain development

Table 5—Mean \pm SEM number of errors in performance of positional and reversal tasks and total number of reversals acquired for the same 48 puppies in Table 1 during T-maze testing at approximately 8 to 13 weeks of age.

Group	Positional task errors	Reversal task errors	No. of reversals acquired
Low-DHA	2.5 \pm 1.2*	16.8 \pm 1.6*	6.8 \pm 0.4*†
Moderate-DHA	2.9 \pm 1.0*	11.3 \pm 1.4†	6.6 \pm 0.2*
High-DHA	3.4 \pm 1.3*	9.5 \pm 1.4†	7.7 \pm 0.4†

After a preliminary training period, positional task assessment was performed in which puppies responded to one side of a T-shaped maze to obtain a food reward concealed in a goal box. For the reversal task, puppies were only rewarded for choosing the side opposite from the previously rewarded side. The number of errors in selection of the correct side was counted for a total of 10 attempts/d for each task until a passing score was attained. For multiple reversal testing, the rewarded side was switched each time the puppy learned the new correct choice; the maximum number of successful reversals possible was 10.

*†Within a column, values with different superscripts are significantly different among groups as determined via least squares means.

Optimal diet for the lactating bitch

Energy Density	4400 kcal ME/kg or greater
Fat	FISH MEAL or FISH OIL
Protein	Meat? By-product meal? Vegetable?
Carbohydrate	Barley? Wheat? Rice Ancient grains? Potatoes? Sweet potatoes?
Fiber	Beet pulp, fructo-oligosaccharides, mannano-oligosaccharides
Omega-6:Omega-3 Fatty acid ratio	FISH MEAL or FISH OIL

* Label values for guaranteed analysis will be a minimum of 20% fat and 30% protein

The pups

- Solid food should start between 3 and 5 weeks of age
- Use bitch's performance food
- Mix with water to gruel consistency and gradually increase
- Solid food 100% at about 42 days of age



The pups

- It is fine to feed any breed the “performance” food or other high calorie food up to weaning
- Large breeds should go on a special food designed for large breed puppies after weaning
- D not use a Large Breed Puppy food to feed the pregnant dam!

Optimal diet for the post weaned puppy

Energy Density

Fat

Protein

Carbohydrate

Fiber

Omega-6:Omega-3
Fatty acid ratio

FISH MEAL or FISH OIL

Meat? By-product meal? Vegetable?

Barley? Wheat? Rice? Ancient grains?
Potatoes? Sweet potatoes?

Beet pulp, fructo-oligosaccharides,
mannano-oligosaccharides

FISH MEAL or FISH OIL

* Label values for guaranteed analysis will be a minimum of 10% fat and 20% protein

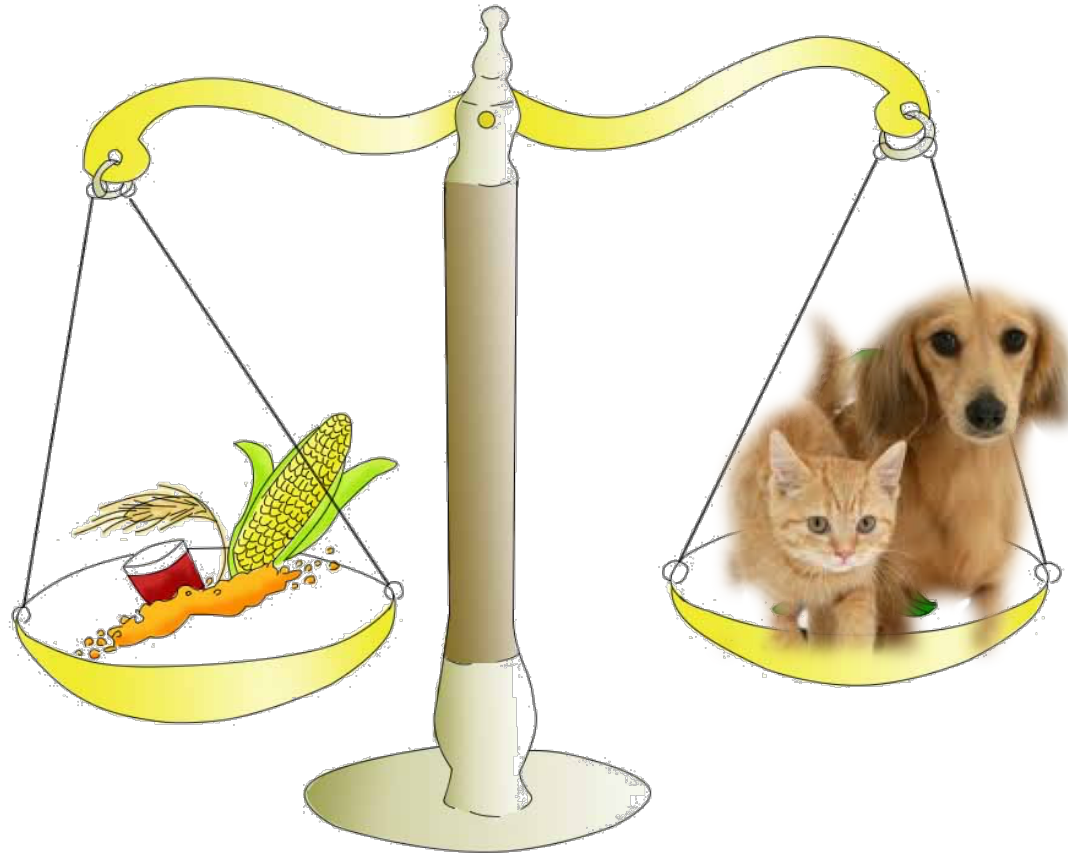
The problem with diet supplements

Nutrient	Amount of Nutrient Provided by Feeding 300 grams of Dry Diet	ALTERED BY ADDITION OF		
		½ cup Cottage Cheese	3 oz. Beef Liver	100 gram More Dry Diet
Protein (g)	93	106	115	124
Fat (g)	63	67.5	67	84
Calcium (mg)	3500	3563	3509	4700
Phosphorus (mg)	2900	3080	3305	3850
Ca:P (ratio)	1.2:1	1.15:1	1.05:1	1.2:1

Based on the average analysis a commercial premium diet guaranteed to contain 30% protein, 20% fat and 4452 kcal ME.

Bringing it together, nutritional management

- Opportunity to track animals over time and make nutrition changes to match their lifestyle
- Key to nutritional management of puppies for a long healthy life is to keep them optimal
- Other nutritional factors to consider: n3 fatty acids from marine based ingredients, mitochondrial cofactors such as L-carnitine, and antioxidants

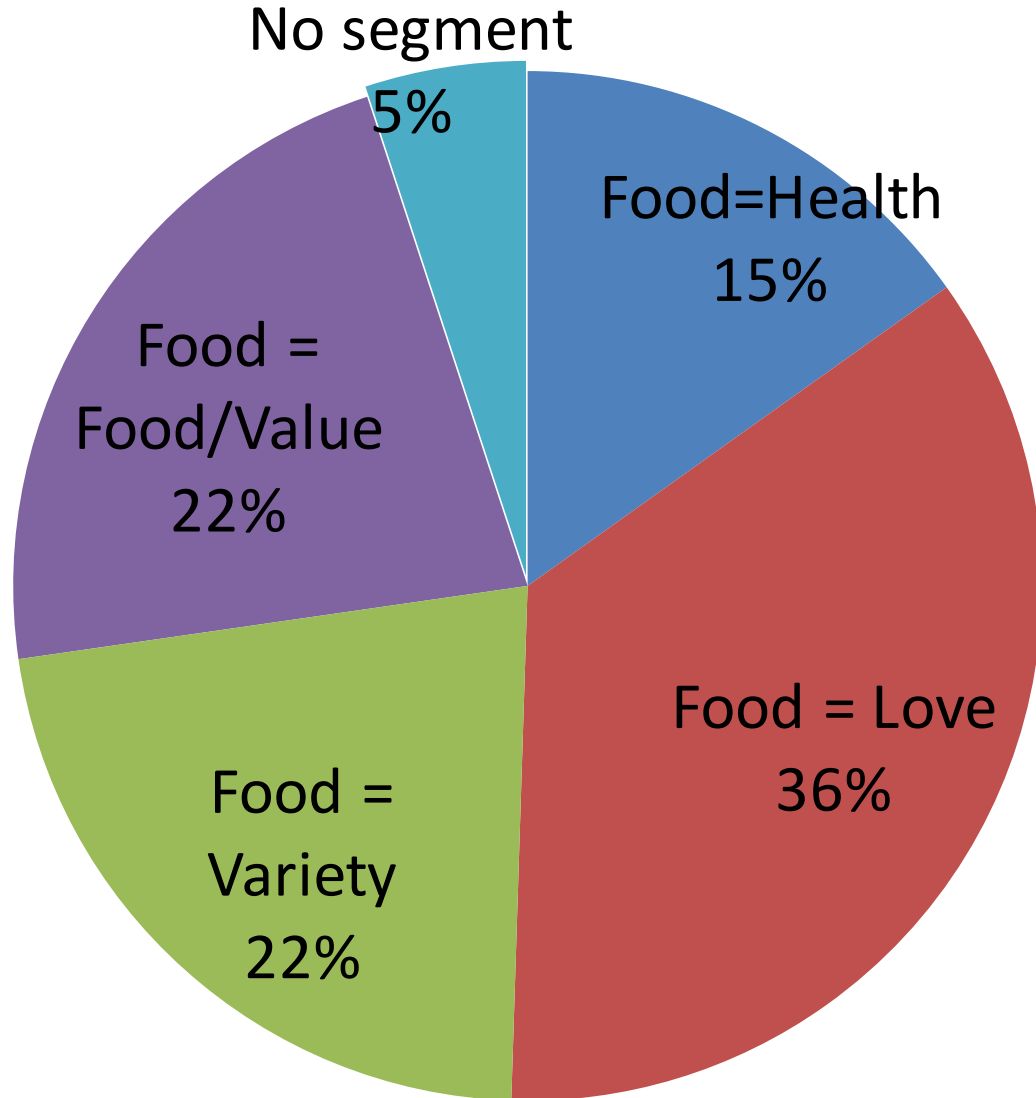


**YOU TALKED ABOUT NUTRIENTS, BUT
ITS ACTUALLY INGREDIENTS, NO?**

Trends of innovation today

- Innovations around consumer demand predominate: ingredients, nutrients, processing, feeding philosophy, individualized needs of pets
- Humanization of pets leads to making products that look more like human food
- Increased regulatory constraints and commitment to quality





When asked the key driver to purchase intent, consumers can be segmented into a variety of areas and each expect something different:

- Food=Value \$\$
- Food=Variety Change brands
- Food=Love *Perception
- Food=Health Claims around health

“Pet parents”



Humanization



The millennial (born late 70's to early 2000's)

Will comprise 40% of the work force by 2020

- 43% do not trust large food manufacturers (vs. 18% of non-millennials)
- 59% will stop buying the brand if they feel it is unethical
- 38% say the retailer is an important factor
- 58% say where they buy their groceries reflects their personal values

Millennials are now the largest group of pet owners and consumers. How will this generation change the pet food industry and is it in the best interest of the dog?

The ingredient debate

Raw market:
2012- 4% growth
2013- 11% growth

- FDA implements Food Safety Modernization Act aiming to apply the same standards to pet food as human food to prevent contamination
- Lawsuits regarding false claims that product contain no chicken or poultry by-products, corn or grain is dishonest and suggests superiority when it has not been shown to exist!

“Naturals” pet food growing at 11% per year vs. traditional pet food growing at 4% per year.

“Grain free and gluten-free” pet food:
2012= 12.6% of the market
2013: 28.6% of the market

Ingredient quality

- Nutrient composition (and quality/chemical state thereof)
 - Presence of anti-nutritional factors
 - Presence of contaminants or adulterants or bacteria
- Processing employed can affect:
 - Digestibility
 - Palatability
 - Food intake

Raw and rendered animal by-products

Murray et al, J. Nutr. 128:2812S.

TABLE 3

Nutrient intakes and digestibilities for five dogs fed diets containing different protein sources

Item	Diet ¹						SEM	Contrasts				
	(A) RMBM	(B) FB	(C) PBPM	(D) FP	(E) DS	(F) WE		A-D vs. E	A-D vs. F	A+C vs. B+D	A vs. B	C vs. D
<i>Intake, g/d</i>												
Dry matter	382	487	418	403	414	394	19.4	NS	NS	0.04	0.01	NS
Organic matter	342	435	374	361	370	354	17.4	NS	NS	0.04	0.01	NS
Crude protein	82	96	87	90	89	88	4.2	NS	NS	0.06	0.03	NS
Fat	53	70	57	61	60	51	3.5	NS	0.04	0.01	0.01	NS
Gross energy, kJ/d	441	559	478	475	470	452	22.9	NS	NS	0.02	0.01	NS
<i>Ileal digestion, %</i>												
Dry matter	75.4	76.3	67.3	77.3	71.9	68.3	3.91	NS	NS	NS	NS	0.04
Organic matter	83.9	84.7	78.9	85.4	80.9	78.5	2.63	NS	NS	NS	NS	0.05
Crude protein	79.9	80.4	73.9	82.8	79.5	77.0	3.06	NS	NS	0.09	NS	0.03
Fat	91.0	92.6	88.3	92.7	91.2	88.5	1.48	NS	NS	0.04	NS	0.03
Gross energy	85.3	86.2	81.3	86.9	82.9	81.7	2.39	NS	NS	NS	NS	0.06
<i>Total tract digestion, %</i>												
Dry matter	83.3	84.4	85.1	84.0	83.1	86.1	0.60	NS	0.02	NS	NS	NS
Organic matter	90.8	92.2	92.2	91.6	90.2	92.8	0.32	0.01	0.01	NS	0.01	NS
Crude protein	88.2	89.8	89.5	89.8	88.3	91.2	0.38	0.01	0.10	NS	NS	NS
Fat	92.9	93.5	93.7	93.5	92.9	93.4	0.39	NS	NS	NS	NS	NS
Gross energy	90.8	92.2	92.1	91.8	90.3	92.7	0.34	0.01	0.02	NS	0.02	NS

Approximately 50% of the protein source of each diet was whole egg; the other 50% was contributed by test substrates and brewers rice.

¹ RMBM, rendered beef meat and bone meal; FB, fresh beef; PBPM, poultry by-product meal (rendered); FP, fresh poultry; DS, defatted soy flour; WE, whole egg.

² NS, not significant, $P > 0.10$.

Calcium: phosphorus, bacterial contamination are risks

1. Diffuse osteopenia and myelopathy in a puppy fed a raw diet. *J Am Vet Med Assoc.* 2009. 15;234(8):1041-8. *The raw meat-based, home-prepared diet fed to the dog was not feed-trial tested for any life stage by the Association of American Feed Control Officials, and its gross nutrient imbalance induced severe metabolic, orthopedic, and neurologic abnormalities.*
2. Nutritional secondary hyperparathyroidism occurring in a strain of German Shepard puppies. *Jpn J Vet Res.* 41(2-4):89. *...puppies fed a diet of 80% steamed rice and 20% raw meat...inappropriate Ca:P ratio...*
3. The occurrence and antimicrobial susceptibility of salmonellae isolated from commercially available canine raw food diets in three Canadian cities. *Zoonoses Public Health.* 2008. 55(8-10): 462. *“...166 commercial frozen raw food diet samples...Salmonella prevalence of 21%...resistence was observed to 12 of the 16 antimicrobials tested...”*
4. Evaluation of the risks of shedding Salmonellae and other potential pathogens by therapy dogs fed raw diets in Ontario and Alberta. *Zoonoses Public Health.* 2008. 55(8-10): 470. *“...we also recommend that feeding raw meat to dogs is to be avoided in homes where immunocompromised people live.*
5. The risk of salmonellae shedding by dogs fed Salmonella-contaminated commercial raw food diets. *Can Vet J.* 2007. 48(1):69-75. *“Dogs fed salmonella-containing raw food diets can shed salmonellae and may, therefore, be a source of environmental contamination potentially leading to human or animal illness.”*
6. Transmission of *Yersinia enterocolitica* 4/O:3 to pets via contaminated pork. 2001. 32(6):375. *“...raw pork can be an important source of Yersinia enterocolitica 4/O:3 infection in dogs and cats...Raw pork should not be given to pets.”*

Consider all sides and evaluate the relative risk!

1. Unconventional diets for dogs and cats. *Vet Clin North Am Small Anim Pract.* 2006. 36(6):1269. *Helps the practitioner understand a clients' motives for seeking alternatives and helps to elucidate whether it is in the pets best interest.*
2. In support of bones and raw food diets. *Can Vet J.* 44(10):783. *Opinion response from veterinarians concerning the efficacy of home made diets.*
3. Resolution of skin lesions and long-term survival in a dog with superficial necrolytic dermatitis and liver cirrhosis. *J Small Anim Pract.* 2000. 41(11):519. *Clinical signs of one dog had resolved after placement on hepatic support diet + EFA supplementation + egg yolks + choline.*

Home-made vs. commercial dog food

Streiff et al, J. Nutr. 132: 1698S.

[†] Nutrient	Home made	Commercial	AAFCO levels
Fat (%)	21.1±11.1	16.1 ±4.4	5.0
Protein (%)	33 ±7.9	25.9 ±5	18
Ca (%)	0.47 ±0.38	1.39 ±0.28	0.6-2.5
P (%)	0.46 ±0.18	1.13 ±0.27	0.5-1.6
Ca:P	0.82 ±0.5	1.26 ±0.23	1.0-2.0
Vitamin D (IU/kg)	332 ±428	974 ±307	500-5 000
Vitamin A (IU/kg)	5209±11918	19131±8279	5 000-25 000
Vitamin E (IU/kg)	19.25±38.65	187±179	50 – 1 000

“Quarreling over food and drink, having neither scruples nor shame, not knowing right from wrong, not trying to avoid death or injury, not fearful of greater strength or of greater numbers, greedily aware only of food and drink- such is the bravery of the dog and the boar.”

Xun Zi