

Introduction to Feeding Normal Dogs

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“What dogs? These are my children, little people with fur who make my heart open a little wider.”
Oprah Winfrey

CLINICAL IMPORTANCE

Much has changed in our perception and use of dogs over the past half century. Our society has moved from an agrarian phase into a postindustrial phase with a concomitant shift of the human population into urban settings. Dogs have, by necessity, made the shift to urban living along with us and in doing so we have discovered their remarkable adaptability and versatility.

Dogs have found a job in virtually every niche of society. Dogs have been useful in law enforcement, as nursing home companions, in the military, in drug enforcement, as paraplegic assistants and in search and rescue. The human-animal bond has become a commonly taught subject in veterinary schools, which testifies to the importance of animals, including dogs, for our mental and physical well-being. The Centers for Disease Control and Prevention (CDC) describe some of the health benefits of pet ownership, including decreased blood pressure, cholesterol levels, triglyceride levels and feelings of loneliness and increased opportunities for exercise, outdoor activities and socialization (2006). Many organizations support the health benefits of pet ownership including the American Veterinary Medical Association, The Delta Society and the National Institutes of Health; these organizations and others have issued statements or provided information supporting the health benefits of pet ownership. According to this national poll of working Americans 18

years of age and over, nearly one in five U.S. companies allow pets at work. A majority of those polled believe pets at work provide benefits such as relieving stress, improving relationships with coworkers, making for a happier workforce and creating a happier work environment (CDC, 2006). Another health benefit for both dogs and people is related to exercise and weight loss. When overweight people and overweight pets exercise together, they both have lower dropout rates from their weight-loss programs (Jewell et al, 2004).

The emphasis on dogs as valued members of society (**Box 12-1**) has driven the development of canine nutrition towards the same goals we strive for in human nutrition: long life, high quality life and enhanced performance.

Demographics

Globally, pet ownership has increased, possibly due to reduced human birth rates, changing family structure and aging populations (Anonymous, 1997). Regardless of a pet's size or species, pet owners consider their pet to be a family member. One survey indicated that 63% of the U.S. population own pets. There are nearly 75 million dogs in the U.S. Furthermore, 45% of U.S. households own dogs; this equates to approximately 1.7 dogs per household (AAMA, 2007). **Table 12-1** lists countries with the most prevalent dog ownership. Breed popularity varies from year to year and from region to region; however, some breeds always appear to be more desired than others (**Table 12-2**). Worldwide, mixed-breed and crossbred dogs are most popular.

Box 12-1. People Treat their Dogs like Family Members.

A majority of American households (62%) own at least one pet, but virtually everyone, more than nine in 10, considers his or her pet a member of the family. Here are some other interesting facts about dog ownership.

- 70% of owners said they give their dogs presents at Christmas.
- 22% of owners celebrate their dogs' birthday by giving a special treat, making a special meal, giving their dog a cake, ice cream, a new toy, a new bone, singing happy birthday, throwing a birthday party with other dogs, taking their dog to a favorite place or taking photographs.
- More than 50% of American dog owners are more attached to their pets than to at least one other person; 36% say they are more attached to their dog than their best friend and 12% say they are more attached to their dog than their spouse.
- 25% of owners let their dog sleep either on top of or in their bed.

The Bibliography for **Box 12-1** can be found at www.markmorris.org.

Table 12-1. Comparisons of dog populations in selected countries.*

| Country | Pet dog population |
|--------------|--------------------|
| USA | 61,080,000 |
| Brazil | 30,051,000 |
| China | 22,908,000 |
| Japan | 9,600,000 |
| Russia | 9,600,000 |
| South Africa | 9,100,000 |
| France | 8,150,000 |
| Italy | 7,600,000 |
| Poland | 7,520,000 |
| Thailand | 6,900,000 |

*Source: Infobase Pvt. Ltd.

Table 12-2. Ten most popular dog breeds registered by the American Kennel Club in 1996 compared with their popularity in 2005.

| Breed | 1996* | | 2005** | |
|---------------------|-------|---------|--------|---------|
| | Rank | Number | Rank | Number |
| Labrador retriever | 1 | 149,505 | 1 | 137,867 |
| Rottweiler | 2 | 89,867 | 16 | 15,916 |
| German shepherd dog | 3 | 79,076 | 4 | 45,014 |
| Golden retriever | 4 | 68,993 | 2 | 48,509 |
| Beagle | 5 | 56,946 | 5 | 42,592 |
| Poodle | 6 | 56,803 | 8 | 31,638 |
| Dachshund | 7 | 48,426 | 6 | 38,566 |
| Cocker spaniel | 8 | 45,305 | 15 | 16,343 |
| Yorkshire terrier | 9 | 40,216 | 3 | 47,238 |
| Pomeranian | 10 | 39,712 | 14 | 19,511 |

*Adapted from U.S. Pet Ownership & Demographics Sourcebook. Schaumburg, IL: Center for Information Management, American Veterinary Medical Association, 1997; 32-35.

**American Kennel Club Registration Statistics, 2005.

The terms “mixed breed” and “crossbred” have slightly different meanings. Mixed-breed dogs' ancestry might not be discernable, whereas breeders often plan crossbreeding by mating two different purebred dogs.

Coinciding with increasing numbers of pets, from 2001 to 2006, sales of commercial pet foods increased 5.4% in the U.S. and more than 10% worldwide. In the U.S., the trend is for less pet food to be sold through grocery stores and more through specialty and mass merchandisers. Packaged dry dog foods are almost universally fed by dog owners (95% of dog owners) compared to canned food use (34% of dog owners) (Packaged Facts, 2006). This highly competitive market and increased demand, coupled with the importance of nutrition to the health and performance of dogs, make it necessary for practicing veterinarians to understand not only the basics, but also the subtleties of canine nutrition to make knowledgeable recommendations to clients about optimal feeding programs.

Species Diversity

The modern domestic canine species encompasses a vast number of breeds each with its own genetic idiosyncrasies (Fogle, 1997). Using genomic techniques (microsatellite genotyping), the genetic similarities of 85 modern breeds were organized into four distinct groups. The breeds in each of the four groups had similar geographic origins, morphology or role in human activities (Parker et al, 2004). The variety of dog breeds has arisen out of selection efforts by people to produce animals with specific traits that may enhance performance, show or behavioral characteristics (Table 12-3). The result is a species that displays a wide variety of morphology; head shape, size, coat characteristics (color, length, etc.) and musculoskeletal structure. By selecting for these traits, we have probably unknowingly selected for variations in metabolism and nutrient usage as has been evidenced in other species. Our knowledge about breed variation in metabolism and nutrient requirements is growing. Furthermore, nutrigenomic technologies create a potential for an even better understanding of breed-specific nutrition (Chapter 4). Nutrigenomics is currently applied to many species including people (Swanson et al, 2003). Because dogs are good models for certain human diseases, the outcome will be an increasing body of knowledge about metabolism and nutrition of the diverse canid species. A common unifying theme is dogs are omnivores.

DOGS AS OMNIVORES

The word carnivore can be used to indicate either a taxonomic classification or a type of feeding behavior. The order Carnivora is quite diverse (Table 12-4) and consists of 12 families containing more than 260 species. Omnivorous and carnivorous feeding behaviors are most common among members of the order Carnivora; however, the order also includes species that are herbivores (e.g., pandas) (Corbet and Hill, 1986; Morris and Rogers, 1983, 1989).

Eating Behavior

Several researchers have examined the eating habits of wolves (*Canis lupus*), the nearest ancestors of our domestic dogs, and close relatives such as coyotes (*Canis latrans*). Both are opportunistic predators and scavengers, hunting and eating what is available regionally (Sheldon, 1992). Coyotes eat carrion and hunt rodents, other small mammals, birds, amphibians and other species (Sheldon, 1992; Landry and Van Kruiningen, 1979). Additionally, they have been reported to consume droppings of herbivorous prey; domestic dogs also will readily consume herbivore feces (Lewis et al, 1987). Regional ungulates such as buffalo, deer, elk, moose, wildebeest, antelope and zebra are the natural prey of wolves (Sheldon, 1992; Landry and Van Kruiningen, 1979). Viscera are typically consumed; therefore, partially digested vegetable material is a normal part of the wolf's diet (Beaver, 1981). Both coyotes and wolves also eat plant matter such as fruits, berries, persimmons, mushrooms and melons (Sheldon, 1992; Landry and Van Kruiningen, 1979; Röhrs, 1987). Similarly, dogs are opportunistic eaters and have developed anatomic and physiologic characteristics that permit digestion and usage of a varied diet.

Anatomy and Physiology

Oral Cavity

The oral cavity functions to decrease the physical size of food for introduction into the rest of the alimentary tract. Decreasing the physical size of food creates particles small enough to pass through the esophagus and increases the surface area of the food, which enhances enzymatic digestion in the stomach and small intestine. Dogs have cutting canine teeth for ripping and tearing and molar teeth with large occlusal tables for crushing, which are associated teleologically with the capacity to use plant material (Figure 12-1) (Morris and Rogers, 1989). Dogs may fix large pieces of food with their paws to tear off small pieces with their cutting canine teeth, after which the food particle is advanced to the back of the oral cavity where it may be crushed by the molar teeth and mixed with saliva before being swallowed (Meyer, 1990).

Stomach

Wild canids typically eat large meals, usually infrequently, due to intermittent food availability. Dogs may consume their daily energy requirement in one or two large rapidly ingested meals (Ruckebusch et al, 1991). This eating pattern means that the stomach must be able to expand markedly. On average, a medium-sized, adult domestic dog has the capacity to ingest 30 to 35 g of dry matter per kg body weight per day (Meyer, 1990a; Meyer et al, 1980). However, the canine stomach can adjust, within limits, to accommodate the amount of food ingested and can hold 1 to 9 liters depending on the breed (Schummer and Nickel, 1960).

Small and Large Intestine

The characteristics of the canine small intestine are consistent with those of animals that digest an omnivorous diet (Morris and Rogers, 1989). The small intestine composes approximate-

Table 12-3. Examples of various functions dogs perform in society.

| |
|--|
| Assisting hearing or physically impaired persons |
| Entertainment |
| Guiding blind persons |
| Herding |
| Hunting |
| Military and law enforcement |
| Pets |
| Racing (sprint or endurance) |
| Rescue operations |
| Show and breeding |
| Social interactions |

ly 23% of the total gastrointestinal (GI) volume of dogs (Ruckebusch et al, 1991) vs. 15% for cats (Wolter, 1982). The ratio of GI tract length to total body length is 6:1 for dogs, 4:1 for cats, 10:1 for rabbits and as high as 20:1 for some herbivores (Morris and Rogers, 1989; Meyer, 1990; Wolter, 1982). This anatomic relationship is consistent with ingestion of an omnivorous diet with intermediate digestibility (i.e., between low digestible herbaceous forages and highly digestible animal flesh). Dogs digest starch effectively via pancreatic enzymes and mucosal disaccharidases.

Nutrient Requirements and Metabolism

Much can be learned about an animal's nutritional requirements simply by analyzing its natural food source. True carnivores, such as cats, are limited to what is available from prey tissues such as skeletal muscle and liver to provide energy and nutrients, including protein, taurine, arginine, arachidonic acid and niacin. Consequently, carnivorous animals (e.g., cats) developed more efficient pathways to use these nutrients, and have lost the ability or have a decreased ability to synthesize them from precursors (Chapter 19). Being omnivorous and feeding on a varied diet of plant and animal tissue, dogs maintained or improved the ability to synthesize nutrients from precursors. These differences lend more evidence to early evolutionary divergence (Martin, 1989) and further support the premise that dogs are omnivores.

Table 12-5 compares the recommendations for daily nutrient intake of adult dogs to the nutrient content of meat (ground beef). This comparison confirms that an all-meat food would be unbalanced for dogs. Specific aspects of nutritional requirements of dogs are discussed in Chapters 5 and 6 and Chapters 13 through 18.

LIFESTAGE NUTRITION

Lifestage nutrition is the practice of feeding animals foods designed to meet their optimal nutritional needs at a specific age or physiologic state (e.g., maintenance, reproduction, growth or senior). The concept of lifestage nutrition recognizes that feeding either below or above an optimal nutrient range can negatively affect biologic performance or health (Chapters

Table 12-4. Taxonomy and natural feeding behavior of the order Carnivora.*

| Family | Canidae | Ursidae | Procyonidae | Ailuropodidae | Mustelidae | Viverridae |
|------------------|---|-------------------------|---|--------------------------|---|------------------------------|
| Feeding behavior | Omnivores | Omnivores Carnivores | Omnivores | Herbivores | Carnivores Omnivores | Omnivores |
| No. of species | 35 | 7 | 13 | 2 | 63 | 35 |
| Examples | Dogs Jackals Coyotes Foxes Wolves | Bears | Raccoons Coatis Kinkajou Olingos | Pandas | Weasels Polecats Mink Ferrets Martens Wolverine Badgers Skunks Otters | Genets Civets Linsangs |
| Family | Herpestidae | Hyaenidae | Felidae | Otariidae | Odobenidae | Phocidae |
| Feeding behavior | Carnivores Omnivores | Carnivores | Carnivores | Carnivores | Carnivores | Carnivores |
| No. of species | 37 | 4 | 36 | 14 | 1 | 19 |
| Examples | Mongoose Meerkats | Hyenas | Leopards Pumas Cats Ocelots Serval Jaguars Lynxes Bobcats Lions Tigers Cheetahs | Eared seals Sea lions | Walrus | Earless seals |

*Adapted from Corbet GB, Hill JE. A World List of Mammalian Species. New York, NY: Facts on File Publications, 1986; 105-121. Nowak RM, Paradiso JL. Walker's Mammals of the World, 4th ed. Baltimore, MD: The Johns Hopkins University Press, 1983. Ridgway SH, Harrison RJ. Handbook of Marine Mammals. New York, NY: Academic Press Inc, 1981.

Table 12-5. Comparison between the recommended daily allowances of selected nutrients for a 10-kg adult dog and the nutrient content of meat (beef).*

| Nutrient | RDA | | Regular ground beef | | |
|-----------------------------|-----------|-----------|--|----------|----------|
| | 10-kg dog | per 100 g | Amount meeting the DER of a 10-kg dog 482 g | % of RDA | Adequacy |
| Metabolizable energy (kcal) | 650 | 135 | 650 | 100 | Yes |
| Moisture (ml) | 650 | 60 | 289 | 44 | na |
| Protein (g) | 24 | 17 | 82 | 341 | No |
| Fat (g) | ≥8 | 20 | 96 | 1,204 | No |
| Calcium (mg) | 1,000 | 10 | 48 | 5 | No |
| Phosphorus (mg) | 750 | 200 | 963 | 128 | Maybe |
| Ca/P ratio | 1:1-2:1 | 1:20 | 1:20 | na | No |
| Sodium (mg) | 250-500 | 70 | 337 | 100 | Yes |
| Potassium (mg) | 550 | 325 | 1,565 | 285 | No |
| Magnesium (mg) | 150 | 25 | 120 | 80 | Maybe |
| Iron (mg) | 14 | 3.25 | 16 | 112 | Yes |
| Copper (mg) | 1 | 0.05 | 0.2 | 24 | No |
| Zinc (mg) | 10 | 1.5 | 7 | 70 | No |
| Iodine (mg) | 0.15 | 0.003 | 0.014 | 10 | No |

Key: RDA = recommended daily allowance, DER = daily energy requirement, na = not applicable, Yes = meets the optimal recommendations, Maybe = does not meet the optimal recommendations, but is neither deficient nor excessive, No = deficient or excessive.

*Adapted from Gesellschaft für Ernährungsphysiologie Ausschuss für Bedarfsnormen. Energie-und Nährstoffbedarf Nr. 5 Hunde. Frankfurt, Germany: DLG Verlag, 1989. Meyer H, Heckötter E. Futterwerttabellen für Hunde und Katzen. Hannover, Germany: Schlütersche Verlaganstalt und Druckerei, 1986. National Research Council. Nutrient Requirements of Dogs. Washington, DC: National Academy Press, 1985. Randoin L, Le Gallic P, Dupuis Y, et al. Tables de composition des aliments. Institut Scientifique d'Hygiène Alimentaire, 6th ed. Malakoff, France: LT Editions J. Lanore, 1990. Watt BK, Merrill AL. Composition of Foods-Raw, Processed, Prepared. Agriculture Handbook No 8. Washington, DC: Agricultural Research Service, USDA, 1975.

5 and 6). This concept differs markedly from feeding a single product for “all lifestages” (all-purpose foods) in which nutrients are added at levels to meet the highest potential need (usually growth and reproduction). Adult animals at maintenance

are always provided nutrients well in excess of their biologic needs when fed all-purpose foods. Because the goals in nutrition are to feed for optimal health, performance and longevity, feeding foods designed to more closely meet individual needs is

preferred. This philosophy is the central tenant to lifestage nutrition and preventive medicine. In addition to providing advice about basic nutritional requirements of their patients, veterinarians should assess and minimize the nutrition-related health risks at each lifestage. For maximal benefit, risk assessment and prevention plans should begin well before the onset of disease.

The value of lifestage feeding is enhanced if risk factor management is incorporated into the feeding practice. In many instances, when the nutritional needs associated with a dog's age and physiologic state are combined with the nutritional goals of disease risk factor reduction, a more narrow, but optimal, range of nutrient recommendations results. For example, essentially all commercial dog foods sold in the U.S. meet or exceed the Association of American Feed Control Officials (AAFCO) minimum nutrient requirements for dog foods. Regulatory agencies such as AAFCO ensure ingredient safety and nutritional adequacy. However, even foods that are nutritionally adequate may have levels of certain nutrients outside a desired range for disease risk factor reduction or optimal performance (these nutrients are nutrients of concern). As mentioned in Chapter 1, besides nutrients of concern, specific food factors such as digestibility and texture can also affect health and modify disease risk. Together, nutrients of concern and specific food factors are referred to as key nutritional factors. The key nutritional factors for commercial foods for different lifestages of healthy dogs will be discussed in Chapters 13 through 18, including those associated with reducing the risk of specific diseases and those involved with optimizing performance during different physiologic states.

Homemade foods, unlike commercial foods, are not regulated. Thus, unless experts in canine nutrition have formulated the recipes from which they are made, there are no assurances that homemade foods will provide adequate nutrition or that the ingredients used to make them are safe for dogs (Chapter 10). However, even if the recipes for homemade foods ensure nutritional adequacy and ingredient safety, key nutritional factors should also be considered, depending on the lifestage of the dog being fed.

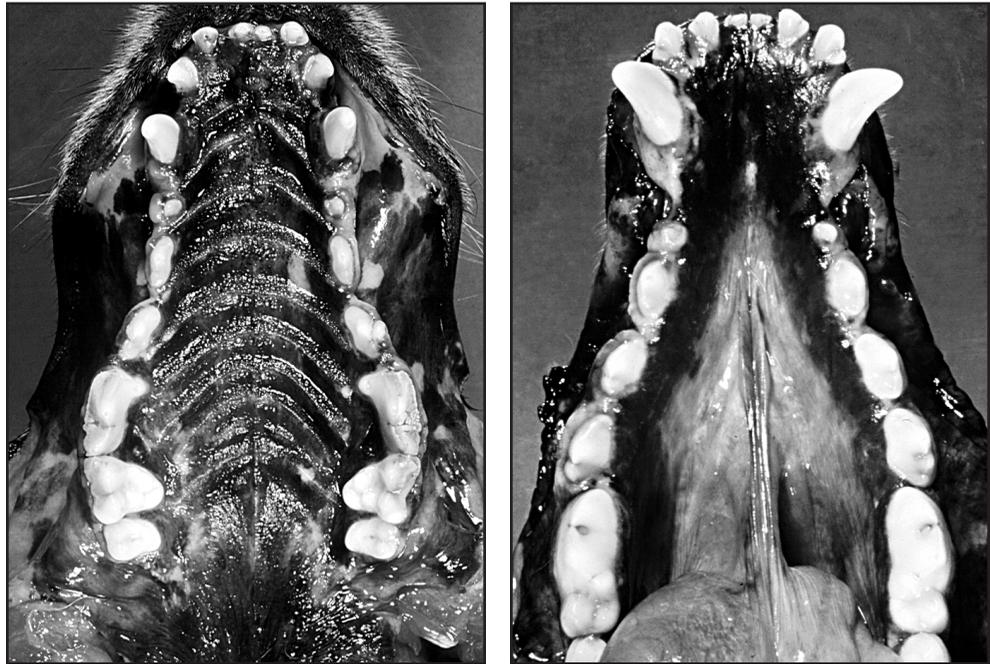


Figure 12-1. Maxillary dentition and palate of a dog (left). Mandibular dentition and sublingual mucosa of the same dog (right). These photographs demonstrate tooth anatomy associated with an omnivorous eating behavior. The cuspid (canine) teeth are long and cutting and are used for capturing and puncturing prey. The maxillary and mandibular premolar teeth interdigitate and provide a shearing action. The carnassial teeth (upper fourth premolar and lower first molar) have broad occlusal surfaces and are used for grinding and chewing. (Adapted with permission from Harvey CE, Emily PP. *Function, formation, and anatomy of oral structures in carnivores*. Small Animal Dentistry. St. Louis, MO: Mosby-Year Book Inc, 1993.)

In sequence, the chapters that follow cover Feeding Young Adult Dogs: Before Middle Age, Feeding Mature Adult Dogs: Middle Aged and Older, Feeding Reproducing Dogs, Feeding Nursing and Orphaned Puppies from Birth to Weaning and Feeding Growing Puppies: Postweaning to Adulthood. The next chapter begins with feeding young adult dogs because most dogs are adults, and the nutrient needs of adult dogs serve as a good basis for comparing nutrient needs for other lifestages. Chapter 18 covers recommendations for feeding adult working and sporting dogs for optimal physical and olfactory performance.

REFERENCES

The references for Chapter 12 can be found at www.markmorris.org.