Chapter 17

Feeding Growing Puppies: Postweaning to Adulthood

Jacques Debraekeleer
Kathy L. Gross
Steven C. Zicker

"Whoever said you can't buy happiness forgot little puppies."
Gene Hill

INTRODUCTION

This chapter covers puppy growth from immediately postweaning to adulthood, which generally occurs between 10 to 12 months of age, depending on breed. The goal of a feeding plan for puppies is to create a healthy adult. The specific objectives of a good puppy feeding plan are to achieve healthy growth, optimize trainability and immune function and minimize obesity and developmental orthopedic disease. Growth is a complex process involving interactions between genetics, nutrition and other environmental influences. Nutrition plays a role in the health and development of growing dogs and directly affects the immune system (Sheffy, 1985), body composition (Meyer and Zentek, 1992; Toll et al, 1993), growth rate (Meyer and Zentek, 1992) and skeletal development (Hazewinkel, 1985; Hedhammar et al, 1974; Kealy et al, 1992). Chapter 33 provides in-depth recommendations for feeding large- and giant-breed puppies (>25 kg adult weight) to avoid developmental orthopedic disease.

PATIENT ASSESSMENT

Puppies should be assessed for risk factors before weaning to allow implementation of recommendations for appropriate nutrition. A thorough history and physical evaluation are necessary. Special attention should be paid to large- and giant-breed puppies (Chapter 33) and breeds and sexes (intact and neutered) at risk for obesity (Chapter 27). In addition, growth rates and body condition scores (BCS) provide valuable information about nutritional risks.

Besides being breed dependent, growth rates of young dogs are affected by the nutrient density of the food and the amount of food fed (Meyer and Zentek, 1992). Puppies should be fed to grow at an optimal rate for bone development and body condition rather than at a maximal rate. Growing animals reach a similar adult weight and size whether growth rate is rapid or slow. Feeding for maximum growth increases the risk for skeletal deformities (Hedhammar et al, 1974; Kealy et al, 1992) and decreases longevity in other species (Chipalkatti et al, 1983). In Labrador retrievers, even moderate overfeeding resulted in overweight adults and decreased longevity (Kealy et al, 2002).

The most practical indicator of whether or not a puppy's growth rate is healthy is its BCS. All puppies should have their body condition evaluated and reassessed at least every two weeks to allow for adjustments in amounts fed and, thus, growth rates (Chapter 1). Owners can be trained to assess body condition and are likely to become more aware of the appearance of a healthy growing puppy. A markedly less effective option is to compare the puppy's weight to breed standards for

Table 17-1. Key nutritional factors for foods for growing puppies.*

Factors	Recommended levels in food (DM) Puppies with an adult BW <25 kg	Puppies with an adult BW >25 kg
Energy density (kcal ME/g)	3.5-4.5	3.5-4.5
Energy density (kJ ME/g)	14.6-18.8	14.6-18.8
Crude protein (%)	22-32	22-32
Crude fat (%)	10-25	10-25
DHA (%)	≥0.02	≥0.02
Calcium (%)	0.7-1.7	0.7-1.2
Phosphorus (%)	0.6-1.3	0.6-1.1
Ca:P ratio	1:1-1.8:1	1:1-1.5:1
Digestibility	See energy density recommendations, above; foods with higher energy density values tend to be more digestible	See energy density recommendations, above; foods with higher energy density values tend to be more digestible

Key: DM = dry matter, BW = body weight, kcal = kilocalories, kJ = kilojoules, ME = metabolizable energy, DHA = docosahexaenoic acid.
*For large- and giant-breed dogs (adult BW >25 kg), also see Table 33-5.

Table 17-2. Recommendations for initial estimate of energy intake of growing dogs.

Time frame	x RER	kcal/$BW_{kg}^{0.75}$	kJ/$BW_{kg}^{0.75}$
Weaning to 50% of adult BW*	3	210	880
50 to 80% of adult BW	2.5	175	735
≥80% of adult BW	1.8-2.0	125-140	525-585

Key: RER = resting energy requirement, kcal = kilocalories, kJ = kilojoules, BW = body weight. RER can be obtained from Table 5-2 or calculated. If calculating RER, use one of these two formulas: for puppies of all body weights, $RER_{kcal} = 70(BW_{kg}^{0.75})$; or for puppies weighing more than 2 kg, $RER_{kcal} = 30(BW_{kg}) + 70$. To convert kcal to kJ, multiply by 4.184.
*Great Dane puppies may need 25% more energy during the first two months after weaning = 250 kcal or 1,050 kJ/$BW_{kg}^{0.75}$. See text.

various months of age based on its estimated mature weight. Furthermore, regularly assessing body condition provides more immediate feedback about optimal nutritional status than using body weights based on estimated adult size.

Key Nutritional Factors

The requirements for all nutrients are increased during growth compared with requirements for adult dogs. Most nutrients supplied in excess of that needed for growth cause little to no harm. However, excess energy and calcium are of special concern; these concerns include energy for puppies of small and medium breeds (for obesity prevention) and energy and calcium for puppies of large and giant breeds (for skeletal health). Also, essential fatty acids can affect neural development and trainability of puppies.

Table 17-1 summarizes the key nutritional factors for growing puppies. The following sections describe these key nutritional factors in more detail. The concept of key nutritional factors is based on the assumption that commercial foods are fed.

Energy

Energy requirements for growing puppies consist of energy needed for maintenance and growth. During the first weeks after weaning when body weight is relatively small and the growth rate is high, puppies use about 50% of their total energy intake for maintenance and 50% for growth (Gesellshaft, 1989; Sheffy, 1978). Gradually, the growth curves reach a plateau, as puppies become young adults (**Figure 17-1**). The proportion of energy needed for maintenance increases progressively, whereas the part for growth decreases. Energy needed for growth decreases to about 8 to 10% of the total energy requirement when puppies reach 80% or more of adult body weight. Because of the shift in energy usage, total food intake of a typical German shepherd puppy (adult body weight ~35 kg), based on energy needs, may no longer increase after about four months of age.

A puppy's daily energy requirement (DER) should be about 3 x its resting energy requirement (RER) until it reaches about 50% of its adult body weight (**Table 17-2**). Thereafter, energy intake should be about 2.5 x RER and can be reduced progressively to 2 x RER. When approximately 80% of adult size is reached, 1.8 to 2 x RER is usually sufficient. Great Dane puppies may have energy requirements 25% higher than those of other breeds. Young Great Dane puppies may not grow when daily energy intake is less than 175 kcal (735 kJ) metabolizable energy (ME)/$BW_{kg}^{0.75}$ (2.5 x RER) (Meyer and Zentek, 1992; Meyer and Zentek, 1991). However, this finding should not be extrapolated to other giant-breed puppies (Rainbird and Kienzle, 1990). These factors are general recommendations or starting points to estimate energy needs. Body condition scoring should be used to adjust these energy estimates to individual puppies.

Prevention of obesity is essential and should start at weaning. As in people, after puppies become overweight, it is very difficult to return to, and maintain, normal weight. Excessive food intake during growth may contribute to skeletal disorders in large- and giant-breed puppies (Chapter 33) (Kealy et al, 1992). If overweight and obesity are carried into adulthood, the risk for several important diseases is increased (Chapter 27). These include hypertension, heart disease, diabetes mellitus, dyslipidemias, osteoarthritis, heat and exercise intolerance and decreased immune function. Obesity also increases cellular oxidative stress. Long-term oxidative stress has its own serious health implications (Chapter 7). Studies show that moderate energy and food restriction during the postweaning growth period reduces the prevalence of hip dysplasia in large-breed (Labrador retriever) puppies and increases longevity in rats without retarding adult size (Kealy et al, 1992; Chipalkatti et al, 1983; Nolen, 1972; Ross and Bras, 1973; Ross, 1972). However, feeding a food with a very low energy density and low digestibility may not supply enough energy and nutrients to support optimal growth. This

approach can lead to intake of large quantities of the food, which can overload the gastrointestinal (GI) tract resulting in vomiting and diarrhea. Together, these factors make for a prudent argument to initiate monitoring of energy and food intake and body condition at an early age. Recommended energy density requirements for growing dogs are listed under the key nutritional factor "Fat" below.

Protein

Protein requirements of growing dogs differ quantitatively and qualitatively from those of adults. Quantitatively, at this stage of growth, protein requirements are highest at weaning and decrease progressively (Meyer, 1990; Burns et al, 1982; Case and Czarnecki-Maulden, 1990). For example, the level of crude protein in bitch's milk is 33% dry matter (DM). Bitch's milk is a highly digestible food with an energy density of 6.4 kcal/g DM. This level is equivalent to 21% highly digestible protein in a commercial food with 4 kcal/g DM. In one study, beagle puppies needed a food with a minimum of 15% DM protein of high biologic value and 90% digestibility to achieve optimal growth immediately after weaning. Only 11.7% (DM) of the same high-quality protein was needed at three months of age (Burns et al, 1982).

For puppies 14 weeks and older, the minimum recommended allowance for crude protein is 17.5% DM (NRC, 2006). The recommended protein range in foods intended for growth in all puppies (small, medium and large breed) is 22 to 32% DM (**Table 17-1**). Most dry commercial foods marketed for puppy growth provide protein levels within this range.

Protein levels above the upper end of this range have not been shown to be detrimental but are well above the level in bitch's milk. Earlier work suggested that excessive protein intake might play a role in the development of skeletal deformities in giant-breed dogs (Hedhammar et al, 1974). Since then, it has been shown that foods containing 23 to 31% crude protein (6.4 to 8.8 g/100 kcal ME) do not have a deleterious effect on skeletal development. Furthermore, these levels support optimal growth, provided calcium and energy levels are appropriate (Nap et al, 1991; Nap, 1993). Most commercial foods for puppy growth contain more protein than is needed.

Protein requirements of growing dogs differ quantitatively and qualitatively from those of adults. An important difference is that arginine is an essential amino acid for puppies, whereas it is only conditionally essential for adult dogs (Young et al, 1978) (Arginine is present in ample amounts in essentially all pet foods and thus is not considered a key nutritional factor for commercial foods).

Foods formulated for adult dogs should not be fed to puppies. Although protein levels may be adequate, energy levels and other nutrients may not be balanced for growth.

Fat

Dietary fat serves three primary functions: 1) a source of essential fatty acids, 2) a carrier for fat-soluble vitamins and 3) a concentrated source of energy. Growing dogs have an estimated

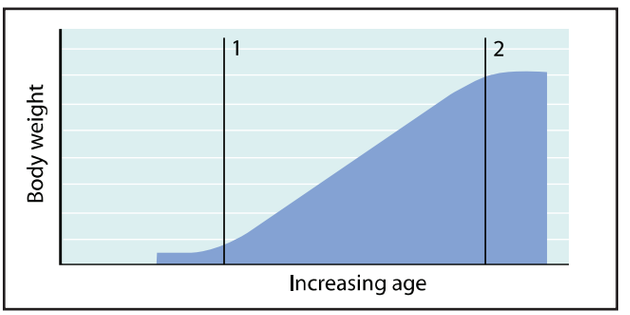

Figure 17-1. Typical sigmoidal growth curve of puppies. Growing puppies' energy needs may be subdivided into two components: the energy needed for maintenance and the energy required for accretion of body tissue. During the first weeks after weaning, when body weight is relatively small and growth rate exponential, puppies use about 50% of the energy for maintenance and 50% for growth. Gradually, the growth curve reaches a plateau. As body weight increases, the share of energy needed for maintenance increases progressively, whereas the part for growth becomes proportionately less important. The starting (line 1) and endpoint (line 2) of exponential growth can shift depending on the breed and individual variation. (See text and references.)

daily requirement for essential fatty acids (linoleic acid) of about 250 mg/kg body weight (Meyer, 1990b), which can be provided by a food containing between 5 to 10% DM fat (Meyer, 1990). The fat source must be carefully chosen when low-fat foods (<10% DM fat) are fed to ensure that sufficient amounts of linoleic acid are provided.

Studies indicate that docosahexaenoic acid (DHA) is essential for normal neural, retinal and auditory development in puppies (Pawlosky et al, 1997). Similar results have been found in other species (Pawlosky et al, 1997; Birch et al, 2002; Diau et al, 2003; Hoffman et al, 2003). Inclusion of fish oil as a source of DHA in puppy foods improves trainability (Kelley et al, 2004). Conversion of short-chain polyunsaturated fatty acids to DHA is an inefficient process in puppies (Bauer et al, 2006). Thus, adding a source of DHA should be considered essential for growth. The minimum recommended allowance for DHA plus eicosapentaenoic acid (EPA) is 0.05% DM; EPA should not exceed 60% of the total (NRC, 2006). Thus, DHA needs to be at least 40% of the total DHA plus EPA, or 0.02% DM.

Fat contributes greatly to the energy density of a food; however, excessive energy intake can cause overweight/obesity and developmental orthopedic disease, as discussed above. The minimum recommended allowance of dietary fat for growth (8.5% DM) is much less than that needed for nursing, but more than is needed for adult maintenance (5.5% DM) (NRC, 2006). To provide a DM energy density between 3.5 to 4.5 kcal/g, between 10 and 25% DM fat is required; this range of dietary fat is recommended from postweaning to adulthood.

Calcium and Phosphorus

Although growing dogs need more calcium and phosphorus than adult dogs, the minimum requirements are relatively low. Puppies have been successfully raised when fed foods contain-

Table 17-3. Feeding plan summary for growing puppies.

1. Estimate adult body weight for determination of the recommended calcium range (>25 kg adult weight, use large-/giant-breed recommendation).
2. Using **Table 17-4** (or manufacturer's information), select a food with the recommended levels of key nutritional factors; ensure the selected food has been approved for puppy growth by a credible regulatory agency (e.g., AAFCO).
3. Avoid free-choice feeding; use food-restricted meal feeding, dividing the amount fed into two to four daily feedings.
4. Estimate the initial amount to feed from recommendations on product package or by calculation (**Table 17-5**). Remember, such recommendations and calculations should be used as guidelines or starting points and not as absolute requirements.
5. Teach owners to perform body condition scoring and have them monitor body condition at least every two weeks and adjust the amount fed by 10% increments to maintain a BCS of 2.5/5 to 3/5.
6. Veterinarians should assess body condition and weight of puppies in conjunction with routine vaccinations and more frequently if any indication of under- or overnutrition is detected. The feeding plan, including food dosage, should be modified as necessary.
7. Underfeeding through the growth phase is healthier than overfeeding and results in the same mature size.

Key: AAFCO = Association of American Feed Control Officials, BCS = body condition score.

Box 17-1. Digestible Carbohydrates in Foods for Growing Puppies.

No specific recommendations for digestible (soluble) carbohydrate levels are available for growing dogs. It has been suggested that foods contain about 20% digestible carbohydrate until puppies are four months of age to ensure optimal health. In one study, feeding young puppies a food high in protein and fat without carbohydrate resulted in lethargy, poor appetite, diarrhea and mortality, which were attributed to fatty liver syndrome. However, another study failed to confirm these results. Body fat is higher when puppies are fed a very high-fat, low-carbohydrate food during growth.

The Bibliography for **Box 17-1** can be found at www.markmorris.org.

ing 0.37 to 0.6% DM calcium and 0.33% DM phosphorus (Jenkins and Phillips, 1960; Jenkins and Phillips, 1960a). Intestinal absorption of calcium can vary from almost 0 to 90% (Hazewinkel, 1985; Nap, 1993), and phosphorus absorption can increase to almost 80% to adapt to intake (Gesellshaft, 1989a; Jenkins and Phillips, 1960). Generally, calcium absorption depends on requirements and calcium intake (Meyer, 1990a). Calcium homeostatic mechanisms may be less precise in young puppies. In puppies between two and six months of age, intestinal absorption of calcium never decreases below approximately 40%, even if they receive high levels of calcium in foods (Hazewinkel, 1985; Hedhammar et al, 1974; Nap, 1993; Jenkins and Phillips, 1960). Retention of calcium, therefore, increases when young dogs receive high levels of calcium, either in the food or as a supplement (Hazewinkel, 1985; Nap, 1993). Absorption of calcium gradually is more regulated after puppies are about 10 months old (Hedhammar et al, 1974).

Foods for large- and giant-breed puppies should contain 0.7 to 1.2% DM calcium (0.6 to 1.1% phosphorus) (Chapter 33). Foods with a calcium content of 1.1% DM provide more calcium to puppies just after weaning than if bitch's milk is fed exclusively (Resnick, 1978). Because small- to medium-sized breeds are less sensitive to slightly overfeeding or underfeeding calcium (Nap, 1993), the level of calcium in foods for these puppies can range from 0.7 to 1.7% DM, (0.6 to 1.3% phosphorus) without risk. The phosphorus intake is less critical than the calcium intake, provided the minimum requirements of 0.35% DM are met and the calcium-phosphorus ratio is between 1:1 and 1.8:1 (Jenkins and Phillips, 1960; Jenkins and Phillips, 1960a). For large- and giant-breed dogs, the calcium-phosphorus ratio should be between 1:1 and 1.5:1.

Digestibility

The ability of 11-week-old puppies to digest foods was less than at 60 weeks of age (Weber et al, 2003). Also, puppies fed foods low in energy density and digestibility need to eat larger quantities of food to achieve growth, increasing the risk of flatulence, vomiting, diarrhea and the development of a "pot-bellied" appearance. Therefore, foods recommended for puppies should be more digestible than typical adult foods. Most pet food companies, however, do not provide digestibility data. An indirect indicator of digestibility is energy density. Foods with a higher energy density are likely to be more digestible.

Other Nutritional Factors

Copper

Most commercial pet foods should contain adequate levels of copper unless the availability is low (e.g., when sources such as copper oxide are used) (Aoyagi and Baker, 1993). Puppies with copper deficiency may have loss of hair pigmentation, with graying of black and dark brown hair (Zentek, 1991; Zentek et al, 1991). Hyperextension of the distal phalanges and splayed toes on the front feet and normochromic, normocytic anemia may develop in more extreme cases (Zentek, 1991; Zentek et al, 1991). The recommended minimum allowance for copper in growing puppies is 1.1% DM (NRC, 2006).

Phenylalanine and Tyrosine

Tyrosine is not an essential amino acid but is made from phenylalanine. Also, tyrosine spares about half of the need for phenylalanine. Therefore, it is appropriate to consider the amount of phenylalanine required as the sum of phenylalanine plus tyrosine. Although phenylalanine and tyrosine have not been shown to be the most limiting amino acids for growth in commercial food, at least twice as much phenylalanine, or phenylalanine plus tyrosine, is required for maximal black hair color as for growth (Biourge and Sergheraert, 2002). Other metabolic needs for phenylalanine and tyrosine include protein, thyroid hormone and catecholamine synthe-

sis (NRC, 2006). The recommended minimum allowance for phenylalanine plus tyrosine in foods for puppy growth is 1.0% DM.

Carbohydrates

Although no specific level of digestible (soluble) carbohydrates exists for growing puppies, inclusion of about 20% (DM) may optimize health (**Box 17-1**).

FEEDING PLAN

The feeding plan consists of choosing the best food and the best feeding method. Reassessment at appropriate intervals is another key to a successful feeding plan. **Table 17-3** summarizes the feeding plan.

Assess and Select the Food

The food assessment phase will help determine the best food to feed or whether it is necessary to change foods if a food has already been selected. If a change is indicated, select a food that has been approved by a credible regulatory agency such as the Association of American Feed Control Officials (AAFCO). However, AAFCO feeding trials only last 10 weeks. During this time, potential problems related to excess calcium and energy consumption, especially in large- and giant-breed puppies may not have had time to manifest. Therefore, foods selected for growth should have key nutrients in the ranges provided in **Table 17-1.**

If the appropriate food was selected for reproduction, puppies of small- to medium-sized breeds (<25 kg anticipated adult weight) may continue to receive the same food as the bitch received during lactation. These puppies were probably transitioned to this food during weaning. Large- and giant-breed puppies should be fed a food that contains less calcium and energy to decrease the risk of developmental orthopedic disease. If possible, such foods should be fed during early weaning. Chapter 33 contains more detailed information about feeding large- and giant-breed puppies. The greatest nutritional influence on the incidence of phenotypic hip dysplasia occurs when energy is restricted very early in life (Lust et al, 1973).

Besides selecting an AAFCO (or a food approved by another credible organization) approved food, the food assessment/selection process includes comparing the nutrient profile of the current food, or the food under consideration, with the key nutritional factors in the amounts discussed above. **Table 17-4** lists levels of key nutritional factors in selected commercial foods marketed for healthy puppy growth and compares them to the recommended levels. If the food in question is not listed in **Table 17-4**, contact pet food manufacturers for this or other missing information. The guaranteed or typical analysis on pet food labels is of limited use and will not contain information about digestibility. Information about digestibility and energy density should be obtained from the manufacturer; digestibility must be sufficiently high to avoid GI problems. Also, foods with similar label declarations can have markedly different nutrient availabilities and growth performance (Huber et al, 1986; Huber et al, 1991).

Growing dogs should not receive vitamin-mineral supplements when fed complete, balanced commercial foods. Supplements may be justified to balance homemade foods. Because it is very difficult for breeders to exactly balance a homemade food, large- and giant-breed puppies should only receive a commercially prepared food specifically designed for such breeds. If an owner insists on using homemade foods, it is best to consult with a qualified veterinary nutritionist to ensure a homemade recipe is balanced (Chapter 10).

The calcium and energy content of treats should be similar to that recommended for the food (**Table 17-4**). If not, the number of treats fed should be limited to no more than 10% of the total amount of food fed. Treats given in large amounts may almost double a puppy's calcium intake (Box 33-5). Most treats are not complete and balanced for puppy growth. Check the product label for this information.

Assess and Determine the Feeding Method

Feeding method assessment is critical to successful management of growing puppies, especially those of large and giant breeds. The feeding method includes how much food is fed and how it is offered. Food can be offered three ways: free choice, time-restricted meal feeding and food-restricted meal feeding. Free-choice and time-restricted feeding should be avoided during rapid growth.

Free-choice feeding may increase body fat, predispose the dog to obesity and, in large breeds, induce skeletal deformities at a young age. Breeders who want to maximize growth of large- and giant-breed puppies should be informed that overfeeding predisposes to developmental orthopedic disease. Even under these circumstances, rate of weight gain and body condition should be monitored closely (at least every two weeks).

Previously, time-restricted meal feeding was recommended (feeding a puppy all it can eat in 20 minutes, twice daily) (Lewis et al, 1987). However, more recent research showed that puppies fed using this method had increased body weight, more body fat and increased bone mineral accretion than puppies receiving the same food free choice (Toll et al, 1993).

During periods of rapid growth, puppies should be fed a measured amount of food (food-restricted meal feeding) every day based on body condition and age. The allotted amount of food can be offered in one or two meals per day. This recommendation includes thin puppies owned by clients who are tempted to feed more food so their puppies can "catch up."

Feeding puppies an allotted amount of food is best for most puppies because it allows for better control of body condition and rate of growth. Using this feeding method for growing puppies is complicated because the amount fed per unit body weight needs to be adjusted regularly. Initially the amount fed needs to be greater per unit body weight and then is reduced as the growth rate and energy requirements per unit body weight decline (**Figure 17-1** and **Table 17-2**). Also, the initial amount fed needs to be determined.

The initial daily food dose can be estimated by dividing the puppy's DER by the energy density of the food. From a practi-

Table 17-4. Comparison of recommended levels of key nutritional factors for small- to medium-breed puppies (adult BW <25 kg) to the key nutritional factor content of selected commercial foods marketed for healthy puppy growth.* For large- to giant-breed puppies (>25 kg), see foods and recommended levels in Table 33-6.

Dry foods	Energy density (kcal/cup)**	Energy density (kcal ME/g)***	Protein (%)	Fat (%)	DHA (%)	Ca (%)	P (%)	Ca:P
Recommended levels	**-**	**3.5-4.5**	**22-32**	**10-25**	**≥0.02**	**0.7-1.7**	**0.6-1.3**	**1:1-1.8:1**
Hill's Science Diet Puppy Healthy Development Original	384	4.2	31.8	22.9	0.22	1.59	1.21	1.3:1
Hill's Science Diet Puppy Lamb Meal & Rice Recipe	377	4.2	31.7	21.7	0.22	1.58	1.10	1.4:1
Hill's Science Diet Nature's Best Chicken & Brown Rice Dinner Puppy	445	4.3	30.2	22.1	0.20	1.43	1.05	1.4:1
Hill's Science Diet Nature's Best Lamb & Brown Rice Dinner Puppy	442	4.2	30.1	22.1	0.17	1.50	1.10	1.4:1
Iams Eukanuba Medium Breed Puppy	463	4.1	31.7	19.2	na	1.50	1.07	1.4:1
Iams ProActive Health Smart Puppy	432	4.2	30.8	18.9	na	1.30	1.10	1.2:1
Medi-Cal Veterinary Diet Development Formula	425	na	28.4	17.5	na	1.20	1.10	1.1:1
Nutro Natural Choice Puppy Lamb Meal and Rice	333	3.8	29.7	14.3	na	1.98	1.54	1.3:1
Purina ONE Healthy Puppy Formula	465	4.6	31.7	20.6	na	1.61	1.11	1.5:1
Purina Puppy Chow	416	4.2	29.8	15.6	na	1.31	1.01	1.3:1
Purina Pro Plan Chicken & Rice Formula Puppy	473	4.6	31.6	20.7	na	1.23	1.04	1.2:1
Royal Canin Medium Puppy 32	402	4.6	35.6	20.0	na	1.12	0.88	1.3:1
Moist foods	**Energy density (kcal/can)****	**Energy density (kcal ME/g)*****	**Protein (%)**	**Fat (%)**	**DHA (%)**	**Ca (%)**	**P (%)**	**Ca:P**
Recommended levels	**-**	**3.5-4.5**	**22-32**	**10-25**	**≥0.02**	**0.7-1.7**	**0.6-1.3**	**1:1-1.8:1**
Hill's Science Diet Puppy Healthy Development Savory Chicken Entrée	205/5.8 oz. 459/13 oz.	4.1	28.2	23.6	na	1.33	0.96	1.4 : 1
Purina Pro Plan Puppy Chicken & Rice Entrée Classic	459/13 oz.	4.9	42.4	38.4	na	1.92	1.48	1.3:1

Key: BW = body weight, ME = metabolizable energy, DHA = docosahexaenoic acid, Ca = calcium, P = phosphorus, na = not available from manufacturer.
*From manufacturers' published information or calculated from manufacturers' published as-fed values; all values are on a dry matter basis unless otherwise stated.
**Energy density values are listed on an as fed basis and are useful for determining the amount to feed; cup = 8-oz. measuring cup.
***Energy density also reflects digestibility; foods with higher energy density are likely to have better digestibility than foods with lower energy density; for kJ/g, multiply kcal/g by 4.184.

cal standpoint, the energy requirement can be estimated but not determined precisely. Estimates of a puppy's DER can be obtained from **Table 17-2** (i.e., this phase of growth can be divided into three periods). The DER can also be calculated. DER calculations are simple and are based on the puppy's RER; **Table 17-2** lists RER factors. RER can be calculated (**Table 17-5**) or obtained directly from Table 5-2 or the food manufacturer.

The initial daily food dose estimate is merely a starting point. Body condition scoring (Figure 1-2) should be used to adjust the food dose estimate to individual puppies and will need to be readjusted regularly (10% increments) to allow for changes in growth rate. This amount can be fed in two to four meals per day. Note that Great Dane puppies may have energy requirements 25% higher than those of other breeds. As mentioned above, young Great Dane puppies may not grow when daily energy intake is less than 175 kcal (735 kJ) ME/$BW_{kg}^{0.75}$ (2.5 x RER) (Meyer and Zentek, 1992; Meyer and Zentek, 1991).

However, this finding should not be extrapolated to other giant-breed puppies (Rainbird and Kienzle, 1990).

REASSESSMENT

Owners should weigh growing puppies weekly and record body weights and food intake (including snacks and treats). Veterinarians, or members of their health care team, can instruct owners about how to BCS their own puppies. A BCS should be obtained at least every two weeks. During office calls for routine vaccinations, veterinarians can compare the owners' scores with their own. This level of attention to BCS can be important to the development of a healthy puppy. The owner is then prepared to continue to make these observations throughout the life of the dog. Such dogs, as adults, should be less likely to experience skeletal diseases (large and giant breeds) and overweight or obesity and the myriad of related problems (most breeds).

Veterinarians should reassess puppies at the time of routine vaccinations and more frequently if any indication of under- or overnutrition is detected. Reassessment should include body weight and body condition assessment, food assessment and determination of correct food dosage (**Table 17-5**).

Table 17-5. Example of a food dosage calculation for a growing puppy.

Problem: what is the estimated amount of a growth food (375 kcal/cup) that should be fed to a five-month-old male Labrador retriever puppy weighing 18 kg?

1) Determine RER by using the linear formula: $RER_{kcal} = 30(BW_{kg}) + 70$; $RER_{kcal} = 30(18) + 70 = 610$ kcal/day or from Table 5-2.
2) Determine DER by using the RER factors in **Table 17-2**, based on age: 2.5 x RER = 2.5 x 610 kcal = 1,525 kcal/day.
3) Divide the DER by the energy density of the food (**Table 17-4**), to obtain the estimated daily amount to feed: 1,525 kcal ÷ 375 kcal/cup = 4 cups/day.
4) Divide the daily amount to feed into two to four individual meals.
5) This amount is only an estimate and is intended to be used as a starting point. The puppy's body condition should be monitored regularly (at least every two weeks) and the amount fed should be increased or decreased by 10%, depending on body condition score.

Key: cup = 8 volume oz. measuring cup (240 cc), RER = resting energy requirement, DER = daily energy requirement.

REFERENCES

The references for **Chapter 17** can be found at www.markmorris.org.

CASE 17-1

Initial Health Care for a Welsh Corgi Puppy

Jacques Debraekeleer, DVM
Hill's Science and Technology Center
Etten Leur, The Netherlands

Kathy L. Gross, PhD
Hill's Science and Technology Center
Topeka, Kansas, USA

Patient Assessment

A 10-week-old, female Welsh corgi puppy was examined as part of a routine health maintenance program. The owners had recently purchased the puppy from a local breeder and had never owned a dog before. They were interested in vaccinations and any other information about caring for puppies. They had had the puppy for two days and indicated that everything appeared normal.

Physical examination revealed an alert and active puppy with no obvious problems. The puppy weighed 6.5 kg and had a normal body condition (body condition score [BCS] 3/5). The estimated adult weight was about 17 kg. Results of a fecal flotation test were negative for intestinal parasites. Routine vaccinations were given.

Assess the Food and Feeding Method

The breeder provided a small amount of an unknown dry food in a plastic bag. The owners had offered small amounts of this food three times per day, and the puppy ate the food very well. They were also given a bottle of chewable vitamin-mineral tablets by the breeder and instructed to give the puppy one tablet per day.

Questions

1. What are the key nutritional factors to consider in developing a feeding plan for this puppy?
2. Outline a specific feeding plan for this patient including an appropriate food and feeding method.
3. Should the owners continue to provide the chewable vitamin-mineral supplement?

4. Besides nutrition, what other health care topics for puppies should be discussed with these owners?

Answers and Discussion

1. Key nutritional factors for growing dogs include energy, protein, fat, calcium, phosphorus and digestibility. Energy is required to support rapid accretion of new tissue; however, excessive energy intake increases the risk of obesity and, in some breeds, developmental orthopedic disease. Foods for puppies should contain 3.5 to 4.5 kcal (14.6 to 18.8 kJ) metabolizable energy (ME)/g dry matter (DM). Fat makes the greatest contribution to the energy density of food and should be 10 to 25% DM in growth-type foods. Puppies also have higher protein requirements than adult dogs to support tissue growth. Protein levels of 22 to 32% DM are recommended for puppies. Adequate calcium is important in foods for growing dogs to support skeletal development. Known calcium deficiency is rarely a concern in growing dogs fed commercial foods, but it may be a problem for dogs fed homemade foods. Excess calcium intake is a risk factor for developmental orthopedic disease and may occur in growing dogs eating some commercial foods and/or receiving mineral supplements. Calcium levels of 0.7 to 1.7% DM are generally recommended for growing dogs. Phosphorus is less critical than calcium provided minimum requirements of 0.35% DM are met and the calcium-phosphorus ratio is between 1:1 and 1.8:1. No specific recommendations for dietary carbohydrate are available for growing dogs; however, puppies appear to do better if growth-type foods contain more than 20% complex carbohydrate DM. Gastrointestinal (GI) distention ("pot-bellied" appearance) and GI disturbances (i.e., flatulence, vomiting, diarrhea) are less common in puppies fed highly digestible foods.
2. A food specifically formulated for growing dogs that addresses the key nutritional factors described above should be recommended. A number of commercial products meet these objectives. Homemade foods can also be fed to growing dogs; however, recipes should be used that contain adequate protein, fat, calcium, vitamins and trace minerals to support growth.Feeding methods for growing dogs include free-choice (ad libitum) feeding, time-limited feeding and food-limited feeding. Free-choice feeding is relatively effortless and may reduce abnormal behavior such as barking at feeding time. In addition, frequent trips to the food bowl may help reduce boredom and coprophagy, and timid or unthrifty dogs experience less competition when eating. Disadvantages of free-choice feeding include food wastage, only dry or semi-moist forms of pet food can be fed and competition or boredom may stimulate overeating. The most serious disadvantage in young growing dogs is increased risk for obesity and developmental orthopedic disease due to over consumption of even a properly balanced food.

   Time-limited feeding is a method in which dogs are allowed free access to food for a defined period, usually 10 to 15 minutes, once or twice daily. This feeding method may result in less overall food consumption when compared with puppies fed free choice. Time-limited feeding may also help in disciplining and housetraining young puppies. The owner interacts with the puppy during this time and is able to observe its general condition and behavior, which may lead to earlier detection of problems. A routine of feeding a puppy and then taking it outdoors can reinforce housetraining by taking advantage of the gastrocolic reflex. Advocates of this feeding method suggest that when some dogs fed in this manner reach adulthood they may voluntarily limit their feeding to once or twice a day and thus avoid overeating. However, research has shown that some dogs may eat as much in 15 minutes as when fed free choice. In this study, dogs fed by a time-limited method had higher weight gain, more body fat and increased bone mineral accretion than dogs receiving the same food free choice. This method is also less convenient for the owner than free-choice feeding.

   Food-limited feeding (feeding a measured amount of food every day) requires knowing how much to feed. This is best obtained by estimating the amount to feed based on the puppy's calculated daily energy requirement or as recommended by the manufacturer, and then adjusting the amount as necessary to maintain a BCS between 2.5/5 to 3.5/5. This amount is divided into two to four meals per day. This is the method of choice for feeding all puppies to reduce the risk of obesity and developmental orthopedic disease because it limits food intake to maintain optimal growth rate and body condition. This method is also less convenient and more time consuming than free-choice feeding because food amounts must be increased as growth occurs.
3. Routine vitamin-mineral supplementation is not necessary for healthy puppies eating balanced commercial growth foods. Supplementation is important if homemade foods are used.
4. In addition to vaccination, intestinal parasite control and nutritional counseling, the following health maintenance procedures should be discussed with puppy owners: 1) external parasites and appropriate control programs, 2) heartworm preventive programs, in endemic areas, 3) the pet's behavior and socialization, 4) specific breed characteristics, 5) routine grooming procedures, 6) basic obedience training and reputable obedience schools, 7) recommendations for neutering, 8) housetraining and 9) manipulation of the mouth to accustom the puppy to toothbrushing later on. All of these topics should be discussed with these clients, especially because they are novice dog owners.

Progress Notes

All of the health maintenance procedures mentioned above were discussed with the owners by the veterinarian or veterinary technician. A commercial specialty brand dry food formulated for canine growth (Science Diet Puppy Healthy Development Original[a]) was recommended. The quantity of food to be fed was based on the feeding instructions on the pet food bag. This amount was divided into three equal daily meals. The owners were instructed to discontinue the vitamin-mineral supplement and were given an

instruction sheet that outlined how to assess the body condition of puppies. The food amount was to be adjusted as the puppy grew according to the feeding guidelines on the bag. The owners were asked to weigh and assign a BCS for the puppy every other week and adjust the food amount as needed to maintain optimal body condition. The veterinary technician would also assess the body weight and condition during subsequent office visits when the puppy was 14 to 16 and 20 to 22 weeks of age.

Endnote

a. Hill's Pet Nutrition, Inc., Topeka, KS, USA.

Bibliography

Toll PW, Richardson DC, Jewell DE, et al. The effect of feeding method on growth and body composition in young puppies (abstract). In: Abstract Book. Waltham Symposium on the Nutrition of Companion Animals. Adelaide, Australia, September 23-25, 1993: 33.