CHAPTER

16

Nutrition for the Normal Cat

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OUTLINE

NORMAL FEEDING BEHAVIOR

The domestic cat, *Felis catus,* evolved from the north African wildcat *Felis silvestris lybica* and began cohabitating with Egyptians as early as 2300 BCE.[29] Although cats have lived closely with humans for many years, when domestication is defined as cultivation and breeding to create a reproductively isolated group, only pedigree cats qualify.[4] Common domestic cats usually choose their own mates and can still reproduce with wild *F. sylvestris* when they share common territory.[4,9] With relatively little breeding interference from humans, most pet cats retain adept hunting skills and feeding patterns similar to those of their wild ancestors. Cats are solitary hunters and eat 7 to 20 small prey meals spread evenly over 24 hours.[17,23] Examples of prey include rodents, lagomorphs, birds, and reptiles.[14]Although domestic cats retain many innate hunting behaviors, they adapt well to controlled feeding situations and can be fed either *ad libitum* or by meals. Free-choice feeding more closely resembles natural feeding patterns but may be a risk factor for obesity. In addition, *ad libitum* feeding makes it more difficult for owners to assess their cat's appetite, and periods of anorexia may go unnoticed until significant weight loss has occurred. Cats are hunters; therefore placing food in different locations and using devices to hide food so that it must be sought (e.g., puzzle balls) not only stimulates predatory drive but also encourages exercise.

Food preferences in cats are both instinctive and acquired. Taste receptors in cats are specialized for eating meat. For example, taste buds of the facial nerve are very reactive to amino acids but do not respond to many monosaccharides and disaccharides.[5] Acquired taste preferences in kittens have been demonstrated through prenatal and postnatal exposure of certain flavors in amniotic fluid and milk of queens.[2] Kittens also learn appropriate food choices by imitating their mothers. One study demonstrated that when weanling kittens (5 to 8 weeks of age) accompanied their mothers as they ate bananas and mashed potatoes, the kittens would later eat the inappropriate foods on their own.[32] Preferences for food texture also appear to be a learned behavior. In a study comparing house cats and outdoor farm cats, the house cats avoided raw meat whereas the outdoor cats shunned dry kibble.[6] Although cats can develop preferences for certain food types on the basis of their experience, they also can grow tired of the same food (known as the "monotony effect") and often prefer a novel diet as long as it has a familiar texture.[4,6]

CARNIVOROUS ADAPTATIONS

Mark Twain once said, "If man could be crossed with the cat it would improve the man, but it would deteriorate the cat."[30] Cats are unique creatures with novel evolutionary adaptations. The carnivorous nature of the cat

has led to anatomic and metabolic modifications. Cats are designed to hunt small prey. Their ears are more attuned to the high-pitched sounds of rodents; they have a large optic cortex to focus on small, quick movements; their retractable claws allow them to stalk prey with soft pads and then attack; they have fewer molars and premolars than do omnivorous dogs; and their jaws have little side-to-side motion for grinding.[1] Because feline prey species comprise mostly protein and fat, cats lack salivary amylase for carbohydrate digestion. Because cats evolved eating a highly digestible diet with little fiber and complex carbohydrates, they have shorter intestinal length and absorptive capacity than do dogs and humans.[1]

The most notable metabolic difference between cats and more omnivorous species such as human beings and dogs is that cats have a much higher requirement for protein. Adult cats require about 4 grams of protein per kilogram of body weight compared with 2.6 grams in dogs and 0.8 grams in humans.[16,24] Because cats have evolved eating a diet plentiful in protein and low in carbohydrates, gluconeogenesis from amino acids is used to maintain blood glucose levels. Dietary protein is also a potent stimulator of insulin release in the cat. Although most animals suppress gluconeogenesis during meals, cats actually increase hepatic glucose production during the absorptive phase to offset increased levels of insulin. Because cats are so dependent on protein for gluconeogenesis, they continue metabolizing amino acids for energy even when protein malnourished. As a result, cats lack the ability to downregulate the production of aminotransferases and urea cycle enzymes in response to low protein intake and can become protein malnourished quickly when anorexic.[26,33] Deficiencies in essential amino acids can lead to severe disease and death. The most dramatic response to an amino acid deficiency is caused by a lack of arginine. Arginine is required by the urea cycle to convert toxic ammonia to urea. Ammonia is a by-product of protein metabolism, and if cats are fed even one meal without arginine, hyperammonemia can occur. Symptoms include vocalization, vomiting, ataxia, apnea, cyanosis, and death within a few hours.[23] Taurine is technically a sulfonic acid rather than an amino acid and can be synthesized from cysteine in most species. Cats have minimal activity of enzymes necessary to synthesize taurine and must obtain it from the diet. Taurine is used exclusively to conjugate bile salts into bile acids in cats, and this causes an obligatory loss of taurine even when dietary intake is deficient.[18] The most notable symptoms of taurine deficiency in cats are dilated cardiomyopathy and retinal degeneration.[1,25]

The carnivorous nature of the wild feline has also led to modifications in fatty acid and vitamin requirements. Arachidonic acid is a fatty acid abundant in animal tissues. Because it is plentiful in the natural feline diet, cats do not have the canine or human ability to synthesize arachidonic acid from linoleic acid. Arachidonic acid is especially important for growth, pregnancy, and lactation.[1,23] Cats and dogs are unable to synthesize vitamin D from sunlight because they lack adequate 7-dehydrocholesterol in the skin. Vitamin D is abundant in animal fat and tissues such as the liver, so deficiencies rarely occur.[15] Vitamin A is found only in animal tissues, whereas its precursor, beta-carotene, is synthesized by plants. Cats have limited ability to convert beta-carotene to vitamin A and must ingest the retinol or retinyl ester form of the vitamin (e.g., retinyl acetate or retinyl palmitate).[24]

ENERGY NEEDS

The cat's caloric requirement, or daily energy requirement (DER), is a combination of several factors. In the average housecat, most energy is devoted to maintaining basal metabolic functions, known as resting energy requirement (RER). Energy is also expended for exercise, digestion, and temperature regulation. To estimate how many kilocalories a cat should be fed daily, RER is estimated using a cat's ideal body weight. Unlike muscle tissue, fat tissue utilizes little caloric energy. Therefore an overweight cat that carries 3 lb (1.4 kg) of extra fat does not need additional calories to support the excess fat mass. RER can be estimated using an exponential or linear equation:

$$\text{RER (kcal/day)} = (\text{Body weight}_{kg})^{0.75} \times 70$$

or

$$\text{RER (kcal/day)} = (\text{Body weight}_{kg} \times 30) + 70$$

For example, a 10-lb or 4.5-kg cat would have an RER of 217 kcal/day with the exponential equation and 205 kcal/day with the linear equation. Once the RER has been estimated, it is necessary to consider the age, activity, and neuter status of the cat to determine its DER. Life stage factors by which RER can be multiplied to estimate DER can be found in Table 16-1. For example, for an intact male cat, its RER is calculated at ideal weight using one of the preceding equations above and then multiplying that number by 1.4 or 1.6.

LIFE STAGE NUTRITION

Adult Maintenance

The first step when developing a nutritional plan for adult cats is to assess the patient's health status. A complete history, physical examination, and necessary

TABLE 16-1 Estimated Energy Requirements for Cats at Different Life Stages*

Life Stage	Factor to Multiply by Resting Energy Requirement
Intact	1.4-1.6
Neutered	1.2-1.4
Obese prone	1
Weight loss	0.8
Senior	1.1-1.4
Geriatric	1.1-1.6
Gestation	1.6-2
Lactation	2-6
Growth	
<50% of adult weight	3
50%-70% of adult weight	2.5
70% to adult weight	2
Active	1.8-2.5

*The resting energy requirement (RER) is calculated and the result multiplied by the appropriate factor to estimate daily energy requirements (DER).

TABLE 16-2 Body Condition Scoring Systems (5- And 9-Point) with Correlated Body Fat Content*

5-Pt Scale	9-Pt Scale	% Body Fat	Body Condition Scoring
1	1	≤5	Emaciated—ribs and bony prominences are visible from a distance. No palpable body fat. Loss of muscle mass.
2	2	6-9	Very thin—ribs and bony prominences visible. Minimal loss of muscle mass but no palpable fat.
	3	10-14	Thin—ribs easily palpable, tops of lumbar are visible. Obvious waist and may have an abdominal tuck.
3	4	15-19	Lean—ribs easily palpable, waist visible from above. Abdominal fat may be present or absent. If present, it is made up of loose skin and no fat within.
	5	20-24	Ideal—ribs palpable without excess fat covering. Cats have a waist and a minimal abdominal fat pad.
4	6	25-29	Slightly overweight—ribs have slight excess fat covering. Waist is discernible from above but not obvious. Abdominal fat pad is apparent but not obvious in cats.
	7	30-34	Overweight—difficult to palpate ribs. Moderate abdominal fat pad and rounding of the abdomen.
5	8	35-39	Obese—ribs not palpable, and abdomen may be rounded. Prominent abdominal fat pad and lumbar fat deposits. Fat deposit may be obvious in shoulder or abdominal area.
	9	40-45+	Morbidly obese—heavy fat deposits over lumbar area, face, and limbs. Large abdominal fat pad and rounded abdomen. Body appears broadened from above.

*Also see Figure 3-3.

laboratory testing should be performed to rule out diseases responsive to specific nutritional modifications (see Chapter 18). A key component of the physical examination should be assessment of body condition. Body condition scoring is a semiquantitative method for estimating body fat mass using a combination of visual assessment and palpation (Table 16-2; also see Figure 3-3). The veterinarian can use either a 5- or 9-point scale in which 1 is cachexic and 5 or 9 is obese (see Chapter 3). Once a body condition is assigned, body fat mass can be estimated. Ideally, cats should be between 20% and 25% fat mass. If the body condition score is 5/5 or 9/9, then the fat mass is estimated to be 40% to 45%. For example, a 15-lb (6.8 kg) cat that is 45% body fat is 55% lean mass: 15 lb × 0.55 = 8.25 lb (3.7 kg) of lean tissue. At an ideal body condition (20% fat mass), 8.25 lb (3.7 kg) of lean tissue is 80% of the cat's total body weight: 8.25 lb × 100/80 = 10.3 lb (4.7 kg) would be the cat's ideal weight. Once the ideal weight is estimated, it is possible to calculate RER from the preceding equations and use a DER factor (see Table 16-1) to approximate daily caloric requirements.

Once the DER is estimated, an appropriate food must be chosen. The most common forms of available commercial food are moist foods, canned foods, and dry kibble. However, frozen, refrigerated, freeze-dried, and semimoist foods are also available forms. Many owners also choose to cook for their cats or feed them raw diets (see Chapter 19). The best form of food to feed cats is debatable. Dry foods tend to be calorically dense, very palatable, and higher in carbohydrates (see Chapter 19 for a discussion of low-carbohydrate diets) and may contribute to feline obesity, especially when fed free choice. Canned foods are more expensive and less convenient to feed. However, they help increase water intake and seem more satiating to many cats.

Assessing the quality of diets on the basis of packaging claims is difficult. The Association of American Feed Control Officials (AAFCO) has established standards and regulations regarding animal feed. One method for assessing the quality of a cat food brand is to look for an AAFCO statement on the package. Foods can either undergo a standard AAFCO feeding trial or be chemically tested to meet AAFCO nutrient requirements. Feeding trials are considered the gold standard because

they test nutrient content, digestibility, and bioavailability. In addition to looking for AAFCO statements before recommending a food brand, the cat owner should also rely on company reputation and look for those with good quality control and safety measures.

Pregnancy and Lactation

The physical demands of pregnancy and lactation can be immense for queens. Therefore optimal nutrition is important for reproducing females before conception. They should not be underweight or overweight and should receive a diet with high-quality protein and plentiful essential fatty acids. Malnourished cats can have difficulty conceiving, produce fetuses more likely to have abnormalities or abort, and give birth to underweight kittens.[11] On the opposite end of the spectrum, obese queens are more likely to experience stillbirths and cesarean sections.[3]

Pregnant queens gain weight in a steady, linear fashion from conception to parturition. This is different from most other species, such as dogs, which gain the majority of pregnancy weight in the last trimester. The weight gained by queens initially goes toward building maternal fat reserves, rather than fetal or reproductive tissue growth.[21] The average weight gain of queens during pregnancy is 40% of prepregnancy weight.[11,21] Cats typically lose only 40% of their excess pregnancy weight during parturition. The remainder is used to sustain lactation.[11]

Queens should produce milk at the time of parturition. For the first 24 to 72 hours, colostrum will be produced. After birth, kittens have a short window (12 to 18 hours) for colostral antibody absorption through the gastrointestinal tract.[8] Lactation peaks 3 to 4 weeks after birth. The best way to assess milk production in queens is through kitten growth and weight gain. Newborn kittens should gain 10 to 15 grams daily. If they are gaining less than 7 g per day, milk supplementation is needed.[11,20]

Information regarding the specific nutritional needs of pregnant and lactating cats is scarce.[11,31] Most nutritional recommendations are based on the requirements of growing kittens. Pregnant queens typically need 25% to 50% more calories than maintenance needs. This can be achieved by feeding 1.6 times RER at breeding and gradually increasing to 2 times RER at parturition (see Table 16-1). Lactating cats require the most energy of any life stage and need 2 to 6 times RER. High-quality, energy-dense growth formulas or formulas designated for pregnancy and lactation should be fed free choice to pregnant and lactating queens.[11] Vegetarian diets are especially hazardous for pregnant and lactating cats because animal-based essential amino acids and fatty acids are needed for fetal and kitten development. In addition, milk production requires increased fluid intake. All cats, lactating cats in particular, should have access to clean, fresh water at all times.[11]

Growth

Kittens usually begin weaning at 3 to 4 weeks of age and complete the process by 6 to 9 weeks. Moist or dry kitten food moistened with water should be offered at the onset of weaning. Kittens will continue to receive most of their calories from milk for the first 2 weeks of weaning and by 5 to 6 weeks of age should be eating about 30% of their calories from solid food.[10] For information on feeding orphan kittens, see Chapter 41.

After weaning, kittens should be placed on a kitten food or a variety of foods that have passed AAFCO feeding trials for feline growth. Estimations for DER can be made using Table 16-1. Kittens can be fed free choice until they are approximately 5 months of age. After this time, owners should monitor their cat's food intake to prevent obesity from developing. Gonadectomy also influences the caloric requirements of juvenile cats. Neutered male cats require 28% fewer calories than do intact male cats, and spayed females require 33% fewer calories than do intact females.[27] Teaching owners to perform body condition scoring is one method to help prevent obesity in the young adult (see Table 16-2). Cats typically reach their adult weight by about 10 months of age and can be switched from kitten to adult food at this time.

Senior and Geriatric Cats

The population of senior and geriatric cats in the United States has nearly doubled in recent years.[28] Many authors consider cats to be senior when they reach 7 years of age. However, metabolic and digestive changes are not usually detected until later in life. For this discussion, cats are considered senior by 11 years and geriatric by 15 years of age.[7]

The nutritional requirements of older cats are unique compared with those of humans and dogs. Whereas the DERs of most animals decrease later in life, elderly cats require more energy to maintain their body weight. There are a couple of explanations for this difference. The activity patterns of cats remain similar throughout their lives.[13] They spend most of their time sleeping and grooming. Therefore a 5-year-old cat may not move much more than a 15-year-old cat. Elderly cats also require more dietary energy because their fat and protein digestion is impaired. Approximately 30% of cats older than 12 years of age have decreased fat absorption, and 20% have decreased protein digestibility.[19] This attenuated digestion can also lead to deficiencies in other vitamins and minerals.[19] To compensate for impaired nutrient absorption, elderly cats tend to eat more food relative to their body weight than younger cats.[12]

Choosing an appropriate diet for senior and geriatric cats should be based on individual needs. Health screenings should be routinely conducted to look for kidney, gastrointestinal, endocrine, and oncologic disease (see Chapter 18). Healthy, geriatric cats with weight loss benefit from highly digestible, calorically dense diets that are higher in fat and protein. Feline growth diets can be used for this purpose. Protein should not be restricted in elderly cats that do not have underlying renal disease. Obesity is a major nutritional concern in cats and tends to peak in middle-aged cats (5 to 10 years old).[22] After approximately 11 years of age, obesity rates decline dramatically. Many senior feline diets are marketed for cats older than 7 years of age and may be designed to minimize weight gain. Therefore senior diets may not be appropriate for all geriatric patients, and the veterinarian should assess body condition and overall health status before making a dietary recommendation.

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