Chapter 22

Feeding Reproducing Cats

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"The greatness of a nation and its moral progress can be judged by the way its animals are treated."
Mahatma Gandhi

INTRODUCTION

Domestic cats generally reach puberty by six to nine months of age. However, the best age for breeding is between one and one-half to seven years of age (Feldman and Nelson, 1996). Queens 10 to 12 months of age are still growing and must meet nutritional demands for their own growth as well as for their fetuses. Queens older than seven years should not be bred due to reproductive complications, irregular estrous cycles and reduced litter size (Feldman and Nelson, 1996). The reproductive stage of the queen can be divided into four periods: 1) estrus and mating, 2) gestation, 3) lactation and 4) weaning. In general, reproducing queens have increased nutritional needs compared with maintenance requirements, especially during late pregnancy and lactation. During reproduction, energy requirements increase and the minimum requirements for certain nutrients exceed even those required for growth.

The objectives of a good feeding program for reproduction are to optimize: 1) the health and body condition of the queen throughout the various reproductive periods, 2) reproductive performance and 3) kitten health and development through the weaning period. Key indicators of optimal reproduction are ease of conception, a low rate of fetal and neonatal deaths, normal parturition, maximum litter size, adequate lactation and an optimal growth rate of healthy kittens. Providing adequate nutrition throughout reproduction has long-range health implications for the offspring. Immune function is impaired for life in animals born to nutritionally deficient dams (Burkholder and Swecker, 1990). Meeting the nutritional needs of reproducing queens is critical to successful conception, delivery and weaning of healthy kittens.

Lactation begins at parturition and lasts six to 12 weeks depending on breed, kitten growth rates and management practices. Most kittens are sufficiently mature at eight weeks of age to maintain adequate food intake for optimal development. Purebred kittens are typically weaned later than domestic shorthair kittens. Lactation is the most demanding stage of reproduction. The queen must maintain its own nutritional needs and provide nutritionally complete, nutrient-dense milk to support the needs of growing kittens. Consequently, queens should enter lactation with sufficient energy stores to support needs above those supplied by daily food intake. Poor lactation performance is common without these reserves. Thus, successful lactation depends on appropriate nutritional management during the pre-breeding period, gestation and lactation.

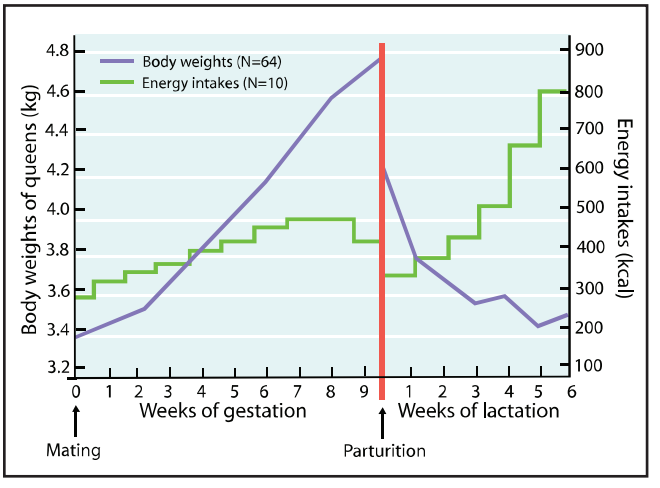

Figure 22-1. Body weight and energy intake during gestation and lactation in queens. Unlike bitches, which have a dramatic increase in energy intake and body weight during the last trimester, queens have a regular linear increase in both body weight and energy intake throughout gestation. Mobilized stores of body fat provide needed energy during lactation, which accounts for weight loss during this period. Food intake parallels lactation and peaks during the sixth to seventh week. (Adapted from Loveridge GG. Body weight changes and energy intake of cats during gestation and lactation. Animal Technology 1985; 37: 7-15.)

PATIENT ASSESSMENT

Estrus and Mating

Optimal nutrition for reproducing cats should precede mating and conception, and ideally start when the animal is a kitten. Female cats are seasonally polyestrous. Repeated estrous cycles occur throughout the breeding season, which typically occur from January through September in the northern hemisphere. Light duration and intensity are major determinants for the estrous period. Therefore, artificial lighting and latitude variation alter the breeding period for individual cats. Vocalizing, rolling, rubbing and treading characterize estrus in the queen; these behaviors culminate in acceptance of the male. Behavioral estrus averages seven to nine days (range one to 21). Cats are induced ovulators (i.e., coital contact is typically required for a luteinizing hormone surge and ovulation).

Queens should have a current vaccination history and be treated for internal and external parasites before breeding. A history and physical examination should precede breeding to assess problems that may interfere with conception, parturition and lactation. Queens should be at ideal body weight at mating (body condition score [BCS] 3/5). Small variations in body condition can be corrected during pregnancy; however, cats that are significantly under- or overweight (BCS <2/5 or >4/5) should not be bred. Both obesity and undernourishment can be detrimental to reproductive performance. Malnourished queens may fail to conceive, abort or bear small, underweight kittens and have a markedly reduced lactation. Lactating queens normally lose weight, but their body weight should return to normal before the next breeding. Obese cats reportedly have a greater incidence of dystocia (Lawler and Monti, 1984). Historical or physical evidence of a narrow pelvic canal, whether due to trauma, genetics or nutritional deficiency warrants careful assessment. Mammary tissue and teat development should be evaluated. Although congenital defects (e.g., multiple teats or teat malformation) rarely prevent queens from raising normal-sized litters, genetic selection away from such traits is advisable. Only cats in excellent health should be considered for breeding.

Tomcats should also be healthy and in optimal body condition (BCS 3/5); however, decreased reproductive performance associated with moderate deviations from ideal (BCS <2/5 to >4/5) have not been reported. In addition to a standard physical examination, the penis, prepuce and testes should be evaluated for anatomic defects. Previous reproductive performance including a weight history should be reviewed. The level of activity required during the breeding period should be ascertained. Single matings result in minimal changes in energy needs, whereas multiple matings may require an increase in the amount of food provided, based on body condition.

Pregnancy

The first assessment step is to diagnose pregnancy. Abdominal palpation is used most commonly to diagnose pregnancy in cats. The fetal vesicles can be reliably palpated from 14 to 25 days of gestation (Feldman and Nelson, 1996). An enlarged uterus is palpable from Day 25 to parturition. Ultrasound can detect pregnancy by Day 11 of gestation and fetal heartbeats are typically heard at 22 days (Davidson et al, 1986). Radiographic diagnosis requires calcification of the fetal skeleton and is most reliable after Day 45 of gestation. Gestation usually lasts 63 to 65 days (range 58 to 70 days) in queens, thus radiography is not useful for early pregnancy diagnosis, but is useful for determining litter size. In addition to the diagnosis of pregnancy, an assessment should include a dietary history, physical examination and any indicated laboratory analyses. Evaluations of body condition, weight gain and food intake are most important. Minimal diagnostics are usually required if the pelvic structures and mammary glands were evaluated and parasite, feline leukemia virus/feline immunodeficiency virus and vaccination status were determined before breeding.

One of the early indicators of successful breeding and conception is a steady gain in body weight. Weight gain increases linearly from conception to parturition in queens (**Figure 22-1**). This pattern is different from that of most other species, which experience small increases in body weight until the last third of gestation when weight gain and energy intake greatly increase. Weight gain in early pregnancy is not associated with significant growth of reproductive tissues or conceptuses but appears to be stored in energy depots (presumably as fat) to support lactation (Loveridge and Rivers, 1989). Mean weight gain during gestation is approximately 40% of the pre-mating weight (900 to 1,200 g for a litter of average size) and has been described by the equation (Loveridge and Rivers, 1989):

Weight gain (g) = 888.9 + (106.5)n (where n = number of neonates).

At parturition, only 40% of the weight gained by queens during gestation will be lost (Loveridge and Rivers, 1989), whereas bitches should return to pre-breeding weight (Feldman and Nelson, 1996a). The remaining 60% of prepartum weight gain will be used during lactation to sustain milk production. Poor nutrition may lead to failure to conceive, fetal death, fetal malformations and underweight kittens. Queens underweight at parturition may subsequently experience poor lactation performance and inability to maintain body condition. Poor maternal nutrition may impair the kittens' immunocompetence for life.

Overnutrition or obesity (BCS 5/5) has an equally negative effect on pregnancy outcome. Stillbirths, dystocia and cesarean sections occur more frequently in obese queens than in cats at ideal body condition (Lawler and Monti, 1984; Bilkei, 1990). Ensuring the queen is at ideal weight (BCS 3/5) before breeding is preferable to limiting food intake during gestation. Therefore, good nutritional management is important to optimal reproductive performance.

If queens are listless or have a poor appetite, the physical examination should closely evaluate uterine size and shape and any vaginal discharges. Laboratory evaluation should include a complete blood count and measurement of serum concentrations of glucose, calcium, protein, urea nitrogen, creatinine, phosphorus and potassium. The abdomen and uterus should be evaluated by ultrasound to evaluate fetal viability or if pyometra is suspected.

Lactation

Unless difficulties arise during parturition or lactation, a veterinarian will not examine most queens. Thus, pre-lactation counseling of the breeder or owner is important because most of the assessment will be performed without veterinary supervision. The queen and kittens should be weighed within 24 hours after parturition. The queen should weigh 700 to 900 g above the pre-breeding weight and each kitten should weigh approximately 100 g. The queen should be evaluated for vaginal discharges, body temperature and maternal behavioral characteristics. A dark reddish vaginal discharge is normal. Bright red discharges indicate hemorrhage, whereas foul-smelling, greenish, gray or brown discharges may indicate a retained fetus, retained placenta or infection. The queen's appetite, which is reduced 24 to 48 hours before parturition, should return to normal or to an increased level within 24 hours of parturition (Lawler and Bebiak, 1986). All kittens should nurse soon after parturition and within the first six to eight hours to ensure transfer of colostral antibodies. Neonatal kittens may not absorb immunoglobulins after 12 hours postpartum. This window of absorption is much shorter in kittens than in puppies and livestock (Casal et al, 1996).

Milk production should begin at parturition. Colostrum is produced during the first 24 to 72 hours of lactation. Milk yield depends on litter size and stage of lactation, with peak lactation occurring at three to four weeks. Investigators measured average milk yields of 1 to 3% of the queen's body weight/day during Week 1 (Dobenecker et al, 1998). Yields increase to 1.3 to 5.9% of the queen's body weight/day at peak lactation then decline slightly until weaning. Although mammary glands should be closely evaluated to ensure health and ready access for the kittens, expressing milk from each gland does not ensure adequate milk production. Continuous weight gain by the kittens is the best indicator of the queen's lactation performance. Neonatal kittens should gain between 10 to 15 g daily. Gains less than 7 g/day are inadequate (Lawler and Bebiak, 1986).

A veterinarian should immediately evaluate the queen and litter if health problems arise during lactation or kitten growth rates are suboptimal. A complete physical evaluation, anamnesis and review of the reproduction records and the nutritional plan should be performed. Blood and urine should be collected from the queen; a minimum database should include a complete blood count, urinalysis and serum biochemistry analysis including electrolytes. Ancillary tests should be performed as indicated.

Table 22-1. Key nutritional factors for foods for reproducing cats.

Factors (units)*	Mating**	Gestation/lactation
Energy density (kcal ME/g)	4.0-5.0	4.0-5.0
Energy density (kJ ME/g)	16.7-20.9	16.7-20.9
Protein (%)	30-45	35-50
Fat (%)	10-30	18-35
DHA (%)	-	≥0.004
Digestible carbohydrate (%)***	-	≥10
Calcium (%)	-	1.1-1.6
Phosphorus (%)	0.5-0.7	0.8-1.4
Ca:P ratio	-	1:1-1.5:1
Sodium (%)	0.2-0.5	0.3-0.6
Average urinary pH	6.2-6.4	6.2-6.5

Key: ME = metabolizable energy, DHA = docosahexaenoic acid.
*Units expressed on a dry matter basis. Concentrations presume an energy density of 4.0 kcal/g. Levels should be corrected for foods with higher energy densities. Adjustment is unnecessary for foods with lower energy densities.
**Foods for most breeding males and females are usually similar to those for young adult cats (Chapter 20).
***Important for lactation.

Key Nutritional Factors

Few studies establish the minimum nutritional requirements for reproducing queens and breeding male cats. Most nutrient recommendations are extrapolated from growth studies, results from other species and clinical experience. Although most commercial foods appropriate for growing kittens are deemed adequate for female reproduction, ideally, complete and balanced foods specifically designed to support gestation/lactation should be fed. Key nutritional factors for tomcats and queens during mating do not appear to be significantly different from those of young adults (Chapter 20). Exceptions will be noted below. **Table 22-1** summarizes key nutritional factors for reproducing cats eating commercial foods. The following section describes these key nutritional factors in more detail.

Water

Water is important for normal reproduction. Expansion of extracellular fluid compartments and maternal and fetal tissues

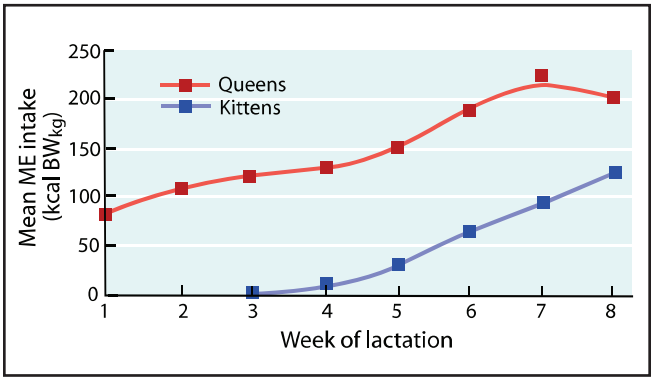

Figure 22-2. Food energy intake during lactation of queens and their kittens. Kittens begin eating the queen's food in increasing amounts from about four weeks of age until weaning. Energy intake peaks for queens at seven weeks and then decreases as kittens consume a larger percentage of their energy from food rather than milk. (Adapted from Munday HS, Earle KE. The energy requirements of the queen during lactation and kittens from birth to 12 weeks. Journal of Nutrition 1991; 121: S43-S44.)

during pregnancy increases the need for water. Water is particularly important for milk production during lactation. Water needs for lactating queens vary according to maintenance needs, type of food (moist vs. dry) and the rate of milk production. Although specific levels of water intake have not been established, reproducing queens should be provided with ample potable water at all times. Some queens are reluctant to leave the nest box during the first few days after parturition. Water intake should be encouraged by placing water very near the enclosure to allow easy access. Feeding moist foods or adding water to food can improve water intake.

Energy

ENERGY NEEDS DURING ESTRUS AND MATING

The energy requirements of most queens during mating do not appear to be significantly different from those of young adults (Chapter 20). The recommendation for energy density for foods for normal weight young adult cats is 4.0 to 5.0 kcal/g (dry matter [DM]) (16.7 to 20.9 kJ/g [DM]). However, during behavioral estrus, queens typically reduce food intake and body weight may decline. Food intake and body weight rebound upon cessation of estrus. In some queens, it may be advisable to feed a highly palatable food with an energy density at the upper end of the recommended range (4.5 to 5.0 kcal/g food [18.8 to 20.9 kJ/g food]) before mating to ensure optimal body condition at conception. Intact female cats typically require more calories than neutered housecats. The daily energy requirement (DER) for sexually intact cats is 1.4 to 1.6 x resting energy requirement (RER).

Breeding male cats that are used infrequently or in small catteries have energy needs similar to those of intact young adult cats (4.0 to 5.0 kcal/g or 16.7 to 20.9 kJ/g [DM]) (1.4 to 1.6 x RER). Tomcats that are used extensively for breeding may have difficulty maintaining proper body condition due to increased energy expenditure or, more often, reduced food intake. The stress of travel, new environments, social interactions and preoccupation with breeding may contribute to inappetence. These tomcats should be managed similarly to cats that are very active or under stress. Foods at the upper end of the recommended range of energy density for young adult cats (4.5 to 5.0 kcal/g food [18.8 to 20.9 kJ/g food]) with above average palatability should help these cats maintain ideal body condition (BCS 3/5) and activity.

ENERGY NEEDS DURING PREGNANCY

One of the most important changes in nutrient requirements of gestating cats is an increase in energy requirement. Although many essential nutrients are required at increased levels during gestation, dietary energy is often the most limiting "nutrient."

As mentioned previously, energy intake and weight gain increase linearly from conception to parturition in queens (**Figure 22-1**). However, food intake normally fluctuates slightly throughout gestation. Reduced food intake occurs approximately two weeks after mating and is thought to occur in association with fetal implantation at about Day 15 postconception (Feldman and Nelson, 1996). Energy intake increases then peaks between six to seven weeks of gestation. A second decline in food intake occurs during the last week of gestation. These transient declines in food intake do not appear harmful. However, inadequate food intake over the course of gestation may impair weight gain, the subsequent lactation and kitten health. The recommended energy allowance for gestation is 25 to 50% above maintenance levels or approximately 90 to 110 kcal/kg body weight/day (376 to 460 kJ/kg body weight/day), although total caloric intake may increase as much as 70% above maintenance (NRC, 1986; Loveridge and Rivers, 1989). The increased need for energy can be met by providing 1.6 x RER at breeding with a gradual increase to 2 x RER at parturition. Energy requirements sometimes exceed the recommended energy allowance due to individual cat variation and increased energy needs of queens with large litters. Therefore, free-choice feeding allows queens to adjust food intake as needed to meet the energy requirement for gestation. **Table 22-2** lists energy requirements of gestating queens at various body weights.

Feeding energy-dense foods (metabolizable energy [ME] = 4.0 to 5.0 kcal/g DM [16.74 to 20.9 kJ/g DM]) helps meet the energy needs of pregnant queens, especially during late gestation when the gravid uterus reduces stomach capacity.

ENERGY NEEDS DURING LACTATION

Lactation is the most energy-demanding stage of a cat's life. Peak milk production typically occurs at three to four weeks of lactation and, theoretically, peak energy demand should occur concurrently. However, actual peak energy demand occurs at six to seven weeks postpartum when energy requirements may exceed 250 kcal/kg body weight/day (1.05 MJ/kg body weight/day) or 2 to 6 x RER (**Table 22-3**). Observed energy intakes of queens and their litters during lactation increase from 90 kcal/kg body weight/day (376 kJ/kg body weight/day) at

parturition to 270 kcal/kg body weight/day (1.13 MJ/kg body weight/day) at Week 7 (Loveridge, 1985). The discrepancy in the timing of peak lactation and peak energy demand is due to combined food consumption by kittens and the queen. Kittens begin eating the queen's food in increasing amounts from three weeks of age until weaning. Therefore, the above estimates of energy requirement for the lactating queen include energy consumed by the queen and its kittens (**Figure 22-2**). When energy intake was measured for the queen alone, the energy requirement at Week 6 of lactation was 229 kcal/kg body weight/day (962 kJ/kg body weight/day) (Munday and Earle, 1991). Within large litters, up to 50% of the total energy was consumed by kittens, increasing the total energy consumption (i.e., kittens and queens) to as high as 306 kcal/kg body weight/day (1.28 MJ/kg body weight/day). Even with these large increases in energy intake, queens will continue to lose weight during lactation and return to pre-mating weight by weaning. Queens that lose excessive weight are prone to lactation failure. **Table 22-3** estimates the energy requirements of lactating queens. However, it is preferable to feed lactating queens free choice because the wide variation in energy needs makes accurate prediction difficult.

The high-energy demands during lactation require a marked increase in total food intake. Feeding an energy-dense food (4.0 to 5.0 kcal ME/g DM, [16.7 to 20.9 kJ ME/g]) helps meet these demands without overwhelming gastric capacity.

If kittens are encouraged to eat a solid food beginning at three weeks of age, the energy demands placed on the lactating queen will decline as kittens increasingly obtain nutrition from solid food. Maintenance energy levels are sufficient for queens at ideal body condition after the kittens are weaned. Queens that have lost excess body weight during lactation should be provided additional food to restore body condition.

Table 22-2. Energy requirements of pregnant queens.*

Body weight		kcal ME per day		kJ ME per day	
		At 90 kcal/kg	At 100 kcal/kg	At 375 kJ/kg	At 420 kJ/kg
kg	lb	BW	BW	BW	BW
2	4.4	180	200	750	840
3	6.6	270	300	1,125	1,260
4	8.8	360	400	1,500	1,680
5	11.0	450	500	1,875	2,100
6	13.2	540	600	2,250	2,520
7	15.4	630	700	2,625	2,940
8	17.6	720	800	3,000	3,360

Key: ME = metabolizable energy, BW = body weight.
*Adapted from the National Research Council. Nutrient Requirements of Cats. Washington, DC: National Academy Press, 1986.

Table 22-3. Daily energy requirements of lactating queens over the lactation period.*

Weeks of lactation	Daily energy requirements		
-	Factor x RER	kcal/kg BW**	kJ/kg BW
1	2.3	115	481
2	2.5	125	523
3	3.0	150	628
4	3.5	175	732
5	4.0	200	837
6	5.0	250	1,046

Key: RER = resting energy requirement, $70(BW_{kg})^{0.75}$ or $30(BW_{kg}) + 70$, BW = body weight.
*Based on average queen at parturition (3.8 kg) nursing four to five kittens. These values represent average energy requirements for lactating queens. Individual animal variation and litter size may alter total daily energy needs.
**Adapted from the National Research Council. Nutrient Requirements of Cats. Washington, DC: National Academy Press, 1986.

Protein

Protein synthesis in the queen is greatly increased during gestation. Additionally, protein quality and quantity are important to provide essential amino acids for healthy fetal growth and development. Protein levels of 20% DM have sustained adequate gestation in gestating queens fed energy-dense (4.8 kcal/g [20 kJ/g]) purified foods. The minimum recommended allowance is 21.3% DM (NRC, 2006). However, 30% DM dietary protein results in near optimal weight gain in queens during gestation and kittens during lactation (Piechota et al, 1995). Considering the varying nutrient availability in typical pet food ingredients compared with purified foods, protein levels at or above 35% DM are recommended for gestating queens (range of 35 to 50%, DM). Animal-based proteins are preferred as the major source of dietary protein because they are usually more digestible and have more desirable amino-acid profiles. Protein deficiency during pregnancy may result in lower birth weights, higher neonatal mortality and impaired immunocompetency in kittens (Burkholder and Swecker, 1990). Additionally, when queens are fed protein-restricted foods during late gestation and lactation, their kittens can have delayed home orientation (i.e., ability to orient to and return to the nest), aberrant locomotor development and decreased emotional responsiveness (Gallo et al, 1984).

During lactation, queens increase protein synthesis to provide milk with adequate protein content for kitten growth (i.e., approximately 36% DM milk protein). Milk protein output for a 4-kg queen nursing a large litter may reach 19 g crude protein/day (Dobenecker et al, 1998). Thus, it is not surprising that protein needs during lactation exceed even gestational requirements.

The minimum recommended allowance for protein for peak lactation is 30% DM (NRC, 2006). Inadequate protein concentrations result in poor lactation and kitten growth. Queens fed foods containing 20% DM protein had lower hematocrit values at Week 6 of lactation compared with queens fed foods with higher protein levels (Piechota et al, 1995). Providing 25% DM crude protein to lactating queens results in satisfactory reproductive performance (Piechota et al, 1995). However, near optimal performance is achieved with foods containing 30% DM crude protein. Queens fed foods with 30% protein lose less body weight than those fed foods with levels of 20 or 25% DM protein. Additionally, food intake and kitten growth rates are

higher at dietary protein levels of 30% DM (Piechota et al, 1995). Because of variations in food digestibility and ingredient quality and the goal to promote optimal reproductive performance, the recommended crude protein allowance for lactation is at least 35% DM (range of 35 to 50%, DM). The protein sources in commercial foods should be highly digestible and have high biologic value. Animal-based protein ingredients should provide the major source of amino acids and protein for lactating queens.

For breeding males, the range recommended for young adult non-breeding cats is adequate (30 to 45%, DM).

Fats and Essential Fatty Acids

Fat delivers 2.25 times the number of calories as the same amount of protein or digestible (soluble) carbohydrate; therefore, increasing dietary fat increases a food's energy density. Thus, smaller amounts of food can be consumed to meet the queen's energy demands. The minimum recommended allowance for queens for late gestation and peak lactation is 9% DM (NRC, 2006). However, as discussed above, higher-energy foods are beneficial because of the increased energy demand during gestation and lactation and because such foods improve reproductive performance. For example, in one study, increasing dietary fat from 15 to 27% of the food DM: 1) increased the number of kittens per litter, 2) decreased kitten mortality from more than 20 to 9% and 3) improved reproductive efficiency in queens (more litters per year) (Olovson, 1986). For optimal reproductive performance, foods for gestating and lactating queens should contain at least 18% DM fat (range of 18 to 35%, DM), although foods with lower levels of fat have been successfully fed during gestation. Nutrients in the food should be balanced to the higher energy content of energy-dense foods (>4.5 kcal/g DM [18.8 kJ/g DM]). The fat content in foods for mating cats is typically between 10 to 30% DM.

Minimum essential fatty acid requirements for lactation do not differ significantly from those of gestation. However, a dietary source of docosahexaenoic acid (DHA, 22:6n-3) is required for normal development of retinal function in nursing kittens (Pawlosky et al, 1997). In children, during periods of early growth, DHA is needed to support retinal and auditory development (Pawlosky et al, 1997; Birch et al, 2002; Diau et al, 2003). Furthermore, brain development and learning ability were enhanced in infants supplemented with DHA (Birch et al, 2002; Hoffman et al, 2003). Similar to findings in other species, the inclusion of fish oil as a source of DHA in puppy foods improved trainability (Kelley et al, 2004). The need for DHA during growth in foods for kittens may be even more important than in foods for puppies considering the cat's reduced ability to convert shorter chain fatty acids to DHA. Milk concentrations of DHA parallel dietary intake. Therefore, DHA should be included in foods fed to lactating queens. Common ingredients such as fish and poultry meal represent a source of DHA in the food of queens. For foods for queens in late gestation and peak lactation, the minimum recommended allowance of DHA plus eicosapentaenoic acid (EPA) is at least 0.01% DM (NRC, 2006). Thus, DHA needs to be at least 40% of the total DHA plus EPA, or ≥0.004% DM.

Long-term deficiency of dietary arachidonic acid (AA) results in reproductive failure in cats (MacDonald et al, 1984). However, Association of American Feed Control Officials (AAFCO) allowances for AA are appropriate for gestating cats (AAFCO, 2007). Therefore, foods with AAFCO label statements acknowledging that a food is appropriate for growth or reproduction should provide adequate amounts (See the Essential Fatty Acid discussion in Other Nutritional Factors, below).

Digestible Carbohydrate

Although a true digestible carbohydrate requirement for cats has not been demonstrated, digestible carbohydrates apparently protect against weight loss in queens during lactation (Piechota et al, 1995). Digestible carbohydrates spare protein necessary to sustain blood glucose concentrations in queens and provide a substrate for lactose during milk production. Providing some digestible carbohydrate improves lactation performance even with an abundant supply of dietary protein (Piechota et al, 1995). Until further studies define optimal levels of digestible carbohydrates for lactation, at least 10% DM digestible carbohydrate should be included in foods for lactating queens.

Calcium and Phosphorus

Calcium and phosphorus are required at levels greater than maintenance to support fetal skeletal development and lactation. The minimal recommended DM allowances for dietary calcium and phosphorus for queens in late gestation and peak lactation are 1.08 and 0.76%, respectively (NRC, 2006). Recommended levels for foods for feline gestation and lactation should be within the ranges of 1.1 to 1.6 for calcium and 0.8 to 1.4 for phosphorus DM. Levels at, or greater, than these recommendations are typically found in commercial cat foods. The calcium-phosphorus ratio should be between 1:1 to 1.5:1. Although eclampsia is uncommon in cats, it does occur pre- and postparturiently (**Box 22-1**). The calcium and phosphorus recommendations for mating cats are the same as for young adult cats (Chapter 20).

Sodium

Reproducing queens, particularly during lactation, consume increased quantities of food to meet their energy and protein needs. In doing so, they consume considerably more sodium than in the non-reproducing state. Some women are predisposed to hypertension during pregnancy, but it is unknown whether or not there is a population of queens predisposed to hypertension during gestation.

There is no direct information to support a minimum recommended allowance for dietary sodium for gestation in queens but it is estimated to be about four times the amount recommended for adult maintenance (NRC, 2006). The minimal recommended DM allowance for foods for late gestation and peak lactation (0.27%) (NRC, 2006) is six to seven times the amount recommended for maintenance. Thus, an upper limit of 0.6%

Box 22-1. Eclampsia in the Queen.

Eclampsia, or periparturient hypocalcemia, is uncommon in cats. Clinical signs result from severe hypocalcemia, with or without other biochemical abnormalities. Predisposing factors may include improper perinatal nutrition, inappropriate calcium supplementation and heavy lactation demands. Whereas dogs typically present within the first four weeks of lactation, cats more commonly are presented during the last three weeks of pregnancy. Affected cats exhibit nonspecific clinical signs of lethargy, depression, weakness, tachypnea and mild muscle tremors. Additional signs may include vomiting, anorexia, and hypothermia, flaccid paralysis, hyperexcitability and other signs of malaise. Eclampsia should be considered as a diagnostic rule-out in queens with vague signs of illness late in gestation.

The pathophysiology of periparturient hypocalcemia in cats is not well understood. Some investigators have implicated excessive prenatal calcium intake. High calcium intake may down-regulate parathyroid gland secretion and impair normal mobilization of calcium from skeletal stores. As demand for calcium increases during late gestation and lactation, calcium homeostasis is unable to maintain critical serum levels. Although high calcium intake is an accepted cause of periparturient tetany in cattle, it remains speculative as the cause of the disease in cats.

Serum total calcium and ionized calcium concentrations usually are decreased. Ionized calcium is the biologically active form. In-hospital serum chemistry and point-of-care analyzers allow veterinarians to obtain serum total calcium and ionized calcium concentrations rapidly. Diagnosis of hypocalcemia is based on low serum ionized calcium concentrations. Blood glucose should be measured as well, because hypoglycemia may be present concurrently.

Treatment is aimed at immediate correction of hypocalcemia with a slow intravenous infusion of 10% calcium gluconate (1.0 to 1.5 ml/kg body weight over 10 to 30 minutes), given to effect. Heart monitoring (e.g., auscultation, electrocardiography) should be performed during intravenous calcium gluconate infusion. If bradycardia or dysrhythmias develop, the infusion must be slowed or discontinued. Dextrose may be administered by intravenous bolus (50% solution) or intravenous infusion (5% dextrose in saline solution) to correct hypoglycemia, if present. After acute signs are corrected, oral supplementation of calcium carbonate (10 to 30 mg/kg body weight every eight hours) is begun and continued throughout gestation and lactation.

If eclampsia is diagnosed following queening, the litter should be removed from the queen for 24 hours, during which time, the kittens should be fed kitten milk replacer by bottle or orogastric tube feeding. In contrast to dogs, it is rarely necessary to wean kittens early. Recurrence of periparturient hypocalcemia has not been reported in cats.

The Bibliography for **Box 22-1** can be found at www.markmorris.org.

DM is recommended for foods for queens in late gestation/peak lactation. The recommendation for sodium in foods for mating cats is the same as for young adult cats (Chapter 20).

Urinary pH

Highly acidified foods should be avoided during gestation because metabolic acidosis may impair bone mineralization in adult cats and kittens, which can be especially detrimental to developing fetuses (Ching et al, 1989, 1990; Dow et al, 1990; Buffington, 1988; Hardardottir et al, 1997). Foods designed to produce average urinary pH values between 6.2 to 6.5 appear to be safe (Allen et al, 1997). Foods for mating cats should produce average urinary pH values between 6.2 to 6.4, as for young adult cats.

Digestibility

For reproducing queens, foods with above average DM digestibility are better suited than less digestible foods because: 1) nutrient needs increase as pregnancy progresses 2) increased abdominal fullness as the pregnancy progresses may impair the queen's ability to ingest adequate amounts of nutrients, especially if the food is poorly digestible and 3) the nutritional demands of lactation are even greater than for gestation.

DM digestibility information for commercial foods marketed for reproduction is not readily available. However, energy density indirectly indicates digestibility. Foods with an energy density of 4 kcal ME/g (16.7 kJ/g) or higher have more fat and less fiber. Fat is typically highly digestible and fiber is poorly digestible. Thus, high-fat, low-fiber foods are usually more digestible.

Other Nutritional Factors

In addition to the key nutritional factors for commercial foods discussed above, the following nutritional factors may be important in some instances, especially when homemade foods are fed (Chapter 10).

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 are not the most limiting amino acids in commercial food, at least twice as much phenylalanine, or phenylalanine plus tyrosine, are required for maximal black hair color as for growth (Yu et al, 2001; Anderson et al, 2002). Other metabolic needs for phenylalanine and tyrosine include protein synthesis and synthesis of thyroid hormones and catecholamines (NRC, 2006). The minimal recommended DM allowance for foods for queens during late gestation/peak lactation for phenylalanine plus tyrosine is 1.91%. To maximize black hair color, 50% or more of this amount must be from phenylalanine (NRC, 2006).

Taurine

Taurine is required for normal reproduction and fetal development (Chapter 19). Taurine deficiency in gestating queens may result in fetal death near the 25th day of gestation, abortions throughout gestation, fetal deformities and delayed growth and development (Sturman, 1991). However, the taurine requirement for gestation is similar to that for other lifestages (i.e., a minimum of 0.1% DM taurine in dry foods and 0.17% DM in moist foods) (NRC, 2006; Kirk et al, 1995). Current AAFCO allowances for taurine are appropriate for reproducing cats (2007). Therefore, foods that have AAFCO label statements acknowledging appropriateness for growth or reproduction should provide adequate amounts.

Essential Fatty Acids

Linoleic and AA and possibly α-linolenic acid are required in foods for cats. Signs of linoleic acid deficiency in cats are similar to those in other animals (Chapter 32). However, the long-term deficiency of dietary AA also results in reproductive failure. Queens with an AA deficiency appear unable to bear live kittens (MacDonald et al, 1984). In contrast to queens, male cats do not appear to require AA for reproduction. Spermatogenesis remains normal in males with an AA deficiency possibly because testes convert linoleic acid to AA. AA at 0.04% of the dietary energy supports normal reproduction in queens. However, lower levels have been used when interference from omega-3 fatty acids is avoided (MacDonald et al, 1984). Current AAFCO allowances for linoleic and AA are appropriate for gestating cats (2007). Therefore, foods that have AAFCO label statements acknowledging that a food is appropriate for growth or reproduction should provide adequate amounts.

Magnesium

Magnesium should not be overly restricted in foods for reproducing queens. Most cat foods intended for prevention of struvite urolithiasis have magnesium levels above the minimum recommended allowance for late gestation and peak lactation (0.05%, DM) (NRC, 2006). Dietary magnesium levels of 0.08 to 0.15% DM are recommended in foods for reproducing queens.

Copper

Copper is required for normal iron metabolism and as an enzyme cofactor in several key metabolic pathways, including those responsible for myelin, melanin and connective tissue production. Copper requirements for growth and reproduction are thought to be approximately 5 mg/kg food (Doong et al, 1983). However, copper deficiency has been reported to occur in queens fed a food containing 15 mg copper/kg food, supplied, in part, by copper oxide (Morris and Rogers, 1994). Copper from copper oxide is poorly available. The combination of poorly available copper from food and competition from high levels of dietary zinc, iron, calcium and phytate significantly impair copper availability. Clinical signs of copper deficiency include fetal death and abortions, achromotrichia, arthrogryposis, fusion of digits, craniofacial deformities and cerebral dysgenesis.[a] For this reason, DM copper levels of 15 mg/kg food from an available source have been recommended for queens eating dry foods (AAFCO, 2007). The minimum recommended DM allowance for foods for late gestation and peak lactation in queens is 8.8 mg/kg (NRC, 2006).

A previous report of experimental copper deficiency cited histochemical defects of the aorta (Doong et al, 1983). Hematologic abnormalities are not a typical feature of copper deficiency in cats, as in other species. Supplemental copper in feline foods should be highly available. Copper sulfate and copper chelates appear to be good dietary sources.

FEEDING PLAN

Generally, feeding plan recommendations are based on information from populations of cats at similar lifestages. However, the feeding plan for reproducing cats should be tailored to meet the needs of the individual cat based on unique variations in genetics, environment, litter size and health status. The feeding plan includes the food to be fed and the feeding method (how much food is fed and how it is offered).

Assess and Select the Food

The process of food assessment includes comparing the current food's key nutritional factor content with the key nutritional factor recommendations for reproduction. **Table 22-4** lists the key nutritional factors in selected commercial foods and compares them to the recommended levels. For foods not listed, the same information can usually be obtained from pet food manufacturers (see pet food labels for toll-free numbers or websites). The comparison discloses potential discrepancies between the key nutritional factors and the cat's current food. Also, the food should be shown to be appropriate for reproduction based on AAFCO or other credible regulatory agency guidelines or feeding trials. Generally speaking, commercial growth-type foods are also intended for feeding to queens for gestation/lactation.

Food assessment during lactation also includes assessment of lactation performance. Evaluation of kitten growth rate and rate of weight loss in the queen can point to nutritional inadequacies in the queen during late gestation and lactation. Nursing kittens should gain approximately 100 g/week or 10 to 15 g/day. Weight gains less than 7 g/day require immediate evaluation of the food, the queen and the kittens. Queens normally lose some weight during lactation but should return to within 2% of their pre-breeding body weight by weaning (**Figure 22-1**). Weight loss is also related to litter size. The anticipated weight loss of queens from Week 0 to 3 can be approximated by the following equation (Loveridge and Rivers, 1989):

Total queen's body weight loss (g) = 339.2 + (58.8)n (where n = number of kittens).

If either the queen's rate of weight loss is excessive, or the kittens' growth rate is inadequate, the food and feeding method

Table 22-4. Comparison of recommended key nutritional factor levels in selected commercial foods for reproducing (gestation and lactation) queens to recommended levels.*

Dry foods	Energy density (kcal/cup)**	Energy density (kcal ME/g)	Protein (%)	Fat (%)	DHA (%)	Carbohydrate (%)***	Ca (%)	P (%)	Ca:P ratio	Na (%)	Urinary pH
Recommended levels	**–**	**4.0-5.0**	**35-50**	**18-35**	**≥0.004**	**≥10**	**1.1-1.6**	**0.8-1.4**	**1:1-1.5:1**	**0.3-0.6**	**6.2-6.5**
Hill's Science Diet Kitten Healthy Development Original	510	4.5	42.3	26.1	0.24	22.2	1.3	1.1	1.1:1	0.39	6.4
Hill's Science Diet Kitten Indoor	510	4.5	42.2	26.1	0.24	22.3	1.3	1.1	1.1:1	0.39	6.4
Hill's Science Diet Nature's Best Chicken & Brown Rice Dinner Kitten	487	4.4	37.6	26.0	0.26	27.6	1.45	1.2	1.2:1	0.46	6.4
Hill's Science Diet Nature's Best Ocean Fish & Brown Rice Dinner Kitten	487	4.4	38.0	26.3	0.23	26.6	1.4	1.1	1.2:1	0.59	6.4
Iams Eukanuba Chicken Formula Kitten	469	4.5	40.0	25.7	na	25.4	1.3	1.1	1.2:1	0.43	na
Iams Kitten	470	5.0	37.8	24.6	na	28.4	1.15	0.9	1.2:1	0.54	na
Nutro Natural Choice Complete Care Kitten	463	4.4	40.7	24.2	0.077	25.3	1.3	1.2	1.1:1	0.44	na
Purina Kitten Chow	457	4.5	44.8	15.6	na	30.8	1.4	1.42	1:1	0.56	na
Purina ONE Healthy Kitten Formula	512	4.8	45.5	21.1	na	24.8	1.3	1.2	1.1:1	0.40	na
Purina Pro Plan Kitten Chicken & Rice Formula	472	4.3	46.0	20.1	na	26.6	1.3	1.2	1.1:1	0.42	na
Royal Canin Babycat 34 Formula	531	4.8	37.4	27.5	na	21.6	1.3	1.1	1.1:1	0.64	na
Royal Canin Kitten 34 Formula	393	4.6	37.4	22.0	na	26.5	1.25	1.1	1.1:1	0.67	na
Moist foods	**Energy density (kcal/can)****	**Energy density (kcal ME/g)**	**Protein (%)**	**Fat (%)**	**DHA (%)**	**Carbohydrate (%)*****	**Ca (%)**	**P (%)**	**Ca:P ratio**	**Na (%)**	**Urinary pH**
Recommended levels	**–**	**4.0-5.0**	**35-50**	**18-35**	**≥0.004**	**≥10**	**1.1-1.6**	**0.8-1.4**	**1:1-1.5:1**	**0.3-0.6**	**6.2-6.5**
Hill's Science Diet Kitten Healthy Development Liver & Chicken Entrée Minced	114/3 oz. 210/5.5 oz.	4.7	49.3	23.9	0.243	16.2	1.3	1.0	1.4:1	0.32	6.4
Hill's Science Diet Tender Chunks (pouch) in Gravy Real Chicken Dinner Kitten	84/3 oz.	4.3	47.8	22.6	0.087	19.5	1.2	1.1	1.1:1	0.43	6.3

Key: ME = metabolizable energy, DHA = docosahexaenoic acid, Ca = calcium, P = phosphorus, Na = sodium, 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. Digestibility: Foods with higher energy density are more likely to have higher digestibility. Foods for most breeding males and females are usually similar to those for young and middle-aged adults (Chapter 20).
**Energy density values are listed on an as fed basis and are useful for determining the amount to feed; cup = 8-oz. measuring cup. To convert to kJ, multiply kcal by 4.184.
***Important for lactation.

should be carefully reviewed. If inadequacies exist, a more appropriate food should be selected. Supplements should not have to be given to improve lactation performance. Supplements, unless carefully balanced to the nutrients in the food, can unbalance a food or impair availability of other nutrients.

Queens should be fed a food appropriate for gestation and lactation at or before mating. Although, nutritional demands are greatest in the last one-half to one-third of pregnancy, conception rate and in utero fetal viability are markedly impaired in queens fed foods with marginal nutrient content and avail-

Table 22-5. Feeding plan summary for reproducing cats.

1. For gestating and lactating queens, use **Table 22-4** to select a food with the appropriate levels of key nutritional factors; for breeding males, use Table 20-4. For foods in neither table, contact manufacturers for key nutritional factor content.
2. Food should be approved by a credible regulatory agency (e.g., the Association of American Feed Control Officials).
3. Determine an appropriate feeding method (Table 20-6). Free-choice feeding is the preferred method for feeding gestating/lactating queens; food-restricted meal feeding may be best for breeding males.
4. For food-restricted meal feeding, estimate the initial quantity of food based on daily energy requirement (DER) calculation (DER ÷ food energy density).
5. DER is calculated by multiplying resting energy requirement (RER) (Table 5-2) by an appropriate factor. Remember, DER calculations are estimates and should be used as guidelines or starting points for amounts to feed individual cats and not as absolute requirements; the amount fed should be refined by monitoring body condition score and body weight.
   Breeding male = 1.4 to 1.6 x RER
   Breeding female = 1.6 x RER
   Gestation = 1.6 to 2.0 x RER
   Lactation = 2.0 to 6.0 x RER
6. At the end of lactation, queens should be fed for weaning as described in Box 23-2.
7. Monitor body condition, body weight, general health, reproductive performance and kitten growth rates.

ability at breeding and early gestation. Changing to a new food more suitable for gestation and lactation before conception: 1) avoids any reduction in food intake or gastrointestinal upsets during the critical time of conception and implantation, 2) improves any marginal nutrient stores and 3) typically increases energy intake.

The food form selected for reproducing queens also warrants consideration. Many semi-moist foods produce urinary pH values below desired levels for reproducing queens. Dry foods are more nutrient dense on an as fed basis and have higher carbohydrate levels than moist foods. Dry foods may benefit queens undergoing rapid weight loss and those spending little time eating. Conversely, moist foods often have higher fat levels and provide additional water to support lactation. The added water also improves palatability; therefore, queens may spend more time eating. Dry and moist food types each have advantages; therefore, many breeders choose to feed both forms during reproduction. If both dry and moist foods are fed, it may be desirable to feed dry foods free choice and provide multiple moist food meals daily. Only fresh moist food should be offered.

Intact male cats in heavy service and those stressed during breeding (e.g., stress of travel, preoccupation with breeding, etc.) should be fed foods with high energy density (4.5 to 5.0 kcal/g DM [18.8 to 20.9 kJ/g DM]). Otherwise, foods appropriate for young adult cats are adequate (Chapter 20). Male cats used in harem-breeding programs are typically fed the same foods as the queens. Although the vitamin and mineral levels of these foods are typically well in excess of the male cat's needs, the high energy density may be beneficial.

Assess and Determine the Feeding Method

It may be necessary to alter the feeding method when managing reproducing cats. This is especially true for queens in late-term pregnancy, those carrying large litters and during lactation. Evaluation of current feeding methods with foreknowledge of reproductive demands will allow for development of a good feeding plan.

Reproducing queens have an increased need for energy and therefore, food. The increased need can be met by providing food on a calorie basis at the daily rate of 1.6 x RER at breeding with a gradual increase to 2 x RER at parturition. The queen's energy needs may increase fourfold over maintenance requirements during peak lactation. However, energy needs sometimes exceed the recommended energy allowances due to individual cat variation and increased energy requirements of queens with large litters. Free-choice feeding is the preferred method for reproducing queens. Note that meal size and therefore calorie intake may be limited as the uterus and fetal mass occupy much of the abdominal cavity and limit gastrointestinal capacity. Providing food free choice allows reproducing queens to consume sufficient calories in multiple small feedings. Queens may also be fed multiple meals (three to four/day) using the recommended energy allowances in **Table 22-1**. However, food intake should not be limited unless obesity becomes a problem. **Table 22-3** lists estimates of average energy intake during lactation. **Table 22-5** provides a feeding plan summary for reproducing cats.

Obesity increases the risk of dystocia and kitten mortality. Thus, careful weight management before breeding and weight monitoring during gestation are important (Lawler and Monti, 1984). Obese-prone queens should be fed three to four meals per day in controlled portions. Obese queens (i.e., those with heavy fat accumulations over the ribs and bony prominences [BCS ≥4/5]) should be fed controlled amounts of food during gestation; however, they should not be fed to lose weight.

The practice of flushing, that is, increasing food intake by 5 to 15% from proestrus through breeding, has been not been evaluated in cats. Even if flushing were proven to be of value, it would be difficult to do because proestrus is rarely observed in cats because they are induced ovulators.

Clean water should be available at all times. Food and water should be placed within easy reach for the queen. Food should be placed directly in or very near the box during the first few days after parturition, when many queens refuse to leave the nest box. Some people have advocated removing the kittens from the nest box for 30 to 60 minutes at a time to encourage queens to eat (Lawler and Bebiak, 1986). This recommendation is effective for some queens, but makes others so frantic it becomes counterproductive. Other methods to improve food intake include adding water or moist food to dry food to enhance palatability and increase water intake.

Kittens should be allowed access to the queen's food, which they typically begin eating at three weeks of age. Kittens may need to be fed away from the queen if the queen is fed portion-controlled amounts of food.

Some queens with strong maternal instincts are reluctant to

leave the nest box. When this occurs, their food and water should be placed in the immediate vicinity. Advise clients to use care when placing water bowls near neonates to avoid accidental drowning. If the queen's food intake does not improve, the kittens may be removed from the queen for short periods three to four times a day.

At the end of lactation, queens should be fed for weaning. On Day 1 of weaning, the kittens and food are withheld from the queen; during this time the kittens are allowed free access to their weaning food. At the end of Day 1 they are returned to the queen and allowed to nurse. On Day 2 the kittens are removed and allowed free access to their weaning food but not returned to the queen; they are weaned. Also on Day 2, the queen is given one-fourth of the amount it was fed for maintenance (pre-breeding ration). Over the next three days, food amounts for the queen are gradually increased to pre-breeding levels. The kittens should continue to be housed and fed separately. To minimize mammary gland engorgement in queens that are abruptly removed from their kittens and/or those that are heavy milk producers, restrict their food intake a day or two before the weaning process, just described.

REASSESSMENT

Breeding queens and tomcats should be reassessed before every reproductive cycle. Females should have returned to optimal body weight and condition (BCS 3/5) before the next breeding. Oral health should be optimal and vaccinations and parasite control should be completed before the next reproductive cycle. The last reproductive performance should be evaluated and compared with previous performance and the cattery average. If performance was suboptimal, a detailed review of genetic selection, husbandry and nutritional management should be completed to identify deficiencies. Modifications can be then be incorporated to improve subsequent reproductive outcomes.

Monitoring the queen during gestation should include weekly assessment of food intake and body weight. Body condition scoring is particularly important in assessing weight gain during gestation. Inadequate nutrition and poor weight gain may be overlooked if total body weight and the queen's expanding abdomen are the only criteria used to monitor weight gain. If underfed, the queen may continue to gain weight as the kittens grow but fail to develop the energy reserves needed for lactation. Body condition scoring during gestation should ignore the abdominal component of the scoring process and allow for slight increases in body fat (Figure 1-3). When assigning body condition scores to pregnant queens, the areas of focus include muscle mass and fat covering the ribs and bony prominences. Body weight and food intake should change gradually in a pattern similar to that depicted in **Figure 22-1**. The queen and each kitten should be thoroughly evaluated at parturition. Average weight loss of the queen at parturition is 6 to 14% (254 to 638 g) of the prepartum weight, depending on litter size (Loveridge, 1985). The remaining 700 to 850 g of gain will be used to sustain normal lactation. Evaluation of gestational performance should include: 1) the queen's weight record, 2) litter size, 3) kitten birth weights, 4) kitten growth rates, 5) kitten vigor, 6) mortality rates and 7) congenital defects. Although stools may normally vary from soft to firm during reproduction, stool quality should be monitored. Constipation and diarrhea are always considered abnormal and should be evaluated and treated as needed.

Reassessment of lactating queens is similar to that of pregnant queens. Most observations will be made by the owner/breeder. The queen should be regularly evaluated for vaginal discharge, mammary gland engorgement or mastitis and matted abdominal hair that interferes with nursing. Body weight and condition should be evaluated after parturition and weekly thereafter. Kittens should exhibit steady weight gain, have good muscle tone and suckle vigorously. Young kittens are quiet between feedings. Kittens are often restless and cry excessively if milk production is inadequate. Gastric distention is not a good indicator of adequate nursing. Aerophagia can give the appearance of gastric fullness in kittens, despite inadequate milk intake.

Kitten mortality reportedly varies from 9 to 63% depending on the source of cats and the cattery (Pedersen, 1991). Breeders should compare reproductive performance of each queen to the cattery standard. Several genetic, husbandry and nutritional factors may cause high kitten mortality. If kitten death or cannibalism rates are high, all three areas should be investigated thoroughly.

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ENDNOTE

a. Kirk CA. Unpublished data. 1994.

REFERENCES

The references for **Chapter 22** can be found at www.markmorris.org.

CASE 22-1

Alopecia in a Lactating Cat

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Patient Assessment

A five-year-old intact female domestic longhair cat was examined for hair loss. The alopecia was generalized and patchy with no evidence of pruritus, excoriations, crusts or primary lesions (e.g., papules or pustules). There was no evidence of flea or other external parasite infestation. The coat was dull, dry and unkempt. The cat appeared thin (body condition score [BCS] 2/5) and weighed 3.0 kg. The remainder of the physical examination was normal.

The queen had delivered five kittens four weeks earlier. The kittens were apparently healthy but had become restless and cried constantly during the previous five days. The kittens had attempted to nurse, but the owner did not know if they were actually obtaining milk. The owner also commented that the kittens had not grown during the past week. The queen's mammary glands did not appear adequately distended for the stage of lactation.

Multiple skin scrapings and a tape preparation were negative for ectoparasites. The hairs appeared somewhat brittle and were easily epilated. Results of a packed cell volume (PCV) were slightly below normal (28%, normal 30 to 52%).

Assess the Food and Feeding Method

The cat was fed a commercial private label dry cat food purchased from a local farm and feed store. The nutritional adequacy statement on the bag indicated that the product "meets the nutritional levels established by the Association of American Feed Control Officials (AAFCO) nutrient profiles for all stages of a cat's life." One cup of dry food mixed with chicken broth was offered twice daily.

Questions

1. What is the most likely cause of this patient's alopecia?
2. Is there a connection between the alopecia and restless, crying kittens?
3. Are there any other diagnostic tests that should be performed?
4. Outline a more appropriate feeding plan for this queen.

Answers and Discussion

1. The integument is a metabolically active organ that is affected by the nutritional status of the animal. Protein and energy are required for development of new hair and skin. Developing hair requires sulfur-containing and other amino acids. Therefore, the animal's food should provide optimal protein quantity, quality (i.e., appropriate levels of essential amino acids) and digestibility for normal skin and hair. Animals have increased protein and energy requirements during growth, gestation, lactation and some illnesses. Abnormal skin and hair will often be noted if nutritionally inadequate foods are fed during these stages and conditions. Telogen defluxion is usually recognized as hair loss associated with a stressful event (e.g., pregnancy, severe illness, surgery) that causes the abrupt, premature cessation of growth of many anagen hair follicles and the synchronization of these hair follicles in catagen, then in telogen. Short-term deficiency of protein, energy or other nutrients during growth, gestation, lactation and illness may cause telogen defluxion if appropriate dietary changes are not instituted. Bitches and queens in late gestation and lactation and growing puppies and kittens are at risk unless they are fed nutritionally balanced, highly digestible foods that meet their increased nutritional requirements.
2. Excessive crying, restless behavior and poor weight gain of kittens are clinical signs associated with lactation failure in queens. Lactation failure can result from inadequate intake of energy and protein to support proper lactation and can thus be linked to the same cause of telogen defluxion.
3. A complete blood count and serum biochemistry profile should be considered to rule out systemic disease as the cause of alopecia and lactation failure. Plucking hairs from the skin and examining them microscopically is termed trichography. This technique is helpful in diagnosing a number of conditions affecting the skin and coat including nutritional diseases. Estimating the ratio of anagen to telogen hair bulbs can be useful. All the hair of normal animals should not be in telogen. A diagnosis of telogen defluxion or follicular arrest is suggested when all the hair is in telogen. Inappropriate numbers of telogen hairs (e.g., mostly telogen hairs during the summer when the ratio should be approximately 50:50) suggest a diagnosis of nutritional, endocrine or metabolic disease. In people, the ratio of telogen to anagen hair increases with prolonged protein deficiency. Unfortunately, well-established normal values are not available for trichograms, which somewhat limits their usefulness in veterinary medicine.

The use of site-, age-, breed- and climate-matched controls, if possible, may increase the usefulness of this diagnostic technique.

4. The commercial dry food fed currently does not appear adequate to support normal lactation, body condition or coat quality in this lactating queen. A commercial food specifically formulated for feline growth and lactation should be recommended. The label of the new product should indicate that the food has undergone AAFCO or similar feeding trials in gestating and lactating cats. This documentation ensures that the nutrient levels and availability are adequate to support normal lactation. The food and water should be offered free choice. If a dry food is chosen, chicken broth or moist foods can also be offered to encourage food intake by the queen.

Progress Notes

The results of a complete blood count and serum biochemistry profile were normal. Plucked hairs had bulbs that exhibited changes consistent with only telogen hairs. The food was changed to a commercial dry specialty brand food specifically formulated for feline growth and reproduction (Science Diet Feline Growth[a]). The dry food and water were offered free choice. The queen's daily energy requirement (DER) was estimated to be 4 to 6 x resting energy requirement (RER) for an ideal weight of 3.5 kg (DER = 700 to 1,000 kcal [2.9 to 4.2 MJ]). Approximately one-fourth of the estimated DER (200 kcal [837 kJ]) was offered as dry food mixed with a highly palatable, gravy-style flavor enhancer (Science Diet Canine & Feline Mixit[b]). This combination of dry food with gravy mixer was offered twice daily in addition to dry food offered free choice.

The kittens were allowed to remain with the queen but were offered a supplemental gruel made from equal parts commercial milk replacer (KMR Liquid[c]) and moist Science Diet Feline Growth four times per day. The queen and kittens were separated during these feedings. The kittens readily consumed the food mixture. The amount of milk replacer was gradually decreased over the following week until the kittens were eating moist food three times daily without milk replacer. The kittens also consumed increasing amounts of the dry growth formula that was available for the queen. The kittens' crying and excessive activity declined with supplemental feeding. The kittens were weaned at six weeks of age when they all weighed at least 500 g.

The owner reported that the queen ate both the dry food and dry food mixed with flavor enhancer very well. The cat gained a small amount of weight during the next month, seemed to produce more milk and stopped losing hair. The queen was fed the growth food for six weeks after the kittens were weaned to improve its body condition and coat. At that point, the food was changed to a similar brand food for adult maintenance.

Endnotes

a. Hill's Pet Nutrition, Inc., Topeka, KS, USA. This product is currently available as Science Diet Kitten Healthy Development Original.
b. Hill's Pet Nutrition, Inc., Topeka, KS, USA.
c. Pet-Ag Inc., Elgin, IL, USA.

Bibliography

Hoskins JD. Clinical evaluation of the kitten: From birth to eight weeks of age. Compendium on Continuing Education for the Practicing Veterinarian 1990; 12: 1215-1225.

Lawler DF, Bebiak DM. Nutrition and management of reproduction in the cat. Veterinary Clinics of North America: Small Animal Practice 1986; 16: 495-519.

Morris JG, Rogers QR. Assessment of the nutritional adequacy of pet foods through the life cycle. Journal of Nutrition 1994; 124: 2520S-2534S.

National Research Council. Nutrient Requirements of Cats. Washington, DC: National Academy Press, 1986.

Piechota TR, Rogers QR, Morris JG. Nitrogen requirements of cats during gestation and lactation. Nutrition Research 1995; 15: 1535-1546.

Scott DW, Miller WH, Griffin CE. Small Animal Dermatology, 5th ed. Philadelphia, PA: WB Saunders Co, 1995.