Chapter 23

Feeding Nursing and Orphaned Kittens from Birth to Weaning

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"Kittens are angels with whiskers."
Author Unknown

INTRODUCTION

Kittens usually depend on the queen to provide food during the neonatal or nursing period. Proper nutrition of the queen during gestation and lactation, the behavior and health of the queen and good neonatal care are important to achieving a successful transition from fetal life to the nursing period. The transition from queen's milk to solid food (weaning) is a gradual process and is an integral part of the nursing period. This chapter includes feeding normal nursing kittens, feeding orphaned kittens and integrating the weaning process.

Kittens are considered orphaned if they lack sufficient maternal care for survival from birth to weaning. Several physiologic needs normally provided by the queen must be met to ensure survival of neonates: heat, humidity, nutrition, immunity, elimination, sanitation, security and social stimulation. A foster queen or the caregiver must meet these needs for orphaned kittens (**Box 23-1**).

PATIENT ASSESSMENT

History

Clients should be encouraged to keep logbooks of all data that may provide information about the health and nutritional status of kittens (i.e., orphaned, fostered and normal) and the reproductive performance of the queen. Records should include food intake, body weight, body temperature and stool characteristics, especially during the first two weeks postpartum. Changes in kitten behavior, activity and other indicators of normal development (e.g., opening of eyes, eruption of teeth and coat quality) may prove useful as well (**Table 23-1**). In some instances, it may be helpful to differentiate individual kittens (**Box 23-1**).

It is particularly important that good records be maintained for orphaned and foster kittens. Orphaned kittens are hand-raised kittens, whereas foster kittens are those raised by a queen other than their mother. Successful management of these kittens depends on the quick recognition and correction of health and management problems. Parameters such as weight gain, daily food intake, stool characteristics and kitten vigor (i.e., muscle tone, activity and alertness) should be recorded. Kittens should be observed for suckling activity in addition to the above parameters.

Orphaned kittens should have consistent weight gains similar to those of suckling kittens (**Figure 23-1**) (Remillard et al, 1993). Orphans, in particular, should be examined for common problems such as hypothermia, hypoglycemia, dehydration and congenital defects. The current nutritional and hydration status

Box 23-1. General Good Husbandry Practices for Neonatal Kittens.

Kittens should be housed in warm draft-free enclosures. Incubators are ideal, particularly for newborn kittens. Pet carriers, shoeboxes or cardboard boxes are suitable substitutes. The bedding should be soft, absorbent and warm. Thread-free cloth, fleece and shavings are appropriate materials and help kittens feel secure as they snuggle into them.

Neonates demonstrate a certain degree of poikilothermy and are unable to regulate body temperature well during the first four weeks of life. Kittens huddle together close to the queen, which generates an optimal microclimate, protects them against changes in environmental temperature and decreases the rate of heat loss. Orphans cannot seek protection near the queen and are more sensitive to suboptimal environmental conditions.

Without the queen, neonates can quickly become hypothermic, which leads to circulatory failure and death. Artificial heat should provide age-optimal environmental temperatures (**Table 23-2**). It is best to set the heating source to establish a gradation of heat in the nest box. A gradation of environmental temperatures allows neonates to move toward or away from the heat source as needed to avoid hyperthermia, which can be as detrimental as hypothermia. Kittens can rapidly become dehydrated secondary to overheating. Maintaining humidity near 50% helps reduce water loss and maintains the moisture and health of mucous membranes.

To fulfill non-nutritive nursing needs, hand-reared kittens often nurse other littermates in the nest box. To avoid skin trauma related to excessive nursing, kittens can be housed individually or separated by dividers. Although beneficial for alleviating problems due to non-nutritive nursing, separation of the litter reduces temperature and humidity in the immediate environment and social stimulation by littermates. Brief, but regular handling, provides social stimulation. The stress associated with regular handling increases neural development and improves weight gain in kittens. Kittens raised without social stimulation develop abnormal behavior patterns (i.e., kittens reduce normal exploratory behavior and become more suspicious and aggressive as adults). Peer contact can compensate for maternal deprivation. Therefore, benefits of separating neonates must be weighed against the potential for development of abnormal behavior and increased risk for hypothermia. Kittens should interact with littermates as much as possible until weaning.

Kittens obtain passive systemic immunity from colostrum and passive local immunity from continued ingestion of queen's milk. If possible, neonates should receive colostrum or queen's milk within the first 12 hours of birth. This is particularly critical for kittens fed only milk replacers because they lack systemic and local immune protection.

Normally the queen will sever the umbilical cord. If not, it should be cut to 1.5 in. (3.5 to 4 cm) and an appropriate topical antiseptic applied. Orphaned kittens are at greater risk for infectious disease; thus, sanitary husbandry practices are important. To reduce risk for diseases, kittens should not be exposed to older animals or grouped within multiple litters. Feeding equipment and bedding should be kept clean and sanitized frequently. Caretakers should wash their hands before handling neonates and after stimulating elimination.

Kittens cannot voluntarily urinate or defecate until about three weeks of age. Until that time, they rely on the queen to stimulate the urogenital reflex to initiate elimination. Caretakers should stimulate kittens after feeding by gently swabbing the perineal region with a warm moistened cotton ball or cloth.

Often, kittens within a litter look similar; therefore, it may be difficult to tell them apart when hand rearing, especially in large litters. Different colored nail polish can be applied to the claws to help differentiate individuals; ask clients to paint a different paw for each kitten (e.g., blue front left paw, blue right rear paw, pink right front paw, etc.).

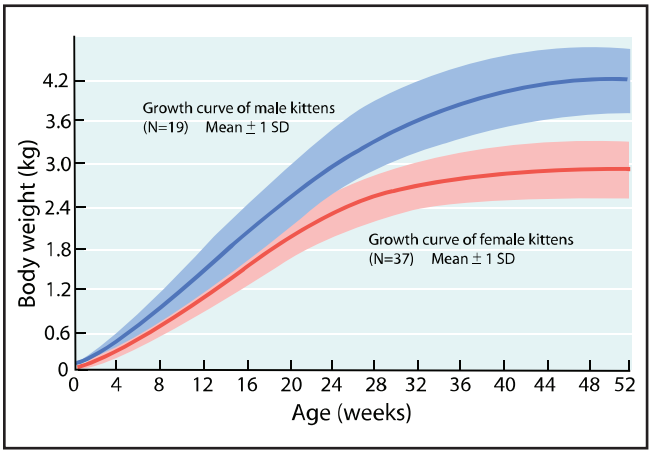

Figure 23-1. Growth curve for female and male kittens. Note after four weeks of age there are significant gender differences in growth rates; female kittens grow at a slower rate and are normally smaller than males. (Adapted from National Research Council. Nutrient Requirements of Cats. Washington, DC: National Academy Press, 1986; 2.)

should also be noted. Kittens fostered onto another queen should be supervised initially to detect any behavioral problems between the foster parent, its young and the orphans. Ideally, kittens should be accepted immediately and allowed to nurse. Ask clients to watch for signs of rejection or impending cannibalism by the foster queen.

Queens should also be monitored for signs of impending cannibalism (e.g., extreme nervousness, aggressiveness toward the kitten(s) and kitten rejection). Unfortunately, cannibalism often occurs without warning. In the case of orphans, the queen, if available, should be examined to detect the potential cause for abandonment.

Additionally, housing and environmental hygiene should also be evaluated. Improper housing and hygiene are important risk factors for poor kitten development and impaired health.

Physical Examination

The goals of the neonatal physical examination are to: 1) establish baseline data for future reference, 2) assess overall health and development of the kittens and 3) detect abnormalities that

Table 23-1. Normal physiologic values for neonatal kittens and data for neonatal care.

Litter size	-	Average: 3-5 (1-7)
Body weight	Birth weight	90-120 g
	Weeks 1-2	Double
	Weeks 3-4	Triple
Daily weight gain	Weeks 1-4	Average: 10-13 g/day
Body temperature	24 hr after birth	33.3-35.5°C (92-96°F)
	End of Week 1	36.6°C (98°F)
Heart rate	Weeks 0-4	>220 beats/min.
Respiratory rate	Weeks 1-2	15-35 breaths/min.
Shivering reflex develops	-	Week 1
Eyes	Eyelids open	8 days (5-14)
	Pupillary light response	24 hr after eyelids separate
Ears	Reaction to auditory stimuli	3 days
	External ear canals open	6-14 days (completely open by 17 days)
	Development functional hearing	21 days
Locomotion	Forelimbs start to support weight	3-4 days (1-10)
	Ability to stand	
	Sitting	10 days (5-25)
	Walking unsteadily	20 days
	Start climbing	21-22 days
Micturition and defecation	Voluntary control	3 weeks
Energy requirements	At birth	380 kcal/kg
	At 4 weeks	250 kcal/kg
Eating solid food	-	28-50 days
Deciduous teeth eruption	Incisors	2-3 weeks
	Canines	3-4 weeks
	Premolars	3-6 weeks
Permanent teeth eruption	Incisors	3-4 months
	Canines	4-5 months
	Premolars	4-6 months
	Molars	4-5 months

may impair normal development and health. During the physical examination, particular attention should be given to kitten behavior, body weight, body temperature and oral cavity health. Additionally, the umbilicus of each kitten should be closely evaluated. Normally, the queen will cut the umbilicus leaving approximately one and one-half inches. Occasionally, queens will remove excessive cord resulting in an umbilicus flush with the abdomen or an open hernia (**Figure 23-2**). Careful wound management and antibiotic therapy are often required to prevent omphalitis and/or septicemia. Umbilical cords left too long may wrap around the kitten's legs or paws cutting off circulation to the affected limb.

Kitten Behavior

Normal kittens are vigorous and have good muscle tone. They should nurse immediately or soon after parturition and have a strong sucking reflex. Well-fed kittens should have a distended abdomen and be quiet after feeding. Kittens that are hungry, cold, hot or in discomfort will cry continuously and should be closely monitored. Nursing behavior and milk intake should be carefully observed because some kittens develop rounded abdomens as a result of aerophagia. Kittens may have difficulty nursing queens of longhaired breeds due to hair accumulation or matting around nipples. In these cases, abdominal hair can be clipped to allow easier access to the queen's nipples. Care should be taken not to damage the queen's nipples during this process.

The behavioral response of kittens to the queen is also important. Poor maternal-kitten interaction may result in cannibalism or neglect. Kittens depend on the queen for food, antibodies, warmth and hygiene; therefore, serious metabolic alterations (e.g., hypoglycemia, hypothermia, dehydration and malnutrition), infectious disease and death are common sequelae to abnormal behavior and maternal neglect.

Body Weight

Monitoring initial and subsequent body weight is a good way to evaluate milk intake and health status of nursing and orphaned kittens. Healthy nursing kittens should be weighed at birth and weekly thereafter using a gram scale. Daily weighing is important to evaluate the queen's milk production and to help assess sick, weak and underweight kittens. Weight loss or slow weight gain in individuals or entire litters may indicate: 1) disease in kittens or the queen, 2) inability of kittens to suckle or 3) inadequate milk production.

Birth weights are normally between 85 to 120 g with mean weights of approximately 100 g. Kittens weighing less than 75 g have very high mortality rates and require extra care and monitoring if they are to survive. Low birth-weight kittens should be weighed every 24 to 48 hours for the first one to three weeks of life to ensure proper weight gain. Kittens gain an average of 100 g/week for the first six months of life. Minimally, they should gain 7 g/day (Lawler and Bebiak, 1986).

Body Temperature

Kittens regulate body temperature poorly during the first four

Table 23-2. Optimal environmental temperature for orphaned kittens.

Age	°C	°F
Immediate environment/incubator for orphans		
Week 1	32-34	89.5-93
Week 2	27-29	81-84
Week 3	24-27	75-81
Weeks 4-12	24	75
Environment around litter		
Week 1	24-27	75-81

Figure 23-2. A neonatal kitten with an open umbilical hernia following excessive umbilical cord removal by the queen after parturition.

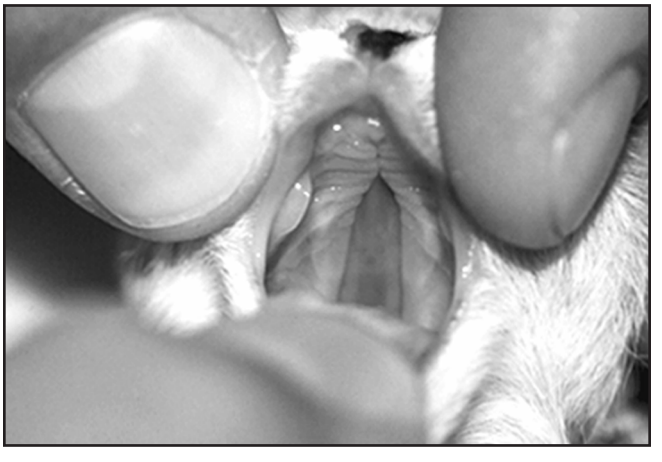

Figure 23-3. Cleft palate in a neonatal kitten. This is a common birth defect in kittens and may be associated with malnutrition of the queen during gestation. Nutrients commonly associated with a cleft palate include deficiencies of zinc and copper, as well as, vitamin A toxicosis during gestation.

weeks of life. Normal body temperature is approximately 36.0°C (96.8°F) at birth and increases to 37.5°C (100.0°F) by one week of age (Lawler and Bebiak, 1986). Extreme environmental conditions or abandonment by the queen may lead to hypothermia, which may quickly result in circulatory failure and death.

Normally the queen maintains the temperature and humidity in the nest box. Without the queen, kittens can quickly become hypothermic. Artificial heat should provide age-optimal environmental temperatures (**Table 23-2**). It is best to set heat sources to establish heat gradation in the nest box. This allows kittens to move away from the heat source as needed to avoid hyperthermia. Hyperthermia can be as detrimental as hypothermia; hyperthermic kittens can rapidly become dehydrated. Maintaining humidity near 50% helps reduce water loss in kittens and maintains the moisture and health of mucous membranes.

Oral Cavity

Examination of the oral cavity should include careful evaluation of the mucous membranes and hard palate. The mucous membranes should be light pink and moist. Cleft palates are relatively common defects in kittens (**Figure 23-3**). Vitamin A toxicity and trace mineral deficiencies (i.e., copper and zinc) during gestation have been associated with the development of cleft palates in kittens. However, in most cases, a cause is not identified. Most kittens with a cleft palate are unable to nurse effectively. Affected kittens must either be tube fed until the time of surgical correction or spontaneous closure, or they should be humanely euthanatized.

Laboratory Evaluation

Laboratory tests should be performed as needed to assess any abnormalities noted during the physical examination. Particular attention should be given to hydration status and serum glucose and electrolyte concentrations. When evaluating laboratory data in kittens, age-appropriate reference values should be used because concentrations of certain analytes (e.g., phosphorus, hematocrit, serum proteins) vary markedly from adult values (Hoskins, 1990).

Key Nutritional Factors

Colostrum and Milk

Colostrum is milk provided by the queen during the first 24 to 72 hours after parturition. Colostrum provides nutrients, water, growth factors, digestive enzymes and maternal immunoglobulins, all of which are critical to survival of neonatal kittens. Colostrum differs from mature milk in water and nutrient composition (**Table 23-3**). The dry matter (DM) content of colostrum is high, which accounts for its sticky, concentrated appearance compared with mature milk. The DM concentration declines as water content increases from Day 1 to 3 of lactation (Adkins et al, 1997). Lactose concentrations are low in colostrum (29.9 g/l or 23 mg/kcal) and increase as milk matures. Protein and lipid levels decline markedly from Day 1 to 3; however, this decline likely reflects the initial change in water content because nutrient levels rebound after Day 3 and increase slightly over the course of lactation. Like protein and lipid levels, the calculated gross energy of colostrum is high on Day 1 of lactation (1,300 kcal/l or 5.44 MJ/l) and falls significantly by Day 3. However, the energy content then increases throughout lactation. Changes in mineral content also vary with time. Calcium and phosphorus concentrations increase up to Day 14, whereas iron,

Table 23-3. Nutrient comparison among queen's colostrum, queen's milk and milk of selected species.

Nutrients	Queen's colostrum*	Queen's milk*	Bitch's milk**	Cow's milk***	Goat's milk***
Moisture (g/100 g)	–	79	77.3	87.7	87.0
Dry matter (g/100 g)	–	21	22.7	12.3	13
Crude protein (g/100 g)	8.3	7.5	7.5	3.3	3.6
Arginine (mg/100 g)	357	347	420	119	119
Taurine (mg/100 g)	26	27	–	0.13	–
Methionine (mg/100 g)	202	188	–	82	80
Crude fat (g/100 g)	9.3	8.5	9.5	3.6	4.1
Lactose (g/100 g)	3.0	4.0	3.3	4.7	4.0
Minerals					
Calcium (mg/100 g)	46	180	240	119	133
Phosphorus (mg/100 g)	114	162	180	93	111
Potassium (mg/100 g)	–	103	120	150	204
Magnesium (mg/100 g)	11	9	11	14	14
Copper (mg/100 g)	0.04	0.11	0.33	–	–
Iron (mg/100 g)	0.19	0.35	0.70	0.05	0.05
ME (kcal/100 g)	130	121	146	64	69
ME (kJ/100 g)	544	506	610	268	288

Key: ME = metabolizable energy.
*Adapted from Adkins Y, Zicker SC, Lepine A, et al. Changes in nutrient and protein composition of cat milk during lactation. American Journal of Veterinary Research 1997; 58: 370-375. Zottman B, Dobenecker B, Kienzle E, et al. Investigations on milk composition and milk yield in queens (abstract). In: Proceedings. The Waltham International Symposium, Orlando, FL, 1997.
**Adapted from Meyer H, Kienzle E, Dammers C. Milchmenge und Milchzusammensetzung bei und Hündin sowie Futteraufnahme und Gewichtsenwicklung ante und post partum.Fortschritte in der Tierphysiologie und tierernährung (Advances in Animal Physiology and Animal Nutrition) 1985; Suppl. No. 16: 51-72.
***Adapted from Pennington JA. Food Values of Portions Commonly Used. New York, NY: Harper Collins, 1989.

copper and magnesium concentrations decline. Early studies reported very low calcium concentrations and calcium-phosphorus ratios of 0.5:1 in queen's milk. These values likely represent colostral milk (calcium-phosphorus ratio = 0.4:1) (Baines, 1981). Recent studies of queen's milk report calcium-phosphorus ratios between 0.8:1 to 1:1 on Day 7; ratios reach 1.2:1 by late lactation (Dobenecker et al, 1998; Adkins et al, 1997). The variation in nutrient content with time probably explains the discrepancy in milk composition published by different investigators. Different values probably represent milk from different stages of lactation.

In addition to providing complete nutrition for nursing kittens, queen's milk also supplies non-nutritive factors that enhance food digestion, neonatal development and immune protection. The immunoglobulin concentration of cat colostrum and mature milk may not be significantly different as they are in most species (Casal et al, 1996). More studies are needed to further evaluate this difference; a decline in immunoglobulin concentrations and an increased casein-whey ratio with time contradict this finding (Adkins et al, 1997). Regardless, kittens acquire passive systemic and local immunity from ingesting either colostrum or mature milk (Casal et al, 1996). Kittens should receive colostrum within the first 12 hours of life to obtain adequate systemic immunity; after 16 hours, passive immunoglobulin transfer does not occur in kittens (Casal et al, 1996). During this time, kittens absorb intact immunoglobulins across the intestine. Failure to ingest colostrum or queen's milk during this absorptive window leaves kittens immunologically compromised and susceptible to infections and sepsis. Passive transfer of systemic immunity is particularly important to orphaned and hand-raised kittens that are fed only milk replacers. Consumption of queen's milk provides local concentrations of immunoglobulins within the gastrointestinal (GI) tract and helps prevent invasion of microorganisms into the bloodstream (passive local immunity). Local immunity persists as long as kittens receive queen's milk. Both systemic and local immunity are important in maintaining kitten health until maturation of the kittens' immune system.

Mature milk is a complete food for nursing kittens. Water, protein, fat, lactose, minerals and vitamins are provided in amounts sufficient for normal growth and development. As mentioned previously, mature milk may sustain high immunoglobulin levels similar to those provided by colostrum. Continued nursing provides high immunoglobulin levels for passive local immunity. Thus, the major feature differentiating mature queen's milk from colostrum is the nutrient content (**Table 23-3**). As lactation progresses, milk energy, protein, lactose, calcium and phosphorus levels increase whereas copper, iron and magnesium concentrations decrease (Adkins et al, 1997). The amino acid profiles of colostrum and mature milk also differ. Notable features include the relatively high concentrations of arginine and taurine in queen's milk, which likely reflect the unique metabolism of cats.

The nutrient requirements of nursing kittens have not been well studied. Although the nutrient profile of queen's milk is thought to provide optimal nutrition, faster growth rates are typically observed in kittens fed milk replacers (Remillard et al, 1993). Nevertheless, nutrient recommendations for neonates are based on the composition of queen's milk and growth studies in weaned kittens. Despite discrepancies in published nutrient values, queen's milk varies markedly from milk of other species (**Table 23-3**). Consequently, milk from other species is unsuitable for nursing kittens.

Table 23-4. Daily energy intake recommendations for orphaned kittens as a basis for determining food dose.*

Age (days)	kcal ME/100 g BW	kJ ME/100 g BW
1-3	15	60
4-6	20	85
>6	20-25	85-105

Key: ME = metabolizable energy, BW = body weight.
*Clients should not overfeed orphan formulas initially; the energy amounts listed for the first six days of the feeding period intentionally underfeed but then gradually increase so that the orphans' energy requirements are being met after about one week. Adapted from Mundt H-C, Thomée A, Meyer H. Zur Energie- und Eiweißversorgung von Saugwelpen über die Muttermilch. Kleintierpraxis 1981; 26: 353-360. Schaefers-Okkens AC. Pediatrie Post University Course, Ghent, Belgium, January 14, 1993. Sheffy BE. Nutrition and nutritional disorders. Veterinary Clinics of North America: Small Animal Practice 1978; 8: 7-29. Monson WJ. Orphan rearing of puppies and kittens. Veterinary Clinics of North America: Small Animal Practice 1987; 17: 567-576. 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.

Replacement formulas with a nutrient profile similar to that of mature milk should be used for orphans and supplemental feedings. Thus, the nutrient content of queen's milk in **Table 23-3** provides a summary of the key nutritional factors for nursing kittens. For nutrients in which the concentration in mature milk is unknown, values recommended by the Association of American Feed Control Officials (AAFCO) for growth should suffice (2007). Also, the key nutritional factor discussion (Chapter 24) for postweaning kitten growth provides information that could be extrapolated to neonates, in lieu of other information.

Water

Kittens contain 78.8% body water at one week of age (Halle, 1992). Total body water decreases to 70.1% at weaning. By comparison, adult cats are composed of only 61.7% water (Halle, 1992). Water is one of the most important nutrients in orphan feeding. The normal water intake of kittens is relatively high. A normal kitten needs about 155 to 230 ml water/kg body weight/day (i.e., 4.4 to 6.5 ml water/oz. body weight). On average, orphaned kittens should receive about 180 ml of liquid/kg body weight to make orphan feeding successful. Water should be given until a total intake of 180 ml/kg body weight/day is reached if the milk replacer doesn't provide this much water at the recommended dilution.

Energy

Queen's milk typically meets the energy requirements of nursing kittens. Newborn kittens require about 24 kcal (100 kJ) metabolizable energy (ME)/100 g body weight for the first four weeks of life. **Table 23-4** provides recommended levels of energy intake for orphaned kittens from one to four weeks of age. By six weeks of age, male kittens are significantly heavier than female kittens and consume a proportionately larger quantity of food. As a rule, milk contains from 0.85 to 1.6 kcal/ml (3.6 to 6.7 kJ/ml) and milk replacers contain approximately 1 kcal/ml (4.2 kJ/ml) as fed. In general, kittens less than one week old will eat a volume equal to 10 to 15% of their body weight as milk or properly formulated milk replacer per day and a volume equal to 20 to 25% of their body weight per day between Weeks 1 to 4. This is also a reasonable target if the caloric content of the food is unknown. A very common mistake is to underestimate the energy requirements of neonates. In the beginning, however, it is better not to overfeed to avoid diarrhea. In most cases, it is best to follow label recommendations on commercial products or feed based on energy calculations.

Protein

The minimum protein requirement of nursing kittens has not been established. However, it is assumed to be comparable to that for weanling kittens, which is approximately 18 to 20% DM (Smalley et al, 1985). These requirements were established using purified diets and may not accurately reflect the needs of kittens fed commercial foods made from typical ingredients. The AAFCO recommendation of 30% DM appears adequate (2007); however, the protein content of queen's milk ranges from 33 to 44% DM (Adkins et al, 1997; Baines, 1981).

It is essential that commercial milk replacers and homemade replacer formulas have adequate protein and essential amino acid content. The arginine and histidine levels in the formula are particularly important. Deficiency of these amino acids can cause cataract development in neonates and contribute to anorexia and poor growth. The minimum recommended levels of these two amino acids for growth in kittens after weaning are 0.96 and 0.33% DM, respectively (NRC, 2006). These recommendations are based on a food with 22.5% DM crude protein. For foods with 30% crude protein, DM arginine should be increased to 0.975% (NRC, 2006).

Taurine

Taurine is important for normal growth and development of kittens. Fortunately, dietary taurine is more available to kittens than adult cats (Earle and Smith, 1994), presumably because of reduced bacterial degradation of taurine in the GI tract. Normal plasma taurine concentrations are maintained in 12- and 18-week-old kittens fed taurine at 150 to 197 mg/kg body weight/day (Earle and Smith, 1994). Queen's milk supplies about 300 mg taurine/liter (NRC, 1986; Adkins et al, 1997). Queens fed low-taurine foods have significantly lower milk taurine levels, which may impair normal growth and development.[a] Dietary taurine intake influences milk taurine concentrations, thus it is not surprising that cow's milk is a poor source of taurine (i.e., only 1.3 mg/l) (NRC, 1986). Therefore, homemade milk replacers based on cow's milk should be supplemented with taurine (30 mg taurine/100 ml milk replacer). Taurine is commercially available as crystalline taurine from veterinary pharmacies or health food stores.

Fat

Milk fat is an important source of energy and essential fatty

acids for nursing kittens. The composition of the queen's diet can significantly influence milk fat quantity and quality, which translates into fat composition of the offspring (Pawlosky and Salem, 1996). The fat content of queen's milk increases throughout lactation. Average fat concentrations of 28% DM or 86 g/l appear typical (Dobenecker et al, 1998; Adkins et al, 1997; Baines, 1981). Queen's milk provides the essential fatty acids linoleic and arachidonic acid at 5.8 and 0.5% DM, respectively (Dobenecker et al, 1998). Docosahexaenoic acid (DHA) is also essential for normal retinal development and function in kittens (Pawlosky et al, 1997). Milk DHA concentrations reflect the dietary intake of the queen. The recommended DM level of DHA plus eicosapentaenoic acid (EPA) for kittens after weaning is 0.01%. EPA should not exceed 60% of the total DHA plus EPA (NRC, 2006). These levels are probably also suitable for orphan formulas.

Carbohydrate

No carbohydrate requirements have been established for nursing and growing kittens. However, the lactose concentration of queen's milk ranges from 14 to 26% DM. Intestinal lactase activity declines to adult levels very soon after weaning (Kienzle, 1987). Overfeeding cow's milk causes diarrhea, bloating and abdominal discomfort in kittens due to bacterial metabolism of undigested lactose in the large intestine. Owners who wish to offer cow's milk should be advised to limit the quantities given and to discontinue feeding cow's milk if intolerance occurs.

Calcium and Phosphorus

Calcium concentrations are low in colostrum (0.22% DM) and increase significantly to approximately 1% DM by mid to late lactation (Adkins et al, 1997). Thus, requirements appear limited early on and increase with bone mineralization and growth. Milk phosphorus concentrations do not vary to the same extent. Therefore, calcium-phosphorus ratios increase from a low of 0.4:1 to 0.8:1 on Day 1 of lactation to approximately 1:1, or higher, between one to three weeks of lactation and remain at that level throughout lactation (Adkins et al, 1997; Dobenecker et al, 1998).

Trace Minerals

Queen's milk contains iron, copper and zinc concentrations markedly higher than those in human and bovine milk but similar to those in canine milk. Copper and iron levels gradually decline throughout lactation, whereas zinc concentrations remain constant. Consequently, mineral deficiencies are rarely reported to occur in nursing kittens fed queen's milk. However, milk replacers made from cow's milk should be supplemented to levels typically found in queen's milk to avoid deficiency (**Table 23-3**).

Commercial milk replacers are often fortified with iron at concentrations higher than those found in queen's milk. Orphaned kittens, especially low birth-weight neonates born with low iron reserves, may benefit from iron intakes higher than those normally found in milk. The additional iron supports hematopoiesis and helps avoid anemia sometimes observed in three- to four-week-old neonates.

Digestibility

DM digestibility of queen's milk is very high (>95%). Digestibility of milk replacer formulas should also be high (>90%) to allow for smaller quantities to be fed and avoid diarrhea.

Osmolality

High osmolality should be avoided in milk replacers because it may cause hyperosmolar diarrhea and potentiate dehydration. High osmolarity may delay gastric emptying and predispose to regurgitation, vomiting and aspiration during the next meal, if the stomach is not completely empty. The osmolarity of queen's milk is approximately 329 mOsm/kg.

FEEDING PLAN

The feeding plan includes determining the best food and feeding method, under the prevailing circumstances. **Tables 23-5** and **23-6**, respectively, provide feeding plan summaries for nursing and orphaned kittens.

Assess and Select the Food

Foods should be liquid until kittens are three to five weeks old, then semi-solid to solid foods may be introduced, which marks the beginning of the weaning process (**Box 23-2**). Foods may consist of queen's milk, commercial milk replacers or homemade milk replacers (including supplemented human enteral formulas). **Table 23-7** provides a list of commercial milk replacers and compares their nutrient profiles (key nutritional factors) with queen's milk. **Table 23-8** provides two homemade milk replacer recipes and **Table 23-9** compares these recipes' nutrient profiles with that of queen's milk.

Kittens should receive colostrum within the first 12 to 24 hours after parturition. Subsequently, immunoglobulins are no longer absorbed from the GI tract and passive transfer will not occur (Casal et al, 1996). If colostrum is unavailable, milk collected from queens at any stage of lactation may be substituted. Antibody levels in non-colostral milk appear to adequately transfer passive immunity to kittens (Casal et al, 1996).

Alternatively, sterile serum may be given to kittens subcutaneously if milk is unavailable (Pedersen and Wastlhuber, 1991). To collect serum, using sterile technique, blood should be obtained from healthy, well-vaccinated donors free of communicable diseases. After the blood has clotted and been centrifuged, the serum is removed and administered in a sterile manner. Ideally, serum donors should be blood-typed to avoid neonatal isoerythrolysis. A dosage of 150 ml/kg/day is divided into three doses and given over a 24-hour period. This dose provides passive antibody concentrations that are similar to antibody concentrations of kittens that receive colostrum until at least six weeks of age (Levy et al, 2001). After the first 24 hours, kittens should be fed queen's milk or a complete and bal-

Table 23-5. Feeding plan summary for nursing kittens.

1. Ensure good husbandry practices are understood and in place (**Box 23-1**).
2. Ensure colostrum intake by the kittens within the first 12 hours.
3. Provide queen's milk only until three to four weeks of age, then initiate the gradual weaning process by introducing small amounts of semisolid to solid food to augment the queen's milk (**Box 23-2**).
4. The weaning food should be a good quality growth/reproduction type commercial food (Chapters 22 and 24).
5. Assess nursing kittens daily. Body weights should be obtained at birth then once weekly, if no complications are present. Normal birth weights range from 85 to 120 g and healthy kittens should gain approximately 100 g/week; minimally they should gain 7 g/day. Poor weight gain or failure to thrive should prompt the breeder/owner to seek an immediate evaluation by a veterinarian.
6. Kittens not thriving on queens' milk should be fed via partial or total orphan feeding techniques; check the queen, including its food, to ensure there are no health or nutrition issues to affect lactation.
7. Wean at six to nine weeks (**Box 23-2**) and feed according to recommendations in Chapter 24 (growing kittens).

Table 23-6. Feeding plan summary for orphaned kittens.

1. Ensure good husbandry practices are understood and in place (**Box 23-1**); have owner attempt to provide as much total care as would be expected from the queen.
2. Ideally, kittens should have had colostrum within the first 12 hours; if not, and if available, queen's milk is the second best choice provided if given in the same time frame; alternatively, sterile serum can be given subcutaneously (50 ml serum/kg body weight every eight hours for a total of three doses).
3. Use foster queen if possible; partial orphan feeding is next best and bottle feeding is the best of the hand-feeding techniques (**Figure 23-4** and Chapter 16).
4. **Table 23-7** lists commercial milk replacers and compares them to queen's milk; **Table 23-8** provides two homemade formulas and **Table 23-9** compares them to queen's milk. Commercial milk replacers are best.
5. Use **Table 23-4** to estimate kittens' daily energy requirement; divide the daily energy requirement by the energy density of the milk replacer to determine the daily amount to feed. Most milk replacers will provide about 1 kcal/ml when properly diluted. Besides energy and other nutrients, on average, orphaned kittens should receive about 180 ml/kg body weight/day; if necessary, add additional water to the milk replacer if the recommended dilution doesn't provide for this total fluid intake.
6. Milk replacers should be heated to 38°C (100°F) and the daily amount divided and fed four or more times/day at equal intervals.
7. Good hygiene is critical and includes: Washing/boiling feeding utensils before each feeding. Preparing no more than 24 hours worth of milk replacer and refrigerating unused portions. Carefully washing kittens with a moist, soft cloth twice weekly.
8. Gradually initiate the weaning process by introducing small amounts of semisolid to solid food to augment the milk replacer (**Box 23-2**).
9. Ensure the weaning food is a good quality growth/reproduction type commercial food (Chapters 22 and 24).
10. Assess orphaned kittens daily. Body weights should be obtained at birth then once weekly, if no complications are present. Normal birth weights range from 85 to 120 g. Healthy kittens should gain approximately 100 g/week; minimally they should gain 7 g/day. Poor weight gain or failure to thrive should prompt the breeder/owner to seek an immediate evaluation by a veterinarian. Weekly veterinary checks should be recommended for the first month.
11. For kittens failing to thrive when receiving the milk replacer, review the milk replacer quality (**Tables 23-7** and **23-9**), dilution calculations and feeding amounts; switch to a different milk replacer if necessary.
12. Wean at six to nine weeks (**Box 23-2**) and feed according to recommendations in Chapter 24 (growing kittens).

anced feline milk replacer.

Queen's milk is considered an ideal food for nursing kittens because it provides all essential nutrients, antibodies, enzymes and hormones. Commercial milk replacers and homemade replacer recipes may mimic the essential nutrient content of queen's milk but lack its other beneficial properties. However, queen's milk is rarely available in sufficient quantities to hand raise orphans. The next best option is to attempt to foster kittens to a surrogate queen. If milk replacers are used, generally commercial products are preferred although several homemade formulas have proved sufficient.

Commercial and homemade milk replacers should closely mimic the profile of queen's milk. Unsupplemented ruminant milk may be used as a base for homemade formulas but does not meet the nutritional needs of kittens. Goat's milk provides no nutritional benefit over cow's milk. **Tables 23-7** and **23-9** are useful for assessing and selecting milk replacers.

The quality of queen's milk and milk replacers is difficult to assess without analysis. Measurement of kitten growth is indirect, but probably the most practical method of assessment. Additionally, the queen's food should be assessed if the queen is losing excessive amounts of weight. A thin queen (body condition score 1/5 to 2/5) may not produce enough milk or may produce poor-quality milk. If milk analysis is required, a sample can be collected by manually expressing milk from the queen after preventing the kittens from nursing for a short time. Parenteral oxytocin (5 IU/queen) facilitates milk collection. Small samples (1 to 3 ml) are easily collected during normal lactation and should be frozen until analysis. Commercial laboratories do not routinely analyze such small milk samples; therefore, an appropriate research facility should be contacted ahead of time for specific information about sample size, preservation and shipping instructions.

Assess and Determine the Feeding Method

Nursing kittens should be allowed free access to the queen as the preferred feeding method. Kittens should be observed to ensure they have received colostrum by 12 hours after partu-

Box 23-2. Weaning.

Weaning is usually a gradual process that begins with the queen avoiding the kittens and kittens eating increasing amounts of solid food. Typically, weaning begins when kittens are three to four weeks old and is complete at six to nine weeks of age. At three to four weeks of age, kittens begin to eat solid foods, although approximately 95% of their caloric intake is still provided by the queen's milk. By five to six weeks of age, kittens eat nearly 30% of their caloric requirement as solid food and the remainder as milk. A progressive intake of solid food continues until the kittens are completely independent of the queen. Most domestic shorthair kittens are weaned by six weeks of age, whereas purebred kittens are usually weaned around eight to nine weeks of age. Later weaning allows more time for kitten growth and immune system maturation, which may help reduce kitten mortality in the postweaning period.

The weaning process may be initiated by the gradual refusal of the queen to allow the kittens to nurse or by the breeder who separates the kittens from the queen. During weaning, many queens will reduce food intake and milk production gradually. Regardless, the queen's energy requirement will decrease from lactation to maintenance levels after weaning is complete.

A commonly used schedule for the final phase of the weaning process follows. On the first day: 1) the kittens and food are withheld from the queen, 2) the kittens are allowed free access to their weaning food and 3) the kittens are returned to the queen at the end of the day and allowed to nurse. The following day: 1) the kittens are removed and allowed free access to their weaning food and not returned to the queen (they are weaned) and 2) the queen is given one-fourth of its ration. Over the next three days, food amounts for the queen are gradually increased to pre-breeding (maintenance) 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, have owners restrict food intake a day or two before the final weaning process is begun.

Weaning can be a stressful event in the kitten's life. Transition to independent feeding, greater environmental exposure and waning maternal antibodies result in reduced immune defense. These factors contribute to increased morbidity and mortality in the postweaning period. Proper nutrition and careful husbandry can reduce these events markedly.

Recommended nutrient allowances for weanling kittens are similar to those for lactating queens and for growing kittens, postweaning (Chapters 22 and 24). Energy requirements for weanling kittens are between 200 to 250 kcal/kg body weight (837 to 1,046 kJ/kg body weight). The stomach volume of kittens is small; therefore, feeding energy-dense foods helps meet the higher energy needs of weanling kittens without exceeding gastric capacity. Kittens from queens with lower body weights reportedly have limited growth. Milk production may be compromised in underweight queens. After weaning, however, smaller kittens compensate by increasing food intake and growth rate until they attain their expected size.

At the onset of weaning (three to four weeks of age), kittens should be offered moist foods or dry foods moistened with water or milk replacer. The food should be moistened until it forms a soft but not liquid gruel. Kittens at this stage lap at but do not prehend food. By six to eight weeks of age, most kittens have learned to eat solid, unmoistened foods; therefore, gruels are no longer necessary. The food should be highly digestible and complete and balanced for growth and reproduction. Semi-moist foods that promote a highly acidic urinary pH should not be fed as the sole food source for growing kittens. High levels of dietary acid may lead to metabolic acidosis and impaired bone mineralization.

The weaning process will be less stressful if kittens are initially offered the same food that will be fed after weaning. Using the same food facilitates the transition away from the queen and helps avoid gastrointestinal upsets associated with a food change. After three weeks of age, kittens should have water and food available at all times in addition to free access to the queen. Food and water should be easily accessible and offered in broad shallow pans. Food should be replenished three to four times daily. High-moisture foods begin to spoil and harbor high levels of bacteria when left at room temperature for prolonged periods (Chapter 11). Thus, washing pans between feedings is recommended. Ideally, food should be warmed to about 38ºC (100ºF) or at least brought to room temperature. Kittens first eat by accident, as they step into food and then ingest it during grooming. This process can be hastened by smearing small quantities of food around a kitten's mouth.

Daily monitoring of physical appearance, activity, stool quality and food intake is recommended. Kittens should be weighed and their body condition assessed weekly; they should continue to grow at approximately 100 g/week. Gender differences in growth rate are now evident; female kittens are normally smaller than males (Chapter 24). Kittens should demonstrate increasing activity and social and exploratory behavior. After a meal, the kittens' abdomen should be well rounded but not overly distended. Crying in neonates and older kittens usually indicates discomfort (e.g., cold, hunger, pain, disease or isolation).

The queen still consumes the kittens' feces to keep the nest box clean early during this phase. At about four weeks, the kittens begin to defecate outside the nest box and stools can be readily monitored. Kittens eating solid foods should have soft-formed stools, whereas those eating predominantly milk will have pasty yellow to light-brown stools. It is vital during this phase to practice good cattery husbandry and monitor kittens closely for disease. Weaning is a stressful event and outbreaks of diarrhea and disease are very common. Growth rate is universally impaired in sick and malnourished kittens.

The Bibliography for **Box 23-2** can be found at www.markmorris.org.

rition. Most neonatal kittens require feeding every two to four hours during the first week of life then every four to six hours until weaning. Weak kittens may need to be placed on the queen and held to facilitate nursing. Chilled kittens will not suckle and have reduced GI function. It is imperative to adequately warm weak kittens before they are fed. Hypoglycemia and hypothermia may occur simultaneously in neonates and have similar clinical signs. If kittens fail to respond to warm-

Table 23-7. Nutrient content of milk replacers compared with that of queen's milk/100 grams of milk, as fed.*

Nutrients** / Manufacturer	Queen's milk -	KMR Liquid PetAg	KMR Reconstituted Powder PetAg	Nurturall C Kitten Liquid† VPL	Nurturall-C Reconstituted Powder† VPL	Just Born Kitten Liquid† Farnam	Just Born Reconstituted Powder† Farnam
Dilution***	na	na	1+2	na	1+1	na	1+1.33
Moisture (g)	79.0	81.7	na	80.1	74.0	80.1	79.1
Dry matter (g)	21.0	18.3	na	19.9	26.0	19.9	21.0
Crude protein (g)	7.5	7.7	7.7	7.7	9.8	7.7	7.9
Arginine (mg)	430	250	310	200	240	200	195
Taurine (mg)	10	10	10	na	na	na	na
Fat (g)	8.5	4.7	4.7	4.4	5.4	4.4	4.5
Linoleic acid (C18:2) (g)	na	na	0.31	na	na	na	na
Arachidonic acid (C20:4) (mg)	na	na	20	na	na	na	na
Carbohydrate							
NFE (g)	na	4.7	3.6	6.2	8.7	6.2	7.0
Lactose (g)	4.0	na	3.1	na	na	na	na
Crude fiber (g)	na	0	0	<0.1	<0.1	<0.1	<0.1
Minerals							
Total ash (g)	0.6	1.2	1.4	1.5	2.1	1.5	1.7
Calcium (mg)	180	190	200	252	373	252	300
Phosphorus (mg)	162	160	200	220	287	220	231
Sodium (mg)	90	80	70	na	na	na	na
Potassium (mg)	103	210	190	102	308	102	248
Magnesium (mg)	9.0	16.0	14.2	18.4	31.5	18.4	25.3
Copper (mg)	0.11	0.26	0.27	0.40	0.73	0.40	0.58
Iron (mg)	0.4	1.2	1.4	0.4	5.5	0.4	4.4
Energy							
ME (kcal)	121	83	79	86	111	86	91
ME (kJ)	505	347	332	360	464	360	379
Osmolarity (mOsm/kg, H_20±SD)	329±18.7	na	na	na	na	na	na
Nutrient content of milk replacers compared with that of queen's milk/100 kcal metabolizable energy††							
Crude protein (g)	6.3	9.3	9.7	9.0	8.9	9.0	8.7
Fat (g)	7.1	5.6	5.9	5.1	4.9	5.1	5.0
Linoleic acid (C18:2)	>1.1	na	390	na	na	na	na
Carbohydrate							
NFE (g)	na	5.71	4.54	7.21	7.85	7.21	7.71
Lactose (g)	3.3	na	3.9	na	na	na	na
Minerals							
Total ash (g)	0.5	1.4	1.8	1.7	1.9	1.7	1.8
Calcium (mg)	150.0	230	250	293	336	293	331
Phosphorus (mg)	135	190	250	256	259	256	255
Sodium (mg)	75	100	90	na	na	na	na
Potassium (mg)	86	250	240	119	278	119	273
Magnesium (mg)	7.5	19.3	17.9	21.4	28.4	21.4	27.9
Copper (mg)	0.10	0.31	0.34	0.50	0.66	0.47	0.64
Iron (mg)	0.3	1.4	1.7	0.5	5.0	0.5	4.9

Key: na = not applicable/available, NFE = nitrogen-free extract, ME = metabolizable energy, mOsm = milliosmoles.
*Manufacturers' data; nutrient content for reconstituted powdered products are manufacturers' calculations based on the recommended dilution. Nutrient data per 100 ml would be reduced slightly (between 1 to 2%), because the specific gravity of milk is greater than that of water.
**g/100 g = %.
***The first number is the milk powder, the second the water (e.g., 1+2 = one part of powder plus two parts of water).
†Nutrients in liquid and powder forms are averages from the yearly laboratory analyses of composite samples from 2004 to date.
††The nutrient levels per 100 kcal ME were calculated from the nutrient and energy levels in the top portion of the table.

ing, a dilute glucose solution (2.5% glucose) may be given orally. This should be repeated until kittens are able to initiate a strong sucking reflex. Because nursing kittens depend completely on queen's milk, the feeding plan for the queen should be evaluated and modified if necessary (Chapter 22).

It may be necessary to alter the feeding method when managing orphaned kittens, especially if they are hand reared. Evaluation of the current feeding method with foreknowledge of growth demands will facilitate this part of feeding plan development. Orphaned kittens and those too weak to nurse are candidates for fostering, partial orphan rearing or hand feeding. These feeding methods are discussed below.

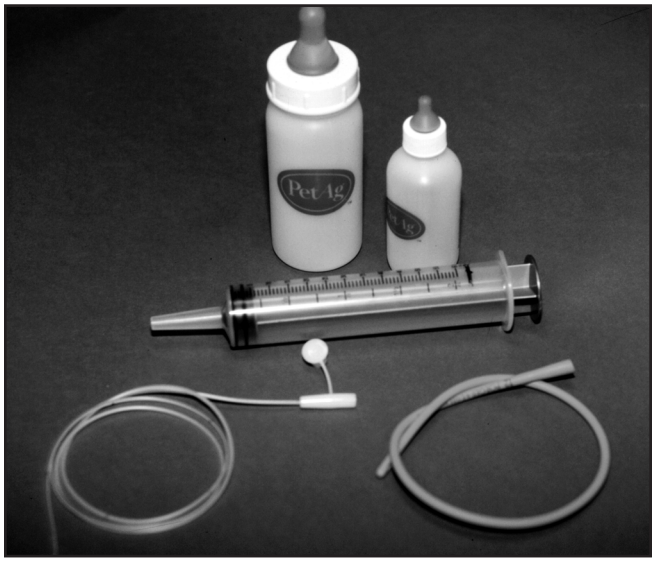

Figure 23-4. Various bottles and feeding tubes can be used for hand feeding orphaned kittens.

Table 23-8. Recipes for homemade kitten orphan formulas.

Recipe 1*		Recipe 2**	
Skim milk	70 g	One whole egg, fresh	15 g
Low-fat curd***	15 g	Protein supplement	25 g
Lean beef hash	8 g	Milk, sweetened, condensed	17 ml
Egg yolk (1/5)	3 g	Corn oil	7 ml
Vegetable oil	3 g	Water	250 ml
Lactose	0.8 g	-	-
Vitamin-mineral mix	0.2 g		
Total	100 g	Total	310 g

*Adapted from Kienzle E. Raising of motherless puppies and kittens. In: Proceedings. World Small Animal Veterinary Association Congress, Vienna, Austria, 1991: 240-242.
**Remillard RL, Pickett JP, Thatcher CD, et al. Comparison of kittens fed queen's milk with those fed milk replacers. American Journal of Veterinary Research 1993; 54: 901-907.
***Do not use cottage cheese because it may increase the risk of clotting in the neonate's stomach.

Table 23-9. Key nutritional factor content of homemade orphan formulas (**Table 23-8**) compared to key nutritional factor content of queen's milk.

Nutrients*	Queen's milk	Recipe 1**	Recipe 2**
Moisture (g)	79.3	83.1	86.4
Dry matter (g)	20.7	16.9	13.6
Crude protein (g)	7.5	7.1	6.4
Fat (g)	8.6	4.4	3.4
NFE (g)	4	4.7	2.9
Ash (g)	0.6	0.8	0.7
Calcium (mg)	180	96.2	109
Phosphorus (mg)	162	126	109
Sodium (mg)	90	33.5	90
Potassium (mg)	103	117	113
Copper (mg)	0.11	0.03	0.2
Iron (mg)	0.35	0.6	3.5
Zinc (mg)	na	0.7	1.9
Energy			
ME (kcal)***	121	80	62
ME (kJ)***	506	335	260

Key: NFE = nitrogen-free extract, ME = metabolizable energy.
*Calculated before addition of the vitamin-mineral mix.
**Calculated based on the addition of 2.5 g Pecutrin (Bayer).
***Calculated.

Fostering

The optimal means of feeding orphaned or rejected kittens is to foster them to another lactating queen. Fostering is the least labor intensive, provides optimal nutrition, reduces mortality, improves immune status, usually provides an optimal physical environment and promotes normal social development of kittens. Unlike large animals, queens readily accept additional kittens during lactation. If several foster mothers are available, it is best to place orphans in litters with fewer than 14 days age difference. Larger kittens often crowd out smaller individuals if the age discrepancy is too large. This situation can be managed by supervised feeding until the orphans can fend for themselves. Unfortunately, foster mothers are not normally available and alternative techniques must be used.

Partial Orphan Rearing

Kittens that cannot be successfully raised by the queen for reasons of health, poor lactation performance or too large of a litter, may be left with the mother but given supplemental feeding to support nutritional needs. Supplemental food may be given by hand feedings or timed feedings using a surrogate queen. Kittens may also be reared in a communal situation. Partial orphan rearing can be accomplished by dividing the litter into two groups of equal number and size. One group remains with the mother while the other is removed and fed milk replacer. The groups are exchanged three to four times daily. It is important to feed the separated group before it is returned to the mother. As a result, the group just placed with the dam will be less inclined to nurse immediately. It is better to supplement all the kittens in the litter rather than just a few. The advantages of partial orphan rearing are similar to those of fostering. In addition, continued access to the mother can help stimulate milk production and mothering behaviors. When using foster or surrogate mothers, it is important to monitor for signs of rejection and cannibalism. Partial orphan rearing may be necessary to assist the efforts of foster mothers. Unfortunately, foster and surrogate mothers are usually unavailable.

Hand Feeding

The most common method of raising orphaned kittens is hand feeding. Eyedroppers, syringes, bottles and stomach tubes are typically used to hand feed orphans. The method of choice largely depends on the age, vitality and adequacy of the sucking reflex of the kitten and the handler's expertise.

BOTTLE FEEDING

Bottle feeding is the preferred method for vigorous kittens with good nursing reflexes. Bottle feeding has the advantage that neonates will nurse until they are satiated and reject the milk or formula when full. However, bottle feeding can be time

Figure 23-5. Feeding tubes should be premeasured and marked at a spot approximately 75% of the distance from the nose to the last rib. This placement will ensure the tube tip is in the distal esophagus.

Figure 23-6. Kittens should be held horizontally in the palm of the hand for tube feeding.

Figure 23-7. A lubricated tube is gently advanced to the premeasured mark and warm formula is administered over several minutes. The tube should be withdrawn and repositioned if resistance or struggling is encountered.

consuming, especially with large litters.

Most kittens will readily nurse small pet nursing bottles available in pet stores (**Figure 23-4**). Feeding bottles for dolls or bottles with nipples for premature human infants are alternatives. The opening should only allow one drop at a time to fall from the nipple when the bottle is inverted. A horizontal slit made with a razor blade instead of a round hole may make it easier for neonates to obtain milk or formula. Milk should be sucked-never squeezed-from the bottle. A rapid flow rate may lead to aspiration of milk resulting in pneumonia and/or death.

Kittens should normally be held horizontally with the head in a natural position. This position reduces the risk of aspiration (Figure 16-1).

TUBE FEEDING

Kittens that are weak or suckle poorly may need to be tube fed. Tube feeding is faster than bottle feeding and is often used when several orphans must be cared for by the same person. Bottle feeding allows kittens to control the amount of food intake, whereas tube feeding bypasses this control mechanism. Infant feeding tubes (5 to 8 Fr.) or soft urethral or intravenous catheters may be used (**Figure 23-4**).

The tube should be lubricated and placed in the lower esophagus, which is approximately 75% of the distance from the nose to the last rib (**Figure 23-5**). It is best to measure and mark the tube with an indelible marker or a piece of tape before insertion. Recheck measurements every few days to account for growth of the kitten. The orphan should normally be placed horizontally in the palm of the hand with its head in a natural position (**Figure 23-6**).

The mouth can be opened using the same hand that steadies the head. Gently advance the tube to the premeasured mark. If resistance is encountered or the kitten suddenly struggles, the tube may be in the trachea. It should be removed and repositioned into the esophagus. Do not feed until proper placement is ensured. After the tube is placed, attach the feeding syringe and slowly administer the warmed formula over one to two minutes (**Figure 23-7**). The stomach may be palpated to determine the degree of distention. Administration of formula should be stopped if the stomach becomes taut or there is resistance to formula flow. Continuation of feeding may result in gastric overdistention and regurgitation. If regurgitation occurs, withdraw the tube and discontinue feeding until the next meal.

Success of orphan rearing depends on how well the caregiver fulfills the daily routine of hygienic measures, strict feeding schedules and all aspects of care normally provided by the queen. These measures are vital for survival of kittens early in life.

Hygiene

Strict hygiene is especially important with hand feeding. Hygienic measures must be more stringent for orphaned kittens because they may have received less colostrum and be more susceptible to infections than other neonates.

- Feeding materials (e.g., bottles and nipples) should be cleaned thoroughly and boiled in water between uses.
- Ingredients for homemade milk replacers should be fresh and refrigerated until used.
- Clients should never prepare more milk replacer than can be used in 24 hours and refrigerate.
- Formulas should be discarded after one hour at room tem-

perature.
- At least twice a week, orphans should be washed gently with a soft moistened cloth to simulate cleaning by the dam's tongue.

Feeding Amount, Schedule and Rate and Formula Temperature

To determine the amount to feed, first use **Table 23-4** to estimate the kittens' daily energy requirement (DER). Then, divide the DER by the energy density of the milk replacer to determine the amount to feed. Most milk replacers provide about 1 kcal/ml when properly diluted. Orphaned kittens should receive about 180 ml/kg body weight/day (18 ml/100 g body weight). If necessary, add additional water to the milk replacer if the recommended dilution doesn't provide for this amount of total fluid intake. During the first week of life the capacity of milk intake is limited to about 10 to 15 ml per feeding.

The energy density of the milk replacer should be adequate at the recommended dilution. If the energy density is too low, the neonate's intake capacity may be exceeded. If this occurs, the neonates might not gain weight, and could actually lose weight, despite apparently adequate volume intake. Affected neonates may start vocalizing and become restless.

Orphans should be fed at least four times daily. Very young neonates and weak kittens should preferably be fed every two to four hours. Older kittens should be fed every four to six hours. Normally, one- to two-week-old kittens will obtain more than 90% of their normal daily intake in four to five meals.

Milk replacer should be warmed to 38°C (100°F) and delivered slowly. Cold foods, rapid feeding rates and overfeeding may result in regurgitation, aspiration, bloating and diarrhea.

Review and have clients correct the feeding methods if untoward signs develop. If diarrhea is observed, food volume should be reduced or diluted with water, then gradually returned to levels to meet caloric requirements over successive feedings. It is better to underfeed than overfeed neonatal kittens.

REASSESSMENT

Nursing kittens should be reassessed daily. Body weights should be obtained at birth then once weekly, if no complications are present. Poor weight gain or failure to thrive should prompt the breeder/owner to seek an immediate evaluation by a veterinarian.

Adequacy of the queen's milk production can be assessed by the growth rate of the kittens, kittens' contentment and, to some extent, the degree of mammary gland distention. Expressing milk from a queen's nipples demonstrates the functionality of individual mammary glands, but does not indicate adequate milk production.

Orphaned kittens should be evaluated daily for the first two weeks of life. They should remain normally hydrated, sleep quietly between feedings and gain weight at a rate similar to queen-raised neonates. Alertness, eagerness to suckle, general behavior, body temperature (i.e., temperature of skin and lower limbs), body weight and stool character should be recorded daily or more often if neonates appear weak or listless.

Orphan rearing permits precise measurement of food intake. Nursing kittens should grow about 100 g/week. If kittens do not thrive when fed a commercial milk replacer or homemade replacer, the nutrient content should be compared with mother's milk (**Tables 23-7** and **23-9**). The dilution recommended by the manufacturer should also be checked. In some cases, it may be necessary to switch to another formula.

Kittens with rectal temperatures less than 35°C (95°F) should not be fed. At this temperature, the sucking reflex is usually absent and normal gut motility has ceased. Neonates should first be warmed slowly after receiving a warm solution of 2.5% glucose by subcutaneous injection (1 ml/30 g body weight).

Weaning is an important event and is integral to successful feeding of nursing and orphaned kittens (**Box 23-2**).

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ENDNOTE

a. Kirk CA. Unpublished data. 1994.

REFERENCES

The references for **Chapter 23** can be found at www.markmorris.org.