1 Kennel Management and Nutrition of the Bitch and Her Offspring

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There is no denying that kennel management, husbandry, and nutrition play equal roles in determining the success of a mating to bear live, viable puppies. Simple management of each of these factors will significantly improve the likelihood of a healthy breeding stock and puppies.

Kennel Management

The facilities which house breeding dogs are a contributing factor to the success of the breeding program. In many cases, the "facilities" may be as simple as a whelping box tucked into the corner of the laundry room, but the facilities could be as complex as a multibuilding campus requiring elaborate husbandry, record-keeping, and sanitation programs. Building styles and materials and outdoor kennel areas affect sanitation and husbandry practices. Whelping and raising puppies requires certain changes in sanitation and husbandry procedures when compared with caring for adult, nonbreeding dogs.

Building Management

Most hobby breeders prefer to keep their dogs in their homes, but some breeders may choose to provide a separate building for breeding and kennel activities. There are three main types of kennel construction materials: wood, metal, or concrete or poured walls. Many buildings are combinations of the available materials. Table 1.1 outlines the advantages and disadvantages of each construction material as it pertains to kennel management and Table 1.2 details the advantages and disadvantages of different outdoor kennel types. Over the past few years, kennel design has moved away from traditional linear kennels and toward building shapes which improve quality of life and decrease stress in dogs. Figure 1.1 shows a V-shaped kennel design which allows all dogs' line of sight to exits as well as the central feeding and grooming areas. Round buildings provide the same effect and have been shown to decrease stress hormones and barking by 40% when compared to linear kennels. Providing safe, clean, and enriched environments for breeding

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Table 1.1 Advantages and disadvantages of different kennel building types.

	Wooden buildings	Metal buildings	Concrete/poured wall buildings
Advantages	• Relatively inexpensive to build • Relatively easy to repair	• More durable than wood • Longer lasting	• Most durable • Long lasting • Easy to clean • Easy to prevent bacteria/ parasite infestation • Does not harbor odor
Disadvantages	• Hard to maintain • Porous (potential bacterial infestation) • Dries slowly • Wood rot/splintering • Termites • Dogs can chew	• Susceptible to rodent invasion • Not easy to control temperatures • More expensive than wooden buildings • Floors will be of different material	• Expensive • Floors must be slightly roughened to improve traction

Adapted from Lawler (1995).

Table 1.2 Advantages and disadvantages of different outdoor kennel or run surfaces.

	Dirt	Grass	Gravel	Concrete
Advantages	• Inexpensive • Few building materials needed • Easy on the joints of the dogs	• Inexpensive • Few building materials needed • Easy on joints	• Relatively inexpensive • Improved parasite control • Ideal for small kennel operations	• Easy to clean • Durable
Disadvantages	• Harbors parasites and bacteria • Dogs may dig • Puddles will form after rain • May increase opportunity for dogs to get dirty	• Harbors parasites and bacteria • Dogs may dig or eat grass • Must rotate animals out of kennel periodically to preserve grass	• Must be 2 or more feet thick to be effective • Requires periodic replacement • Feces may stick to rocks • Dogs may dig	• Requires periodic sealant application to prevent bacteria infestation • Must be the correct texture to prevent foot pad trauma • Expensive initial cost

dogs and puppies decreases stress and improves overall health and well-being (Lawler, 1995).

Sanitation and Husbandry

Sanitation programs are ideally established before a breeding program is developed; however, it is important to intermittently review the sanitation practices with the health and safety of the breeding bitch and the puppies, both *in utero* and on the ground, in mind. Sanitation programs can be divided into four main areas: the overall building, monthly sanitation, periodic cleaning, and daily cleaning. Most sanitation practices are common-sense and need only to be refreshed in the mind of the primary caregiver. Table 1.3 provides a list of activities for areas of the sanitation program. Figure 1.2 illustrates the order in which kennels should be cleaned.

Figure 1.1 V-shaped kennel building decreases barking and increases line of sight for all dogs in kennel.

Table 1.3 Sanitation practices for kennel and outdoor areas.

Daily	Monthly	Quarterly	Overall building
Kennel ● Follow established protocol each day ● Remove dog before cleaning ● Reintroduce dog after kennel is dry ● Do not allow dog to drink soapy water or disinfectant ● Ensure dog door, if present, is in correct working order Food and water bowls ● Use soap and disinfectant to kill bacteria ● Allow bowls to dry before adding food ● If automatic waterers are used, check to make sure water is flowing ● Follow manufacturer directions for soap and disinfectant use	Rodent control ● Use poison sparingly if at all and never near dog areas ● Check rodent traps and replace as needed Insect control ● Use pesticides approved for use around pets ● *Never* use pesticides directly in dog areas	Building ● Clean fan blades and motors ● Clean overhead lights ● Repair cracks, rust, or holes ● Clean heating/ cooling vents and replace filters Food and storage rooms ● Empty and clean all surfaces	Food room ● Dedicate a separate space, away from animals for all food ● Keep open food in sealed containers ● Do not put garbage bin in same room as food bins ● Keep room cool and dry Kennels ● Repair cracks, holes, or rust ● Prevent weeds, debris from buildup around kennel to decrease pest population Cleaning supplies ● Only combine soaps and disinfectants as suggested by manufacturer

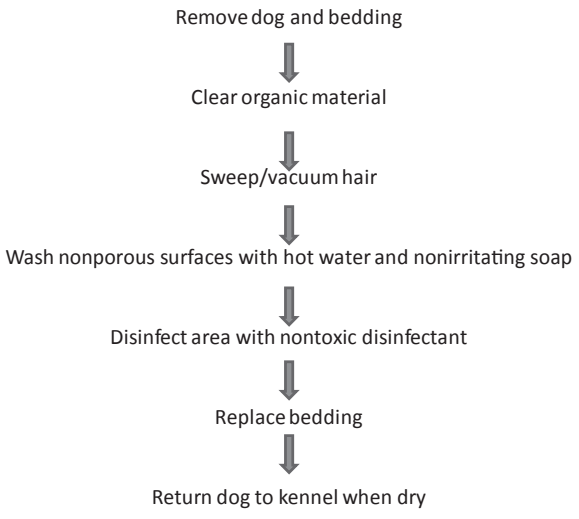

Figure 1.2 Kennel cleaning order of events.

Puppies are inoculated with their initial microflora milieu from their dam and their environment; therefore, it is essential to manage both in such a way to provide a healthy start to life. Transmission of potentially infectious agents and expression of infection depend on the type of contact and susceptibility of the host animal. Transmission can be direct and immediate between the current reservoir host and the potential new host, or through surfaces or other vectors (Lemarie & Hosgood, 1995). Factors which influence the likelihood of infection of the host include age, nutritional status, immune health, and environmental factors like season, overcrowding, ventilation, and sanitation. For example, increases in seasonal humidity can affect the incidence of mastitis, metritis, and neonatal mortality (Case et al., 2000).

In preparation for whelping, the bitch should be introduced to the whelping area, if different, at least 5 days prior to whelping. This allows her to acclimatize and "nest" to make the area her own prior to the onset of labor. The whelping area should be draft free and preferably temperature controlled, regardless of season. Optimal room temperature is 70°F if the dam is present to provide additional warmth (Case, 1999). If central heating/cooling is not possible, provisions should be made for providing a thermal neutral or comfortable temperature for the bitch and puppies. If it is too cool, there is an increased risk of respiratory complications and if it is too warm, an increased risk of infections. Puppies do not have the shiver response until they are over 5 days old, so one cannot rely on the puppies' reaction to their environment as an indicator of appropriate temperature (Case et al., 2000).

Heat lamps are a viable alternative only if placed so that they warm only one-half to two-thirds of the whelping box rather than the entire box so that both the bitch and the puppies can move away from the direct heat if they become too warm. Heating pads should be used with caution, especially when the pups are very young. Prolonged exposure to a too-warm heating pad can cause tissue degeneration and breakdown of organs. Never warm chilled puppies quickly on a heating pad; instead, use body heat to slowly warm chilled puppies over 1–2 hours.

The opposite problem, attempting to cool the bitch and puppies, also requires careful consideration. Fans circulate air, but can also blow potential infectious agents onto the puppies. Fans may also cause drafts which could lead to chilling. Cold, wet towels can be used to cool the bitch but should not be used with young puppies.

The whelping box should be 1.5 to 2 times the length of the bitch from nose to base of tail. There are many different whelping box options. Examples of simple boxes would include a child's hard plastic wading pool or a plastic box open at the top so the dam can come and go, or an open fronted plastic box with a piece of plastic blocking the bottom half of the open side to keep the puppies contained. More elaborate commercial boxes can be purchased which contain safeguards like a rail along the inside (pig rail) which prevents the bitch from accidentally smothering a puppy between her body and the side of the whelping box. Whelping nests are available to build into the center of the whelping box. The heat to the nest itself is controlled by a rheostat, while the surrounding edges of the box are cooler for the bitch. Once the puppies are older they will start to leave the nest and explore the cooler areas of the box. The temperature rheostat is adjusted as the puppies age.

All whelping boxes should be nonporous and easy to clean. In the first few weeks, the bedding will have to be changed multiple times per day. Appropriate bedding would include old towels, mattress pads, cloth diapers, or indoor/outdoor carpeting. Newspapers are often used for the first few days but should be discontinued when the puppies begin to move around and use their mouths to explore. As puppies grow and begin to explore their environment, surrounding the whelping box with a wire or epoxy-coated wire exercise pen is advisable. This allows the puppies to move away from the whelping box and observe the surrounding environment through the open wire of the pen but still keep them safely contained.

Puppies are very fragile for the first few weeks of life. A multiyear analysis of breeding kennel records indicated the highest risks for neonatal mortality were either being stillborn (29%) or death between 0 and 3 days of age (49.6%) (Lawler, 2008). After the first week, mortality dropped considerably. There appears to be a strong correlation between postwhelping weight and survival. It is not uncommon for puppies to lose a small amount of their initial birth weight, similar to human babies. However, a postwhelping loss of 10% or greater was linked with lower survival rates. Table 1.4 contains general causes of mortality in pups.

Table 1.4 General causes of mortality in pups.

Environmental/management	Biological
Stress	Birth weight
Sanitation	Hypoxia
Noise	Acid–base balance
Humidity (and barometric pressure)	Temperature
Temperature	Infection
Feeding (malnourishment/ unable to feed)	
Trauma	
Cannibalism	

Adapted from Lawler (1995).

Further discussion will be found in the neonatal disease chapter (Chapter 8). Weighing puppies daily for the first 2 weeks and then every third or fourth day until 4 weeks of age makes it easy to determine if the pups are continuing to grow appropriately and allows the caregiver a quick daily physical exam of each puppy. A general rule of thumb is a puppy should gain 1–2 g/day for each pound of anticipated adult body weight. As an example, a puppy that is predicted to weigh 40 lb as an adult should gain 40–80 g or 1.6–3.3 oz/day for the first 4 weeks.

Nutrition of the Bitch and Offspring

Planning the Plane of Nutrition

It can take several weeks for a dog to entirely adjust to a new food. The endogenous gut bacteria require approximately 3 weeks to adjust to a new food (Czarnecki-Maulden & Patil, 2002). During this time there are increases and decreases in certain bacterial populations based on the ingredient and nutrient matrix of the food. In addition, enzymes for digestion of nutrients have to be adjusted for the new nutrient matrix. Therefore, abrupt changes in diet can cause gastrointestinal upset in some dogs and result in flatulence, soft stool, or diarrhea.

Dog skin cells turn over every 21 days, which means visible changes due to diet are often not seen for the first few weeks after diet change. The muscle cells take even longer to turn over, approximately 45 days for striated muscle and the subsequent changes in metabolic enzyme concentrations are dependent on consistent delivery of nutrients.

Therefore, it is often recommended to switch to the chosen food for gestation and lactation at least by the day of breeding, but in reality it is preferred to switch to the food well in advance (at least 21 days) of breeding to allow the dog to adjust to the new diet before the stress of egg production and to maximize breeding potential.

Good kennel or breeding program management requires considering not only the ancestry, physical, and behavioral attributes of the breeding stock but also an element of preplanning, especially with regard to plane of nutrition of the

dogs at time of breeding. Many things can affect conception rates, the incidence of pseudopregnancy, and the number of viable offspring; for example, appropriate detection of estrus, the number of oocytes released, and the parity or number of prior litters. Two other factors that can influence conception rates and pseudopregnancy are plane of nutrition (or nutritional status) and body condition.

Body condition score is a predefined set of criteria used to estimate the relative composition (or proportion of body fat and muscle) of animals (Figure 1.3). Each score equates to an approximate body fat percentage. Bitches with appropriate body condition are less likely to have conception problems or pseudopregnancy. If the body condition score is less than 4.5 out of 9 (Figure 1.3), then the dog is considered underweight. Bitches who do not have adequate body reserves are considered physiologically stressed from the lack of available nutrition. Dogs that are stressed have been shown to ovulate fewer follicles than dogs that are not experiencing stress, therefore, underweight dogs may not release as many oocytes as a bitch that has appropriate body condition score under the same environmental and health conditions (Lawler et al., 1999).

Overweight bitches, or those whose body condition scores are in excess of 5.5 out of 9, are subjected to physiological stress from excess adipose tissue. Fat tissue produces hormones and cytokines which have been linked with immune system compromise. The more fat tissue an obese dog has the more pro-inflammatory mediators it produces. Obese dogs may not conceive as readily as dogs with appropriate body condition score and are more likely to have pseudopregnancy and dystocia (Lawler et al., 1999). It is important that clients of breeding stock are aware of the role of plane of nutrition on breeding performance before they begin to breed.

Feeding for Gestation

Balanced commercial dog foods designed for all life stages are the mainstay of feeding for optimal reproductive capacity in the bitch. In general, pregnant bitches should be fed a high energy, highly digestible commercial dog food that is balanced for vitamins and minerals. The food should be labeled adequate for "all life stages." Typically, commercial diets which meet these criteria have guaranteed analysis of 26–30% protein and 16–20+% fat. During the first few weeks of pregnancy, there are many developmental changes in the fetuses; however, there is little increase in size of the fetuses. Food intake should not increase during the first 5 weeks of gestation, however, the food intake requirements will increase to 1.25–1.5 times maintenance during the last third of gestation. Several small meals per day should be fed in the last third of gestation because puppies are taking up all the abdominal space. Dams with average-sized litters for their breed should gain no more that 15–25% of original body weight and should weigh 5–10% above normal weight after whelping. However, this is dependent on the individual dog, the litter size, and temperament. Table 1.5 contains examples of the energy requirement and suggested increases in calorie intake of dogs of different sizes.

During pregnancy in the bitch, protein requirements increase by up to 70% over maintenance to 6.3 g of protein per 100 calories fed (Kirk, 2001). High-quality, digestible animal-based proteins are preferred. Protein deficiency during pregnancy can result in lower birth weights, higher neonatal mortality, and potential decreased placental size and function (Ontko & Phillips, 1958). In other species, subclinical protein deficiency of the dam results in decreased birth weight, brain weight, and altered fat metabolism of the progeny.

Fats and essential fatty acids, such as linoleic, are in increased demand during pregnancy and lactation in the bitch. Essential fatty acid deficiency during gestation has been associated with preterm labor, poor placental development, small litter size, low birth weights, and delayed puberty in the female progeny (Kirk, 2001). Recently it was confirmed that dams fed a diet rich in the omega-3 fatty acid decosohexanoic acid (DHA) will deliver puppies that have improved learning ability, memory, and vision. Although there is no "ideal" food for increasing litter size, a study of a large colony of breeding dogs showed decreased litter size in dogs fed diets with low digestibility and low levels of omega-3 fatty acids (like the fats found in cold water fish) compared with breeding

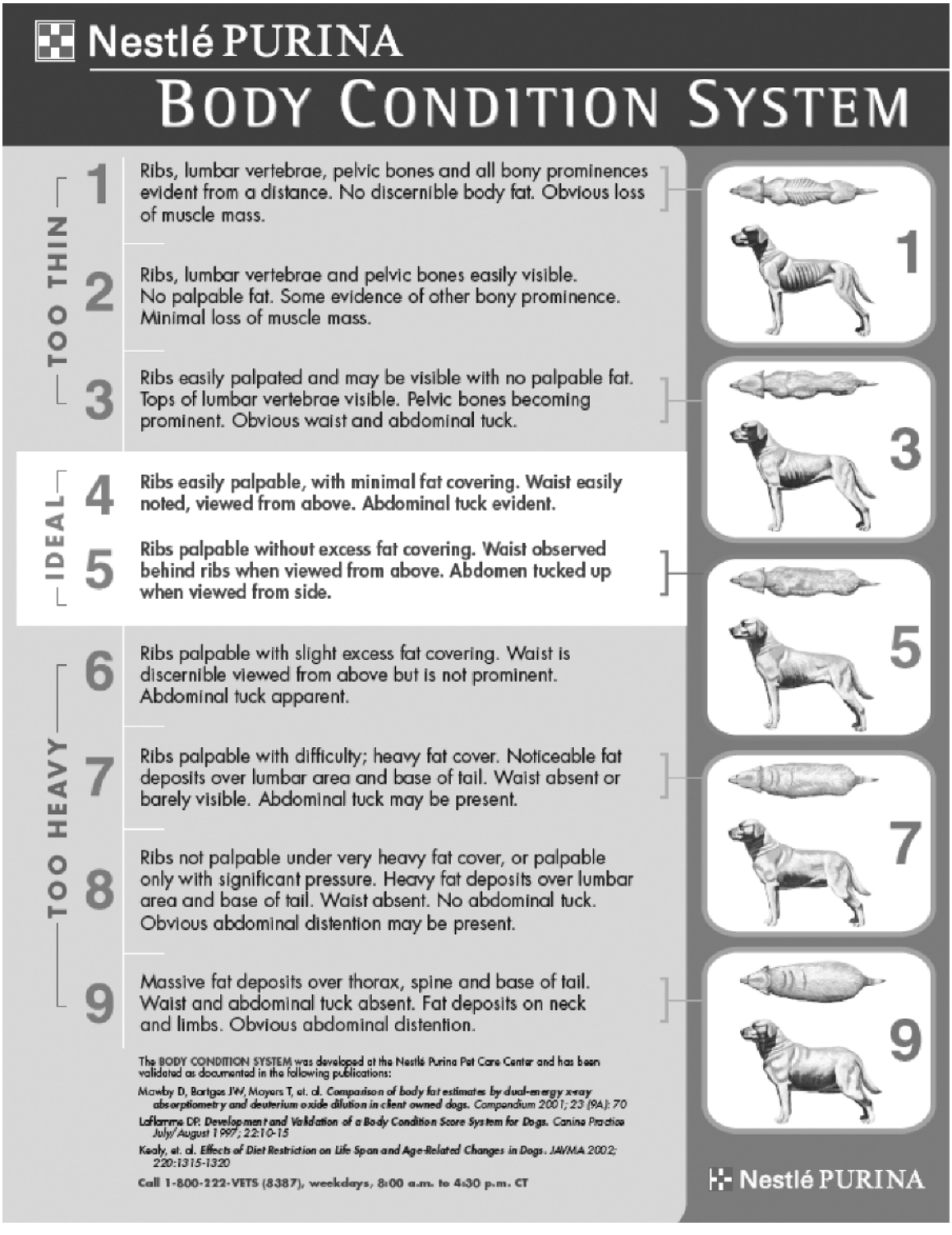

Figure 1.3 Body condition score for dogs. Scores between 4 and 5 are ideal. Source: Nestle Purina Petcare.

Table 1.5 Energy requirement and suggested increases in calories.

Maintenance weight in pounds	Maintenance weight in kilograms	Maintenance calorie requirement (calories/day)	25% increase in calories over maintenance	50% increase in calories over maintenance	200% increase in calories over maintenance	300% increase in calories over maintenance
10	4.5	400	500	600	800	1200
40	18.2	1012	1265	1518	2024	3036
80	36.4	1610	2012	2415	3220	4830

bitches fed diets with high digestibility and high levels of omega-3 fatty acids (Case et al., 2000).

Pregnant bitches do not require vitamin or mineral supplementation as long as they are fed a diet which meets the requirements for all life stages. Supplementation, particularly of fat-soluble vitamins (Vitamin A or D), can cause subclinical toxicity, thereby decreasing breeding efficiency. Certain minerals, including calcium, phosphorus, zinc, or selenium can cause imbalances in the absorption of other vitamins or minerals, creating an abnormal metabolic state which can be detrimental to the pups. In the past, breeders have supplemented the diets of pregnant bitches with calcium. High dietary calcium during gestation does not seem to increase the risk of, nor offer protection against, eclampsia in dogs. However, excessive oral calcium signals the parathyroid gland to downregulate calcium mobilization from body tissues, resulting in a change in calcium homeostasis or balance. This change in calcium homeostasis can result in a decreased amount of calcium available for use by the tissues, which can result in clinical or subclinical hypocalcemia. Bitches do have an increased vitamin and mineral requirement during gestation; however, these needs are met by the increased consumption of a complete and balanced diet.

Supplementation with certain vitamins (such as vitamin E and folate) has, in the past, been considered not harmful and may in fact be beneficial to pregnant bitches. Unfortunately, recent studies in humans and other species have suggested that vitamin E supplementation in excess may be harmful and lead to a pro-oxidant state with increased inflammation. Prenatal folate supplementation has been promoted in human medicine to alleviate midline closure defects such as spina bifida and cleft palate. A study in dogs showed that supplementation of folate in Boston terriers resulted in a decrease in the percentage of puppies with cleft palates (Elwood & Colquhoun, 1997). Unfortunately, the study was performed with dogs fed a homemade diet deficient in grains which contain large amounts of folate. Another study in Rhodesian Ridgeback bitches supplemented with folic acid, starting at the time of breeding or prior, had a markedly reduced (55%) incidence of dermoid sinuses (Roberts & Nicholis-Grzemski, 1996).

There are also some nutritional supplements which are commonly administered to bitches during pregnancy that should be avoided. Red raspberry supplements, commonly used in humans to augment strength of contractions, actually have the opposite effect in the bitch, predisposing them to eclampsia. Fish oil supplements should be assessed for mercury content and only used if they are mercury free or have <2 ppm mercury. Flaxseed oils should not be used to top dress foods as they may contain phytoestrogens, which can result in abnormal hormonal profiles.

Clients who prefer to offer raw or other homemade foods rather than commercial foods will have to supplement the diet offered with vitamin and minerals supplements. In this case, it is strongly recommended that the client work with a trained veterinary nutritionist or animal nutritionist to develop a balanced diet prior to breeding. There is no regulation or policing of raw food or homemade formulas for nutrient content or efficacy and it is a risk to both the dam and the puppies to use a homemade diet without extensive research, even if the bitch has been maintained on the diet prior to

Table 1.6 Recommended increases in food intake for lactation.

Week of lactation	Amount of food to feed over maintenance requirement
1	1.5
2	2
3	2.5–3
4	2.5–3
7	1.25–1.5

breeding. Furthermore, raw diets may predispose the bitch to systemic infection due to passage of bacteria from the raw food in the bloodstream in later pregnancy, when the bitch's immune function is decreased due to prolonged exposure to elevated progesterone concentrations. Systemic infection may manifest as placentitis or pyometra due to the greatly increased blood supply to the uterus and placentas.

The stress associated with reproduction will manifest even the smallest nutrient inadequacy in diets assumed to be complete. The inadequacies of the diet may not be enough to prevent the bitch from reproducing, but these inadequacies will prevent her from performing at her genetic potential and/or will require increased nutrient mobilization from her body stores to meet the nutrient requirements of the progeny. As stated previously, deficiencies in maternal nutrition can be associated with adult disorders in the progeny.

Feeding for Lactation

Lactation is the most energy-demanding metabolic state and energy requirements may increase by three times over basal requirements by the time of weaning, particularly in large litters. Lactation during weeks 1–4 is the most demanding for the bitch (Table 1.6). During lactation, protein and energy requirements are even higher, particularly in large litters.

Research in lactating bitches indicated that dams fed a diet with an energy density of 4200 calories/kg (1900 calories/lb) of food lost little or no weight and maintained milk production during lactation, whereas bitches fed diets with an energy density of 3200 calories/kg (1455 calories/lb) of food were not able to consume enough calories and lost weight during lactation even when allowed to eat free choice (Case et al., 2000). Feeding multiple times a day, with concentrated high-quality food, is essential to maintain body condition of the bitch, otherwise milk production will suffer and neonatal growth will be affected. It is not unexpected for bitches to lose some body weight during lactation but the loss should not exceed 10% of normal body weight.

Fat delivers more calories per gram of food (2.25 more calories) than carbohydrates or protein, making it an essential component of an energy-rich diet for late gestation and lactation. DHA, mentioned previously for its importance in fetal development, is also important during lactation. This omega-3 fatty acid is transferred through the dam's milk to the puppies and has been shown to improve puppy trainability in addition to aiding in brain and eye development in young puppies (Bauer et al., 2004; Heinemann & Bauer, 2006).

It is most appropriate to maintain lactating bitches on the same diet as they were fed during gestation to minimize any complications that might be associated with food transition. In many cases, diets that are designed for all life stages are growth diets intended for use in growing puppies, as well as pregnant and lactating bitches. One note of caution: in general, large breed puppy foods are not suitable for gestating or lactating bitches because the calcium:phosphorus (Ca:P) ratio is often less than 1.0:0.8. Read the label or call the pet food manufacturer before using large breed puppy foods for pregnancy and lactation.

Pregnant and lactating bitches do not seem to require calcium supplementation unless to balance a homemade diet or to treat eclampsia if present. The proper Ca:P ratio in diets for pregnant and lactating bitches is between 1:0.8 and 1.2:1.0. During lactation in the bitch, the demand for calcium increases exponentially (Adkins et al., 2001). In particular, small breed dogs such as Chihuahuas may be at increased risk for eclampsia, particularly if they are being fed homemade diets such as boiled chicken and rice, without calcium supplementation. All treatments for the

Table 1.7 Weaning protocol.

Day of weaning	Amount of food to feed dam
1	None
2	25% of maintenance requirement
3	50% of maintenance requirement
4	75% of maintenance requirement
5	100% of maintenance requirement

prevention of alleviation of eclampsia should be closely monitored by a veterinarian, not self-prescribed.

In addition to increased energy and nutrient needs, there is an increased need for water. A general rule of thumb is 1 mL of water for every calorie consumed. So if a 40-lb bitch is consuming 3036 calories a day during peak lactation, she needs to consume a minimum of 3 L of water per day. Insufficient fluid intake can result in decreased milk production and compromised growth of the litter. Always provide access to clean, fresh water at all times.

In order to facilitate weaning, the dam should be fed fewer calories in the 3–5 days prior to the weaning date to help decrease milk production. On the day of weaning, withhold all food from the dam, provided she is in good physical condition. Then each day after weaning, increase her food intake by 25% until 100% of her maintenance daily food intake is achieved (Table 1.7). This facilitates the cessation of milk production. This is also the best time to begin converting her diet back to the original, nongestating, nonlactating diet used during maintenance, if different.

Feeding Puppies for Optimal Growth

Newborn puppies are fragile and need to be provided with all the possible tools to start their lives off in the best way; therefore, it is vitally important that the newborn pups receive colostrum during the first 24 hours after birth. Colostrum contains specific growth factors which help the puppies' gastrointestinal tract and immune systems to begin the maturation process. In addition, colostrum contains immunoglobulins, specialized immune proteins which provide passive immunity from the dams to the pups. The immunity received from the bitch can protect the puppies for the first 12–16 weeks of life.

Puppies will begin to be interested in their dam's food at between 3 and 4 weeks of age. Mixing the dam's food with warm water will make a thick gruel which the puppies can taste and begin to consume. It is important to use water and not cow's milk to make the gruel because cow's milk has much higher lactose content than dog's milk and can cause diarrhea in puppies. For the first few days, the puppies will waste more than they eat, but they will soon learn the process of eating semi-solid food. Gruel should be provided to the puppies several times per day but should not be left out for long periods of time as it will become dry, hard, and unpalatable for the puppies. By 5 weeks of age, pups should be consuming semisolid food and by 6 weeks can be transitioned to dry, solid food. Toy breeds may take longer before they are ready to eat dry food and the kibble size chosen should be appropriate for the size of puppy. Puppies should be fed three times per day until 16 weeks of age and then can be fed twice per day after that. As dogs reach maturity, many people choose to feed one time per day. Dogs are evolutionarily gorgers and do not require multiple meals per day under normal circumstances.

At weaning, it is appropriate to begin providing a growth diet for the puppies' special nutritional needs. There are a variety of different growth foods available from which to choose. Some growth diets are formulated to provide extra immune protection while others are targeted for specific size-based nutrition.

Growth rates differ dramatically between small and medium, large, and even giant breed puppies. For example, a miniature poodle may be sexually and physiologically mature at 6–8 months of age, whereas a Great Dane may not achieve maturity until 28–36 months (3 years) of age. As a result of these breed size differences in the rate of growth, food companies have designed foods for small,

medium, large, and giant breeds. The smaller puppy diets are higher in energy and protein, while the large and giant breed diets are lower in caloric content yet still high enough in protein to allow proper growth and development. Overfeeding large breed puppies has been shown to increase the incidence of osteoarthritis (OA) and obesity (Kealy et al., 2002). Mismatch in the amount of protein and energy in the diet may result in relative protein deficiency that can cause immune problems and carbohydrate intolerance later in life (Nap et al, 1991).

Puppy foods that match the amount of protein to the amount of energy in the diet provide the most ideal diet for growth in small, large, and giant breed puppies. Ideally, foods for growing puppies should contain at least 25% protein on a percent energy basis. Feeding instructions should be considered guidelines as individual puppies have different metabolic rates and may require adjustments to keep them in a lean body condition (between 4 and 5 on the body condition scale). Excess body weight is recognized as a risk factor for OA in both humans and dogs, while avoiding obesity can help reduce OA. Dogs maintained in lean body condition through food restriction experienced decreased severity, and delayed onset, of OA (Kealy et al., 2000).

Puppies, like human babies, develop the majority of the adipose tissue cells they will have for their lifetime during the first few months of growth. Fat puppies develop more fat cells than leaner puppies and are more likely to become obese as adults. A 14-year life span study in dogs showed that dogs maintained in lean body condition (between 4 and 5 on the body condition scale) from 8 weeks of age lived 15% longer (approximately 2 years longer) than their littermates who weighed more. In addition, there was a delayed onset of chronic disease and OA in the lean dogs compared with dogs with a body condition score of 5.5 or more (Kealy et al., 2000).

The amount of omega-3 and omega-6 fatty acids is essential to promoting a healthy immune system, skin, and haircoat both *in utero* and in developing puppies. Foods should contain the proper amount of essential fatty acids, including linoleic acid, for growth and development (Wright-Rodgers et al., 2005). Most recently, the Association of American Feed Control Officials (AAFCO) has recommended the addition of a minimum of 0.05% DHA into growth diets to optimize growth and sensory development (Heinemann et al., 2005).

Differences in mineral requirements between large and small breed puppies may be one of the most important aspects of puppy nutrition. While miniature poodle puppies will grow and develop normally on a wide range of calcium intake, Great Dane puppies require a much narrower calcium range for normal skeletal growth. Skeletal defects (hip dysplasia, panosteitis, etc.) and depressed growth were observed when high levels of calcium were fed to Great Dane puppies (Schoenmakers et al., 2000). Small, large, and giant breed puppy foods have varying amounts of calcium and phosphorus in the proper ratios to control growth and development of bones and cartilage. Puppy foods developed for all breed sizes, like the growth diets with immune boosters, tend to have a Ca:P ratio considered safe for all sizes.

The adult size of a puppy is not determined by the rate of growth (accelerated beyond normal), but by the genetic makeup of the puppy (the size of the parents). Again, slower, more controlled growth of the skeleton is associated with more normal development. Rapid growth has been associated with the development of OA, osteochondrosis dissecans, hip dysplasia, and metabolic bone disease in large and giant breed dogs (Kealy et al., 2000). Calcium supplements should not be used because of the detrimental effects on bone growth, particularly in large breed puppies. Natural supplements such as yogurt and cottage cheese contain excessive amounts of calcium; for example, yogurt contains 450 mg of Ca per cup.

Puppies can be susceptible to diarrhea, particularly at the time of weaning or if insufficient colostrum has been ingested. The microflora in the gastrointestinal tract consists of normal and pathogenic microflora. When diarrhea occurs, the administration of probiotics is warranted. *Enterococcus faecium* will repopulate the intestine with "helpful" bacteria to allow repair and stabilization of gut flora (Benyacoub et al., 2005). Probiotics are available from several different pharmaceutical and pet food companies. It is important to pick a probiotic designed for puppies that has undergone rigorous clinical trials and studies to prove efficacy. Yogurt contains too much calcium to be used as a probiotic

and most yogurts do not contain measurable amounts of beneficial bacteria to be considered probiotics. One should determine if the probiotic has stability (doesn't revert to a pathogenic strain), and whether it survives in the gut for at least 14 days. The beneficial microorganisms in the probiotic contribute to intestinal mucosal integrity, metabolism, and immune status (both local and systemic). In addition, probiotics or live active cultures have been shown to have beneficial effects in the host animal by improving its intestinal microbial balance. However, one of the most interesting studies on the effects of *E. faecium* found that there were statistically significant increases in immunoglobulin A (IgA) observed in animals fed the probiotic (Benyacoub et al., 2003). This boosting of the immune system in young puppies has tremendous implications for vaccination and improving the immune response to early vaccination. This may be particularly true for viruses such as distemper and parvovirus, which directly affect the intestinal tract.

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