Applied Animal Nutrition 300/500

Module 5

Companion Animal Nutrition

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Learning Objectives

On completion of this module you should:

- Understand the concepts of feeding companion animals based on their nutrient and energy requirements
- Understand the nutritional needs of dogs and cats in relation to their phylogeny and ancestral origins
- Be able to apply appropriate feeding strategies for dogs and cats in different life stages and physiological states
- Have a basic knowledge of the dietary factors that impact on companion animal health and some dietary strategies for disease prevention
- Understand the nutritional claims of pet foods and how these are substantiated.

Key Terms and Concepts

Life stage; energy density; maintenance feeding; optimal nutrition; AAFCO

Introduction to the Module

The first commercial dog food was produced and sold in London in 1860 by James Spratt and by the mid 1930's there were several brands available on the supermarket shelves. By 1992 commercially prepared dog foods accounted for more than 60 percent of all food fed to dogs in Australia. This century has seen an increased awareness of the nutritional needs of dogs and cats, with an increased focus on animal health. The ready availability of nutritionally complete and balanced commercial pet foods has greatly reduced the incidence of nutritional deficiencies. Dogs and cats of today are more likely to suffer nutritional imbalances related to over-consumption and over-supplementation than deficiencies due to nutritionally inadequate diets.

Applied Animal Nutrition 300/500

Topic 30

30. Nutrient requirements of dogs and cats

30.1 Water

30.2 Energy

30.3 Nutrient requirements and pet foods

30. Nutrient requirements of dogs and cats

Introduction to the Topic

The basic nutrient requirements of dogs and cats is similar to those of all animals; energy, protein, vitamins, minerals and water. However, companion animals, and in particular cats, have a unique suite of requirements outside those previously discussed in this text. Also, the objective of companion animal nutrition is to maintain a healthy pet for many years, unlike many other domestic animal species.

Water and energy requirements are discussed in this topic with specific reference to the differences between cats and dogs.

30.1 Water

The importance of water is often overlooked when considering an animal's daily requirements from a nutritional perspective. It should be the first consideration, as no amount of nutrients will be useful to an animal that is deprived of water. An animal can survive the loss of almost all of its body fat and more than half its protein; but a loss of 10 to 15% of the body's water is fatal. As domestic animals often have restricted access to water, it is important from a management perspective that we know what the daily water requirements are. From a health perspective, it is equally important to be able to assess whether an animal's voluntary water intake is normal.

Daily water requirement

Precise daily water requirement, and voluntary daily water intake, will depend on many factors. Importantly, intake will need to increase to compensate for any increased water losses.

The daily water requirement (ml) for a sedentary dog in thermo-neutral environs is approximately:

- 2 to 3 times its DM food intake (g), or approximately
- 50 to 60 ml per kg BW

Cats have a greater capacity to concentrate their urine, and therefore require less than this amount.

Water losses and increased water requirements

Increased water losses must be compensated for by increased water intake. The following list summarises the main factors that will increase the body's daily requirement for water:

- Increased physical exercise (panting, increased food intake)
- Increased body temperature (panting, evaporation)
- Increased environmental temperature (panting)
- Lactation (water lost in milk)
- Illness (water losses from diarrhoea and vomiting)
- Inability of the kidney to concentrate the urine

It should be noted that significant water losses can result from panting in hot weather as this is a normal mechanism for dissipating heat in both dogs and cats.

30.2 Energy

The objectives of maximum weight gain and feed conversion efficiency do not generally apply to companion animals; rather our objective is to maintain ideal bodyweight.

There are two sides to the energy balance equation: energy intake from ingested food on the one hand, and energy expenditure on the other. When energy intake exceeds energy expenditure, the result is weight gain. Maintenance of bodyweight is achieved when there is a perfect balance between intake and expenditure, such that the animal's exact energy requirements are met, but not exceeded.

Energy Intake	>	Energy Expenditure	⇒	Weight Gain
Energy Intake	<	Energy Expenditure	⇒	Weight Loss
Energy Intake	=	Energy Expenditure	⇒	Maintenance of Bodyweight

In reality, this simple equation is complicated by other factors, and the maintenance of an ideal bodyweight is not always so easy to achieve. The body's energy requirements do not remain constant, and fluctuations in energy intake are not automatically accompanied by corresponding changes in energy expenditure.

Maintenance Energy Requirements

Maintenance energy requirement (MER) is the energy required for the body's internal metabolic processes, plus the energy needed to obtain and utilise food and maintain bodyweight in a thermo-neutral environment. To maintain ideal bodyweight, dogs and cats are fed amounts calculated to meet their individual maintenance energy requirements (MER), and based on the metabolisable energy (ME) of the diet.

Calculating energy requirements for dogs is problematic, due to the vast range of bodyweights and sizes in this species. Several predictive equations have been proposed, all of which utilise metabolic bodyweight (the bodyweight raised to a specified power) which gives a better estimation of energy requirements for dogs. Cats, on the other hand, do not vary greatly between breeds, allowing their energy requirements to be expressed on a bodyweight basis.

Calculating Maintenance Energy Requirements (MER)

The following equations can be used to calculate MER (kcal ME per day) for adult dogs and cats:

Dogs –

$MER = 132 \times BW\ (kg)^{0.75}$

Cats –

For sedentary cats, MER = 50 kcal per kg BW

For moderately and very active cats,

MER = 60 and 70 kcal per kg BW respectively

It should be noted that the above equations estimate the energy requirements for adult animals in thermo-neutral environs. Variations in energy requirements to allow for different situations can be estimated as shown in figure 30.1 below.

Factors To Be Applied
To Maintenance Energy Requirement (MER)*
To Obtain Daily Energy Requirement For:

Work—1 hour light work (hunting) = 1.1 × MER+
1 full day light work = 1.4–1.5 × MER
1 full day heavy work (sled dog) = 2–4 × MER
Inactivity = 0.8 × MER (dog)
Gestation—first 6 weeks = 1 × MER
last 3 weeks = 1.1–1.3 × MER
Peak Lactation—3–6 weeks = [1 + 0.25 (number in litter)] × MER
= 2–4 × MER
Growth —Birth to 3 mo. = 2 × MER
3 mo. to 6 mo. = 1.6 × MER
6 mo. to 12 mo. = 1.2 × MER
3 mo. to 9 mo. (giant dog breeds) = 1.6 × MER
9 mo. to 24 mo. (giant dog breeds) = 1.2 × MER
Cold—wind-chill factor of 8.5°C (47°F) = 1.25 × MER
subfreezing wind-chill factor = 1.75 × MER[10]
Heat—tropical climates = up to 2.5 × MER

Figure 30.1 Maintenance energy requirements in different situations, taken from Lewis, *et al.* (1987)

Two alternate equations that have been suggested for dogs are:

Eq. 2) $MER = 100 \times BW(kg)^{0.88}$

Eq. 3) $MER = K \times BW(kg)^{0.67}$

Where K = 99 (inactive), 132 (active) or 160 (Very Active)

Feeding on an energy basis

An important concept to understand is feeding on an energy basis. The nutrients that an animal needs to meet its requirements must be delivered within the animal's daily caloric intake. It is pointless to formulate a daily ration that contains all of the necessary nutrients but has an energy content that is five times greater than the animal's daily energy needs. The animal will not consume the entire meal, and will therefore only receive a portion of its daily nutrient requirements. This is of particular importance for companion animals, where the main objective is to maintain health and ideal bodyweight; and a significant consideration for dogs as different breeds vary so greatly in their energy requirements.

Nutrients for energy

The nutrients that provide the body with energy are carbohydrates, fats and proteins. They are utilised as energy sources to varying degrees by different species, in different circumstances, and produce different end products (figure 30.2). Fats are the preferred energy source for dogs, and they have a greater capacity to metabolise fats than most species; metabolising free fatty acids at twice the rate of humans. Cats, on the other hand, rely primarily on protein for their energy needs.

Carbohydrates, although an important component of most canine diets and some feline diets, and a useful source of energy, are not essential for dogs and cats.

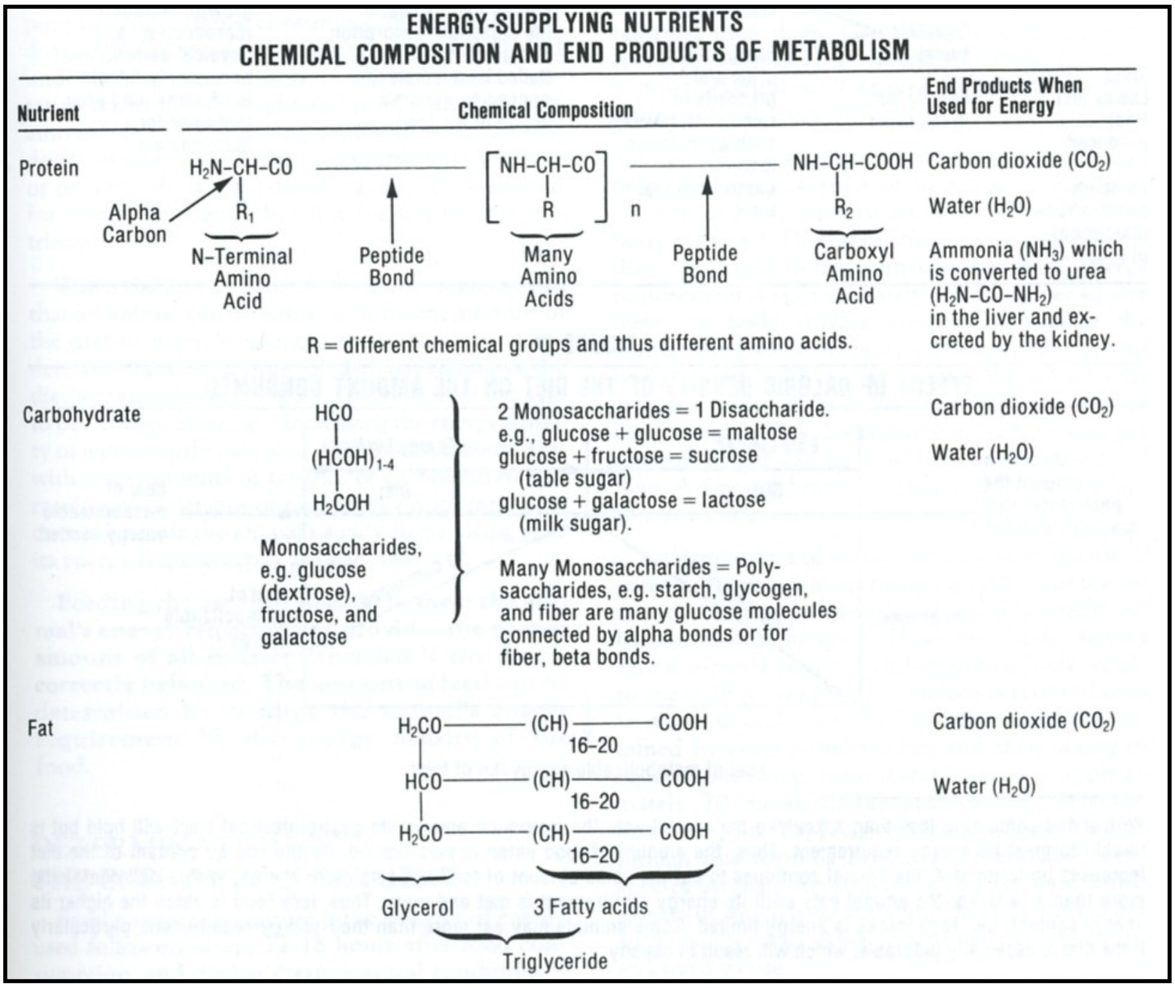

Figure 30.2 Energy-supplying nutrients requirements. Lewis, *et al.* (1987)

Carbohydrate metabolism

All animals have a metabolic requirement for glucose, which can be supplied by endogenous synthesis, or from dietary sources of carbohydrates. Although not an essential nutrient for dogs and cats, carbohydrates are well utilised and digested in both these species, providing a useful source of energy and glucose. Carbohydrates in the canine diet can reduce the requirement for dietary protein which might otherwise have been utilised to meet its energy needs. Glucose is produced endogenously in the liver and kidneys from amino acids, glycerol, propionic and lactic acids by gluconeogenesis. These gluconeogenic pathways are said to be active at all times in cats and other carnivores, enabling the cat to maintain normal blood glucose levels during prolonged periods of fasting.

30.3 Nutrient requirements and pet foods

Phylogeny of the dog and cat

When considering nutrient requirements and feeding management of the dog and cat it is useful to consider their phylogeny and ancestral origins. Both the domestic dog (*Canis familiaris*) and cat (*Felis catus*) belong to the class Mammalia and order Carnivora. It is often assumed that all members of the order Carnivora are carnivorous. This is true for the super-family Feloidea, all of whom are flesh-eaters and strictly carnivorous. In contrast to this, the Canoidea include families of diverse dietary habits; the herbivorous panda, the omnivorous bear and racoon, and the carnivorous weasel (Figure 30.3).

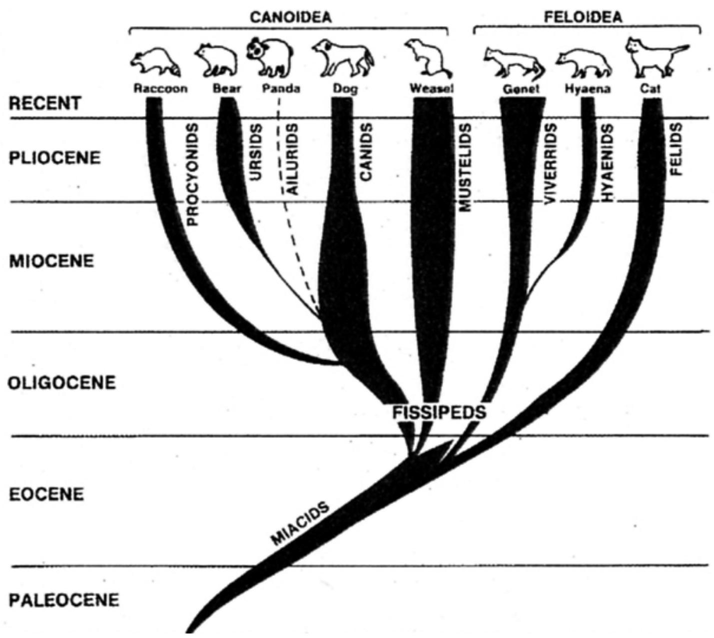

Figure 30.3 Phylogenic tree of the dog and cat (MacDonald *et al.*, 1984)

Within the same genus as the domestic dog are four species of jackals, all of which are omnivorous, and the coyote (*Canis latrans*) capable of subsisting on fruit and plant material when prey is scarce (Bradshaw, 2006). Also within this genus is the wolf (*Canis lupus*), identified as the principal and perhaps sole ancestor of the domestic dog (Clutton-Brock, 1995). The diet of the wolf consists primarily of meat in most of the areas that it currently inhabits (Bradshaw, 2006) and yet the stomach contents of 32 wolves culled from their natural habitat in Greece revealed that plant material (grasses and fruits) contributed substantially to their diet (Papageorgiou *et al.*, 1994).

The domestic dog is an opportunistic feeder, with the ability to adapt to a wide variety of foodstuffs when required. This is demonstrated by the findings of a study conducted on feral dogs in Italy (Boitani *et al.*, 1995). The feral dogs were observed to feed primarily on human refuse scavenged from open dump sites. Consistent with the findings of other investigators (Nesbitt, 1975) (Scott & Causey, 1973) there was little evidence of predation.

The dentition of the domestic dog is consistent with a more omnivorous diet and this is reflected in its nutritional requirements compared with those of the carnivorous cat. The dog has a lower protein requirement than the cat and is able to convert beta-carotene to active vitamin A, and linoleic acid to arachadonic acid, enabling the dog to meet these particular nutrient requirements from plant sources, whereas the cat cannot (MacDonald et al., 1984). Additionally, it appears that the dog (but not the cat) is able to meet its taurine requirement from dietary sulphur amino acids supplied by plants (MacDonald et al., 1984). From this we can infer that it is possible for the dog to subsist on a diet based on plant ingredients, whereas the cat, an obligate carnivore, cannot gain all of its essential nutrients from plant sources.

Nutritional idiosyncrasies of the cat

The evolutionary history of the cat suggests that felids have adhered to a strictly carnivorous diet for many millions of years, and have developed specific metabolic adaptations as a result. This has manifested in unique nutrient requirements, some of which can only be obtained naturally from the flesh of animals.

The unique nutritional requirements of cats that differentiate them from dogs, and are of practical importance, can be summarised as follows:

- High protein requirement
- Taurine is an essential amino acid
- Require preformed vitamin A
- Require arachadonic acid

The high protein requirement in cats is partly due to their unique energy and glucose metabolism; but also to their requirement for a higher dietary intake of specific amino acids such as taurine, arginine, methionine, and cysteine. Cats use protein as an energy source as well as for other metabolic processes (eg urea cycle) even when dietary protein is restricted.

Dietary intakes of taurine are essential for the cat because it is not able to synthesise adequate quantities from the usual precursors (methionine and cysteine). Further, endogenous taurine losses are greater in cats as they conjugate bile acids using only this amino acid. Preformed vitamin A (found naturally only in animal tissues) must be included in feline diets as the cat is not able to convert beta-carotene to active vitamin A. Unlike most other species, cats are not able to convert linoleic acid to arachadonic acid, and therefore have a dietary requirement for this nutrient also.

Nutrient tables for dogs and cats

There are two important publications of nutrient requirements for dogs and cats. The National Research Council (NRC) has recently published (2006) a comprehensive evaluation of nutrient requirements for dogs and cats based on peer-reviewed scientific literature. However, as earlier editions had based these nutrient requirements on experimental purified diets (to scientifically establish absolute minimum requirements of specific nutrients), the pet food industry has preferred to rely on guidelines published by the Association of American Feed Control Officials (AAFCO). This organisation produces an official publication annually that provides “practical nutrient profiles” for dog and cat foods “based on commonly used ingredients”. Where nutrient values of feed ingredients are expressed relative to their energy value, the units of energy used in both the NRC and AAFCO publications is kcal, as is the convention within the pet food industry.

Providing complete and balanced nutrition

In addition to providing nutrient profiles for dog and cat foods, the AAFCO publication also provides standardised methods for substantiating pet food claims, thus providing a regulatory mechanism for ensuring nutritional adequacy in pet foods. The AAFCO Dog and Cat Food Nutrient Profiles and the AAFCO Feeding Protocols are the only recognised methods for substantiating the nutritional adequacy of “complete and balanced” pet foods. Where a pet food is formulated to provide complete and balanced nutrition based on the AAFCO nutrient profiles, and the known nutrient values of the feed ingredients (or chemical analysis of the diet), the manufacturer can make a claim to this effect. The inference is that all of the nutrient requirements will be met when feeding the diet as the sole dietary intake. However, chemical analysis does not take into account the digestibility and bioavailability of the feed ingredients. Pet food manufacturers have the additional option of conducting feeding trials using AFFCO Feeding Protocols. Products that pass this additional measure of adequacy can include this claim on the label.

Readings

NRC. (2006). Nutrient requirements of dogs and cats. Washington DC: The National Academies Press.

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Self Assessment Questions

1. What are the water requirements of a dog at rest?
2. Which is the true carnivore; dog or cat?
3. Are carbohydrates an essential component of canids and felids? Why or why not?
4. Metabolically, what can canids do that felids cannot? (Hint: beta-carotene and linoleic acid)

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Topic 31

31. Feeding throughout the life cycle

31.1 Feeding management

31.2 Pregnancy and lactation

31.3 Growth

31.4 Geriatric nutrition

31.1 Feeding management

The pet owner or kennel manager has two main options for the feeding management of dogs and cats: 1) free choice or *ad libitum* feeding, and 2) meal feeding. Some of the issues associated with these two options are summarised in table 31.1.

Table 31.1 Comparison of two feeding regimens for dogs and cats

Free-choice (*ad libitum*)	Meal feeding
Easy for owner	Time or portion controlled
Suited to dry food	Portion controlled feeding best for most situations
Animal must self-regulate intake	1-2 meals daily for adults
Reduces noise at feed time for busy kennels	May contribute to gastric dilatation in large breed dogs
Reduces boredom & associated undesirable behaviours	Full control over diet
Intake may increase	Requires knowledge of correct feeding levels
Poor intake may go unnoticed	Guidelines on pet food labels

Insight into the dog and cat's natural feeding behaviour can be gained from their ancestral origins and wild relatives; and should not be overlooked when choosing an appropriate management style for the dog and cat.

The dog's ancestor, the wolf, hunts large prey in packs. The wolf and other wild canids eat rapidly and intermittently - gorging themselves after a kill, and then not eating for an extended period until they kill again. Social facilitation of eating behaviours, whereby dogs will consume more in the presence of other dogs, is characteristic of both wild and domestic canids.

The African wild cat (*Felis libyca*) is the ancestor of the domestic cat, and, in contrast to the ancestral dog, it is a solitary hunter, feeding primarily on small rodents. It is a frequent feeder and eats slowly. Several studies of eating behaviour in domestic cats have shown that when food is available *ad libitum*, cats will eat frequently and randomly over a 24 hour period. In this situation cats will often consume between 9 and 16 meals per day, with each meal providing on average 23 kcal. Interestingly, the caloric value of a small field mouse is approximately 30 kcal.

31.2 Pregnancy and lactation

Pregnancy and lactation places additional demands on the animal which changes their nutrient requirements during this period. To maintain health and support reproductive performance, the nutrient composition and feeding regimen should be adjusted accordingly. In general, a high quality, highly digestible diet should be fed throughout gestation and lactation. If feeding a commercial diet, one that has been formulated for gestation and lactation is recommended.

Feeding the pregnant and lactating bitch

The following feeding regimen is recommended for gestating and lactating bitches:

- Feed maintenance amounts for the first 5-6 weeks
- Increase feed by 25%, then 50% by the end of term
- Weight gain should be 15 to 25%
- Feed 2 to 3 times maintenance amounts during peak lactation (*ad lib.*, or by offering several small meals daily)
- Gradually reduce intake after the 4th week of lactation
- Ensure free access to clean water at all times

Feeding the pregnant and lactating queen

The following feeding regimen is recommended for gestating and lactating queens:

- Gradually increase diet amounts from 2nd week gestation
- Intake should be increased 25 to 50% by end of term
- Feed *ad lib.* and monitor weight gain

Figure 31.2 shows the weight gain patterns and energy needs of queens during gestation and lactation. The cat experiences a linear bodyweight gain from the second week of gestation, whereas the majority of weight gained by the pregnant bitch occurs in the final third of the pregnancy. Sixty percent of bodyweight gain in queens is body fat which is lost gradually during lactation; whereas almost all of the weight gain in pregnant bitches is lost at whelping.

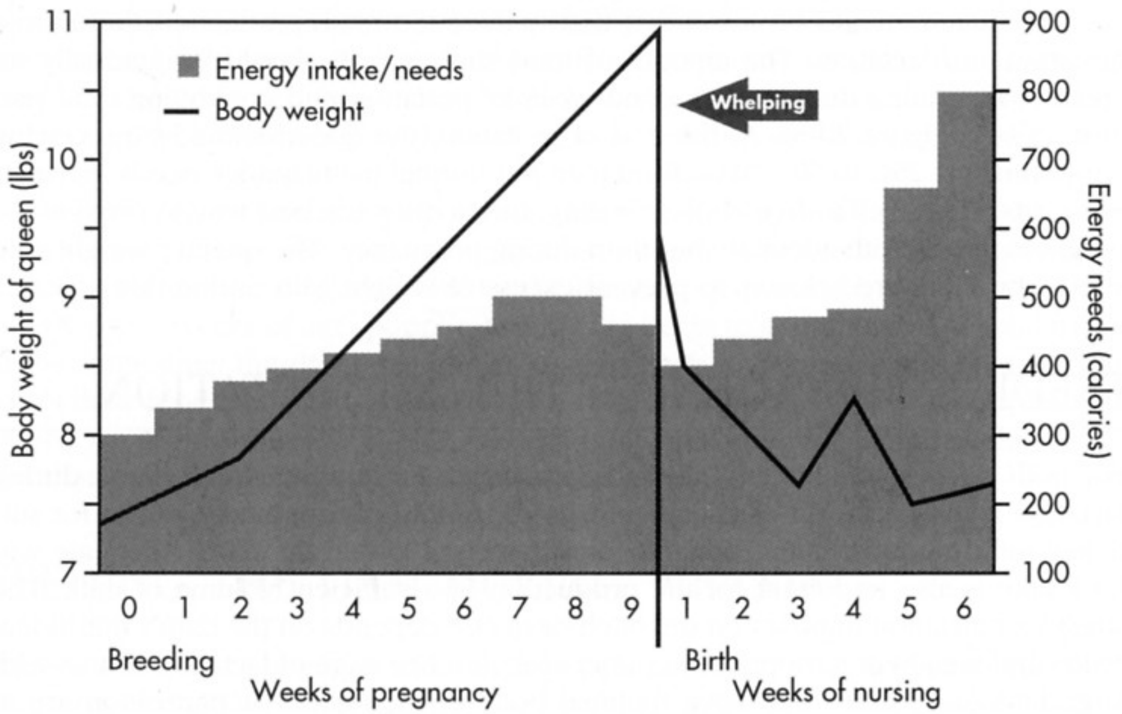

Fig 31.2 Weight gain patterns in queens during gestation and lactation (Case et al, 2000).

Feeding through lactation

Lactation represents one of the greatest challenges to the nutrition of the animal. Dogs and cats that have large litters, or are of low bodyweight at parturition, are at greatest risk. It is vitally important to meet the energy and water needs (2 to 3 times maintenance amounts), as insufficient water and energy intake will result in weight loss and insufficient milk production. Lactating queens and bitches should be fed good quality, highly digestible, nutrient dense diets. Additional nutritional supplements are not necessary.

Eclampsia or "milk fever"

Lactating bitches and queens can be at risk of developing eclampsia or puerperal tetany (commonly referred to as milk fever). The condition occurs most commonly in small breed dogs, immediately before, or 2-3 weeks after, parturition. Eclampsia is caused by the inability of the body to mobilise calcium to the blood following calcium losses from lactation (figure 31.3). Calcium ions in the blood are necessary to stabilise electrical charges across nerve and muscle cell membranes. With depleted calcium stores, cell membranes become hyper-excitable leading to convulsive seizures and tetany. The condition is successfully treated with an intravenous infusion of calcium and rapid recovery normally follows, provided that treatment is provided in time. Symptoms that begin with restlessness, panting and nervousness, can develop rapidly to ataxia, trembling, and convulsive seizures within 8 to 12 hours. Elevated body temperature (107°C is not uncommon) often accompanies the increased muscular activity.

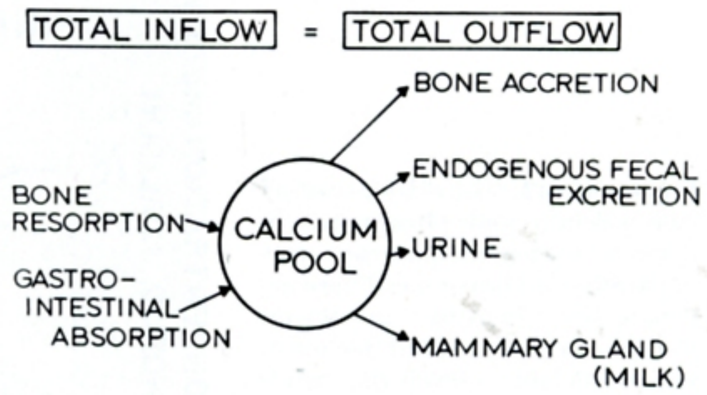

Fig 31.3 An imbalance between the rates of inflow and outflow from the extracellular fluid calcium pool due to increased loss into the milk is an important factor in the pathogenesis of eclampsia in the bitch (Capen & Martin 1983).

Nutritional strategy for prevention of Eclampsia

Feeding diets that are high in calcium during pregnancy is contraindicated as this actually *increases* the incidence of eclampsia. Hypocalcaemia exerts negative feedback on PTH (parathyroid hormone) synthesis and secretion. This results in a decreased ability to mobilise calcium from bone, as well as a decreased ability to increase intestinal absorption of calcium. When calcium demand suddenly increases for lactation, the body is unable to respond. Calcium is diverted preferentially to milk, giving rise to a deficit in the blood.

Moderately low intakes of dietary calcium during pregnancy may help to reduce the risk of eclampsia; however feeding a diet that is formulated for gestation and lactation is the recommended best practice. Commercial diets for this purpose are formulated to deliver complete and balanced nutrition, and should not be supplemented with additional calcium.

31.3 Growth

Good nutrition is particularly important in the first 6 months of a dog or cat's life when the most rapid growth occurs. The growing dog and cat have increased protein and energy requirements, and are more susceptible to having their health compromised by nutritional imbalances. Puppies and kittens should be fed 3 times daily (*ad-lib* feeding is not recommended) for the first 6 months, and then twice daily until the animal reaches maturity. The following is a guideline for the age that maturity is reached:

8-12 months for cats and small dogs

12-18 months for medium-sized dogs

18-24 months for large and giant breeds

Different breeds of dogs vary in their adult bodyweights and grow at different rates (figure 31.4). Consequently, dogs of different breeds and sizes have different nutrient requirements during the growth period. Small and toy breed dogs have higher energy needs per bodyweight than larger dogs. Therefore, diets formulated for growth in small breed dogs have a higher energy and nutrient density, are highly digestible, and have an appropriately small kibble size (for dry foods). Diets intended for growth in large and giant breed dogs are formulated with lower energy, fat, and 30% less calcium and phosphorous than diets for small breed puppies.

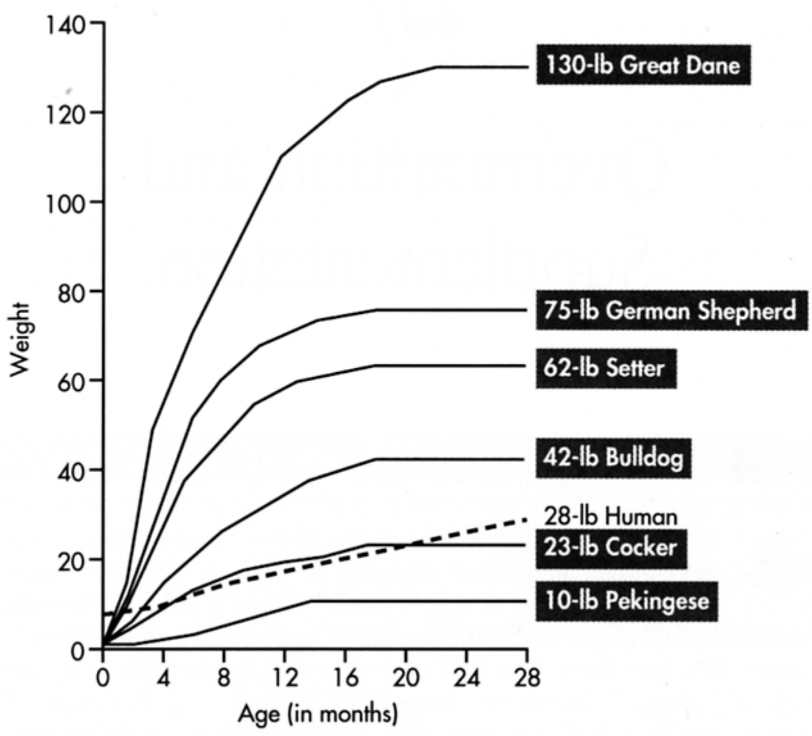

Fig 31.4 Representative growth curves of several dog breeds (adapted from Current Veterinary Therapy V Philadelphia, 1974, WB Saunders).

Optimum versus maximum growth

The large and giant breed dogs have the greatest potential for rapid growth (figure 31.4). However, studies have shown that rapid growth rate is not compatible with optimal skeletal development and maturation. The feeding objective for large and giant breed puppies is to achieve the genetically determined potential adult size, but at a slower rate. In practice, this is achieved by feeding adequate amounts of a balanced diet, and monitoring weight gain and body condition. Large and giant breed puppies should not be fed *ad libitum*. Restricting the diet to promote optimum rather than maximum growth allows the skeleton to develop more slowly, reducing the biomechanical stresses associated with rapid growth.

Calcium supplementation during growth

The routine supplementation of puppy diets with calcium is a common but unnecessary practice. On the contrary, excessive calcium intake has been shown to result in significant skeletal abnormalities, especially in giant breed puppies. Several controlled studies in Great Danes have demonstrated pathological skeletal changes (such as osteochondrosis, radius curvus, decreased bone turnover, and stunted growth) in puppies fed high-calcium diets.

There are several developmental skeletal disorders in dogs for which inappropriate feeding practices during the growth phase are a major contributing factor. These conditions occur most frequently in large and giant breed dogs, usually through over-feeding or over-supplementation of a specific nutrient such as calcium during periods of rapid growth. The most common of these disorders are osteochondrosis, hypertrophic osteodystrophy (HOD), and canine hip dysplasia (CHD). Although some large breed dogs have a genetic predisposition to these disorders, nutrition plays a major role in the expression and progression of these diseases.

Excessive dietary calcium in dogs has also been known to cause a relative deficiency of zinc, possibly through competition for absorption sites. A controlled study found that when supplemental calcium was added to otherwise balanced diets, puppies developed zinc deficiency within 2 to 3 months. Clinical signs accompanying the deficiency were dull coarse hair, impaired growth, anorexia, conjunctivitis and desquamating skin lesions. Clinical cases have also been reported in litters of puppies that, on investigation, had been receiving 2 to 3 times the NRC requirements for calcium. In these cases, clinical symptoms improved dramatically within 7 to 10 days of oral supplementation with zinc.

Calcium deficiency

A deficiency of dietary calcium results in a condition known as nutritional secondary hyperparathyroidism (NSHP), and it has been stated that this is the most commonly encountered nutritional bone disease in dogs (Figure 31.5). The reduced calcium intake stimulates an increase in the secretion of parathyroid hormone (PTH) which causes an increase in calcitriol production which together with PTH stimulates increased bone resorption in an attempt to restore the balance of calcium ions in the extracellular fluids.

Puppies and kittens are most susceptible, and NSHP has been clinically recognised for many years as a consequence of feeding predominantly meat diets. Feeding an all meat diet to dogs of any age will result in NSHP, with varying degrees of skeletal abnormalities. The low calcium content and unfavourable calcium to phosphorous ratio of non-supplemented all meat diets do not meet the daily requirements of these nutrients for either puppies or adult dogs. Kittens fed exclusively on beef hearts develop locomotor disturbances within 4 weeks, as beef hearts contain minimal amounts of calcium and a markedly imbalanced Ca:P ratio (1:20 to 1:50).

Fig 31.5 Nutritional secondary hyperparathyroidism in a young pup, illustrating severe deformities of the fore- and hind limbs (Capen & Martin, 1983).

Calcium deficiencies and other nutritional imbalances can result from the addition of meat to an otherwise balanced diet, as seen in figure 31.6. On this basis, it is recommended that the addition of meat or food scraps, if these are to be used, be restricted to 25% of the diet.

*Nutrient Composition of a Performance Dry Dog Food with Added Proportions of Beef (Dry-Matter Basis)**

Nutrient	Dry Dog Food	75% Dog Food/25% Beef†	50% Dog Food/50% Beef	25% Dog Food/75% Beef
Protein	34%	39%	46%	55%
Fat	23%	24%	25%	26%
Carbohydrate	35%	30%	23%	14%
Crude fiber	1.9%	1.6%	1.3%	0.75%
Calcium	1.3%	1.1%	**0.87%**	**0.53%**
Phosphorus	1.0%	0.89%	**0.73%**	**0.53%**
Calcium:phosphorus ratio	1.3:1	1.2:1	1.2:1	1:1
Potassium	0.87%	0.89%	0.92%	**0.96%**
Sodium	0.60%	0.53%	0.44%	0.31%
Magnesium	0.11%	0.09%	0.08%	**0.06%**
Iron	215 mg/kg	183 mg/kg	142 mg/kg	**85 mg/kg**
Vitamin A	21,700 IU/kg	18,500 IU/kg	14,400 IU/kg	8600 IU/kg
Vitamin D	1950 IU/kg	1670 IU/kg	1290 IU/kg	**770 IU/kg**
Vitamin E	153 IU/kg	130 IU/kg	100 IU/kg	**60 IU/kg**
Thiamin	19.5 mg/kg	16.7 mg/kg	13 mg/kg	7.7 mg/kg
Riboflavin	25 mg/kg	21 mg/kg	16.5 mg/kg	10 mg/kg
Niacin	64 mg/kg	55 mg/kg	42 mg/kg	25 mg/kg
Metabolizable energy (ME)	4700 kcal/kg	4800 kcal/kg	5000 kcal/kg	5200 kcal/kg
Caloric Distribution				
Protein	27%	31%	35%	41%
Fat	45%	45%	47%	48%
Carbohydrate	28%	24%	18%	10%

*Imbalanced nutrients are expressed in bold print. Nutrient levels were compared to the Association of American Feed Control Officials' (AAFCO's) *Nutrient Profiles* and corrected for differences in energy density.

†Beef = fresh ground round.

Fig 31.6 Nutritional imbalances (in bold) from the addition of meat to a dry dog food (Case, *et al*. 2000).

Vitamin C supplementation

The guinea pig is the only companion animal that has a dietary requirement for vitamin C (ascorbic acid). Dogs and cats, like most other animals, synthesise vitamin C in the liver from either glucose or galactose. Nevertheless, many puppies are routinely supplemented with vitamin C, with the belief that this will assist skeletal development, especially in large breed dogs. It is likely that this misconception has been perpetuated from some early publications that suggested a relationship between vitamin C and HOD, a developmental skeletal disorder that occurs primarily in rapidly growing large breed puppies. Controlled studies have since been conducted that clearly demonstrate no beneficial effect of vitamin C on the prevention, development, incidence, or treatment of HOD in dogs.

The two most important nutritional factors in the development of skeletal disease in dogs are excess caloric intake during growth and high calcium intake.

31.4 Geriatric nutrition

Cats and small dogs are considered to be geriatric at around 12 years of age; whereas medium and large breed dogs age much quicker, becoming seniors at 7 to 9 years of age. As a consequence of ageing, resting metabolic rate decreases, resulting in decreased energy needs; digestion may become impaired or slowed; and the ability to de-saturate essential fatty acids decreases. Immune function also declines with age.

Geriatric dogs and cats are likely to benefit from specific dietary supplements, such as gamma-linolenic acid, an omega-6 fatty acid that is important for maintaining healthy skin and coats, as older cats and dogs have a diminished ability to produce this fatty acid from dietary linoleic acid. Supplementation with antioxidants to enhance immunity may also be of benefit. Research in dogs and cats has demonstrated a beneficial effect of antioxidants, such as vitamin E, beta-carotene, and lutein on the immune system; including extended immunity following vaccination and improved learning ability in older dogs.

Chronic renal failure

Chronic renal failure is the major cause of illness and mortality in geriatric cats, and one of the main causes of death in ageing dogs. Kidney insufficiency leads to weight loss, muscle wasting, altered plasma protein profiles, decreased feed intake, intestinal malabsorption and decreased assimilation of nutrients. The accumulation of protein metabolites, such as urea, exacerbates the clinical condition. Therefore, nutrition and dietary management should aim to minimise the accumulation of end products in the blood whilst supplying sufficient energy and crude protein to maintain bodyweight and reduce muscle wastage associated with old age and compromised renal function. In practice, this is achieved by feeding a diet based on high quality protein ingredients. Contrary to earlier views, recent research findings indicate that it is not necessary to feed protein-restricted diets to healthy geriatric dogs and cats, but rather that slight increases in dietary protein may be necessary. The use of high-quality protein ingredients minimises protein end products, and this is preferable to reducing protein intake, which will lead to further muscle wastage. Once clinical conditions have developed, special therapeutic diets are available to address some of the conditions associated with old age, such as kidney disease and arthritis.

Readings

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Self Assessment Questions

1. Based on the natural feeding behaviours of the dog and cat, which feeding regimen do you suggest is most appropriate for each species?
2. Briefly explain why animals of different ages within the same breed have different nutrient requirements.
3. Should large dog breed puppies be supplemented with extra calcium or fed an "all meat" diet? Why or why not?
4. Should vitamin C or vitamin E be fed to older dogs and cats? Explain why.

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Topic 32

32. Diet related health disorders in dogs and cats

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Introduction to the Topic

Amongst the array of health problems afflicting our canine and feline companions, there are those that can be classified as diet-related, being either directly attributable to the diet; or the condition being ameliorated by dietary intervention even where the diet is not the cause of the disease (e.g. some inherited metabolic disorders). This topic covers some of the more common diet-related health disorders in dogs and cats.

32.1 Obesity

Obesity is currently the most common diet-related disorder of the modern-day dog and cat. Today's pets are more likely to suffer complaints related to overindulgence than problems of under-nourishment. One study conducted in the United Kingdom in 1983 assessed 8268 dogs using a clearly identified 5-point scale and found that 24.3% were overweight (Edney & Smith, 1986). The Labrador was found to be the breed most likely to become obese, and the incidence of obesity was twice as high in neutered animals as entire ones. A separate study conducted in Britain in 1970 similarly found that 28% of the 1000 dogs assessed were obese, and this study also recorded the general physique of the owners (Mason, 1970). The results of this study revealed that obesity in dogs increased with age, and was more prevalent in females (32%) than males (23%). Owners that were elderly or obese were most likely to own obese dogs, and Cocker Spaniels, Labradors and Collies were more likely to be obese than other breeds. The relationship between owner and dog obesity is interesting. Whatever interpretation is given for this, it indicates that there is an "owner factor" that must also be taken into account when considering causative factors for this condition. The incidence of obesity in dogs is believed to have increased in recent years, and it is suggested that this might be due to the current trends of feeding highly palatable, energy-dense foods coupled with sedentary lifestyles of our modern-day dogs (Case *et al.*, 2000).

Definition and diagnosis

Obesity is defined as "the excessive accumulation of fat in the adipose storage areas of the body" (Case *et al.*, 2000). Veterinary evaluation of an animal for obesity normally involves a visual assessment and palpation of the animal, and applying a well-defined, body-condition scoring system.

An alternative definition of obesity is based on actual bodyweight: if the bodyweight is in excess of 15-20% above normal (or ideal), then that individual is generally considered to be obese. In the case of purebred dogs, the ideal weights recommended by breed standards can be used as a guideline for normal bodyweights for specific breeds of dogs.

Aetiology

Two types of obesity are recognised. In most cases, obesity arises from an increase in body fat due to an enlargement of the fat cells, or adipocytes, and this is known as hypertrophic obesity. Once an animal reaches adulthood, the body has a limited capacity for increasing the number of fat cells, and no ability for decreasing the number of adipocytes. Obesity initiated in adulthood results from an increase in size of the already established fat cells. A second type of obesity, hyperplastic obesity, occurs from a combination of increased fat cell size and increased number. This condition normally occurs as a result of overfeeding while young animals are growing and results in an increased disposition towards obesity in adulthood, and difficulty in maintaining weight loss. This is due to the excess number of fat cells, all of which maintain their stimulus for lipid deposition, and are resistant to reductions in fat content below a certain minimum level. For this reason, it is important to maintain sufficient, but not excessive nutrition during growth periods in young animals.

Causes

There are many contributing factors in obesity, but primarily, obesity results from an intake of energy in excess to that utilised. In practical terms this implies too much food, or too little exercise. However, as Sibley points out, this generalisation does not fully explain all cases of obesity, and there are other factors to consider (Sibley, 1984).

Diet Composition and palatability

Whilst age, stage of growth and development, and level of activity will all impact on energy requirements; the major factors affecting energy intake in the dog and cat are food availability, composition of the diet, and palatability. Maintenance of ideal of bodyweight can be achieved by careful selection of a diet that matches the energy needs, as well as providing the necessary nutrient requirements. The frequency and quantity of meals needs to be regulated by the owner to ensure that animals do not eat amounts that are in excess to their energy requirements. This is especially the case with highly palatable diets. Palatability is an important characteristic of commercial pet foods, and essential to their marketing. It has been suggested that the greatest factor contributing to obesity in companion animals is the over consumption of highly palatable diets.

The composition of the diet is as important as the quantity when considering the overall energy value of a particular diet. Diets that are high in fats supply the highest amounts of energy and therefore will be most likely to promote weight gain. Dry and semi dry diets provide more energy per kg of food than wet (tinned) diets, which typically contain about 80% water.

Social facilitation in dogs

The effect of social setting on eating behaviour is an additional factor that is important to consider in dogs. Competition for the meal, either perceived or real, is provided by the presence of another animal, and this will stimulate most dogs to eat more rapidly and to consume a greater quantity (Houpt & Hintz, 1978). This process is called *social facilitation*, and is particularly pronounced in dogs (Case *et al.*, 2000).

Inactivity

Significant decreases in energy expenditure can be brought about by inactivity, and this can be an important contributing factor towards obesity in companion animals. The modern-day domesticated dog is most often kept specifically for companionship and as such leads a more sedentary life than the working dog. Further reductions in activity often accompany the ageing dog, and dogs with problems of locomotion. Whatever the cause, decreased physical activity always leads to a direct reduction in energy expenditure, and unless there is a corresponding decrease in energy intake (food), an increase in bodyweight will follow.

Changing energy requirements with age

Having established a suitable diet at a particular stage of a dog's life, the owner often fails to recognise the need to change the diet to match the changing requirements of the dog, particularly as the dog ages and matures. Ageing in the dog, as with humans, is accompanied by a decrease in lean muscle tissue (Harper, 1998), and this results in a decreased basal metabolic rate. The lowered basal metabolic rate, together with reduced physical activity (which is normal in the ageing dog), results in a substantial reduction in the maintenance energy requirements for older dogs. The maintenance energy requirement of an average sized seven-year old dog has been estimated to be 20% less than its requirements as a young adult (Case *et al.*, 2000). A failure to recognise this changing need, can give rise, inadvertently, to obesity.

Effect of de-sexing

The inclination for de-sexed animals to be overweight has long been recognised and surveys conducted in the UK have supported this finding (Anderson, 1973; Edney & Smith, 1986). Anderson and Lewis (1980) consider that this is primarily due to a decrease in physical activity. They point out that the absence of testosterone in the castrated male reduces muscle deposition, and suggest that this might also contribute to obesity, as more energy would be converted to fat. Likewise, these authors suggest that high levels of follicle stimulating hormones (FSH) in the spayed female might contribute to the higher incidence of obesity reported in this group.

Effects of breed

Surveys conducted in the United Kingdom have shown that some breeds have a higher incidence of obesity than others (Edney & Smith, 1986; Mason, 1970), suggesting that genetic predisposition might be a contributing factor towards obesity in dogs. The larger of these two studies surveyed more than 8000 dogs from 11 different veterinary practices (Edney & Smith, 1986). The dog breeds identified as having the highest incidence of obesity were Labradors, Cairns Terriers, Cocker Spaniels, Dachshunds, Shetland Sheepdogs, Basset Hounds, Cavalier King Charles Spaniels, and Beagles. This is consistent with the results of Mason's study, in which 1000 dogs were surveyed, that found Cocker Spaniels, Labradors and Collies were more likely to be obese than other breeds.

Owner effect

The survey conducted by Mason examined the characteristics of the dog owners, as well as the dogs, for possible factors influencing obesity in their pets (Mason, 1970). Mason's study found that obese animals were most likely to be owned by middle-aged and elderly people. In the group of dogs owned by middle-aged people, there was a higher incidence of obesity in dogs with obese owners, than owners who were not obese. It is suggested that this is probably related to exercise levels, as well as feeding regimens, and that the elderly and obese owners are not as likely to be as physically active, and probably do not provide as much exercise for their pets.

Endocrine disease

There are two endocrine disorders found in dogs that can be causal factors in obesity. In hypothyroidism, reduced levels of hormones are produced by the thyroid gland, resulting in a decreased resting metabolic rate, which in turn can lead to obesity. Idiopathic atrophy of the thyroid gland is the most common cause of hypothyroidism in dogs, and this condition occurs most frequently in middle-aged and older dogs. Hypothyroidism occurs more often in de-sexed females than entire ones, and some breeds have a higher incidence than others (Case *et al.*, 2000). In addition to weight gain, animals can be dull and listless; the coat may be coarse and dry; the skin may become hyper-pigmented, and the animal sensitive to cold.

Cushing's syndrome results from an excessive production of corticosteroids by the adrenal cortex, and this can cause an increase in bodyweight. Like hypothyroidism, this condition occurs more often in middle-aged and older dogs and in some breeds more than others. Clinical signs include polyuria (excessive urination), polydipsia (excessive drinking), lethargy, hair loss, and the development of a pendulous abdomen (Case *et al.*, 2000).

Implications for animal health

It has been demonstrated that health problems in humans begin to increase when the bodyweight exceeds 15% above normal (Van Itallie, 1980). Dogs that are overweight also have an increased risk of chronic health problems. As in humans, a clear association has been demonstrated between obesity and problems such as hyper-insulinemia, glucose intolerance, and diabetes (Mattheeuws *et al.*, 1984). It is likely that obesity also contributes to the development of cardiovascular (Rocchini *et al.*, 1987) and pulmonary disease (Case *et al.*, 2000), and to joint and locomotor problems such as arthritis. The results of a five-year controlled study involving 48 Labrador Retrievers found a significant positive correlation between the severity and incidence of osteoarthritis in the hip joints of these dogs with increased bodyweights and levels of feeding (Kealy *et al.*, 1997). In this study, littermates were paired according to gender and bodyweight at 8 weeks of age. One dog from each pair was fed ad-libitum, and the other fed 75% of this amount. Frequency and severity of osteoarthritis was determined by radiographic examinations of the hip joints of all dogs taken when dogs were aged 4m, 6m, and 1, 2, 3, and 5 years. Anderson and Lewis suggest some additional problems that can occur in dogs as a result of obesity (Anderson & Lewis, 1980). These include increased irritability, decreased hepatic function resulting from a fatty liver, increased dystocia, heat intolerance, impaired immune and gastrointestinal function, and skin problems. Obese animals are at increased risk when given anaesthetics, and show increased morbidity and mortality following surgical procedures (Case *et al.*, 2000).

32.3 Periodontal disease

Periodontal disease has been identified as the most frequently occurring clinical condition in both dogs and cats (Lund *et al.*, 1999). The disease begins with the accumulation of bacterial plaque on the tooth surfaces initiating an inflammatory response that affects the supporting tissues of the tooth and eventuates in the total loss of tooth attachment (Hennet, 1995). The texture of the habitual diet is a major contributing factor, with gingivitis and dental deposits being most extensive when dogs are fed soft diets (Burwasser & Hill, 1939; Whitney, 1960; Egelberg, 1965). Interestingly, no such relationship has been established with dietary components (Carlsson & Egelberg, 1965). Periodontal disease occurs most frequently in small breeds of dogs, and in all dogs, the incidence of periodontal disease increases with advancing age (Harvey *et al.*, 1994). As the disease progresses, feeding becomes difficult and painful, and tooth extraction is often recommended, which can be both traumatic and hazardous particularly for the elderly dog.

Periodontal disease is not a newly identified condition in dogs. A study conducted by Talbot in 1899 found that 75% of dogs between the age of 4 and 8 years had periodontal disease, indicating that the condition was as prevalent then as it is today (Talbot, 1899). In 1923, Gray correctly identified the major causes and associated risk factors of the condition, including the feeding of soft diets (Gray, 1923). Later, in 1965, a series of three experiments were conducted by Egelberg and Carlsson, to investigate the local effects of diet on plaque formation and gingivitis in dogs. The combined results of these three experiments indicate that the most important dietary factor influencing dental health in dogs is dietary texture, rather than dietary composition, or the presence of food within the oral environment.

32.5 Inherited metabolic disorders

The inability to absorb, assimilate or metabolise specific nutrients can result in clinical disease. In some cases, this inability arises as a result of an inherited disorder of nutrient metabolism. Several inherited metabolic disorders have been identified in dogs.

Malabsorption of Vitamin B_{12} in Giant Schnauzers

Inherited vitamin B_{12} malabsorption has been identified in Giant Schnauzers, and has not been identified in other breeds. Vitamin B_{12} is required as a coenzyme for several metabolic reactions in the body, and more importantly, for normal DNA synthesis and erythropoiesis. Deficiency results in macrocytic anaemia and neurological impairment. Absorption of vitamin B_{12} from the diet requires the presence of a compound known as the intrinsic factor (IF). Intrinsic factor in dogs is produced by the gastric mucosa and the pancreas, and binds to vitamin B_{12} as it passes through the gastrointestinal tract. The IF-B_{12} complex then attaches to specific receptor sites on the cells of the intestinal mucosa from where it is absorbed into the body. In affected Giant Schnauzers, it appears that the defect is located at the cellular level of the small intestine, and that dogs with inherited vitamin B_{12} malabsorption lack a receptor for the IF-B_{12} complex in their brush border microvilli. The disorder is successfully treated with regular intramuscular injections of vitamin B_{12}.

Copper storage disease

Copper is a vital trace element, required for the transport and absorption of iron, the formation of haemoglobin, and the normal functioning of the cytochrome oxidase enzyme system (Case *et al.*, 2000). These processes require the passage of excess copper through the liver where it is then excreted in bile. Copper toxicosis in the liver sometimes occurs as a secondary disorder to conditions that effect bile excretion causing an accumulation of copper to toxic levels in the liver. There is also an inherited copper-storage disease in dogs, occurring mainly in Bedlington Terriers and West Highland White Terriers, and less frequently in Doberman Pinschers and Cocker Spaniels. This disease is characterised by the impaired removal of copper from the liver, and a resulting accumulation of this mineral as the dog ages. Treatment involves feeding a copper-restricted diet together with medications that either decrease intestinal absorption or increase urinary excretion of copper. Recent evidence suggests that zinc acetate, which acts by blocking the intestinal absorption of copper, may be the best treatment for dogs with this disease (Brewer *et al.*, 1992).

Zinc Malabsorption

Zinc deficiencies and zinc-responsive dermatosis can arise from the feeding of imbalanced diets. Inherited conditions of zinc malabsorption also occur, with varying degrees of severity, in certain breeds of dogs. The most severe of these disorders is the lethal condition of acrodermatitis in Bull Terriers, and involves a complete inability to absorb any amounts of dietary zinc. The average survival time for animals with this condition is 7 months.

A less severe zinc-responsive disorder occurs in Alaskan Malamutes and Siberian Huskies, and occasionally in Great Danes and Doberman Pinschers. The first clinical signs of this disease usually occur at puberty and characteristically include crusting and scaling of the skin around the face, elbows, prepuce and vulva. Oral supplementation of zinc to affected dogs is an effective treatment for this disease, resulting in the rapid disappearance of all clinical signs.

Hyperlipidemia

Hyperlipidemia is an inherited disorder of lipid metabolism that occurs in Miniature Schnauzers. It is diagnosed by elevated levels of triglycerides and/or cholesterol in animals that have been fasted for 12 hours. The underlying cause of this well documented disorder remains unknown. Treatment is by feeding a low-fat, calorie-restricted diet.

Purine metabolism in Dalmatians

Dalmatian dogs are unique amongst the dog breeds in that they excrete uric acid in their urine, rather than allantoin, in the breakdown of nucleic acids, due to a metabolic defect inherent in all Dalmatian dogs (Briggs & Harley, 1986). The excretion of high levels of uric acid in the urine of this breed of dog predisposes them to urate urolithiasis (urinary stones containing uric acid), and some authors consider that the dogs' usual diet may be a contributing factor (Bijster *et al.*, 2001). It is well documented that the administration of purines to Dalmatian dogs, both orally and intravenously, results in corresponding increases in uric acid excretions in the blood and urine (Briggs & Harley, 1986). Therefore, the inclusion of high purine foods in the diet fed to Dalmatian dogs (such as meats, especially organ meats such as liver; seafood; and dried legumes) would also result in increased uric acid excretion. Recommendations to reduce the risk of the formation of urinary calculi in these dogs include feeding a low-protein or low purine diet, and monitoring urine acidity. The reduction of dietary purines reduces the amount of uric acid in the urine that could potentially form urinary calculi, whilst maintaining a high urinary pH prevents their precipitation (Bijster *et al.*, 2001).

There is a commercially available diet recommended for the prevention of urate calculi in dogs (Hill's Prescription Diet® Canine u/d®). However, the long term feeding of this diet, or other diets severely limited in protein, has been questioned, and several cases of dilated cardiomyopathy resulting in congestive heart failure have been reported in Dalmatian dogs maintained on this diet (Freeman *et al.*, 1996). Another disadvantage of prescription diets is that they are only available by veterinary prescription, making the feeding of these diets on a regular basis both costly and inconvenient.

Commercial dog foods cover a wide range of protein levels and sources, and as such, some of these diets could be more suitable for consumption by Dalmatian dogs than others. Dog foods that are high in cereals and vegetable protein, and lowest in meat content, would theoretically be the most suitable diets (lowest in purines) for Dalmatian dogs, and have been recommended by some authors (Thornhill, 1980). To test this theory, researchers at UNE evaluated four commercial diets, an anti-uric acid diet, and an all-meat diet in Dalmatian dogs (Brown *et al.*, 2003). The crude protein content of these diets ranged from 10.4% to 62.5% (dry matter). Dalmatian dogs produced significantly lower amounts of precipitates in their urine when fed low-protein diets than when they were fed high-protein diets or meat. A commercial dry dog food with a crude protein content of 15% was found to be the most effective at reducing urinary precipitates, and equally effective as the special anti-uric acid diet. Importantly, this study demonstrated that it is not necessary to severely restrict the protein content of the diet, as the commercial diet providing 2.2 g/d CP per kg BW was equally effective at reducing urinary precipitates as the prescription diet that provided only 1.3 g/d CP per kg BW. The effect of time and frequency of feeding were also found to be significant factors in the formation of urinary precipitates in Dalmatian dogs. Dogs produced the lowest levels of urinary precipitates when they were fed a single meal offered late in the day.

32.6 Vitamin deficiencies and excesses

Serious vitamin deficiencies are not commonly encountered in pet dogs and cats; however specific nutrient deficiencies and toxicities can arise from inappropriate feeding practices. The most common vitamin disorders and their dietary causes are summarised below (Table 32.1) and described in detail in the following sections. Cats are generally more susceptible to nutritional disorders because of their higher nutrient requirements together with their finicky eating habits. It is not uncommon for cats to develop a fixation for a particular food and, once this has developed, they refuse to eat anything else.

Table 32.1 Vitamin disorders in dogs and cats and their likely dietary causes.

Vitamin disorder	Dietary cause
Vitamin A toxicosis in cats:	Predominantly liver diet

Deforming cervical spondylosis	
Vitamin E deficiency in cats: Pansteatitis	Mainly fish diet, especially red tuna (low in Vit E & high in PUFAs)
Thiamin deficiency	Raw fish diet
Biotin deficiency	Feeding raw egg whites

Vitamin A toxicosis in cats

Excess dietary intakes of fat-soluble vitamins can be toxic to dogs and cats. This is not usually a problem, with the exception of vitamin A. Vitamin A toxicosis occurs most commonly in cats fed a diet that is exclusively or predominantly liver and other organ meats. This results in a condition known as *deforming cervical spondylosis,* a vitamin-A induced skeletal disease of cats characterised by bony outgrowths along the cervical vertebrae and long bones of the forelimbs, causing pain and difficult movement.

Early clinical signs include anorexia, weight loss, and lethargy accompanied by an increased reluctance to move which is noticeable as reduced attempts at grooming creating an unkempt appearance. As the disease progresses, cats adopt a characteristic sitting position with the front legs in the air and a fixed stare. As the condition progresses, lameness develops in the front legs.

The regular inclusion of liver, cod liver oil or other fish oils in the diet over many years (even when added to an otherwise balanced diet) can potentially cause skeletal problems as the vitamin A accumulates in the body.

Vitamin E deficiency in cats

Feeding diets that are marginal in vitamin E and high in polyunsaturated fatty acids (PUFAs) can lead to vitamin E deficiency in cats, resulting in a condition known as *pansteatitis*, or yellow fat disease. The body's requirement for vitamin E (alpha-tocopheral) increases with increasing levels of PUFAs in the diet. When cats are fed diets that are high in PUFAs (such as fish and fish oils) without a corresponding increase in vitamin E to prevent oxidation, reactive peroxides are formed that accumulate in the adipose tissues. Pansteatitis in the cat is characterised by chronic inflammation and a yellowish discolouration of the body fat (determined by biopsy). Visible signs include subcutaneous fatty lumps that are painful when palpated.

Initially, most cases of pansteatitis occurred in cats fed diets of canned red tuna; however the condition can result from diets that are high in fish products generally.

Thiamin deficiency

Some types of fish contain the enzyme *thiaminase* which destroys thiamin (vitamin B_1). The enzyme is heat-labile and readily denatured by normal cooking temperatures. Thiamin deficiency, although uncommon, has been reported in cats fed diets of predominately raw fish. Thiamin deficiency has also been reported in a team of sled dogs after 6 months on a diet of raw carp, one of the fish species known to contain thiaminase. As the central nervous system is affected by a deficiency of this vitamin, neurological signs characterise the advanced condition, and permanent neurological damage can occur.

Biotin deficiency

Egg white contains a substance called *avidin* which, when consumed, binds with biotin in the intestine, preventing its absorption. The regular inclusion of raw egg whites in the diets of dogs and cats can therefore lead to biotin deficiency. This can be prevented by cooking the egg white, thus destroying its ability to bind with biotin. It is also preferable to feed the whole egg, as the yolk contains high amounts of biotin making it less likely to result in biotin deficiency.

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Self Assessment Questions

1. In all but those afflicted by an endocrine disorder, obesity is a preventable disease in companion animals. Briefly describe what obesity is and how it can be prevented.
2. How can periodontal disease be prevented in dogs?
3. What does feeding raw egg whites do to a dog or cat?

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