Feline nutritional peculiarities in health and disease
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To understand the cat’s complex and highly individual pattern of feeding it is important to consider its ancestry. The evolution of cats as strict carnivores has resulted in notable anatomical, nutritional and metabolic adaptations. The domestic cat (Felis catus) is an obligate carnivore adapted to a hunting lifestyle existing on an almost totally animal diet. Its jaws, digestive system and behaviour have been developed to accommodate this behaviour. Cats have a highly adapted metabolism with requirements for nutrients such as taurine, arginine, arachidonic acid and preformed vitamin A, which are only found in meat and fish. Cats have a natural tendency to be neophilic—preferring novel foods over familiar ones—probably to increase nutritional adequacy in the wild. With a desert-dwelling ancestry, cats have also adapted physiologically to a dry environment with a lower thirst stimulus than dogs and the ability to produce highly concentrated urine. Whilst this is beneficial in the desert it can predispose cats to the formation of urinary stones and crystals. Recent studies in feline nutrition have confirmed that adding bovine colostrum to the diet of healthy kittens helps provide local protection against intestinal infections, helps stabilise gut microflora and stimulates a kitten’s immune system—helping improved their immune response and enhance vaccination response. At the other end of a cat’s life, old age is associated with a progressive loss of lean body mass in cats that may be mitigated in part by feeding higher protein levels. In addition, a study showed that a diet containing supplemental antioxidants, PUFAs, and a prebiotic increased longevity and improved health of senior cats.

Sick cats also have specific and unique nutrition needs. Diabetic cats’ exogenous insulin requirements can be dramatically reduced when they are fed a high protein, low carbohydrate diet. Obese cats also benefit from high protein diets as high protein helps maintain lean muscle, reduce fat, increase satiety and improve weight loss in overweight cats. Cats with FLUTD have been shown to benefit from increasing their water intake—either by using a wet diet or by adding moderate (1.2%) sodium levels (salt) to the diet. This level of salt has been demonstrated to be safe in healthy adult cats. Stress is an under recognised cause of intestinal flora imbalance in cats leading to clinical diarrhoea and/or subclinical pathological changes in the gut. There are many proven benefits to the addition of E. Faecium SF68® probiotic in cats and kittens including improved immune function and microfloral balance and stability, reduced incidence of conditions such as conjunctivitis and non specific diarrhoea and improved faecal quality.
Feline Peculiarities in Health

Cats are obligate carnivores

Domestic cats (*Felis catus*) are obligate carnivores designed to eat a predominantly meat-based diet. Anatomically they have teeth designed to seize and tear prey and a short simple digestive system with a quick digestive transit (18-24 hours). As obligate carnivores, some of the metabolic pathways and enzymes present in omnivores are redundant in the cat. Cats’ natural diet is high in animal protein and fat and low in carbohydrate- the only carbohydrates eaten being those semi-digested in the gut of their prey. Cats have very low levels of amylase in their saliva and very low levels of enzymes designed to digest carbohydrates (amylase, maltase, sucrase) in their digestive system. Despite this, cats are able to efficiently digest cooked starch which can therefore be useful as an energy source. The high protein requirement of cats is due to their high requirement for nitrogen. This appears to be because cats have a limited ability to control the activity of their aminotransferases and urea cycle enzymes. Protein is also the main source of energy for cats. The lack of downregulatory control over aminotransferases and urea cycle enzymes renders cats immediately able to metabolise and use amino acids for gluconeogenesis and as an energy source. There are several other nutrients considered essential in feline diets that are not recognised as essential in most other species due to the low activities of enzymes in their synthetic pathways. These are the amino acids arginine and taurine, niacin (vitamin B3), vitamin A and vitamin D. Cats also require linoleic and arachidonic acid (omega-6 fatty acids) as they lack the enzyme to synthesise them from other food components.

Cats require variety

Feral cats are opportunistic hunters and generalist predators- if left to procure food on their own they select from a wide range of prey rather than limiting themselves to a single food source which should increase the nutritional adequacy of their diet. Cats tend to be neophilic- preferring novel or less familiar foods to familiar ones. This may explain some types of finicky behaviour in our domestic cats. A feeding study from Nestlė PURINA shows that cats with a history of dietary variety will initially eat slightly less when offered a novel food for 5 consecutive days, however, by the 5th day they will have returned to their normal eating pattern. While domestic cats no longer need variety for nutrition, they may need it for enjoyment.

Cats are small drinkers and have very concentrated urine

As cats have evolved from desert-dwelling animals which derived most of their water from eating their prey, they do not have a strong natural urge to drink frequently. They can survive on less water than dogs and compensate by producing very concentrated urine. The downside of this natural behaviour is that concentrated urine increases the risk of urolithiasis and urinary crystal formation. In cats prone to FLUTD it may therefore be necessary to provide intervention to increase cats’ water intake. Cats fed a wet diet retain more water and produce more urine than those fed a dry food. Adding 1.2% sodium (salt) to a healthy cat’s diet also increases urine volume and reduces concentration of calculogenic materials in the urine. In a 6 month trial cats fed 1.2% sodium experienced no significant changes in blood pressure, renal function, weight, stool quality or general health. Adding sodium at 1.2% to the diet of cats is therefore considered safe and effective in increasing urine volume and reducing urine concentration.

Kittenhood- support of the feline immune system

Amongst the patients seen in daily veterinary practice, young kittens are some of the most delicate ones,
being frequently presented for investigation of digestive upsets and various infections and infestations that can sometimes be life threatening. The critical lifestage of kittenhood is not only a time when there is a strong demand on the body for growth and development but also is a time when the immune system is still developing and thus not functioning optimally and the intestinal microflora is still unstable. Kittens also undergo many stressful changes during this period ranging from leaving their mother and siblings, to going to a new home and environment - stressors which can adversely affect their intestinal microflora and challenge the function of their immune system.

During the first year of life kittens also experience changes to their immune system. Up until weaning, kittens receive antibodies and other immune components from their mothers’ milk which are vital to protect their health. At weaning the antibody levels drop. Immunity reaches a low around 3 weeks of age which lasts until about 5 months of age when the immune system matures. This is known as the Immunity Gap.

There has been significant recent interest in nutritional immunostimulation to support kittens during this Immunity Gap. Bovine colostrum has been investigated as an immunostimulant as it is rich in growth factors, antibodies, antimicrobial factors and prebiotics. Studies were performed to assess if colostrum could have benefits on the local and systemic immune system in weaned kittens and to evaluate its positive impact on the intestinal flora. Twenty-four domestic shorthair kittens weaned at 12 weeks of age were included in a 44 week trial. Kittens were allocated into one of 2 diet groups- group 1 were fed a high quality kitten food and group 2 were fed the same diet supplemented with colostrum. All kittens received a feline rabies virus vaccine at time 0 and a booster vaccine at week 36. During the test period, kittens were subjected to a mild stress (room relocation) in order to evaluate the faecal microflora stability during a stress event. During the 44 weeks study health parameters were regularly monitored.

The kittens fed with the test diet supplemented with colostrum showed a significantly quicker and stronger response to rabies vaccination. There was a 50% increase in antibody levels in the kittens fed the colostrum-diet compared with kittens fed the control diet (figure 1).

Stimulation of the local intestinal immune system was also observed in the group fed the colostrum- supplemented diet (figure 2). This enhanced local production of antibodies is likely to help protect kittens from potential intestinal infections making them more able to cope with intestinal upsets.

These studies demonstrate that dietary supplementation with natural antibodies and other bio-actives found in colostrum have beneficial health effects in kittens. These compounds help to enhance the kitten’s immature immune system to better respond to challenge, without overstimulation. The compounds also help stabilise the gut microflora, lowering the potential for infection and stress-related diarrhoea. Based on this recent study, PRO PLAN® kitten formulas have been formulated with OPTISTART®, containing natural antibodies and other bioactives from colostrum, and have been proven to reinforce the kitten’s immune system.
**Figure 1.** Colostrum enhances systemic immune status in kittens

**Figure 2.** Colostrum stimulates GALT increase secretory IgA
7+ cats need high levels of high quality dietary protein

Cats over 7 years of age experience:

- Increased Maintenance Energy Requirements: In contrast to dogs and humans, elderly cats may experience an increase in their maintenance energy requirements. This is due to a better-maintained basal metabolic rate and progressive compromise in fat and protein digestion.

- Reduced Digestive function: Mature/senior cats have a lower capacity to digest fat, fat-soluble vitamins and protein. Around one third of cats over the age of 12 do not digest fat and fat soluble vitamins efficiently. They also experience a higher probability of imbalanced microflora and reduced stool quality.

- Loss of lean body mass (figure 3): This can be mitigated in part by feeding high dietary protein levels.

- Variability in body condition (obese then frail): Maintenance energy requirements decrease as cats mature and become middle-aged (4-9 years of age), explaining the tendency of many cats to gain weight during this time. However, energy requirement sharply and progressively increase again in these cat when they become older, starting at 10 to 12 years of age. If daily caloric intake is not increased, progressive weight loss will result, due in large part to the loss of lean body mass (i.e., muscle mass), a phenomenon referred to as the “sarcopenia” of ageing.

- Lower spontaneous activity.

- Increasing likelihood of diseases that may need nutritional intervention.

Diets designed for healthy elderly cats should therefore concentrate on being energy dense, highly digestible with high levels of high quality protein and with an increase in the proportion of protein calories, and being fed with the aim of supporting optimal body weight. There is no evidence to suggest that feeding healthy elderly cats a restricted protein diet will mitigate the risk of them developing renal failure.
Mature/senior cats- nutrition can extend healthy lifespan

Recent studies\textsuperscript{16,17} have proven that cats aged 7 years plus, when fed exclusively on a diet containing supplemental antioxidants, prebiotic fibres (chicory root), and fatty acids lived significantly longer whilst enjoying good health. 90 healthy cats aged 7-17 years were split into 3 equal groups. Group 1 cats were fed a nutritionally complete adult cat food (diet 1). Group 2 were fed diet 1 with added antioxidants (vitamin E and □ carotene) and group 3 were fed diet 1 with a blend of added nutrients known as Longevis\textsuperscript{®}- antioxidants (vitamin E and □ carotene), prebiotics [chicory] and omega-3 and 6 fatty acids.

Results revealed that senior cats fed the diet containing the Longevis\textsuperscript{®} blend lived significantly longer than cats fed a standard nutritionally complete cat food (figure 4). A positive impact on gastrointestinal and endocrine systems was also seen suggesting that Longevis\textsuperscript{®} may contribute to improvements in health as well as increased longevity. Diet 2 (antioxidants only) had no significant difference compared to diet 1 (control).

Cats fed Longevis\textsuperscript{®} also:

- Had stable food intake.
- Maintained better lean bodyweight and bone density
- Maintained higher vitamin E levels.
- Maintained healthier blood parameters.
- Maintained better skin thickness.
- Maintained better balanced intestinal microflora

![Figure 4](image-url) Cats fed longevis\textsuperscript{®} blend had a longer healthy lifespan
Feline peculiarities in disease

Diabetes Mellitus and Carbohydrate Metabolism

Traditional diets recommended for cats with Diabetes Mellitus have been high in fibre to help reduce glucose fluctuations with moderate carbohydrate levels. However, while healthy cats are able to readily use carbohydrates in good quality diets, diabetic cats may not be able to do so as efficiently. A cat’s blood glucose concentration results from a balance between glucose entering the blood (either from gluconeogenesis or absorption from the diet) and the rate of cellular glucose uptake through insulin-mediated and non-insulin mediated mechanisms. Replacing dietary carbohydrate with protein appears to be an effective means of slowing the release of glucose into the bloodstream. Numerous studies have confirmed the benefit of high protein, low carbohydrate diets for diabetic cats, with decreased insulin requirements and/or enhanced glycaemic control when the cats were fed a high protein diet. In fact a number of diabetic cats that received high protein (10-15g protein/100 kcal ME), low carbohydrate (1.7-3.5g/100 kcal ME) diets along with insulin therapy were able to discontinue exogenous insulin altogether.\(^\text{18,19,20}\)

In one study, 9 cats previously fed a high fibre diet were transitioned onto PURINA VETERINARY DIETS DM Diabetes Management® - a high protein, low carbohydrate diet. After 8 weeks all cats were in excellent health. 3 cats no longer required any insulin and all the others were on reduced doses of exogenous insulin without compromising glucose control (See figure 5). Collectively all cats fed DM had a significantly reduced exogenous insulin requirement\(^\text{18}\).

![Figure 5](image-url)

**Figure 5.** Change in insulin dosage in diabetic cats fed Purina Veterinary Diets DM Diabetes Management

Insulin requirements decreased for 89% of cats completing this 8-week trial, from a mean of 4.8 U/day to 2.0 U/day. Three of the nine cats longer required exogenous insulin at the end of the study.

FLUTD (Feline Lower Urinary Tract Disease)

Feline Lower Urinary Tract Disease (FLUTD) is very common in cats- affecting 4-10% of cats admitted to veterinary hospitals. The incidence increases with stress, inactivity, an indoor lifestyle, neutering, obesity, genetics and infrequent urination/low water consumption. Although it can affect cats of any age the incidence peaks in cats aged 2-6 years of age. FLUTD is a syndrome with many causes but the top three are Feline Idiopathic Cystitis, urolithiasis (mainly struvite and calcium oxalate) and urethral plugs. Management of FLUTD includes a dietary change, reducing environmental stress and increasing water intake. Diets to manage FLUTD should be designed to:

- Reduce saturation of urine with urolith precursors & crystals
  - Urine undersaturated or metastable.
  - Increase urine dilution.
- Optimise urine pH.
- Reduce risk of obesity.
- Support the bladder lining (Glycosaminoglycans).
- Help reduce urinary tract inflammation (Omega-3 fatty acids).
- Be easy to use (i.e. manage all 3 main causes of FLUTD).

In order to increase urine volume and dilution in cats with FLUTD veterinary surgeons recommend a number of strategies:

- **Feed a canned food:** Cats who consume canned food take in more water (from food and water) than cats who consume dry food (278 ml vs. 227 ml/day) and produce greater urine volume (166 ml vs. 79 ml/day).
- **Encourage greater drinking from the water bowl.**
  - Fresh water in metal or ceramic bowl- never plastic as this can taint the taste of the water.
  - Fill the bowl right to the top so the cat can see the attractive glistening on the surface of the water.
  - Use a large water bowl so the cat’s whiskers do not touch the bowl whilst she is drinking.
  - Cats are often attracted to drinking running water- running water fountains can be purchased for cats (or leave a tap dripping).
  - Locate water bowls in a peaceful location away from litter tray.
- **Feed a diet containing added salt** (1.2% sodium). 1.2% sodium is safe for healthy adult cats and significantly increases urine volume and reduces urine specific gravity."
Obesity in cats

Obesity is a common and growing problem in the European cat population. High protein has been shown to help obese cats in a number of ways:

- **High protein helps maintain lean muscle and increases fat loss**: In a study of 8 healthy but overweight adult female cats, half the cats were fed a high protein (HP) diet (40% dietary crude protein as fed) and the other half were fed a normal protein (NP) diet (30% dietary crude protein as fed). Both groups were fed the appropriate calorie levels to achieve a 1% weight loss per week. Serum biochemistry and dual energy x-ray absorptiometry (DEXA) analysis were assessed. DEXA allows for the assessment of the cats’ body composition. Cats fed the high protein diet during weight loss preserved their lean muscle tissue and lost more fat than those fed normal moderate protein levels (figure 6).

- **High protein helps increase satiety**: High protein diets decrease subsequent energy intake at the next meal compared to lower protein diets. The mechanisms for this are unclear but there are several theories:
  - A “satiety centre” may exist in the brain which is sensitive to amino acid levels in the blood and once levels reach a certain point, hunger would cease. Therefore cats fed a high protein diet would have higher blood amino acid levels which would “shut off” hunger.

![Figure 6](image-url)  
*Figure 6.* Feeding high dietary protein resulted in greater fat loss and greater retention of lean body mass compared to feeding normal protein levels.
• High protein diets lead to higher CNS leptin sensitivity. Leptin is a hormone whose levels increase in proportion to body fat levels and it acts on the brain to inhibit appetite. An increase in dietary protein from 15% to 30% of energy at a constant carbohydrate intake produces a sustained decrease in ad libitum caloric intake that may be mediated by increased central nervous system leptin sensitivity and results in significant weight loss.

• **High protein helps improve weight loss:**
  - Due to increased satiety and decreased subsequent energy intake.
  - Due to an increase in energy expenditure (greater "thermic effect") - The thermic effect of a food is the increase in energy expenditure above baseline following consumption. Typical thermic effect of protein is 20%–35% of energy consumed and for carbohydrate this number usually falls to between 5% and 15%.

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**Proven benefits of probiotics in cats**

Probiotics are live organisms that when administered in adequate amounts confer a health benefit for the host. Considerable scientific research has led to a clearer understanding of the value of probiotics in the treatment and prevention of a number of disorders. The most widely studied probiotics are strains of *lactobacillus*, *bifidobacterium*, *enterococcus* and *saccharomyces*. The beneficial effects of probiotics may be both species- and strain-specific. To ensure appropriate viability of the organism, very careful production and stabilisation methods are required.

Probiotics have two broad mechanisms of action but within each of these the interactions are complex and varied:

- **Modification of the bacterial flora of the intestinal tract**, for example by:
  - Inhibiting growth of pathogenic bacteria.
  - Inhibiting the adhesion of pathogenic organisms to the intestinal epithelium.
  - Production of bacteriocins (proteins that inhibit other bacteria).
  - Enhancing mucus production.
  - Reducing the luminal pH.

- **Modulation of the immune system**, for example by:
  - Binding to Toll-like receptors and stimulation of innate immune responses.
  - Improved epithelial barrier function (including reduced permeability).
  - Enhanced IgA production and appropriate immune responses.
  - Modification of cytokine responses to reduce excessive inflammation.

The cat’s intestinal flora can become imbalanced for many reasons usually relating to stress. These include during kittenhood and at the senior life stage, as a result of dietary or environmental change or travel and as a result of infections or broad spectrum antibiotic usage. The consequences of intestinal flora imbalance include clinical diarrhoea or subclinical changes in the gut such as increased shedding of pathogenic bacteria, reduced function...
of the protective intestinal barrier, inconsistent faecal quality and increased susceptibility to disease.

PURINA VETERINARY DIETS FortiFlora® contains a strain of *E. faecium* (SF68®) (E 1705) - a lactic acid bacterium that is recognised as a safe, ‘friendly’ bacteria, and valuable probiotic. A unique and proprietary microencapsulation technique ensures the bacteria in FortiFlora® remain viable, and that the product can be used with confidence in its efficacy. In cats, studies have confirmed that feeding SF68® significantly increases beneficial bacteria in the faeces and reduces quantities of potential pathogens (such as clostridia). In clinical trials, SF68® has been shown to significantly improve microfloral balance and stability in cats and kittens, improve the immune status of kittens, reduce the incidence of conjunctivitis in cats infected with feline herpes virus-1 (FHV-1), prevent diarrhoea outbreaks in kittens and reduce non-specific diarrhoea in shelter cats.

Based on these studies, FortiFlora® can be recommended for cats to support the nutritional management or prevention of:

- Acute infectious and non-infectious enteritis (e.g. food intolerance, dietary indiscretion).
- Diarrhoea associated with GI microbial imbalance (e.g. stress, antibiotics, diet change).
- Poor faecal quality in kittens.

FortiFlora® may also have a role to play in other conditions such as:

- Chronic enteropathies, for example, inflammatory bowel disease.
- Promoting optimal immune responses in health and disease.

### Faecal clostridium perfringens in adult cats

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<th>Number of Cats</th>
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Number cats positive for *C. perfringens*
SF68® improves faecal quality in cats with chronic diarrhoea

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<th>Soft, formed</th>
<th>Slightly, formed</th>
<th>Liquid</th>
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Control

E. Faecium® SF86

SF68® prevents diarrhoea outbreaks in kittens

Kittens fed SF68® had lower incidence of spontaneous diarrhoea than controls
Further Reading


5. Nestlé Purina research 2001


