Advances in Puppy & Kitten Health Care

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Nutrition of puppies and kittens: an overview

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Introduction

Balanced nutrition of puppies and kittens is important for optimal growth and functional development. Growth rates, especially in large breed dogs, are high in the first months of life and do not slow down until maturation is achieved at the age of 12-18 months. The availability of essential nutrients, either via the mother during the intrauterine and early postnatal period, or through balanced and functional diets affects a wide range of physiological traits. Growth and maturation are dynamic processes, both finishing at a time point dependent on species and breed. Birth weights of puppies and kittens are lower compared to most other species and dependent on factors such as breed, litter size and adequate nutrition of the mother.

In general, dogs have more biological diversification due to the enormous variation in body size. Puppies of large breeds have relatively lower birth weights compared to puppies of small breeds. Another important issue is that large breeds produce larger litters compared to small breeds, exposing the puppy to a very competitive situation regarding the mother’s milk. These basic physiological facts may be a contributing factor to higher reproductive losses in large breeds compared to smaller breeds.

In cats, litter size has been shown to affect the fate of the kittens. Large litters result in reduced kitten growth and small queens with large litters are particularly at risk. Kittens from small queens and kittens from large litters were weaned at a lower body weight that those of heavy queens or small litters. Under poor environmental conditions, large litters are likely to be less successful than small litters. This underlines the need...
Nutritional influences on intrauterine development

Before placentalation, the embryos are nourished by a liquid surrounding, the so-called yolk sac. After about 3 weeks the uterus wall provides the nutrient supply via placental blood flow (foetal stage). The efficiency of maternal-foetal physiological exchange depends upon the thickness of the interhaemal membrane and upon the maternal-foetal blood flow interrelationship.Embryos that have completed organogenesis are quite sensitive to malnutrition or other diet related adverse effects and over- or undernutrition of the dam can influence the growth and survival of the embryos at this stage. Deficiencies of vitamins or trace elements or the exposure to mycotoxins can lead to embryonic death or to malformations.

Starting with the 5th week of pregnancy the growth of the foetuses increases rapidly and attention must be paid to the nutrition of the mother, both qualitatively and quantitatively. The energy and nutrient supply should be increased 1.5-1.7 fold compared to maintenance requirements. Energy deficiency may develop either due to a low energy density of the food, low palatability or as a consequence of maternal diseases. A lower energy intake during gestation has a severe impact on the birth weight of the offspring. In pregnant cats, restriction of energy intake to 50% of the amount recommended for optimal management, care, and nutrition for optimal litter size. However, balanced nutrition during pregnancy is the most important prerequisite to provide puppies’ and kittens’ optimal functional development and a good start in life.

In pregnant cats, restriction of energy intake to 50% of that normally freely consumed reduced the weights of the cerebral cortex, cerebellum and brain stem in the neonate, and this was not fully compensated in female kittens allowed ad libitum feed intake later in life. Interestingly, the male kittens allowed the ad libitum food access tended to exceed values for these brain regions compared to control males. Bitches and queens should be fed with diets providing sufficient amounts of protein and with a balanced amino acid profile. In cats, taurine supply is crucial for foetal brain development. During pregnancy, taurine intake must meet the requirements to achieve live births and normal development of visual cortex and other regions of the nervous system of kittens. Short term nutrient deficiencies that may occur during pregnancy do not normally negatively influence the physiological status of newborns. However, under- and overfeeding pregnant bitches with macro- and microminerals and vitamins should be avoided. Extremely high or low maternal calcium intake may pose a risk to the development of the skeleton and stress the regulatory hormonal system. Specific attention should be paid to the supply of trace elements. Insufficient intake of iron, zinc, iodine and selenium may impair the maternal and foetal organism. The passage of transferrin bound iron from maternal plasma to the foetuses in cats has been calculated to be only 5 µg/d. This rate of iron transfer would be inadequate to account for the accumulation of iron in the foetus, and part of the iron transfer seems to be accomplished by the transfer of maternal erythrocytes. Vitamins are important for the development of the young and are stored to a certain extent in the mother to provide a functional reserve that can be utilised during lactation. The foetus is not able to accumulate substantial amounts of fat soluble vitamins. However, colostrum quality is dependent on the mother consuming sufficient vitamins during pregnancy. In newborn dogs vitamin A in the plasma was low but increased within four weeks to levels found in adult dogs.

Recent research indicates that the development of the young is influenced by the fat source used in the mother’s diet. Dietary unsaturated fatty acids from the food are incorporated into maternal and foetal tissue, including the brain. Kittens from mothers given different fat sources had different fatty acid composition in brain lipids. Corn oil based diets were capable of maintaining arachidonic acid (AA, 20:4n-6) concentrations in the developing brain and retina of kittens, but only diets actually containing docosahexaenoic acid (DHA, 22:6n-3) allowed for a high accumulation of DHA to support retinal function. Long chain polysaturated fatty acids (LCPUFAs) are required for the development of the retinal function but also for the central nervous system in dogs and cats. Linoleic acid (LA, 18:2n-6) and alpha-linoleic (ALA, 18:3n-3), are the precursors of AA and DHA acid respectively. Both AA and DHA are known to be essential for the function of the brain. It may well be, that preformed AA and DHA are necessary for brain development and long term integrity and function. Clinical manifestations of a deficiency in n-3 LCPUFAs are subtle: decreased visual acuity, abnormal retinal function, polyneuropathy and decreased learning ability have been reported. DHA is required for neurologic growth and development and there are some indications that the rate of synthesis from the precursors ALA is somewhat limited. Diets for breeding dogs and cats should therefore contain sufficient amounts of LCPUFAs, specifically DHA.

Physiological idiosyncrasies in the post-natal period

After birth young puppies and kittens are exposed to lower temperatures compared to the intrauterine milieu. The neonate has to actively regulate body temperature to maintain basic physiological functions, including the immune function. The ability of puppies to regulate and to maintain body temperature in the optimal range is not yet fully developed after birth. The body temperature is influenced directly by milk intake and by environmental temperature. Unfavourable environmental conditions, especially suboptimal temperature, humidity and draught can reduce body temperature. Such a situation can severely affect health and development of the young; in extreme situations it can even impair the vital essential functions. A physiological decrease of body temperature occurs directly after birth. This can be explained by the evaporation of water and is normally not detrimental as long as the environmental conditions are in the optimal range. When the environmental conditions are inadequate, puppies and kittens will lie closely to each other, have increased respiratory rates and will show a general restlessness. Normally, this situation also induces increased anxiety and activity of the queen or the bitch. Healthy puppies and kittens that feel comfortable spend most of the time sleeping. Adequate energy intake is essential in the first phase of life to cover the needs for temperature regulation. The capacity of newborn dogs and cats to maintain optimal body temperature is limited compared to adult animals and it is subjected to a circadian rhythm. The liver is the central organ for the regulation of energy metabolism. The liver of newborn animals represents about 7-10% of the total body mass and it is the main energy store after birth. Newborn puppies and kittens have to meet their energy requirements from the energy stores in the liver until they have ingested colostrum. Hepatic glycogen is the main energy source in newborns because they have limited fat stores. Hepatic glycogen provides enough fuel for 6-8 hours in mature newborns.
Immature puppies have lower energy stores and therefore have a higher need for colostrum as an energy source compared to mature pups. Hepatic glycogen maintains blood sugar levels in the newborn. It has been demonstrated in young dogs that blood sugar levels are subject to considerable variation during the first two days of life before stabilising. In addition to the hepatic glycogen reserve, small amounts of energy are provided by glycerol that is stored in the heart muscle and in lung tissue. Skeletal muscles contain only low concentrations of glycogen. Newborn puppies are also dependent on an adequate intake of other nutrients. After birth, they have only moderate hepatic iron and copper reserves. In dogs the levels of vitamin A and E in liver tissue are normally only moderate hepatic iron and copper reserves. In dogs the levels of vitamin A and E in liver tissue are normally very low, necessitating a sufficient supply of exogenous vitamins.

Newborn dogs and cats are released from a sterile intrauterine environment into a situation that offers more or less favourable living conditions. However, the sudden exposure to variable temperatures after birth may result in rapid changes. The newborn must now adjust to its new environment. The young body has mechanisms to defend itself against these conditions and to maintain its vital functions. The nutrient requirements of newborn dogs and cats change quickly depending on the need for tissue growth and maturation. The functional maturation of the digestive tract of newborns is different compared to adult animals.21 It adapts in the very early postnatal period to the physiological requirements because young animals have reduced renal capacity10 and high protein intakes or inadequate protein quality may affect renal function. Renal clearance of amino acids in puppies becomes similar to the adult pattern after 3-8 weeks.10 It appears that the rapid development of amino acid transport precedes development, or functional maturation of other transport systems.

Fat digestion is well developed in newborn dogs and cats and they are able to digest milk fats very efficiently. Lipase activities have been detected in the milk itself, in the stomach contents and in the pancreas.1 In kittens, gastric lipase activity persists whilst suckling; however, none of the fat digestion has been demonstrated in weaned and adult cats.2 Problems with fat digestion have only been reported with certain milk replacers that had inadequate fat qualities. Adequate intakes of fluid are essential for renal function. If the environmental temperature is too high, dehydration may occur and this can affect renal excretory function.

The digestive and absorptive processes, the digestive tract of newborn dogs and cats has some idiosyncrasies when compared to adult animals. In dogs the foetal pattern of intestinal myoelectrical activity is present up to 15 days after birth, and adult patterns are achieved after 40 days.11 Increases in intestinal dimensions provide a greater capacity for digestion and absorption.11 Rapid enteric growth, mediated by milk intake, also stimulates enteric mucosal growth.12 The stomach volume is relatively small after birth resulting in a reduced capacity for feed intake. The gastric volume increases considerably after the introduction of solid food.13 The concentration of maternal antibodies in the colostrum decreases quickly and it is therefore essential to allow all puppies, especially the last pups born in large litters, to ingest sufficient amounts of colostrum. Critical situations may occur in large litters. Puppies that are delivered first will have a better chance to ingest colostrum with a higher density of maternal antibodies. Puppies that are born later may ingest smaller quantities of colostral antibodies. To achieve optimal colostrum quality, the mother should be fed with a complete and balanced diet during pregnancy and lactation. The intake of protein and essential amino acids, vitamins A and E and vitamins of the B-group are particularly important because these nutrients can affect colostrum quality.

Optimal colostrum specificity is achieved when the mother has been living in the same environment for a long time before delivery of the puppies. Specific problems can be expected when the mother is not able to produce sufficient amounts of colostrum due to diseases or when the mother dies. In those cases it may be necessary, where possible, to use colostrum from other bitches or queens. Colostral milk may be stored in the freezer for about 12 weeks. Enzyme activities can be influenced by diet composition, but some substrates are not suitable for young sucklings. Saccharose and starch induce digestive disturbances because the ability for digestion of these substrates is limited and higher intakes induce a so-called fermentative diarrhoea.30 In such a situation, the intestinal microflora utilises the carbohydrates that have not been digested by the pancreatic or intestinal enzymes leading to increased colonic fermentation rates, the production of lactic acid and subsequent diarrhoea. The pH of the faeces decreases substantially.

Nutrient Digestion

Protein digestion is different in puppies and kittens compared to adults. The ability of the newborn to produce gastric acid is underdeveloped. It can be expected that the secretion of hydrochloric acid increases substantially at the age of three weeks. Before that time the acidity of the gastric chyme is only moderate and probably mainly related to the bacterial formation of organic acids by microorganisms. The weak acidity seems to be sufficient for the coagulation of milk proteins and the subsequent digestion by endopeptidases, but the risk for the passage of pathogenic bacteria through the stomach into the gut increases. Feeding easily digestible protein sources is mandatory in young animals. The amount of protein should be adjusted to the physiological requirements because young animals have reduced renal capacity10 and high protein intakes or inadequate protein quality may affect renal function. Renal clearance of amino acids in puppies becomes similar to the adult pattern after 3-8 weeks.10 It appears that the rapid development of amino acid transport precedes development, or functional maturation of other transport systems.
microscopy and the metabolic activity of the intestinal microflora. After birth, the gastrointestinal tract is colonised by a few bacteria in newborn dogs and cats. However, within a few days the bacterial density increases and the ecology becomes similar to the adult type of microflora.34 Current data on the composition of the intestinal microflora in puppies and kittens shows a clear impact of age and diet, but more specific data using molecular techniques are needed to develop a deeper understanding for the occurrence of defined species. Recent data shows that results from older studies should be interpreted according to the microbiological methods that were used.35

**Practical aspects of feeding newborns**

Healthy newborns will regulate milk intake depending on their requirements.17 When problems occur, it may be necessary to support underdeveloped newborns by separating large litters into two groups, allowing suckling periods of 3-4 hours, so that all puppies or kittens get sufficient time for suckling. For optimal development it is important that colostrum is consumed within the first 12 to 24 hours of life. This allows the young animals to absorb sufficient amounts of colostral antibodies. If necessary, puppies and kittens can be supported by the application of a diluted glucose solution or milk replacer. It is recommended to monitor the weight of each individual puppy and kitten, because any weight loss is considered an unfavourable sign of the health status. It is important to provide sufficient amounts of food, because the energy density of these products varies and are usually lower than in mother’s milk. Milk replacers should be offered in 6-8 small meals equally distributed over the day in very young puppies and kittens it is necessary to stimulate gut motility and defaecation by massaging the ventral abdominal region because the defaecation reflexes are not yet developed.18

Once the puppy and kitten is fully weaned onto an appropriate lifestyle diet for adolescents it’s important that their weight gain is closely monitored. Feeding guidelines provided for both puppies and kittens should be fine tuned for each individual to ensure that their weight gain is closely monitored. Feeding amounts of food, that have to be diluted with adequate amounts of water. For optimal development it is necessary to support underdeveloped newborns by separating large litters into two groups, allowing suckling periods of 3-4 hours, so that all puppies or kittens get sufficient time for suckling. For optimal development it is important that colostrum is consumed within the first 12 to 24 hours of life. This allows the young animals to absorb sufficient amounts of colostral antibodies. If necessary, puppies and kittens can be supported by the application of a diluted glucose solution or milk replacer. It is recommended to monitor the weight of each individual puppy and kitten, because any weight loss is considered an unfavourable sign of the health status. It is important to provide sufficient amounts of food, because the energy density of these products varies and are usually lower than in mother’s milk. Milk replacers should be offered in 6-8 small meals equally distributed over the day in very young puppies and kittens it is necessary to stimulate gut motility and defaecation by massaging the ventral abdominal region because the defaecation reflexes are not yet developed.18

**Summary**

Physiological nutrition of newborns and dogs is more than just fulfilling requirements. The nutritional status during neonatal development and in the growth period impacts body development and organ function and over- or undernutrition should be avoided. The interaction of nutrients with the gene expression profiles requires further investigation. Nutrition follows genetics and should be optimised to ensure health and longevity of cats and dogs.

**References**


