Canine Nutrition

Nutrients

- A nutrient is any component of food that helps to support life.
- These can be divided into six basic categories, including:

  -water

  -carbohydrates

  -protein

  -fat

  -vitamins

  -minerals

Nutrients continued...

- Nutrients are considered essential if they:
  -act as a structural component
  -participate in metabolism
  -transport substances into or throughout the body
  -maintain temperature
  -supply energy
- Whatever the nutrient is, there is a "safe" zone of adequate nutrient intake, with toxicities and deficiencies being possible for all nutrients.

Water

- Water is considered the most important of all nutrients, being vital to life. It has four basic functions:

  -it acts as the solvent into which substances are dissolved and transported throughout the body

  -it is necessary for numerous chemical reactions

  -it helps to regulate body temperature (water can "hold" heat quite well to maintain temperature, and can evaporate to lower it)

  -it provides shape and resilience to bodies, such as lubricating joints and providing skin elasticity

- Water is one of the largest components of the body, ranging based on species and age. In general, water composes between 40% and 80% of the body. The requirements for water intake are generally met through food and drink. If deficiencies do exist, thirst helps to ensure the balance is met.
- Even small factors of dehydration can lead to ill health, and if it escalates, to death (generally requires at least 15% dehydration). Over-hydration is possible, although rare, and can lead to issues such as pulmonary congestion.

Carbohydrates

- Carbohydrates are made up of carbon, hydrogen, and oxygen. They are composed of a general molecular formula of (CH2O)n, and can be sub-divided into two basic groups; simple and complex carbohydrates.
- Complex carbohydrates can be further divided, based on their digestibility.

- Starches are complex carbohydrates that can be digested by the animal's digestive enzymes, whereas fibers cannot and require digestion through microbial fermentation.
- The function of simple carbohydrates and starches is to provide a source of glucose for the body. They are also used as building blocks for other nutrients, and when in excess of the body's immediate energy requirements, simple carbohydrates and starches are stored as glycogen, or they are converted to fat.

- Carbohydrates supply about 4kcal/g. Although there is no actual minimum requirement of carbohydrates, they can be considered "conditionally essential" in times of growth and high-energy needs. In these situations, food should contain at least 20% carbohydrates.

- Although fibers resist digestion, they have important functions. They increase fecal bulk and water content of intestinal contents. They also promote and regulate normal bowel function. Fibers can also be used to give animals a feeling of "fullness" during weight loss programs.

- Specific organs and tissues, such as the brain and RBCs, require glucose for energy.
- Because the body strives to maintain an energy supply to these key tissues/organs, if the dietary intake is inadequate, then amino acids and fats will be re-directed from muscle growth, fetal growth, and milk production in favour of glucose synthesis.

Protein

- Proteins are made up of various combinations of amino acids and they are the principal structural components of tissues and organs. They also function as hormones, antibodies, and enzymes.
- Similarly to carbohydrates, they supply approximately 4kcal/g. There are 10 essential amino acids for dogs, meaning they cannot be synthesized by the body and must be supplied by the diet. It can therefore be argued that animals do not have a protein requirement, but amino acid requirements.

- If a protein contains optimal proportions of all essential amino acids, it is considered a high quality protein, whereas low quality proteins lack one or more essential amino acids.
- Protein deficiency causes various clinical signs, including reduced growth, reduced milk production, poor coat, anaemia, infertility, and reduced immune status.
- Toxicities from proteins and amino acids can occur, but these are rare, especially when the protein source is plant or animal based. It occurs more often when synthetic amino acids are incorrectly added to foods.

- Many sources provide protein to pet foods.
- Examples of animal tissues are:

  -chicken

  -turkey

  -fish

  -beef

  -lamb

  -kangaroo

  -viscera (livers, lungs, and spleens)

- Examples of commonly used plant sources of proteins are:

  -rice

  -corn

  -wheat

  -barley
- Some plant sources, such as soybean meal and corn gluten meal, are quite concentrated. Multiple sources of protein are typically combined to improve to overall quality and amino acid profile of the feed.

Fats & Oils (Lipids)

- Lipids are high energy compounds, supplying 2.25 times the energy of proteins and carbohydrates; approximately 9kcal/g. Lipids which are solid at room temperature are fats, and those liquid at room temperature are oils.
- Functions of lipids include:

  -supplying energy

  -providing essential fatty acids

  -providing a suitable environment for fat-soluble vitamin absorption (A, D, E, and K)

  -providing insulation

- Omega-6 and omega-3 fatty acids are considered essential. O-6 fatty acids are required for growth, reproduction, and as precursors of eicosanoid and prostaglandin synthesis (EXPAND).
- O-3 fatty acids are required for brain and retinal function. Both families contribute to cell membrane fluidity and skin health.
- Processing of EFA in pet foods can decrease their effectiveness; this is why supplementation with these fats can be beneficial for brain, eye, joint, skin, and coat health.

- Increasing fat and oil concentrations tends to increase the palatability of food.
- There are numerous plant and animal fats and oils used in commercial pet foods.
- When animals consume specific fats, it alters their profile of fats for storage and metabolism. "You are what you eat“ applies more to fats than the other macronutrients.

Vitamins

- A vitamin is a substance that:

  -is an organic compound different from fats, proteins, and carbohydrates

  -must be a component of the diet

  -must be essential in minute amounts for normal physiological function

  -deficiencies can exist

  -must not be synthesized in sufficient quantities for normal function
- Vitamins must meet all 5 criteria, and therefore, are species-specific (vitamin C is essential for primates and guinea pigs, but not for most other species).

- Two major groups of vitamins exist; fat soluble (A, D, E, and K) and water-soluble (B vitamins and vitamin C).
- In general, fat-soluble vitamins are stored in lipid centers of tissues. This makes them more resistant to deficiency, but then also more likely to cause toxicity.
- Water-soluble vitamins are essentially the opposite. They are depleted quicker due to limited storage, so they are less likely to cause toxicity than leading to a deficiency.

Minerals

- Minerals are all inorganic substances of food (what makes up the majority of ash after combustion of organic substances).
- Basic functions of minerals include:

  -Structural components of the body, including bones and teeth (calcium, magnesium, and phosphorus)

  -Components of body fluids (blood, CSF, and gastric juices)

  -Enzymes and hormones

- Different sources of food not only have various amounts of minerals, but they can differ in how much of it can be used by the animal. Factors include:

  -The chemical form of the mineral

  -The amount present

  -Interactions with other chemicals

  -The individual animal (age, gender, etc.)

  -Intake and need (if there are body stores available)

  -Environmental factors (K, Mg, Ca)

Energy

- Energy itself is not a nutrient, but fats, carbohydrates, and proteins contain energy within their chemical bonds.
- All organisms and body functions require energy, and the ultimate source of energy is the sun.
- Photosynthesis is a process whereby plants use the sun's energy to transform carbon dioxide and water into energy-containing nutrients.
- Animals then eat these plants, or other animals which have eaten them.

- The energy content of food determines the amount of food consumed by the animal.
- Energy, therefore, determines the amount of other nutrients consumed, so they must be balanced with the energy content.
- If the diet is very energy-dense, then the other nutrients must also be present in higher amounts to ensure their dietary requirements are met.
- Conversely, if the energy content is low, then the other nutrients should be present in lower amounts to help avoid toxicity.

Requirements of the Various Nutrients

- As a general rule, animals require approximately 2-3mL of water per kilogram of body weight per hour per day (or approximately 50mL/kg/day).
- For example, a 10kg Frenchie requires 20-30mL of water per hour, or approximately 500mL per day.

- The need for glucose is greatly increased during pregnancy for fetal growth and development, and during lactation for lactose synthesis in milk.
- Different studies have been performed to determine canine needs.
- Dogs have been fed high fat, carbohydrate-free with 26% of ME from protein.
- These bitches developed hypoglycaemia in the week prior to whelping, had reduced live birth numbers, were themselves more lethargic and had reduced mothering ability, relative to bitches fed diets with 44% of ME as starch.

- Research shows that starch-free diets in pregnant bitches need a minimum of 33% ME from protein in order to successfully provide glucose precursors.
- For this reason, it is recommended to have a minimum of 23% carbohydrate in diets for pregnant and lactating bitches, with excess typically not being a concern in dogs (dry dog foods typically contain 30-60% carbohydrates).
- Low glycaemic indices are considered beneficial in certain cases, such as obesity and diabetes. Here, the blood glucose levels after eating are better controlled.

- As with other nutrients, more protein is required during growth, pregnancy/lactation, and disease.
- The amount of protein included in a diet is dependant on how much food the animal consumes.
- If they consume an energy-dense diet, then a higher protein content is needed to meet needs, but if the energy content is low, then the protein content may also be lower and still meet requirements (because larger portions are consumed).

- As mentioned, requirements vary depending on the protein quality.
- A growing dog requires about 18% DM protein and an adult dog 8% DM protein from a high quality protein.
- Commonly used protein sources in dog foods are more of a moderate quality, and they should be at least 22% for growth and 18% for maintenance.

- Calories supplied by fats can be more beneficial than those from proteins or carbohydrates.
- An example is when there is a high-energy demand, and if the limiting factor is food intake, then an increased fat content will increase the energy content.
- Dietary fat also provides the physical environment for the gut to absorb vitamins A, D, E, and K. No specific type of fat is required for this, but fats need to account for at least 1-2% of the diet for this to occur properly.
- Lipid deficiencies can lead to various conditions, ranging from poor skin to reduced wound healing, fetal death and emaciation.

- Lipid excess does not necessarily lead to fat animals. It does increase the energy available in food, and if there is already ample energy available from other nutrients, then it can alter body composition.
- Excessive unsaturated fats in the diet along with inadequate antioxidants can result in "yellow fat disease". Here, the body fat becomes rancid, and affected animals are depressed, anorexic, lethargic, and often febrile.
- This causes them to move stiffly and be painful when handled due to inflamed subcutaneous fat, but can be treated by correcting the diet and adding oral vitamin E until clinical signs resolve.

- As with other nutrients, vitamin requirements depend on multiple factors, including lifestage, growth, and reproduction.
- Additionally, there are "antivitamins", which act to reduce the activity of certain vitamins.
- Thiaminases exist in some raw fish or shellfish, brussel sprouts, and red cabbage.
- Thiaminases can deactivate thiamine, however, can be destroyed through adequate cooking (but not freezing).
- Avidin is another antivitamin, and is found in raw egg whites. This binds biotin and can lead to its deficiency.
- Biotin can help regulate blood glucose and promote healthy fur growth.

- Most commercial pet foods contain added vitamins. Additions are required because:

  -It is difficult to have diets adequate in all vitamins just from ingredient sources

  -There are disputed requirement levels

  -Processing can affect stability and availability
- Because commercial diets have added vitamins, supplementing further with additional multivitamins (and minerals) is usually not necessary (but may be warranted if disease affects vitamin metabolism, such as ratsak toxicity).

- There are at least 18 minerals that are considered essential for mammals.
- Macrominerals are those required in percentage amounts within the diet, whereas microminerals ("trace") are required in "parts per million" (mg/kg or ppm).

- Of the 18 essentials, 7 are macrominerals:
  -calcium
  -phosphorus
  -magnesium
  -sodium
  -potassium
  -sulfur
  -chloride

- At least 11 are microminerals:
  -iron
  -zinc
  -copper
  -iodine
  -selenium
  -manganese
  -cobalt
  -molybdenum
  -flourine
  -boron
  -chromium

- Different names and terms have been given for determining energy requirements, including:

  -basal energy requirement

  -resting energy requirement

  -maintenance energy requirement

  -daily energy requirement (DER), which is most commonly referred to, as it is most practical.
- Predictive values for DER have been calculated by determining the RER and multiplying this by certain factors, depending on:

-size (smaller animals produce more heat per unit of body weight, relative to larger animals)

-age and life-stage (younger animals are typically more active)

-growth (increased requirements decline as animals approach maturity)

-reproduction (most fetal growth occurs in the last third of gestation, and lactation greatly increases demand)

-activity (standing requires 40% more energy than lying down)

-thermoregulation (if in a cold environment, 10-90% more energy may be required than in optimal environments)

-neuter status (debate whether weight gain is due to increased appetite or reduced expenditure)

-breed (coat and body composition can reduce energy needs; husky compared to great dane)

-gender (important in humans, but no obvious effect in dogs)

-disease status (responding to disease at a cellular level requires increased energy)

-expected weight loss/gain

Food Labels

- AAFCO is the Association of American Feed Control Officials.
- It is the recognized information source for pet food labeling, ingredient definitions, official terms, and standardized feed testing methods.
- Their values are adequate to meet the known nutrient requirements of most healthy dogs and cats.
- AAFCO has developed model laws and regulations, however, these are not directly enforceable as AAFCO is not a government agency.

- There are certain percentage rules with label terminology:

  -Non-specified terms ("beef", "chicken", etc.) requires that those ingredients be at least 95% of the total weight of all ingredients, exclusive of water, and no less than 70% of the total product.

  -Specified terms, such as "beef dinner", "beef formula", "beef platter", "beef entre", etc. requires that beef be at least 25% of the total weight of ingredients, exclusive of water, and no less than 10% of the total product.

-"With beef" quantifies minor ingredients, where beef must be at least 3% of the total product.

-"Flavour" ("beef flavour", "chicken flavour", etc.) requires no minimum percentage, but is generally used when that ingredient is less than 3% of the total product.

-This also applies to moisture content; maximum moisture content of commercial foods is 78%, but can be higher if terms such as "gravy", "broth", "stew", or "juice" are used.

- Individual ingredients are generally listed in descending order based on their weight in the product as a whole.
- This can be misleading if the manufacturer puts a "better" ingredient higher on the list because it is heavier due to water-weight, or apparently less-desirable ingredients misleadingly appear lower in the list if they are listed separately (wheat meal, wheat bran, and wheat flour vs. wheat products).

- Specific claims, such as "no fillers" are misleading, as some people consider ingredients other than meat and vitamins as "fillers" (including grains and animal by-products), but these can be excellent nutrient sources.
- "Complete and balanced" diets can sustain the animal on their own. If this claim is not made, then the food is likely better suited as a treat or addition to another diet.

Pet Food Forms

- The two main categories are "dry food" and "wet food".
- Wet foods have a moisture content typically of at least 60%, but can be much higher.
- Dry food has a moisture content of 3-11%.
- Semi-moist (or semi-dry) foods have a moisture content between 25-35%.
- Small differences in moisture content can seem trivial, but actually represent large differences in non-water nutrients.

Specific Foods

- In general, these are divided into life-stage (puppy or growth, adult or maintenance, and geriatric or senior), or special-needs groups (urinary, renal, dental, etc).
- The energy content available in different diets based on life-stage tends to reduce as the life-stage increases.
- Large and giant breed puppies tend to have less regulated calcium retention. Because of this, the calcium content in feeds specific to them have tighter ranges of calcium content, and more specific calcium to phosphorus ratios.

- Dental food kibble tends to stay intact more, so it maintains contact with the tooth longer as it goes through.
- This provides great mechanical cleaning.
- Renal diets have lower protein and phosphorus levels than typical diets to help limit their impact on the kidneys.
- Urinary diets can alter the pH and content of urine to make it less likely than certain crystals and stones form, while reducing the digestible carbohydrate portion available can benefit cancer patients.
- Many special-needs diets exist and can be an integral component of treatment in certain cases.

Home-Made Diets

- These are often based on the concept that the food we eat must be of a certain standard, and if we care about our pets then they deserve this as well.
- Some people believe that human foods are inherently superior to pet foods.
- The truth is that humans and pets have different nutritional needs, and most commercial pet foods are better balanced to meet these needs than "human" food.

- Many homemade diets for dogs contain excessive protein, but are deficient in calcium, vitamins, and microminerals.
- Commonly used meat and carbohydrate sources contain more phosphorus than calcium, which can affect the dog's ratio, and most contain excessive meat, providing (again) excessive phosphorus and exceeding the protein requirement.
- Many people do make complete and balanced home-made diets, but it can be difficult to do so, but many references are available.
- Pets do not need human food to be healthy, but it can provide variety as a portion of it.

BARF and Raw, Meaty Bones

- Home-made diets have paved the way for more specific, commercial and non-commercial diets.
- BARF advocates feeding raw meaty bones daily, with additions of offal, vegetables, and other supplements (such as yogurt, kelp, oils, and herbs).
- This can be purchased or made at home.
- The "raw, meaty bones" diet is based on the notion that dogs are carnivores.
- The animal parts supplied depend on the size of the dog (chicken necks for smaller dogs, and carcasses and thigh bones for larger dogs).

- Bowls are not deemed necessary with this diet, as the gathered dirt and grass is theorized to supply the necessary vitamins and minerals from the earth.
- Dogs are fed approximately 3% of their body weight daily, or about 20% over a week.
- The feed can be in bulk pieces with portions then refrigerated for the following day.
- If pieces are buried, it is likely because an excess has been provided.
- Dogs fed these diets typically do have good teeth (unless broken), as the bones physically scrape them and seem to improve gum health.
- However, raw diets are subject to decomposition and can lead to bacterial infections.
- They can be suitable for some, but may not be balanced and complete for the majority.

Choosing Between Different Foods

- Palatibility, digestibility, stool quantity and quality, and cost can be used in diet selection.
- Palatibility includes the taste and smell of the food, its texture, moisture and "acceptance" (willingness to eat it) and "preference" (choosing it over other options).
- Digestibility and stool can be considered together.
- Fecal volume correlates with overall dry-matter digestibility.
- Fecal consistency is affected by GIT motility and colonic function. Higher digestibility improves both.

- Food cost can be a gimmick; some people believe that because it costs more, it must be superior.
- More expensive diets often do have more expensive ingredients, but food cost is directly dependant on its energy content and digestibility.
- The lower these are, then more of the food is required, so even if cheaper per unit, more units means more cost.
- There are obviously many factors to consider, but no diet is "best", and certain diets can be more beneficial in certain circumstances.