

# YOUR DOG'S NUTRITIONAL NEEDS

A Science-Based Guide For Pet Owners

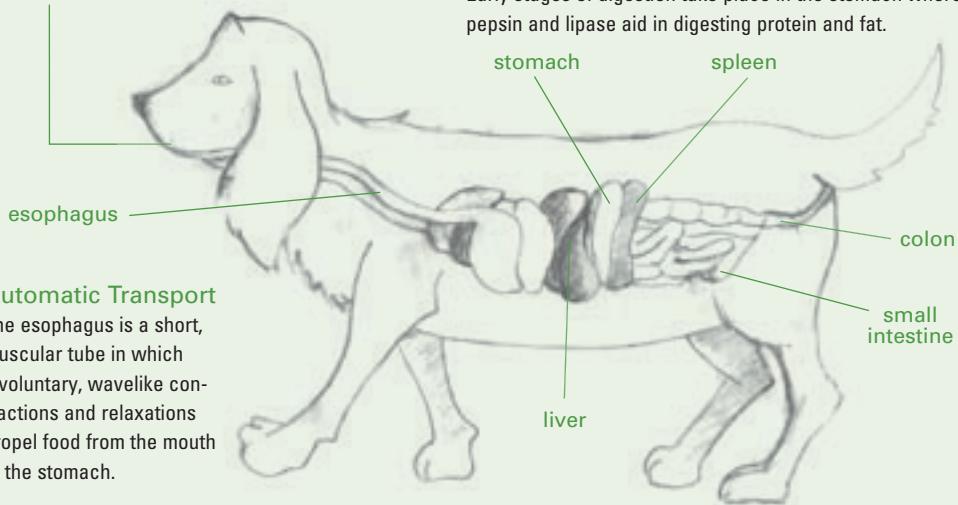


NATIONAL RESEARCH COUNCIL  
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# THE DIGESTIVE TRACT

## Point of Departure

The mechanical breakdown of food begins in the mouth, where food is ingested, chewed, and swallowed.



## Automatic Transport

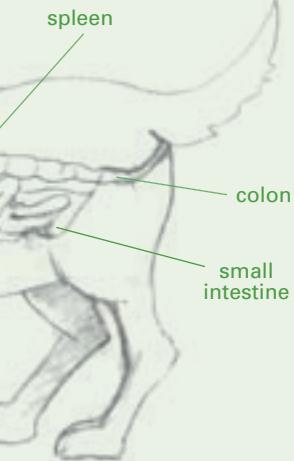
The esophagus is a short, muscular tube in which involuntary, wavelike contractions and relaxations propel food from the mouth to the stomach.

## Treatment Facilities

In the small intestine, enzymes break down large, complex food molecules into simpler units that can be absorbed into the bloodstream. The pancreas is an organ that does double duty, secreting digestive enzymes into the gut and hormones, including insulin and glucagon, into the blood. Important for fat metabolism, the liver produces bile and partially stores it in the gall bladder between meals.

## Storage and Processing

The stomach acts as a temporary storage and processing facility before emptying its contents into the small intestine. Early stages of digestion take place in the stomach where pepsin and lipase aid in digesting protein and fat.



## End of the Line

The primary function of the large intestine is to absorb electrolytes and water. Also, this is where microbes ferment nutrients that have so far escaped digestion and absorption.

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Support for this pamphlet was provided by the President's Circle Communications Initiative of the National Academies. The pamphlet was written by Dale Feuer based on a report by the Committee on Nutrient Requirements of Dogs and Cats. Illustration and design by Van Nguyen.

Copies of *Nutrient Requirements of Dogs and Cats* are available from the National Academies Press, 500 Fifth Street, N.W., Washington, DC 20001; 800-624-6242 or 202-334-3313 (in the Washington area); <http://www.nap.edu>.

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## INTRODUCTION

How much should I feed my dog? Does the food I'm providing meet my dog's nutritional needs? As our knowledge of the relationship between diet and health continues to advance and as the range of foods available for dogs continues to expand, it's more important than ever to base feeding choices on good information.

The information in this pamphlet is based on *Nutrient Requirements of Dogs and Cats*, a technical report issued by the National Research Council as part of its Animal Nutrition Series. The Food and Drug Administration relies on information in the report to regulate and ensure the safety of pet foods. Other reports in the series address the nutritional needs of horses, dairy cattle, beef cattle, nonhuman primates, swine, and small ruminants. Scientists who study the nutritional needs of animals use the Animal Nutrition Series to guide future research. The series is also used by animal owners, caretakers, and veterinarians to develop specialized diets for individual animals. Links to reports in the series can be found at <http://dels.nas.edu/banr>.



Dogs need several different kinds of nutrients to survive: **amino acids from proteins, fatty acids and carbohydrates, vitamins, minerals, and water**. The tables in this pamphlet provide recommended daily allowances for dietary nutrients based on the minimum amount required to maintain good health in normal dogs. Your dog's unique nutritional requirements will depend on its size, its breed, and its stage in life, among other factors. A better understanding of how dogs use the various nutrients in food and how much of them they need can help you choose a healthier diet for your pet.

## PROTEINS AND AMINO ACIDS

Dogs cannot survive without protein in their diets. Dietary protein contains 10 specific amino acids that dogs cannot make on their own. Known as essential amino acids, they provide the building blocks for many important biologically active compounds and proteins. In addition, they donate the carbon chains needed to make glucose for energy. High-quality proteins have a good balance of all of the essential amino acids. Studies show that dogs can tell when their food lacks a single amino acid and will avoid such a meal.

Dogs are known to selectively choose foods that are high in protein. Whether this is simply a matter of taste or a complex response to their biological needs for all 10 essential amino acids is not known. However, dogs can survive on a vegetarian diet as long as it contains sufficient protein and is supplemented with vitamin D.

## FATS AND FATTY ACIDS

Dietary fats, mainly derived from animal fats and the seed oils of various plants, provide the most concentrated source of energy in the diet. They supply essential fatty acids that cannot be synthesized in the body and serve as carriers for important fat-soluble vitamins. Fatty acids play a role in cell structure and function. Food fats tend to enhance the taste and texture of the dog's food as well.

Essential fatty acids are necessary to keep your dog's skin and coat healthy. Puppies fed ultralow-fat diets develop dry, coarse hair and skin lesions that become increasingly vulnerable to infections. Deficiencies in the so-called "omega-3" family of essential fatty acids may be associated with vision problems and impaired learning ability. Another family of essential fatty acids called "omega-6" has been shown to have important physiologic effects in the body.

## DAILY RECOMMENDED ALLOWANCES FOR PROTEIN AND FATS

|               | PUPPIES<br>(Weighing 12 lb, 33 lb at maturity) | ADULT DOGS<br>(Weighing 33 lb) | PREGNANT/NURSING DOGS<br>(Weighing 33 lb with 6 puppies) |
|---------------|--|--------------------------------|--|
| Crude Protein | 56 g   | 25 g                           | 69 g/158 g   |
| Total Fat     | 21 g   | 14 g                           | 29 g/67 g  |

### Determining Grams of Essential Nutrients from Petfood Labels

Petfood labels do not generally list amounts of essential nutrients in grams. However, all pet food labels must state guarantees for the minimum percentages of crude\* protein and crude fat, and the maximum percentages of crude fiber and moisture. To convert these percentages to grams, simply multiply the crude percentages times the weight of your dog's daily portion. For example, if you feed your dog a 1-lb (454-gram) can of food per day, and the food contains 8% crude protein, the grams of protein would be  $0.08 \times 454 = 36$  grams.

\*"Crude" refers to the specific method of testing the product, not to the quality of the nutrient itself.

### TIDBIT

Scientific research has shown that an adult dog's daily diet can contain up to 50% carbohydrates by weight, including 2.5–4.5% from fiber. A minimum of approximately 5.5% of the diet should come from fats and 10% from protein.

## ENERGY NEEDS

Dogs need a certain amount of energy to sustain the normal activities of their daily lives. Growth, pregnancy, lactation, and exercise all increase these normal energy requirements. Generally measured in terms of calories, energy comes from three major dietary components: **carbohydrates, protein, and fats**.

Omnivorous animals get some of their energy from carbohydrates, which include sugars, starches, and dietary fibers. The major sources of carbohydrates in commercial dog foods are cereals, legumes, and other plant foodstuffs. So-called absorbable carbohydrates, including glucose and fructose, can be directly absorbed and do not need to be digested by enzymes. Digestible carbohydrates are readily broken down by intestinal tract enzymes. Fermentable carbohydrates include certain starches and dietary fibers that pass undigested through the small intestine to the colon, where they are fermented by microbes into short-chain fatty acids and gases. Some studies suggest that fermentable fibers may aid in the regulation of blood glucose concentrations and enhance immune function. Nonfermentable fibers, such as cellulose and wheat bran, contribute little in terms of energy or nutrition and are primarily used to decrease caloric intake of the overweight animal.

## AVERAGE DAILY ENERGY NEEDS

| TYPE OF DOG  | CALORIES PER DAY<br>(Kilocalories per day*) |       |       |       |       |
|--|---|-------|-------|-------|-------|
|  | 10 lb                                       | 30 lb | 50 lb | 70 lb | 90 lb |
| PUPPIES (10 lb puppy growing to 33 lb at maturity)   | 990   | —     | —     | —     | —     |
| INACTIVE DOGS—dogs with little stimulus or opportunity to exercise.  | 296   | 674   | 989   | 1,272 | 1,540 |
| ADULT ACTIVE DOGS—dogs with strong stimulus and ample opportunity to exercise, such as dogs in households with more than one dog, in the country or with a large yard. | 404   | 922   | 1,353 | 1,740 | 2,100 |
| PREGNANT DOGS—from 4 weeks after mating until delivery.  | 518   | 1,274 | 1,940 | 2,570 | 3,170 |
| YOUNG ADULT ACTIVE DOGS  | 436   | 993   | 1,451 | 1,876 | 2,264 |
| OLDER ACTIVE DOGS  | 327   | 745   | 1,093 | 1,407 | 1,700 |

\*1 Calorie = 1 kilocalorie = 1,000 calories. The term Calorie that is used on food nutrition labels is really a “food calorie” sometimes called a “large calorie.” It is equivalent to 1,000 calories (or 1 kilocalorie) as calories are defined scientifically (the amount of energy needed to warm 1 gram of water 1°C). In Nutrient Requirements of Dogs and Cats, energy needs are expressed in terms of kilocalories, which are equivalent to Calories in this document.

| Number<br>of Puppies | ENERGY NEEDS IN CALORIES<br>(Calories per Day for a 33 lb and 50 lb Nursing Dog) |       |       |       |          |       |       |       |
|----------------------|--|-------|-------|-------|----------|-------|-------|-------|
|                      | Weeks into Lactation   |       |       |       |          |       |       |       |
|                      | 1  |       | 2     |       | 3 (peak) |       | 4     |       |
|                      | 33 lb  | 50 lb | 33 lb | 50 lb | 33 lb    | 50 lb | 33 lb | 50 lb |
| 2                    | 1,645  | 2,328 | 1,789 | 2,546 | 1,897    | 2,709 | 1,969 | 2,818 |
| 4                    | 2,185  | 3,146 | 2,473 | 3,581 | 2,689    | 3,909 | 2,833 | 4,127 |
| 6                    | 2,455  | 3,555 | 2,815 | 4,100 | 3,084    | 4,509 | 3,265 | 4,782 |
| 8                    | 2,725  | 3,964 | 3,157 | 4,618 | 3,481    | 5,109 | 3,697 | 5,437 |

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### TIDBIT

Severe illness or trauma may increase a dog's energy needs. Whenever your dog becomes ill, please consult with your veterinarian or dog nutritionist for your dog's changed nutritional needs.

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## ENERGY NEEDS OF GROWING PUPPIES

The growing puppy starts out needing about twice as many calories per pound of body weight as an adult dog of the same breed. Owners should start feeding puppies food at approximately 4 weeks after birth, because mother's milk is no longer sufficient. Food is best offered to puppies in multiple, well-spaced meals.

## ENERGY NEEDS OF OLDER DOGS

Because of decreased physical activity and slowed metabolism, older dogs need 20% fewer total calories than do middle-aged adult dogs. As dogs age, they tend to become overweight. It may take obese dogs longer for their blood glucose concentrations to return to normal. This disrupted carbohydrate metabolism can lead to diabetes.

## ENERGY NEEDS OF LACTATING DOGS

New mothers generally suckle their puppies for at least 6 weeks. The mother's need for calories increase with the number of puppies and the week of lactation, up to 4 weeks. Giant breeds (like Great Danes) have proportionately smaller digestive tracts and may not be able to eat enough to sustain themselves during lactation. Owners of such dogs may need to start feeding puppies supplemental food at an early age.



# VITAMINS

Vitamins are organic compounds that take part in a wide range of metabolic activities. Dogs require vitamins in their food, albeit at low concentrations. First noticed in dogs some 75 years ago, vitamin deficiencies can cause a variety of health problems. Clinical signs of vitamin A deficiency, one of the first deficiencies studied in dogs, include motor and vision impairment, skin lesions, respiratory ailments, and increased susceptibility to infections. Dogs fed diets lacking vitamin E show signs of skeletal muscle breakdown, reproductive failure, and retinal degeneration. Thiamin deficiency can lead to brain lesions and other neurological abnormalities if the deprivation is sudden and to heart damage and death if it is chronic. Some vitamins, such as vitamin D, are not only essential in small doses, but also toxic in excess amounts.



## DAILY RECOMMENDED ALLOWANCES FOR VITAMINS

|                  | FUNCTIONS  | RECOMMENDED ALLOWANCE* | SIGNS OF DEFICIENCY/EXCESS  |
|------------------|--|------------------------|---|
| <b>Vitamin A</b> | Vision; growth; immune function; fetal development; cellular differentiation; transmembrane protein transfer | 379 µg                 | Anorexia; body weight loss; ataxia; conjunctivitis; corneal disorders; skin lesions; respiratory ailments; increased susceptibility to infection<br><b>Imbalance in bone remodeling processes; artery and vein degeneration; dehydration; central nervous system depression; joint pain</b> |
| <b>Vitamin D</b> | Maintenance of mineral status; phosphorous balance   | 3.4 µg                 | Rickets; lethargy; loss of muscle tone; bone swelling and bending<br><b>Anorexia; weakness; diarrhea; vomiting; calcification of soft tissue; excessive mineralization of long bones; dehydration; dry and brittle hair; muscle atrophy</b>   |
| <b>Vitamin E</b> | Defense against oxidative damage   | 8 mg                   | Degeneration of skeletal muscle; reproductive failure; retinal degeneration   |

|  |  |         |   |
|--|--|---------|---|
| <b>Vitamin K</b>                       | Activation of clotting factors, bone proteins, and other proteins  | 0.41 mg | No reports of naturally occurring deficiencies in normal dogs   |
| <b>Vitamin B<sub>1</sub> (Thiamin)</b> | Energy and carbohydrate metabolism; activation of ion channels in neural tissue  | 0.56 mg | Failure to grow, weight loss and neurological abnormalities in puppies; damage to the nervous system and to the heart in adult dogs                             |
| <b>Riboflavin</b>                      | Enzyme functions   | 1.3 mg  | Anorexia; weight loss; muscular weakness; flaking dermatitis; eye lesions   |
| <b>Vitamin B<sub>6</sub></b>           | Glucose generation; red blood cell function; niacin synthesis; nervous system function; immune response; hormone regulation; gene activation | 0.4 mg  | Anorexia and weight loss in puppies; convulsions, muscle twitching, and anemia in adult dogs<br><b>Impairment of motor control and balance; muscle weakness</b> |
| <b>Niacin</b>                          | Enzyme functions   | 4 mg    | Anorexia; weight loss; inflammation of the lips, cheeks, and throat; profuse salivation; bloody diarrhea<br><b>Bloody feces; convulsions</b>                    |
| <b>Pantothenic Acid</b>                | Energy metabolism  | 4 mg    | Erratic food intake; sudden prostration or coma; rapid respiratory and heart rates; convulsions; gastrointestinal symptoms; reduced antibody production         |
| <b>Vitamin B<sub>12</sub></b>          | Enzyme functions   | 9 µg    | Appetite loss; lack of white blood cells; anemia; bone marrow changes   |
| <b>Folic Acid</b>                      | Amino acid and nucleotide metabolism; mitochondrial protein synthesis  | 68 µg   | Weight loss; decline in hemoglobin concentration  |
| <b>Choline</b>                         | Phospholipid cell membrane component   | 425 mg  | Loss of body weight; fatty liver  |

\*Daily needs for an adult dog weighing 33 pounds, consuming 1,000 Calories per day.  
g = grams; mg = milligrams; µg = micrograms



## MINERALS

Twelve minerals in the table are known to be essential nutrients for dogs. Calcium and phosphorus are crucial to strong bones and teeth. Dogs need magnesium, potassium, and sodium for nerve impulse transmission, muscle contraction, and cell signaling. Many minerals that are present only in minute amounts in the body, including selenium, copper, and molybdenum, act as helpers in a wide variety of enzymatic reactions.

Dogs can get too much or too little of a specific mineral in their diets. A deficiency of dietary calcium, for instance, causes a condition known as secondary hyperparathyroidism.

Recognized clinically for many years in dogs fed meals consisting mainly of meat, this disease results in major bone loss, skeletal abnormalities, and pathological fractures. An excess of calcium, on the other hand, may also cause skeletal abnormalities, especially in growing large-breed puppies.

### DAILY RECOMMENDED ALLOWANCES FOR MINERALS

|                   | FUNCTIONS  | DAILY<br>RECOMMENDED<br>ALLOWANCE* | SIGNS OF<br>DEFICIENCY/EXCESS   |
|-------------------|--|------------------------------------|---|
| <b>Calcium</b>    | Formation of bones and teeth; blood coagulation; nerve impulse transmission; muscle contraction; cell signaling                  | 1 g                                | Nutritional secondary hyperparathyroidism; significant decreases in bone mineral content, which can result in major skeletal abnormalities<br><b>Different types of skeletal aberrations, especially in growing puppies of large breeds</b> |
| <b>Phosphorus</b> | Skeletal structure; DNA and RNA structure; energy metabolism; locomotion; acid-base balance                                      | 0.75 g                             | Reduced weight gain; poor appetite; bowing and swelling of forelimbs in puppies   |
| <b>Magnesium</b>  | Enzyme functions; muscle and nerve-cell membrane stability; hormone secretion and function; mineral structure of bones and teeth | 150 mg                             | Reduction in weight gain, irritability, and convulsions in puppies; hyperextension of carpal joints and hind-leg paralysis later in life  |

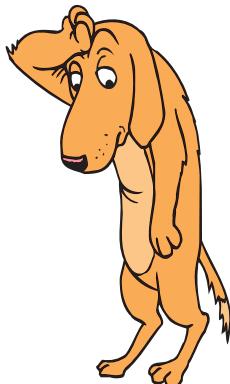
|                  |   |        |   |
|------------------|---|--------|---|
| <b>Sodium</b>    | Acid-base balance; regulation of osmotic pressure; nerve impulse generation and transmission  | 200 mg | Restlessness; increased heart rate, water intake, and hemoglobin concentration; dry and tacky mucous membranes  |
| <b>Potassium</b> | Acid-base balance; nerve-impulse transmission; enzymatic reactions; transport functions   | 1 g    | Poor growth in puppies; paralysis of neck muscles and rear legs and general weakness later in life  |
| <b>Chlorine</b>  | Acid-base balance; transfer of extracellular fluids across cell membranes   | 300 mg | Reduced weight gain and weakness in puppies   |
| <b>Iron</b>      | Synthesis of blood components; energy metabolism  | 7.5 mg | Poor growth; pale mucous membranes; lethargy; weakness; diarrhea<br><b>At acute levels, dangerous oxidative reactions that lead to gastrointestinal and other tissue damage</b> |
| <b>Copper</b>    | Connective tissue formation; iron metabolism; blood cell formation; melanin pigment formation; myelin formation; defense against oxidative damage | 1.5 mg | Loss of hair pigmentation in puppies; anemia  |
| <b>Zinc</b>      | Enzyme reactions; cell replication; protein and carbohydrate metabolism; skin function; wound healing   | 15 mg  | Poor weight gain; vomiting; skin lesions  |
| <b>Manganese</b> | Enzyme functions; bone development; neurological function   | 1.2 mg | No studies of deficiency in dogs  |
| <b>Selenium</b>  | Defense against oxidative damage; immune response   | 90 µg  | Anorexia; depression; breathing discomfort; coma; muscular degeneration   |
| <b>Iodine</b>    | Thyroid hormone synthesis; cell differentiation; growth and development of puppies; regulation of metabolic rate                                  | 220 µg | Enlargement of thyroid glands; dry, sparse hair coat; weight gain<br><b>Excessive tearing, salivation, and nasal discharge; dandruff</b>  |

\*Daily needs for an adult dog weighing 33 pounds, consuming 1,000 Calories per day.

g = grams; mg = milligrams; µg = micrograms

## UNDERWEIGHT OR OVERWEIGHT?

### UNDERWEIGHT



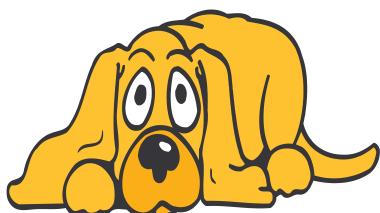
Your dog is not getting enough to eat if you can easily see its ribs, vertebrae, and pelvic bones, feel no fat on the bones, and possibly notice some loss of muscle mass. If chronically underfed, adult dogs may experience impaired ability to nurse young and perform work, and increased susceptibility to bacterial infections and parasites; puppies may be stunted in their growth; adult dogs may develop osteoporosis.

### IDEAL



Your dog is at an ideal weight if you can easily feel its ribs. The waist should be easily observed behind the ribs when viewed from above. An abdominal tuck is evident when viewed from the side.

### OVERWEIGHT



Your dog is overweight if you cannot feel its ribs, see fat deposits over its back and the base of its tail, discern no waist behind the ribs when viewed from above, and see no abdominal tuck in profile. Obesity occurs in one out of four dogs in western societies. Its incidence increases with age and is more common in neutered animals. Health risks include diabetes and osteoarthritis.

# FEEDING PRACTICES

## *Q: Does my dog need to eat meat?*

A: Because dogs are descended from omnivores, they are not strict meat eaters. They are remarkably adaptable to a wide range of ingredients, texture, and form in terms of what they will eat. Though many dogs may prefer animal-based protein, they can thrive on a vegetarian diet. Regardless of whether the protein comes from plant or animal sources, normal adult dogs should get at least 10% of their total calories from protein. Older dogs appear to require somewhat more protein to maintain their protein reserves, perhaps as much as 50% more.

## *Q: How much fiber is good for my dog?*

A: Fiber in the diet is probably good for overall gastrointestinal health and may help some dogs keep their weight down. The typical diet of normal adult dogs contains between 2.5 and 4.5% fiber. However, the fiber content of some “diet” dog foods may be higher. This may allow the dog to feel full without consuming too many calories for effective weight control. Diets high in fiber also may help in the management of hyperglycemia (high blood sugar), and may improve large intestine function.

On the other hand, too much fiber in the diet can decrease the digestibility of other important nutrients and result in loose stools, frequent defecation, and reduced palatability of the dog food. Wheat bran and barley products are high in fiber. Conversely, dog food ingredients high in starch, including rice and dried potatoes, have less fiber.

## *Q: How often should I feed my dog?*

A: Dogs eat larger, less frequent meals than do cats. It is fine to feed an adult dog one or two times per day. Puppies, however, need two to three daily meals.

## *Q: How can I help my overweight dog trim down?*

A: The most obvious answer is to feed your dog smaller amounts on the same feeding schedule. Some dog owners offer less tasty food or allow less time to eat. Another option is to feed your dog one of the low-calorie dog foods on the market. It's also important to remember to keep your dog from sampling the dog-next-door's food and to refrain from giving your dog table scraps.

## *Q: How do heat and exercise affect the amount of water my dog needs?*

A: Fresh water should be available to your dog at all times to reduce the risk of becoming overheated. A dog's need for water increases in keeping with the amount of energy he expends during exercise, and this need may more than double in warm conditions. Ideally, you should actively offer your dog water during exercise.



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## TIDBIT

Exposure to certain flavors and textures of food early in life can shape strong preferences later on.

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# FOOD CHOICES

Commercial dog foods come in a variety of forms. The most common types are **dry, semimoist, and canned**. The moisture content of these foods ranges from 6 to 10 % for dry, 15 to 30% for semimoist, and 75% for canned. Most canned food has relatively more fat and protein and fewer carbohydrates than

does dry and semi-moist food, and generally contains much higher levels of animal products.

Pet food labels must list the percentage of protein, fat, fiber, and water in the food. When reading labels, it is important to remember that what may appear to be a big difference in the amount of a nutrient—for example, 8% protein in a canned dog food vs. 27% protein in a dry dog food—reflects the fact that there is more water in the canned food.

## PET FOOD ADDITIVES

Some other substances that might be found in pet foods, which are not required nutrients, are described below:

**Chondroprotective agents** are used by the body to make cartilage and joint tissues. Although, use of chondroprotective agents may be indicated for selected clinical conditions, widespread inclusion in the diets of healthy populations may not be warranted at this time.

**Antioxidants** work to prevent oxidative damage to nutrients and other compounds in the body and inhibit or quench the formation of free radicals. At this time, data are lacking to make specific recommendations beyond those for the essential vitamins and minerals that are components of antioxidants.



**Herbs and botanicals** are used in pet foods either to provide flavor or, more often, to have a medicinal effect on the body. This is especially true in the case of extracts, where the classical nutritive components of the plant may be separated from the extract in the process. Because the intended functions are more pharmacologic versus nutritional in nature, discussion of potential benefit is beyond the scope of this publication.

**Flavors and extracts** derived from animal tissues such as poultry or fish are considered "natural" flavors. A wide variety of flavors can be derived from other animal and plant materials, including dairy products, eggs, herbs, and spices. Acceptable processing methods include roasting, extraction, and fermentation. Except for artificial smoke and bacon flavors, synthetic substances are rarely used in most dog and cat foods.

**Colors** are synthetic compounds used to replace or accentuate the inherent color of the food. Only certified colors approved for use in human foods are allowed in pet foods. Iron oxide is a synthetic but noncertified color that can be used at levels not to exceed 0.25% of the pet food product to give dog and cat food a red, meaty appearance. Titanium dioxide is another common color additive in human and pet foods because it can induce a "brightness" in foods by complementing other color additives. Its use is limited to 1% of the food by weight.

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### TIDBIT

Pet foods marketed as "snacks" are not required to have nutritional adequacy labels.

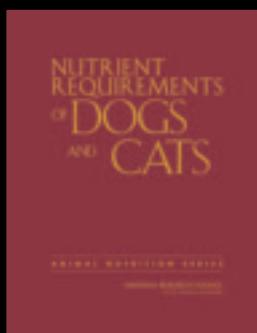
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For more than 80 years, the National Academies has fostered improved understanding of the nutritional needs of pets, wildlife, laboratory-research species, and food-producing animals through its Nutrient Requirements of Domestic Animals series—a series that is considered the “gold standard” for animal nutrition in the United States and worldwide.

This pamphlet is based on recommendations from the 2006 release of *Nutrient Requirements of Dogs and Cats*. The report contains useful information for companion animal nutritionists, veterinarians, scientists in industry and academe, regulators, pet owners and anyone with an interest in the health and welfare of these important animals. To order the report, contact the National Academies Press, 500 Fifth Street NW, Washington, DC 20001; (800) 624-6242 or <http://www.nap.edu>.



For more information, contact the Board on Agriculture and Natural Resources (BANR) at **202-334-3062** or visit <http://dels.nas.edu/banr>. BANR is part of the National Academies’ Division on Earth and Life Studies. Sign up for the division’s free e-mail notifications of new reports, projects, committees, and events at <http://dels.nas.edu>.

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