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Nutrition and Thyroid Function Affect Canine Behavior and Cognition

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Nutrition, Behavior & Cognitive Aging

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Dogs have been “man’s best friend” for thousands of years. In fact, dogs are thought to be the first animal species domesticated by humans, about 15,000 years ago. While they were likely first selectively bred to perform specific jobs, such as hunting, shepherding and guarding, it’s thought that for about the last 2,000 years dogs have primarily served as companions. As anyone who has been “owned” by a dog knows, the human-canine bond runs deep, and for the most part the relationship is mutually beneficial and rewarding. But tinkering with the genome of any species has its price.

Dogs, after all, are a species of canid—social predators that include the wolves, foxes, coyotes and jackals. Considering that dogs “speak” a different language than humans, they have adapted amazingly well to domestic life. Cross-breeding of dogs over thousands of years has produced more than 400 domestic breeds that today bear little genetic and behavioral resemblance to their wild ancestors. But even though our dogs often seem to understand us better than our closest human friends, they are still not “furry people,” and they sometimes exhibit problem behaviors -- including aggression, disobedience, destructive behavior, excessive barking, running away and house soiling -- considered disruptive by their human caretakers. Sadly, millions of dogs a year are relinquished to shelters, with an estimated three to six million of them euthanized due to “behavior problems”. Even those that manage to avoid euthanasia often face a grim future; once a dog has been labeled with behavioral issues, it is difficult for him to overcome the stigma. Approximately 20% of adopted shelter dogs are returned, and many are euthanized.

Unfortunately, when a dog “misbehaves,” nutrition is rarely considered to be a possible contributing factor. But, with what we now know about the ability of food to communicate with the genome, we need to take a closer look at how this relationship affects a dog’s *behavioral health* as well as his physiological health. While little clinical research has been conducted in this area, evidence shows that dietary components *can* modulate the behavior of both humans and animals.

Canine Cognitive Dysfunction (CCD), for example, can lead to anxiety, lack of sociability, house soiling and many other behavioral changes, while hypothyroidism, discussed further below, is associated with abnormal behaviors such as anxiety, phobias, irritability and attention-deficit disorder.

Dietary influences on your dog's behavior and steps you can take to maximize his cognitive function are outlined below:

High-Glycemic Index (GI) Carbs

High-GI carbs sabotage brain health by negatively affecting behavior as well as contributing to numerous chronic illnesses in dogs. Have you ever experienced a child who becomes wildly hyperactive shortly after consuming a sugary food or drink, and then “crashes” into a state of sluggishness a couple of hours later? We agree with Colleen Paige, who in *The Good Behavior Book for Dogs* states that high-GI foods such as corn and wheat create similar mood swings in dogs as they do in people.

After ingesting these foods, dogs experience a “sugar high” (e.g., hyperactivity and lack of focus) that owners often mistake as “ill-mannered” and “uncooperative” behavior, but which are actually food-related. This “high” is followed by a “low,” which Paige says can cause dogs to become “sleepy, lethargic, moody and irritable”.

Impaired glucose metabolism caused by sugary foods may also promote brain starvation, leading to memory problems such as Alzheimer's disease, which is very similar to CCD in dogs. Diabetic people have four times the risk of developing Alzheimer's, while those with pre-diabetes have triple the risk. High-glycemic foods can also lead to hunger-related behavioral problems. Simple carbohydrates digest and absorb quickly (hence the rapid rise and fall in blood sugar concentrations), leaving dogs feeling hungry again quicker. This effect can lead to undesirable begging behaviors or even munching on inappropriate “foods” such as shoes and furniture.

Curbing behavioral problems is just one more reason to skip high-glycemic carbs and instead feed your dog a more satiating diet containing wholesome, functional carbohydrates.

Tryptophan and Tyrosine

Tryptophan and tyrosine are amino acids that act as precursors to neurotransmitters, the chemical messengers in the brain that transmit signals between neurons and help regulate mood. Neurotransmitters play an important role in regulating everything from heartbeat and digestion to mood and behavior.

Every wonder why you feel calm and tired after eating a big Thanksgiving or other holiday meal? Other than the fact that your stomach is full, it's likely because turkey contains tryptophan, a large neutral amino acid. Tryptophan is the precursor to serotonin, a neurotransmitter that promotes a sense of relaxation and well being. When tryptophan crosses the blood-brain barrier, it can double serotonin synthesis in the brain. Serotonin affects many parts of the brain, including those involved in controlling appetite, pain, general mood and behavior. Insufficient levels of dietary tryptophan have been associated with aggressive behavior, depression and elevated stress hormone levels such as cortisol in laboratory animals, dogs, livestock and people. Studies have also shown that adding tryptophan could play a role in canine socialization, as well as reduce fear and aggression.

We advise supplementing the diet of dogs with behavioral issues with a moderate amount of tryptophan, either via a prescription from your veterinarian, or in the form of a high quality over-the-counter supplement.

Nutritional Support for Aging Brains

It's heartbreaking to watch a beloved dog mentally decline as he ages. According to a 2008 study, there are more than 52 million dogs older than age seven in the United States. As dogs age, they display many of the same declines in cognitive ability as elderly people. Senior and geriatric dogs often display CCD with impaired learning and memory, disorientation, a reduced ability to interact socially, house soiling, destructive behaviors, lethargy and disturbances in sleep patterns. The good news is that great strides are being made into the causes of aging-related cognitive decline and natural treatments using nutraceuticals and functional foods.

Free radicals that cause oxidation of cells, have been identified as a major cause of aging. If you're unsure of exactly what oxidation is, think of the rust on an older car or the brown spots on your peeled apple. Both of these arise from the interaction of the substance with oxygen molecules in the environment. Oxidation also occurs in the body's tissues and is a leading cause of age-related signs, ranging from a reduction in muscle mass and wrinkled skin to reduced memory capacity.

Whereas younger dogs' bodies can counteract oxidation, seniors are not as capable of protecting themselves from free radical damage. As a result, elderly dogs show signs of increased oxidative stress. Moreover, the brain is extremely vulnerable to oxidation. Left unprotected, oxidation in the brain can cause damage and death of neurons, resulting in a decline in cognitive function.

A diet rich in antioxidants can help counteract the effects of free radicals on the brain. In 2002, scientist Carl Cotman and colleagues from the University of California's Institute of Brain Aging and Dementia tested the theory that oxidative damage sets off a chain of events that decrease cognitive function. They fed aged Beagles a diet rich in antioxidants; after six months, the dogs showed considerable improvement in cognitive function. Other studies also support the beneficial effects of an antioxidant-rich diet on the cognitive ability of senior dogs.

One group of researchers concluded that:

The most important aspect of this work is the discovery that cognitive performance can be improved by dietary manipulation. Furthermore, the effects of the dietary manipulation were relatively rapid. Antioxidants may thus potentially act to prevent the development of these age-associated behaviors, and possibly neuropathological change, by counteracting oxidative stress.

Which ingredients are proven to ramp up cognitive activity in aging dogs? Cotman and colleagues fed their dogs the following:

- Vitamins E and C (antioxidants) along with a mixture of fruits and vegetables to reduce free radical damage.
- Alpha-lipoic acid and L-carnitine (mitochondrial cofactors), which improve the function of aged mitochondria.

Other important nutrients also show the ability to improve cognitive function in senior dogs. Some of the most studied:

Coconut oil (and other Medium Chain Triglycerides, MCTs)

MCTs possess many therapeutic qualities, but perhaps the most amazing is its scientifically proven ability to improve brain function in older dogs and people. It has also very recently been shown

to have antiepileptic properties associated with ketogenic diets and offers another therapeutic option for epilepsy treatment.

As the body's supercomputer, the brain requires a lot of energy, most of which is satisfied when the body breaks down glucose from food. However, as we age, we metabolize glucose less efficiently, leaving a gap in the brain's energy requirement. When this occurs, alternative sources of fuel become important to fill this gap and provide much needed energy to the brain. This is where medium chain triglycerides (MCTs), such as those contained in *coconut oil*, can help:

- Unlike regular fats (which the body metabolizes slowly), MCTs break down and absorb rapidly into the bloodstream, providing a quick source of non-carbohydrate energy.
- MCTs readily cross the blood-brain barrier, supplying up to 20% of a normal brain's energy.
- MCTs are important for ketone production, which serve as an additional source of "brain food."
- MCTs help the body use *omega-3 fatty acids* more efficiently and increase *omega-3* concentrations in the brain (a good reason to give your dog both *omega-3s* and *coconut oil*).

One study showed that when 24 Beagles who were between the ages of 7.5 and 11.6 years old at the start of the trial were fed a diet supplemented with 5.5% medium chain triglycerides, their cognitive ability improved significantly. The dogs showed improvement in learning-related tasks after only about two weeks of consuming the supplemented diet, and within one month their learning ability improved significantly.

In addition to its brain-boosting qualities, *coconut oil* is purported to provide a host of other health benefits, including:

- Contains antiviral, antimicrobial and antifungal properties.
- Helps with weight loss (MCTs increase metabolism, sending signals of satiety and cannot be stored as fat).
- Improves digestion and absorption of fat-soluble vitamins.
- Benefits the skin and coat.
- Provides a rapid form of non-carbohydrate energy.

The *coconut oil* you select should be unrefined (virgin) and expeller pressed or cold pressed. If possible, choose organic brands to avoid potential contamination from pesticides. *Coconut oil* does not need to be stored in the refrigerator, but since it is light sensitive (like all oils), it's best to keep it in a dark cupboard. Dark glass containers are excellent storage choices. Studies show that when fed as 10% or less of your dog's diet, there are no digestive or other health issues.

Omega-3 fatty acids

Many functional nutritional ingredients don't just benefit one part of the body; they promote health across a wide range of systems. Not only do the *omega-3 fatty acids*, **DHA** (docosahexaenoic acid) and **EPA** (eicosapentaenoic acid), fight obesity, decrease inflammation, combat arthritis and cancer and promote overall health, but they also benefit brain health—especially since the brain is made up of as much as 60% fat.

About 20% of the brain's cerebral cortex (the outermost layered structure of neural tissue) is made up of DHA, which also provides structural support to neurons (the cells that make up the central nervous system). Studies in people show that supplementation with DHA is beneficial in supporting cognitive health in aging brains and that inadequate levels can cause neurons to become stiff, hindering proper neurotransmission both within cells and between cells.

In elderly people, low levels of plasma DHA are associated with cognitive decline in both healthy individuals as well as those suffering from Alzheimer's disease, while higher DHA levels are associated with a decreased risk of Alzheimer's. In one study, patients who supplemented with DHA at 900 mg/day for 24 weeks showed improved learning and memory function associated with age-related cognitive decline. This means that supplementing with DHA does not only work to prevent age-related cognitive decline; it can also *reverse* the symptoms.

In addition to Alzheimer's disease, low levels of DHA in people are associated with:

- Bipolar/manic-depressive disorder
- Depression
- Memory loss
- Schizophrenia

A study of 48 Beagle puppies showed that dietary fortification of fish oil rich in DHA following weaning resulted in improved cognitive learning, memory, psychomotor, immunologic and retinal functions during the developmental stage. The high-DHA food also contained higher concentrations of the antioxidant vitamin E, taurine, choline, and l-carnitine, which may also have played a positive role on the puppies' development.

EPA, along with DHA, can also benefit mood. As anyone who has cared for an elderly relative or friend knows, depression is a common side effect of age-related cognitive decline: EPA from marine sources such as fish oil can decrease cytokines associated with depression. Another recent study showed a direct impact of dietary fatty acids on intestinal-specific, and subsequently central nervous system-specific, cellular immune responses in autoimmunity, which might have therapeutic implications for autoimmune diseases such as multiple sclerosis.

Milk thistle

The silibinin extracted from the seeds of the *milk thistle* plant has shown tremendous promise as a therapeutic agent to treat cancer, but its benefits don't stop there. Silibinin also prevented impairment of both short-term memory and recognition memory in mice injected with a peptide fragment having neurotoxic properties. Silibinin worked here as an antioxidant, by protecting the hippocampus (the part of the brain associated with memory) against oxidative damage caused by this powerful neurotoxin.

Phosphatidylserine

Phosphatidylserine is a phospholipid, a class of lipids (fats) that makes up a major part of cell membranes. Synthetic phosphatidylserine was once derived from cows' brains, but due to concerns about mad cow disease, it is now manufactured primarily from soy lecithin. Until a decade ago, the FDA held the position that phosphatidylserine showed no benefit in people with cognitive dysfunction, citing a lack of credible scientific evidence. However, on November 24, 2004, they changed their position in a letter titled, *Letter Updating the Phosphatidylserine and Cognitive Function and Dementia Qualified Health Claim*. The letter acknowledged studies demonstrating the beneficial effects of phosphatidylserine for individuals at risk of dementia and cognitive dysfunction and admitted that there is "credible evidence" for its use.

Senilife®, manufactured by Ceva Animal Health, combines phosphatidylserine with ginkgo biloba, vitamin E, pyridoxine (vitamin B6) and grape skin extract. According to the company's studies, Senilife® improves several signs of CCD starting within seven days, including:

- Decreases sleeping problems.
- Decreases apathy and disorientation.
- Increases playful behavior.
- Increases response to commands.

SAMe (s-adenosylmethionine)

DNA methylation as an important epigenetic signaling tool for normal gene expression. *SAMe is the brain's major methyl donor* and is responsible for forming a variety of compounds, including proteins, neurotransmitters, phospholipids, glutathione, myelin, coenzyme Q10, carnitine, and creatine. SAMe also improves neuron membrane fluidity and increases levels of serotonin and dopamine metabolites.

In several human studies, reduced SAMe concentrations were detected in the brains of patients with Alzheimer's disease, indicating that a methyl group deficiency in the central nervous system may play a part in causing the disease. Supplementation with SAMe has also been shown to effectively reduce the symptoms of depression in people -- and might even be as beneficial as some prescription antidepressants.

Novifit®, a SAMe supplement manufactured by Virbac Animal Health, has undergone testing in senior dogs with signs of CCD. Novifit showed favorable results beginning after just one month of testing on client-owned dogs, including:

- A 44% reduction in problem behaviors, including a reduction in house soiling, after both four and eight weeks (compared to 24% in the placebo group).
- Marked improvement in activity and playfulness.
- Significant increase in awareness.
- Decreased sleep problems.
- Decreased disorientation and confusion.

Denosyl®, manufactured by Nutramax Laboratories, is another SAMe product marketed to support liver and brain health.

SAMe works in conjunction with the methyl donors folate and vitamin B12, so supplementing with a B-complex vitamin is also advised. People with bipolar disorder, migraine headaches, Parkinson's disease and active bleeding, as well as those on prescription antidepressants, should not take SAMe. Similar precautions should be followed in dogs. We advise starting with a very low dose and monitoring your dog for adverse effects, which in people have been noted to include anxiety, restlessness, insomnia and mania.

Berries

The benefits of antioxidants on the cognitive health of senior dogs is well-recognized; anthocyanins, the phytochemical compounds that give *berries* their pigment, are a rich source of antioxidants. Anthocyanins can protect against—and even reverse—declines in cognitive function due to age-related oxidative stress.

Anthocyanins are credited with:

- Enhancing memory.
- Helping prevent age-related declines in neural function.
- Modulating cognitive and motor function.

Glutens

Here's even more reason to remove gluten from your senior dog's diet: gluten sensitivity in people has been linked with impairment of brain function, including learning disabilities, ADHD and memory problems. Gluten sensitivity may even manifest *exclusively* as a neurological disease, without any GI symptoms. The link between gluten sensitivity and impairment of brain function makes perfect sense, according to David Perlmutter, MD, FACN, a board certified neurologist and fellow of the American College of Nutrition as well as the author of *Grain Brain: The Surprising Truth about Wheat, Carbs, and Sugar—Your Brain's Silent Killers*.

Perlmutter points out that the body's antibody response to *gliadin*, a protein in gluten, results in elevated levels of inflammatory cytokines that are present in Alzheimer's disease and other neurological conditions, such as Parkinson's, multiple sclerosis and autism. Gliadins also promote development of autoimmune thyroiditis.

In 2006, researchers from the Mayo Clinic found an association between patients with both celiac disease and progressive cognitive impairment, further supporting the link between the damaging effects of gluten and impaired brain health. The last thing your aging dog needs is a cascade of brain-related inflammation. For this and many other reasons previously discussed, we advise removing gluten from your dog's diet.

An important non-nutritional aspect of canine cognitive health is mental stimulation. Just as with humans, dogs "use it or lose it" when it comes to their cognitive ability. While your canine companion can't pick up the latest *New York Times* crossword puzzle, he can engage in a variety of mentally challenging "dog brain games". Old dogs are wonderful students and love to learn.

Thyroid and Nutrition

[Excerpted from: "*The Canine Thyroid Epidemic*", by W. Jean Dodds and Diana R. Laverdure, DogWise Publ, 2011.]

Since thyroid disorder is closely tied to behavioral changes, we also recommend a full thyroid panel to rule out this cause. We also advise examining non-diet related environmental influences, such as your dog's dynamic within the "pack" (i.e., family unit), his background (e.g., whether he was previously abused or abandoned) and potential chemical toxins, such as those we discussed earlier. If, for example, you recently brought a new puppy into your home and your adult dog is acting out, chances are it's not due to his diet!

Nutrients that play an important role in maintaining a healthy immune system and thyroid function include:

Soy

Soybeans and the many soy derivatives commonly found in pet foods are recognized as one of the main causes of both acute and sub-acute food allergies as well as long-term food intolerances in pets. Symptoms of true food allergies vary and can include dry, scratchy, red and inflamed skin, hives and rashes. Food intolerances, which occur over longer periods of exposure to the food antigen (we will discuss the differences between food allergies and food intolerances in greater detail later), typically manifest as disorders of the skin (primarily itching) or gastrointestinal tract (a "leaky gut"). Beware of soy in its various forms: it typically appears in pet foods as soybean

meal, soy flour, grits, hulls, soy protein concentrate, isolated soy protein and textured vegetable protein.

Soybeans, which are commonly used as a source of vegetable protein, are dietary goitrogens (substances that causes *goiter*, or enlargement of the thyroid gland). The prevalence of soy in many dog foods helps to explain the increasing incidences of canine hypothyroidism. Soy inhibits the effects of thyroid peroxidase, an important thyroid enzyme which helps convert T4 to T3. Cruciferous vegetables such as broccoli, Brussels sprouts, cabbage, cauliflower, kale, rutabagas and turnips can also reduce thyroid function by blocking the activity of thyroid peroxidase, but this goitrogenic effect is reduced when they are cooked. However, millet, when cooked, has enhanced goitrogenic activity.

The effects of soy on the thyroid gland are modified by dietary iodine; iodine deficiency enhances soy's goitrogenic effects, whereas iodine supplementation (e.g. kelp in modest amounts) is protective. However, the iodine concentration in commercial pet foods today is 3-5 times the stated minimum requirement, which causes more problems because excess iodine is associated with hypothyroidism and thyroiditis in dogs (and *hyperthyroidism* in cats).

Isoflavones in soy are the primary compounds linked to decreased thyroid function. Isoflavones such as genistein interfere with the TPO (thyroid peroxidase) gene's role in making thyroid peroxidase, an enzyme necessary for the chemical reaction that ultimately produces T4 and T3 via the protein thyroglobulin.

Glutens

Just because a dog food is labeled as "grain-free," this does not mean that it is also *gluten-free*. Grain-free dog foods most often refer to foods that do not contain wheat, corn, and soy. However, "secondary grains" used in the standard grain-free diets do contain gluten. Glutens include wheat, rye, barley, oatmeal unless labeled gluten-free, kamut, spelt and couscous. There is a connection between autoimmune thyroid disease and gluten intolerance in people and pets, which leads to "leaky gut" and inflammatory bowel disease (IBD). Studies show a strong link between autoimmune thyroiditis in people (both Hashimoto's and Graves' diseases) and gluten intolerance. The link is so well-established that researchers suggest that all people with these endocrine autoimmune diseases be screened for gluten intolerance, and *vice versa*. Similarly, dogs with IBD should be screened for thyroid dysfunction, and those with thyroid function should be screened for IBD.

What explains the connection? It's a case of mistaken identity. The molecular structure of gliadins, one of the two main groups of proteins in gluten, closely resembles that of the thyroid gland. When gliadin breaches the protective barrier of the gut and enters the bloodstream, the immune system tags it for destruction. These antibodies to gliadin also cause the body to attack thyroid tissue. This means that if you or your dog has autoimmune thyroid disease and eat foods containing gluten, your immune system will attack the thyroid gland, causing progressive damage leading to clinical hypothyroidism.

This immune response can last up to *6 months* each time your dog eats gluten. So, if your dog is gluten intolerant, his diet must be totally gluten-free to prevent immune destruction of the thyroid gland.

How do you find out if your dog is gluten intolerant? Unfortunately, standard lab tests aren't very accurate, as they test for antibodies to gluten in the bloodstream. But antibodies in the blood will only be found in cases where the gut has become so permeable ("leaky") that gluten can pass through, which occurs during a relatively advanced stage of the disease. Thus, serum blood tests will miss the many milder cases of gluten intolerance that haven't yet progressed to that stage. Saliva (or fecal) analysis is far more sensitive, because they detect antibodies produced in the digestive tract that haven't yet escaped into the bloodstream. See www.nutriscan.org

It is best to eliminate all gluten-containing foods from your dog's diet if you suspect or identify specific food reactivities. This includes treats and supplements, so please read ingredient labels carefully. You can then gradually reintroduce some of the non- or less reactive grains, paying careful attention for symptoms such as vomiting (upper GI tract hypersensitivity) or diarrhea (lower GI tract hypersensitivity), excessive gas production or bloating, and abdominal pain or tenderness or constipation.

Iodine

Iodine is vital to normal thyroid function, since it is essential to the production of thyroid hormone. Given this, it's understandable that many dog parents supplement the diets of their hypothyroid canines with kelp and other foods rich in iodine in an attempt to help boost the thyroid gland. However, iodine supplementation is extremely tricky, and giving too much can prove harmful. An excess of iodine can negatively affect the pet's thyroid medication, leading to a worsening of the very hypothyroidism that you are trying to treat.

Whether or not you should supplement with iodine depends largely upon the type of diet you feed your dog. Follow these guidelines to ensure that you do not "overdose" your pet on iodine:

- If you feed your dog cereal-based kibble, do not supplement with sea kelp or other forms of iodine more than three times per week. These foods are fortified with high doses of iodine.
- If you feed your dog a home cooked or raw diet, you can supplement with iodine every day, taking care to follow the product guidelines.

Zinc

Zinc is a trace mineral essential to the health of our canine companions. Zinc is critical to the function of the entire immune system and plays a key role in more than 300 enzymatic and metabolic processes, including cell replication and the production of thyroid hormones. It is also vital to the health of the skin. Zinc deficiency commonly results in a condition known as zinc responsive dermatosis, which is especially prevalent among Huskies, Malamutes and Samoyeds – breeds that have a genetic predisposition to poor zinc absorption. Symptoms of zinc responsive dermatosis include: hair loss; dull and dry hair coat; scaly, crusty skin around the legs, head, and face (especially on the nose and circling the eyes, ears, chin, and mouth); poor wound healing; and thick and crusty foot pads. Zinc deficiency can also affect reproduction.

Selenium

Selenium is another essential trace mineral with many important roles, including defending the body against oxidative damage and boosting immune response. Selenium also potentially increases the effectiveness of vitamin E. Many countries, contain soils deficient in selenium. Crops grown

on these soils – including cereal grains used for pet foods – will contain relatively low levels of selenium. Selenium is important in maintaining the health of the thyroid and a link has recently been shown between selenium deficiency and hypothyroidism. Selenium as it relates to hypothyroidism is often difficult to spot because blood, but not tissue, levels of thyroid hormones rise in cases of selenium deficiency. This means that although a selenium deficient dog may display clinical signs of hypothyroidism, his blood thyroid levels will appear normal. Synthetic antioxidants still used to preserve some dog foods can impair the bioavailability of selenium (as well as vitamin A and vitamin E). To help prevent selenium deficiency, you should feed your pet diets preserved naturally with vitamins E and C rather than with synthetic chemical antioxidants. Remember that selenium is a toxic mineral, and is only required in very low doses.

Vitamin E

Vitamin E is a fat-soluble antioxidant with many important roles for the health of our canine companions. By neutralizing harmful free radicals that can cause cellular damage, vitamin E helps to prevent cancer and diseases of the circulatory system (such as arteriosclerosis) as well as slowing the aging process. Vitamin E also boosts the immune system, oxygenates the blood, improves the function of the internal organs, prevents hormones from oxidation, reduces inflammation, and helps fight infection. Vitamin E has also been used to treat skin disorders and immune-mediated diseases in dogs. Good sources of vitamin E include cold pressed vegetable oils, meats, nuts, seeds, and green leafy vegetables.

Vitamin B-6 (pyridoxine)

Vitamin B-6 is essential for a healthy nervous system, protein metabolism, the formation and function of red blood cells, and healthy cognitive and immune function. Signs of vitamin B-6 deficiency include anemia, seizures, skin disorders, arthritis, fatigue, kidney stones, and kidney damage. Since all B vitamins are water-soluble, excess amounts are not stored in the tissues as they are with fat-soluble vitamins. If too much vitamin B-6 is ingested, it can be eliminated from the body via the urine, greatly reducing the risk of toxicity. Cooking and processing destroys much of the vitamin B-6 that's present in raw foods. Good sources of vitamin B-6 include meat, poultry, fish, whole grains, legumes, and green leafy vegetables such as kale, collard greens, Brussels sprouts, broccoli and chard. Bananas are also an excellent source of vitamin B-6.

Vitamin D

Today, many articles published in medical journals or the press discuss the dangers of vitamin D deficiency, and the benefits of supplementation. Vitamin D plays an important role in balancing the cell-mediated and humoral arms of the immune system, regulating insulin secretion, and balancing blood sugar. Vitamin D deficiency has been associated with numerous autoimmune diseases, and is specifically associated with autoimmune thyroid disease. Supplementation with vitamin D has been shown to benefit autoimmune-mediated thyroid dysfunction.

A variety of mechanisms reduce the absorption, production and biologic activity of vitamin D:

- Since vitamin D is absorbed in the small intestine, a leaky and inflamed GI tract – which is very common with low thyroid function – reduces the absorption of vitamin D.
- High cortisol levels (caused by stress or medications like steroids) are associated with lower vitamin D levels. The synthesis of active vitamin D from sunlight depends on cholesterol.

Stress hormones are also made from cholesterol. When the body is in an active stress response, most of the cholesterol is used to make cortisol and not enough is left over for vitamin D production.

- Obesity reduces the biologic activity of vitamin D. Obese animals and people have lower serum levels of vitamin D because it gets taken up by fat cells.
- Not eating enough fat or not digesting fat properly reduces absorption of vitamin D. Vitamin D is a fat-soluble vitamin, which means it requires fat to be absorbed. Individuals on low-fat diets, and with conditions that impair fat absorption (like bowel, gall bladder or liver disease) are more likely to have low levels of vitamin D.
- A variety of drugs reduce absorption or biologic activity of vitamin D. Unfortunately, these include drugs that are among the most popular and frequently prescribed – including antacids, replacement hormones, corticosteroids, anticoagulants and other blood thinners.
- Aging reduces the conversion of sunlight to vitamin D.
- Inflammation of any type reduces the utilization of vitamin D.

In order for circulating vitamin D to perform its functions, it must first activate the vitamin D receptor (VDR). The problem is that many with autoimmune disease have a genetic polymorphism that affects the expression and activation of the VDR and thus reduces the biologic activity of vitamin D. With low thyroid function, vitamin D deficiency can occur even if blood levels of vitamin D are normal.

Linoleic Acid

Linoleic Acid is an omega -6 fatty acid. If you have ever supplemented your dog's diet with fish or vegetable oil to produce a healthy, shiny coat, then you have experienced the benefits of fatty acids. Fatty acids are polyunsaturated fats with specific molecular combinations of carbon, hydrogen, and oxygen. The two main groups of fatty acids are omega -3 and omega- 6. Fatty acids that cannot be manufactured in the body, such as linoleic acid, are referred to as essential fatty acids (EFAs). EFA's must be obtained from food. Linoleic acid is the most important omega- 6 fatty acid for dogs, since it is used to produce other omega-6 fatty acids. Linoleic acid is also especially important for the health of a dog's skin and coat, as it allows the skin to become permeable to water. Sunflower, safflower, soybean, corn, and evening primrose oil are excellent sources of linoleic acid. However, feeding too much omega-6 fatty acids can be pro-inflammatory.

Commercial pet foods often advertise themselves as “balanced,” however they may contain an improper ratio of major nutrients, vitamins, and minerals. While commercial pet food manufacturers compensate for variations in ingredients by adding vitamin and mineral supplements, it is difficult to determine optimum levels for so many different breeds of animals having varying genetic backgrounds and metabolic needs. Supplementation with vitamins and minerals should not be viewed as a substitute for feeding premium quality fresh and/or commercial pet foods.

In addition, commercial foods are often highly processed and may contain chemical preservatives to enhance their stability and shelf life. These chemical preservatives detract from the wholesomeness and nutritional quality of the product.

Vegetables and Fruits

Our dogs benefit from the disease-fighting nutrients in vegetables and fruits just as we do. This is especially true of green leafy and yellow orange vegetables, and bright colored fruit, which contain a wealth of important nutrients.

Green leafy vegetables are packed with antioxidants and cancer-fighting nutrients such as phytochemicals [non-nutritive plant chemicals that may help prevent disease], including carotenoids (e.g. beta-carotene, lutein, zeaxanthin), flavanoids (e.g. quercetin, resveratrol, rutin), and phytosterols. Green leafy vegetables are also low in fat and calories and high in fiber, so your canine companion can boost his immune system without packing on the pounds.

There are many tasty varieties of green leafy vegetables to entice even the most carnivorous canine. Try lightly steaming or blending (to break down the fiber and cellulose) some spinach, broccoli, kale, lettuce, Italian parsley, Swiss chard, collards, bok choy or turnip greens and offer them as part of your pet's dinner at least three times per week.

The stars of the yellow orange family of vegetables are the carotenoids [phytochemicals which give them their lovely bright color]. Yellow orange veggies also contain a wide variety of phytochemicals in addition to the carotenoids, including vitamin C and flavanoids, known for their antioxidant and disease-fighting properties. Have fun integrating a wide variety of yellow orange vegetables such as squashes, carrots, pumpkin, yellow beets, yams, and sweet potatoes into your dog's diet. Lightly steam them for super taste and maximum nutrition.

Many fruits also provide a healthful addition to our pets' diets. Fruits such as apples, peaches, pears, bananas, and berries (blueberries, raspberries, cranberries, pomegranates, but *not* strawberries) are high in many valuable vitamins, minerals, and antioxidants. Offer your pet a slice of banana or apple for a snack instead of a tradition doggy biscuit, or add a scoop of blueberries to some yogurt for an immune-boosting breakfast.

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