Canine Nutrition NEWSLETTER

June 2010

In this Issue

Calcium and phosphorus are the two most important minerals in your dog's body. The calcium/phosphorus balance in food is important and the concentration of these minerals in a dog's blood is tightly regulated. For more information about calcium, phosphorus, vitamin D, sunlight, parathyroid hormone and the physiology of calcium and phosphorus regulation in the body, please read:

Kidney disease results in phosphorus retention in the dog's body which can lead to secondary hyperparathyroidism and renal osteodystrophy. This article reviews the physiology of the changes in calcium and phosphorus metabolism in renal disease and discusses dietary management strategies to prevent these adverse secondary conditions. For more info, see:

Young puppies are unable to regulate calcium and phosphorus uptake to the same degree as adult dogs. The calcium-to-phosphorus ratio in a puppy diet is critical for normal skeletal development. An inappropriate ratio can lead to skeletal defects that will last the dog's lifetime. For more info, see:

Blood samples from dogs fed home-made meals in India reveals wide-ranging calcium and phosphorus disturbances. For more info, see:

Subscribe to Newsletter, click here

To receive this newsletter free each month sign up: http://www.completeandbalanced.com/newsletter.html

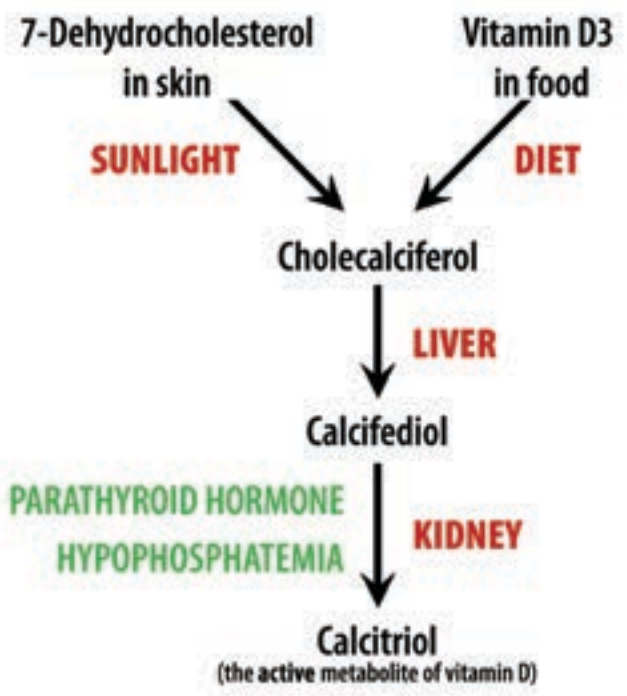
Calcium, Phosphorus, Vitamin D & Parathyroid Hormone

By Hilary Watson BSc

This month's newsletter is about calcium and phosphorus, the two most important minerals in your dog's body. In this article, I'm going to discuss calcium/phosphorus balance, vitamin D, sunlight, kidney function and parathyroid hormone. Just for fun, I'm going to cover these topics by asking and answering a series of questions – that way you can test your own knowledge by answering the question before you read my answer!

Question 1: What is the role of sunlight in vitamin D production and how does that fit with dietary vitamin D and vitamin D synthesis by the kidney?

The diagram below answers this question.



To summarize:

7-Dehydrocholesterol	A fat soluble molecule in the skin that can be converted into vitamin D3 (cholecalciferol) in the presence of ultraviolet light.
Cholecalciferol	Also called vitamin D3, found in some foods, or it can be produced from 7-dehydrocholesterol in the skin using ultraviolet light
Calcifediol	Also called 25-hydroxycholecalciferol, the form of vitamin D produced by the liver from cholecalciferol
Calcitriol	The active form of vitamin D produced by the kidney from calcifediol.

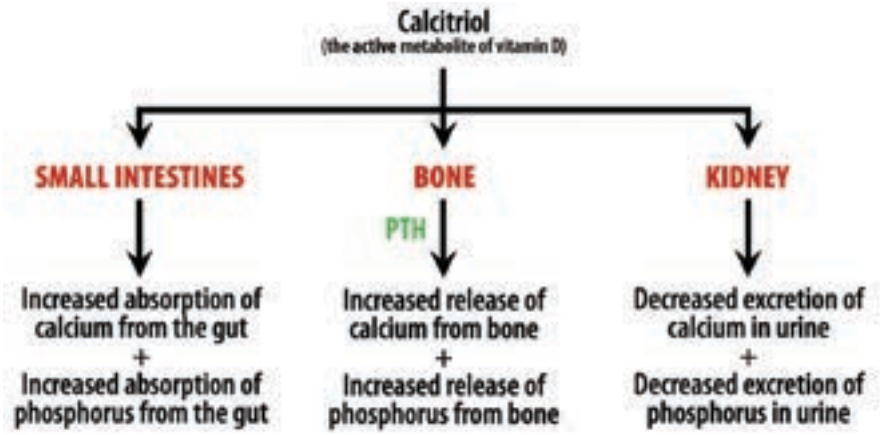
Question 2: What Controls the Production of Calcitriol?

The liver's production of calcifediol is "substrate-driven", meaning that the liver takes whatever vitamin D3 it gets from the diet or from the skin and immediately converts it into calcifediol. This reaction is not under any control. As long as the precursors are present, the liver makes that conversion.

The kidney's production of calcitriol, on the other hand, is tightly controlled and varies according to the dog's needs. Two things can trigger the production of calcitriol: hypophosphatemia (low phosphorus in the blood) and the presence of parathyroid hormone (PTH) in the blood. PTH is a hormone produced by the dog's parathyroid gland in response to hypocalcemia (low calcium in the blood).

Question 3: What is the Function of Calcitriol?

The function of calcitriol is to increase the levels of calcium and phosphorus in the blood. Calcitriol acts primarily on the small intestines and kidneys, but in the presence of parathyroid hormone, it also acts on bone. In the small intestines, calcitriol increases calcium and phosphorus uptake from food in the gut. In the kidneys, calcitriol decreases calcium and phosphorus losses in urine. In the presence of parathyroid hormone, calcitriol causes bone resorption and the release of calcium and phosphorus from bone into the blood. In all cases, the net effect is an increase in the uptake and retention of both calcium and phosphorus by the dog's body.

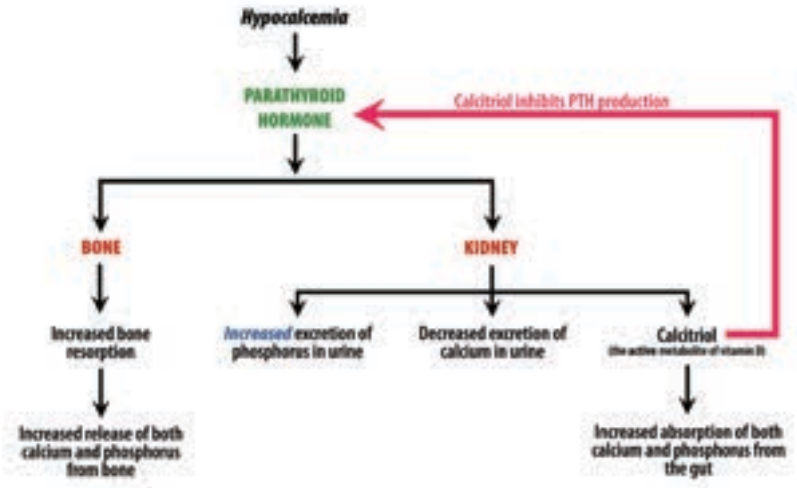


Question 4: What is the Function of Parathyroid Hormone and how is its Function Different from that of Calcitriol?

While calcitriol increases the blood concentrations of both calcium and phosphorus, parathyroid hormone (PTH) raises plasma calcium concentration only. While calcitriol is primarily a regulator of phosphate homeostasis, PTH is the agent that corrects hypocalcemia. The principle difference in their actions occurs in the kidneys, where calcitriol decreases excretion of phosphate in urine (ie calcitriol enhances phosphate retention in the body), while PTH increases excretion of phosphate in urine (ie PTH enhances phosphate loss from the body).

Question 5: In Hypocalcemia, PTH Regulates the Kidney and the Kidney Regulates PTH. How does this Feedback Loop Work?

It works like this:



Calcitriol is the negative feedback shut-off mechanism for PTH. Calcitriol attaches to receptors in the parathyroid gland leading to the inhibition of PTH synthesis once blood calcium levels have been restored to normal. Stopping PTH production is an important function of calcitriol produced by kidney cells. In kidney disease, loss of functional kidney cells leads to reduced production of calcitriol and this can lead to hyperparathyroidism (see the article on renal disease for more information).

Question 6: What is the Relationship Between of the Calcium-to-Phosphorus Ratio in the Food and Calcium/Phosphorus Balance in the Body?

The calcium-to-phosphorus ratio in your dog's food directly affects the relative uptake of these two minerals from the gut and this directly affects the calcium/phosphorus balance in the dog's body. The calcium-to-phosphorus ratio is the most important nutrient balance in a recipe and it is one of the most difficult ratios to get right in home-made meals. Most human foods are very high in phosphorus and relatively low in calcium. Meats typically contain 10-20 times more phosphorus than calcium, different types of liver contain 40-80 times more phosphorus than calcium, and veggies are all over the map (for example beans have a calcium-to-phosphorus ratio of 1:1, peas have a ratio of 1:4 and spinach has a ratio of 2:1). You can't guess. The calcium-to-phosphorus ratio of every food is unique. To further complicate matters, the phosphorus in food is generally more digestible than the calcium in food. The digestibility of food calcium is typically only 20-30% whereas the digestibility of food phosphorus is usually at least 50% and may be as high as 90% depending on the form of phosphate in the food. It is absolutely critical to get the calcium-to-phosphorus ratio correct in the food in order to ensure appropriate uptake of both minerals from the gut. According to AAFCO, there should always be between 1 and 2 grams of calcium for every gram of phosphorus in the food, meaning the calcium-to-phosphorus ratio should be at least 1:1 and never more than 2:1. Many commercial raw foods have calcium to phosphorus

ratios well outside this range. I've seen commercial raw dog foods with a calcium-to-phosphorus ratio as low as 0.3:1 and as high as 16:1. To complicate matters, many commercial raw diets are also severely deficient in vitamin D3 which affects the uptake of these two minerals from the gut. These deficiencies and imbalances alter calcium and phosphorus balance in the body and lead to bone disease.

Question 7: Will an imbalance in the Calcium-to-Phosphorus Ratio Show Up in a Dog's Blood Tests?

Eventually, an imbalance in dietary calcium/phosphorus will show up as hypocalcemia and other disturbances in blood tests (ie elevated PTH, low ALP etc), but these anomalies may take months to develop. Feeding a recipe with insufficient calcium causes an immediate negative calcium balance but the dog will draw calcium from its bones to make up the shortfall. Blood calcium and phosphorus concentrations are tightly regulated by the actions of calcitriol and PTH. Blood calcium can be kept within the normal ranges for weeks or months even when the dog's calcium intake is well below requirements. The body considers it far more important to keep blood calcium concentrations normal than to maintain healthy bone density and full bone mineralization. One of the most important functions of bone is to act as a store of calcium so that blood calcium concentrations can be more easily maintained within the healthy range.

"Yuki"

Testimonial

Yuki is our beloved 7-year-old Bichon. At age 2 she started showing signs of food and plant sensitivity. She had chronic ear infections. She was put on a daily dosage of prednisone. This gave her relief but when the dosage was reduced, she would chew at her paws. We tried several commercial pet foods, even Hill's formula as recommended by her Vet. None of these foods gave her any relief. I was determined to get her off the prednisone but she was in agony, constantly chewing at her paws. They were red and raw. She was anxious and very unhappy.

A friend recommended Dr Bartlett to me. He understood Yuki's agony and suggested Yuki see a dermatologist. He also told me about Hilary's Blend Supplement. I was determined to give her a 'pure' diet in an attempt to minimize her food allergies but we were concerned about the nutrition level of this diet. I emailed Hilary about Yuki's allergies and diet and was thrilled at her immediate response. I tried Yuki on the Limited Antigen Fish 4. Yuki loved the food change but seemed hungry more often, now eating 4 times per day instead of 2. I emailed Hilary and again I received an immediate response. Hilary customized a recipe with some additional suggestions for Yuki.

Between the dermatologist and her new nutritional diet, I am thrilled to say that we now have a very happy, relaxed, and healthy little girl again. We are now sleeping at night!!!

Thank you so much Hilary.

The McCluskeys

There are two important messages here.

First, calcium/phosphorus imbalances will not show up immediately in blood tests because in the short term, calcium deficiencies will be met by calcium drawn from bone. The corollary of that is that if hypocalcemia is detected on a blood test, then the calcium deficiency has been present for awhile and the negative calcium balance is severe. Basically, that dog has removed so much calcium from its bones that it is no longer able to use bone stores to cover its calcium deficiency.

The second message is that it is very important to include HILARY'S BLEND supplement every time you prepare one of my recipes. Take Adult Recipe 2 (R12). When this recipe is made as described in the cookbook using HILARY'S BLEND supplement, it has an ideal calcium-to-phosphorus ratio of 1.35-to-1 and it provides sufficient levels of all essential nutrients to meet AAFCO guidelines. The same recipe made without my supplement has a calcium-to-phosphorus ratio of 1-to-7 (not healthy!), it is deficient in calcium, phosphorus, iron, copper, manganese, zinc, iodine, vitamin E, thiamin (vitamin B1), pyridoxine (vitamin B6), and folic acid; and it is marginal (barely above AAFCO) in magnesium, riboflavin (vitamin B2), pantothenic acid (vitamin B5), choline and vitamin B12. Getting all these essential nutrients at the right level and in the right ratio is the job of my supplement. Without it, my recipes are not complete and balanced.

Question 8: How Can you Tell if the Calcium-to-Phosphorus Ratio is Correct in the Food You are Feeding?

To determine the calcium-to-phosphorus ratio of the food you are feeding, take the food's calcium content and divide by its phosphorus content – the answer should be between 1 and 2. Ask the pet food company to provide an independent laboratory analysis showing calcium, phosphorus and vitamin D levels on an as fed and dry matter basis, then compare these values to AAFCO's guidelines below (see Liz Pask's article for AAFCO guidelines for puppies):

AAFCO minimums and maximums for calcium, phosphorus and vitamin D, all expressed per 100g (dry matter basis) in adult dog food.			
	Units	AAFCO Minimum	AAFCO Maximum
Calcium	g	600	2500
Phosphorus	g	500	1600
Calcium:phosphorus ratio		1:1	2:1
Vitamin D	IU	50	500

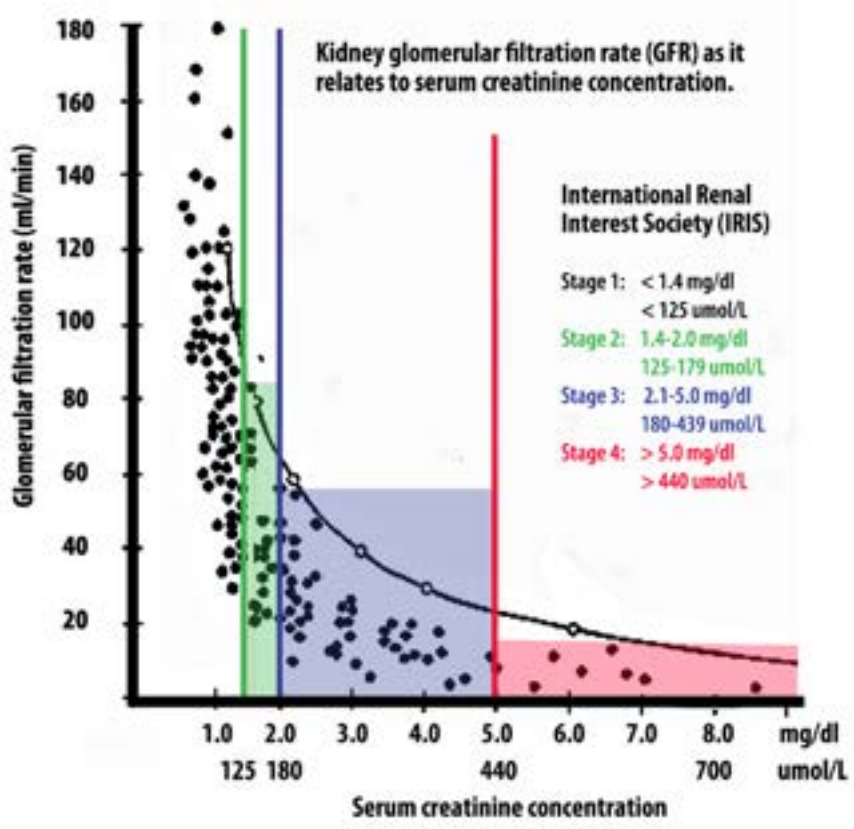
Calcium/Phosphorus Balance in Renal Disease

By Hilary Watson BSc

Glomerular filtration rate (GFR) is the best measure of kidney function. GFR describes the rate of flow of filtered fluid through the kidneys. When a dog develops kidney disease, GFR drops. The degree of GFR decline corresponds to the degree of loss of functional kidney tissue.

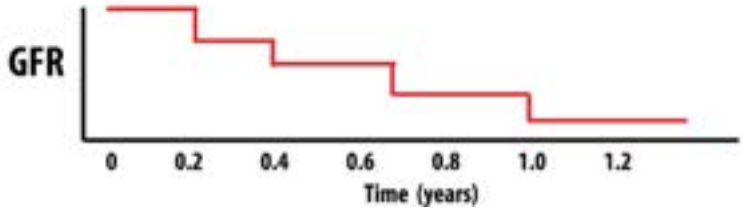
Creatinine is a metabolic waste product that is normally excreted in urine. In kidney disease, as GFR declines, blood creatinine rises. Blood creatinine is therefore used as a marker to assess kidney function. However, creatinine values do not correlate directly to GFR. In fact, the International Renal Interest Society (IRIS) defines Stage 1 renal disease as having serum creatinine within the normal range.

The graph below helps to illustrate this concept. This graph plots the GFR of 171 individuals versus their serum creatinine values. Look at the dots to the left of the green line. These individuals all have "normal" serum creatinine values. Note that the individual with the highest GFR (180 ml/min) has a serum creatinine of about 1.2 mg/dl but there is another individual with the same serum creatinine who has a GFR of about 30 ml/min. A normal creatinine value can represent a GFR anywhere from 180 ml/min (excellent kidney function) down to 30 ml/min (significant kidney impairment). That's a huge range! One of the best reasons for regular wellness blood profiles in senior dogs is to detect trends in an individual creatinine values over time. If a dog's creatinine values start trending upwards, even while staying within the normal range, renal disease should be suspected.

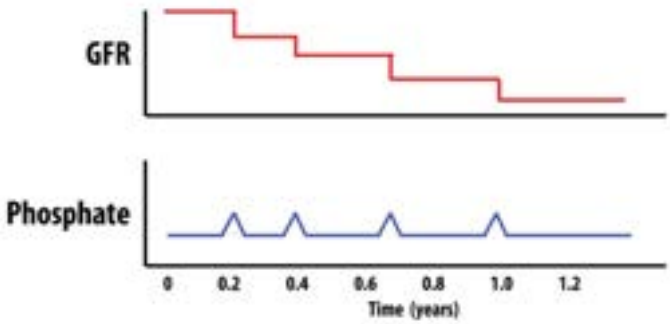


The Connection Between GFR, Calcium/ Phosphorus Balance and PTH

As renal disease progresses GFR drops. However, this decline tends not to be continuous, but rather occurs in steps as functional renal mass is lost and compensatory mechanisms that initially work subsequently fail. The decline in GFR in chronic renal disease looks something like this:



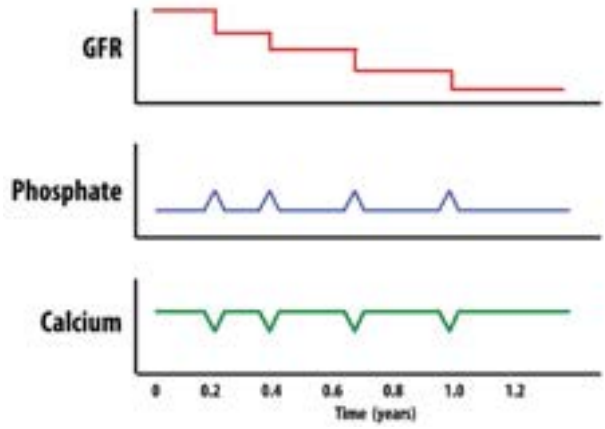
In a normal individual 80-95% of the phosphate filtered out of the blood by the kidneys can be lost in urine. That percentage drops to only 15% when GFR falls below 20-30 ml/min. As GFR drops, more and more phosphate is retained in the body. Every time there is a drop in GFR, there is a corresponding spike in blood phosphorus concentration, as shown below:



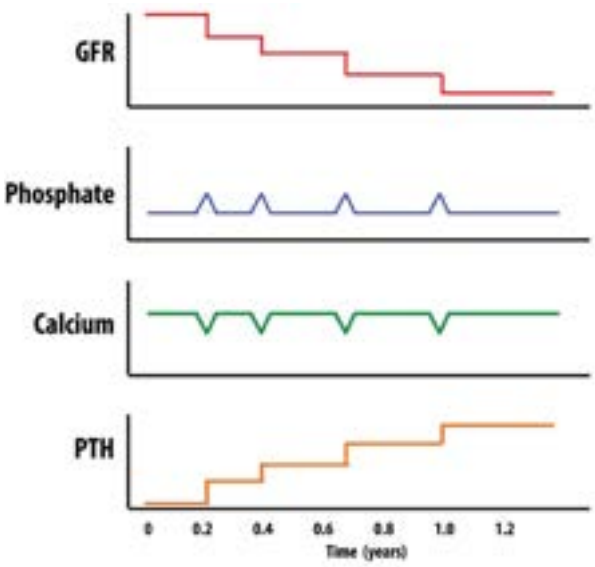
So here's the first question: why does that blood phosphorus concentration return to normal after it spikes? Why doesn't the drop in GFR cause a steady increase in blood phosphorus concentration? The answer is that although phosphate is retained in the body, the extra phosphate does not remain in the blood. The extra phosphate in the blood reacts with free calcium in the blood, driving the following reaction to the right:

$$Ca^{++} + HPO4^{--} <-> CaHPO4$$

In other words, the surplus phosphate reacts with free calcium to form calcium phosphate salts and the blood phosphate concentration subsequently returns to normal. However, this process causes periodic dips in blood calcium. This looks like this:



So now the questions is: what causes the calcium dips to return to normal? The answer is parathyroid hormone (PTH). The dips in blood calcium are detected by the parathyroid gland which produces PTH to correct hypocalcemia. Parathyroid hormone corrects hypocalcemia by attempting to increase phosphate losses in urine (which works to some degree in early renal failure but doesn't work as well as kidney disease progresses) and by pulling calcium from bone (which does raise blood calcium levels but it also brings phosphate with the calcium which increases blood phosphate concentations as well). Although blood phosphorus and calcium values tend to return to normal after each drop in GFR, as renal disease progresses, maintaining normal blood calcium and phosphorus becomes increasingly difficult and requires increasing levels of PTH. So the complete picture looks like this:



If you happen to sample blood during a period when GFR is dropping and the body is reacting to that change, you may detect hyperphosphatemia or hypocalcemia but in the early stages of renal disease, it's more likely that you'll sample during one of the plateaus and the blood calcium and blood phosphorus values will appear normal. This doesn't necessarily mean that calcium/phosphorus balance is being properly maintained by the dog. It may be that blood calcium and phosphate are being maintained within the normal range at the expense of increasing levels of PTH in the blood and this can be very detrimental to the dog.

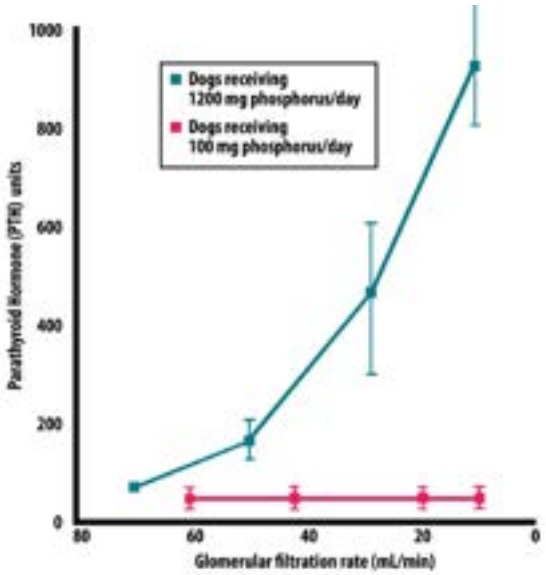
The Negative Consequences of Hyperparathyroidism in Renal Disease

In renal patients, loss of functional kidney cells limits calcitriol production and also affects the kidney's ability to excrete phosphate from the body. PTH ends up correcting hypocalcemia by stealing calcium from bone. This causes secondary renal osteodystrophy. Pulling calcium from bone to correct the phosphate spikes drives the formation of calcium phosphate salts. These salts are solid material that gets deposited in soft tissues like arteries, lungs, kidneys, heart etc. Mineralization of soft tissue in renal disease greatly accelerates the progression of the disease and causes many secondary complications. When PTH steals calcium from bone, it draws phosphorus with it. So, as PTH acts to correct hypocalcemia, it can cause hyperphosphatemia. This becomes a vicious circle – PTH pulls calcium from bone to correct hypocalcemia which causes hyperphosphatemia which drives the formation of calcium phosphate salts which causes hypocalcemia which causes more PTH to be produced.

Finally, as noted in my previous article, the negative loop shut-off mechanism for PTH is calcitriol produced by the kidney. In renal disease, calcitriol production drops, so the normal mechanism for shutting down PTH is not working. PTH may continue to be produced long after its actions have corrected hypocalcemia. This further exacerbates the vicious cycle.

One of the key objectives in managing kidney patients is to try to prevent secondary hyperparathyroidism. How do we achieve this? There are three possible approaches: dietary phosphorus restriction, oral phosphate binders and calcitriol supplementation. Let me cover each of these.

Phosphorus Restriction in Renal Patients



By far the safest and most effective way of preventing hyperparathyroidism is to restrict the phosphorus content of the diet. The graph at right from a study published in 1971, almost 40 years ago! Groups of dogs with renal disease were fed diets with either normal levels of phosphate (turquoise line) or with greatly restricted phosphate content (red line). Their PTH concentrations were plotted against their renal function (measured as GFR). Blood samples were taken as the dogs moved from a moderately impaired GFR of about 70 ml/min (left side of horizontal axis) to just before death when their GFR dropped to less than 20 ml/min (right side of horizontal axis). With normal phosphate intake, the PTH concentrations increased exponentially as GFR declined. In the dogs with phosphate restriction however, PTH did not increase as GFR declined. This is why dogs with renal disease should always be fed low phosphorus diets.

The goal in managing renal patients is to drop phosphorus intake every time there is a drop in GFR so that you don't get the spikes blood phosphate concentration illustrated earlier in this article. If you restrict phosphorus in increments as GFR drops, you can prevent secondary hyperparathyroidism and renal osteodystrophy. This is the rationale behind the six renal recipes in my cookbook. By offering six recipes with six different levels of protein and six different levels of phosphorus, it is possible to deliver appropriate levels of protein and phosphorus according to the body weight of the dog and the stage of the disease. Below is Table 22 taken from page 52 in my cookbook – six different renal recipes with different levels of protein and phosphorus.

Renal Recipe	Page	Protein (g/1000 kcal)	Phosphorus (mg/1000 kcal)
R91	159	31	615
R92	160	37	709
R93	161	43	783
R94	162	48	875
R95	163	53	939
R96	164	58	1006

And here is Table 23 from the same page showing how different degrees of protein and phosphorus restriction are appropriate for different stages of renal disease. So for example, a 40lb dog in early renal disease should be fed recipe R94, but as the disease advances, that dog should be moved to recipe R93 and eventually R92.

Dog's body weight		Stage of kidney disease		
kgs	lbs	Early	Advanced	End-stage
< 14	< 30	R93	R92	R91
15–27	31–60	R94	R93	R92
28–50	61–110	R95	R94	R93
> 50	> 110	R96	R95	R94

Phosphate Binders

Phosphate binders are substances that bind to phosphorus in the intestines and prevent it from being absorbed into the dog's body. Phosphate binders are typically calcium- or aluminum-containing compounds (ie calcium carbonate, calcium acetate, aluminum hydroxide), lanthanum carbonate (ie Renalzin for cats) or polymeric structures (Sevelamer for humans) that bind to phosphate. As you can appreciate from the contents of this article, phosphate binders need to be used with care. Binders containing calcium can cause hypercalcemia if the balance between the calcium in the diet + binder and the phosphorus in the diet is not appropriate. Prolonged use of aluminum-containing binders has been associated with encephalopathy in humans. Although binders can be useful, it is difficult to ensure the correct calcium-to-phosphorus ratio in the food and the correct uptake of calcium from the gut as kidney disease progresses.

Calcitriol Supplementation in Renal Patients

Since calcitriol enhances phosphate uptake from the gut, it would seem counter-productive to give calcitriol to a renal patient. The reason calcitriol is given to renal patients is because calcitriol is the negative feedback shut-off mechanism for PTH (see question 5 in my previous article). In renal disease, damage to kidney cells leads to a reduced capacity of the kidneys to produce calcitriol. In the absence of calcitriol, there's no shut-off mechanism for PTH and the parathyroid gland may continue to produce PTH even after blood calcium levels have returned to normal. PTH production may be temporarily shut down by the administration of calcitriol but this approach has its risks. Calcitriol increases phosphate uptake from the gut which will trigger the production of PTH. Calcitriol also increases the uptake and retention of calcium which can cause hypercalcemia. Calcitriol should never be administered to a dog that is hypercalcemic.

Although the safest way to prevent hyperparathyroidism is to restrict phosphorus in the food, the challenge comes in finding ingredients that are naturally low in phosphorus. Remember that meats typically contain at least 10-15 times more phosphorus than calcium and many fruits and vegetables are also relatively high in phosphorus. Using formulation software however, it is possible to create recipes that do deliver phosphorus intake well below AAFCO guidelines and yet still meet all of the dog's other nutrient requirements. A properly formulated renal recipe can improve the quality of life of dogs with renal disease and can greatly extend their life expectancy by reducing debilitating secondary conditions such as hyperparathyroidism and renal osteodystrophy.

Calcium and Phosphorus in Growing Puppies

By Elizabeth Pask, PhD

We often think of bone as a stable and inert substance. Bone provides our dog's body with the structural support required to do everything in life. Bone also functions as a storage vat for the essential minerals calcium and phosphorus. Bone growth requires a tremendous amount of energy, calcium and phosphorus. We often think that bone only contains calcium but it also contains phosphorus and collagen (protein). All nutrients are important to growing puppies however we need to pay special attention to calcium and phosphorus. The absolute amount of calcium and phosphorus is important however the calcium to phosphorus ratio is as important if not more. If we supply too much of one mineral and not enough of the other (i.e. too much calcium and not enough phosphorus) we can cause poor bone formation which can result in severe bone and cartilage deformations. In order to understand how this happens we'll first look at bone formation and the role of calcium in the body.

Calcium and Bone

Bone is made up of a crystal called hydroxyapatite (HA) (a chemical structure containing calcium, phosphate, oxygen and hydrogen). HA is hardened onto a collagen scaffold made by specialized bone cells called OSTEOBLASTS ("blasts" build bone). This hardened HA then forms into bone. Bone is not a static tissue it is constantly broken down and built up again. The cells that are responsible for breaking down bone are called OSTEOCLASTS ("clasts" collapse bone) in a process called resorption. The calcium-phosphate that forms HA comes from the blood which in turn comes from the diet. In a growing puppy the dietary requirement for calcium and phosphorus is 1% and 0.8% respectively on a dry matter basis and should be fed in a ratio of between 1 and 1.5 to 1 (Calcium:Phosphorus). The calcium to phosphorus ratio in meat is inverted which results in too little calcium and too much phosphorus being present in the food. A well balanced dog food, whether commercially prepared or home made, will have added calcium to correct this imbalance (Table 1).

Table 1: Meat that is included in dog food has too little calcium and too much phosphorus. As a result, diets need to have added sources of calcium (i.e. calcium carbonate or calcium caseinate) to balance this out.

	Units	Cooked salmon	Cooked ground beef	Cooked ground pork	Cooked chicken breast	Cooked chicken liver
Protein	g	22	28	26	31	24
Calcium	mg	15	16	22	15	11
Phosphorus	mg	252	250	226	228	405
Ca:P ratio		1:17	1:16	1:10	1:15	1:37
Potassium	mg	384	433	362	256	263
Zinc	mg	0.43	6.84	3.21	1.00	3.98
Vitamin A	IU	50	0	8	20	13,328

If your dog's food does not have this imbalance corrected by the addition of calcium then your dog will have a greatly increased risk of calcium deficiency which will result in bone deformations and possibly fractures. This effect of improperly balanced commercially prepared dog food is becoming an increasing problem in the dog food industry because of the increasing number of small dog food companies that are not adding enough vitamins and minerals to their formulations. A case report published in the Journal of the American Veterinary Medical Association in 2009 reported an 8 month old Shetland Sheepdog puppy that was fed a diet of raw ground beef and an organic premix that did not contain any calcium. The dog was taken to the veterinarian with severe neck pain and weakness. The dog was diagnosed with osteopenia (poor bone mineralization) and multiple bone fractures indicative of vitamin D deficiency (rickets). These conditions were reversed with medical and dietary intervention. Consequently, it is crucial to

ensure that dog foods contain adequate levels of minerals and vitamins.

Hormonal Control of Calcium in the Body

Calcium is involved in a number of roles in the body and as such it is under rigorous hormonal control. The level of calcium in blood is tightly controlled by hormones in the body. In addition to bone formation calcium plays a role in muscle contraction and it also acts as a messenger for some hormones. When levels of calcium are low in the blood parathyroid hormone (PTH) is released from the parathyroid gland in the neck. PTH stimulates the activation of vitamin D which works to increase blood calcium by increasing absorption from the intestine and reabsorbtion from the kidney. In addition, vitamin D increases bone resorption thus releasing calcium AND phosphorus from bone. As a result if we have not enough calcium (HYPOcalcemia) in the diet the body will break down bone to increase the amount of available calcium in the blood. This in turn causes too much phosphorus to be released in the blood (HYPERphosphatemia) (Table 2).

Table 2: Summary table of the hormonal control of calcium and phosphorus

Hormone	Effect on intestine	Effect on kidney	Effect on Bone
Parathyroid hormone	No effect	↑ calcium reabsorbtion ↓ phosphate reabsorbtion	↑ resorption
Vitamin D_3	↑absorption of calcium and phosphorus	↑ reabsorbtion of calcium and phosphorus	↑ resorption
Calcitonin	none	↓ reabsorbtion	↑ deposition

Modified from Human Physiology, S.A.Fox, 6th edition

Growth disorders linked to poor nutrition

There are multiple disorders that have been linked to inappropriate mineral balance. Growth disorders can occur in any sized breed of dog but they are more prevalent in growing giant breed dogs. In 1985 a study was conducted on Great Danes to determine the effect of excessive calcium on the incidence of skeletal disorders. In the study, dogs were fed either a diet containing the recommended level of calcium as determined by the National Research Council (NRC) or they were fed a diet containing 3 times the recommended level of calcium. Dogs that were fed the high calcium diet had chronic hypercalcemia (too much calcium in the blood) or hypophosphatemia (too little phosphorus in the blood). These dogs had a higher incidence of poor bone development which could result in osteochondrosis. This was one of the first studies that examined the effect of mineral imbalance on growth of giant breed dogs. In a further study Great Danes puppies (6 weeks old) were fed one of the following diets for 10 weeks: control, a high calcium or high calcium and phosphorus diet. Puppies fed the high calcium diet had a higher incidence of poor bone mineralization and "severe disturbances in skeletal growth". Calcium intake was normalized and puppies were then fed the control diet. The bone mineralization normalized but the puppies went on to develop osteochondrosis. The high calcium and phosphorus diet puppies had stunted growth, hypophosphatemia, and developed osteochondrosis that only partially resolved when puppies were placed on control diets.

In young animals the intestinal absorption of dietary calcium is not under the same strict level of hormonal control that it is in adults. Yong animal under 6 months of age tend to absorb whatever calcium is in the diet up until a certain point. After that point the capacity of absorb calcium becomes saturated and they can't absorb any more. Therefore it is crucial that the correct amount of calcium and phosphorus is in the diet. Too much or too little calcium and phosphorus can be devastating the structural integrity of your puppy's skeletal structure. A study conducted on beagles and Labrador foxhound crosses found that beagles were able to absorb more calcium on a high calcium diet when compared to the large breed dogs. This confirms our observation

that large and giant breed dogs may be less tolerant of calcium and phosphorus dietary irregularities. However a more recent study examined Great Danes and Miniature Poodles. The study found that there were no differences in how the two different breed handled calcium absorption. Therefore there appears to be some controversy in how different breeds absorb calcium. The one thing that both studies agree on is that calcium absorption does not come under the same level hormonal control until the dog reaches approximately 6 months of age. However, regardless of how the calcium is being absorbed we still need to feed our small breed puppies' sufficient calcium and phosphorus in order to ensure that they develop normally.

Table 3: Summary of growth disorders linked to nutritional imbalance in growing dogs.

Disorder	Risk factors
Osteochondrosis: A disruption in bone formation at the growth plate or on the joint cartilage surface. This disruption leads to poor calcification of growing bone. In growing dogs it occurs in the shoulder, elbow, hock or stifle (knee).	excessive dietary calcium or calories
Hip Dysplasia: poor hip joint formation	excessive dietary calcium or calories especially during puppy hood (3-8 moths of age)
Panosteitis: increased calcium accretion & decreased bone remodelling, with decreased blood supply to the bone marrow resulting in degeneration of adipose bone marrow	excessive dietary calcium
Hypertrophic osteodystrophy: excessive bone deposition resulting in pain and soft tissue swelling in the radius, ulna and tibia (radius and ulna are front leg bones; tibia is in the hind leg)	excessive dietary calcium or calories especially during puppy hood (3-8 moths of age)
Wobbler's syndrome: reduced bone resorption of the vertebral canal leading to canal narrowing pinching the spinal cord	excessive dietary calcium
Radius curvus syndrome: poor maturation and premature closure of growth plate in the ulna coupled with continued lengthening of the radius, leading to curvature of the forelimb	excessive dietary calcium or calories

When feeding our puppies we should be feeding to an optimal level of calcium and phosphorus. Below are AAFCO guidelines comparing puppy and adult calcium and phosphorus requirements on both a dry matter and per 1000 kcal basis. As you can see from these values, puppies have a much higher requirement for both calcium and phosphorus than adults. Foods that are formulated for adult dogs generally don't contain enough calcium and phosphorus to meet the increased needs of growing puppies.

AAFCO requirements (***per 100g - dry matter basis***)				
	Units	Adult minimum	Puppy minimum	Maximum
Calcium	mg	600	1000	2500
Phosphorus	mg	500	800	1600
Ca:P ratio*		1:1	1:1	2:1

AAFCO requirements (***per 1000 kcal***)				
	Units	Adult minimum	Puppy minimum	Maximum
Calcium	mg	1700	2900	7100
Phosphorus	mg	1400	2300	4600
Ca:P ratio*		1:1	1:1	2:1

* for large breed puppies, the optimal range for the calcium-to-phosphorus ratio is narrower, with a minimum Ca:P ratio of 1.2-to-1 and a maximum ratio of 1.5-to-1

Each month, we'll review one nutrition research study published within the last 2 months. These reviews won't be limited to canine nutrition. We may review human, equine, livestock and zoo animal nutrition research if we find it interesting and relevant. The common denominator is that each study will be recently published in a peer-reviewed scientific journal and they will all provide new insight into some concept of nutrition.

Research Study of the Month

By Laura Scott MSc

Title of study:	*Appraisal of Feeding Practices and Blood Metabolic Profile of Pet Dogs Reared on Homemade Diets*
Authors:	*C. Shakhar, A.K. Pattanaik, K.B. Kore and K. Sharma*
Journal:	*Animal Nutrition and Feed Technology*
Issue:	*Volume 10 , 61-73, 2010*
Species:	*Dogs*
Link:	*http://www.indianjournals.com/ijor.aspx?target=ijor:anft&volume=10&issue=1&article=007*

Background Information

Homemade diets for dogs are popular in North America and are very common in Northern India. Homemade diets for pet dogs in India are typically not formulated on a scientific basis and are not balanced. Dogs are typically fed food that was prepared for the family. Feeding an unbalanced diet has a number of risks including both short and long term nutritional deficiencies. In addition to nutrient imbalances, dogs can develop metabolic problems such as hypoproteinemia, hyperglycemia and a risk of obesity. Blood profiles can be used to determine relevant blood biochemical attributes.

Purpose of this Study and Study Design

The authors of this study wanted to evaluate the feeding practices of pet dogs in Northern India and the impact of this on their blood biochemical attributes. The owners of 494 dogs were surveyed for information about their dog and their feeding practices. From these dogs, 251 blood samples were collected. Samples were taken from healthy dogs visiting one of three clinics for routine health care or vaccinations. The blood was centrifuged and the resulting plasma was analyzed for concentrations of glucose, total protein, albumin, urea, cholesterol, calcium, phosphorus, and alkaline phosphatase (ALP).

Study Results

There was a lot of variability amongst the diets fed, however they were grouped into 5 categories. Diet I was a milk and bread based diet with no supplements (23.1%), Diet II was milk and bread based supplemented with vegetables (19%), Diet III was milk and bread based supplemented with egg or meat with vegetables (37.2%), Diet IV was milk and bread based supplemented with egg/meat along with processed dog food (17.2%) and finally Diet V was exclusively processed dog food and milk. Almost all dogs surveyed were fed diets that included milk, and in most cases the dog received food that was cooked for the family's consumption.

Despite the fact that virtually all home-made diets included milk, an excellent source of dietary calcium, 39.2% had plasma calcium levels below the normal reference range (hypocalcemia). A further 23.3% had plasma calcium levels above the normal reference range (hypercalcemia). 29.4% had plasma phosphorus levels above the reference range (hyperphosphatemia), and 41.8% had ALP (alkaline phosphatase) levels below normal. These results indicate advanced disturbed metabolism of bone forming minerals.
Dogs fed homemade diets also had significantly higher plasma cholesterol and glucose levels than dogs fed a commercial dog food. This may indicate an increased risk for obesity and its associated health risks.

My thoughts

The feeding practices in this study do not necessarily reflect normal feeding practices in North America, so the results found may not be indicative of North American dogs eating homemade diets. However this type of study involving blood samples from hundreds of dogs fed homemade meals has never been undertaken in North America. There are some points from this study that are relevant to North American dog owners. First, the dogs all in this study appeared normal and healthy, while their blood work showed nutritional deficiencies. It is not always clear just by looking at a dog whether they are receiving adequate and appropriate nutrition. Second, supplementation in different ways did not correct the deficiencies.

Ensuring that dogs received properly balanced diets is key to preventing nutritional deficiencies or excesses which can lead to serious health problems. Pet nutritionists can use formulation software to create complete and balanced recipes that ensure that nutrient deficiencies and excesses are avoided. In addition, regular blood biochemical profiling can be useful in indicating whether potential nutrient deficiencies (or other health problems) are present.

"Bond... James Bond"

Testimonial

We brought James Bond our Boston Terrier into our home when he was 8 weeks old. We noticed right away something was wrong. He was extremely bloated, very gassy and his bowel movements were not normal. We took him to the veterinarian's the same week to figure out what was wrong. Our veterinarian ruled out the possibility of worms or parasites. Testing showed everything was negative. Our veterinarian suggested we switch his puppy food to a veterinary brand for sensitive stomachs. So we did. A week went by and he seemed to be getting worse. So back to the veterinarian we went. Our veterinarian diagnosed him with gastroenteritis so he was put on an anti-biotic (metronidazole) to help make him comfortable. It seemed to help him out a little bit but not enough to completely rid him of his symptoms. When the prescription was finished James Bond was back to feeling bloated and uncomfortable again. We did not want to continue medicating our poor little puppy. There had to be another way.

We then decided, along with the help of our veterinarian, we would make homemade food for James. Dr. Carol gave us a copy of Hilary Watson's Complete & Balanced cookbook and a jar of HILARY'S BLEND supplement. This was the best thing that could have happened to James Bond. The very first recipe we tried, Puppy Recipe #9 was the cure! His symptoms disappeared completely. We had a bouncy 11 week old puppy, with the added bonus of his coat changing from being dull and flakey to it being extremely shiny.

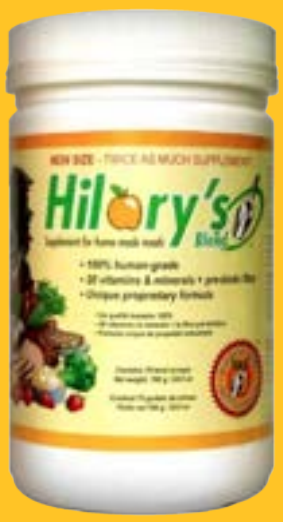
People say our dog is spoiled. We say if spoiling your dog is feeding him the best food possible then yes we spoil our dog. We have continued spoiling him with homemade food and will continue for the rest of his life. He is now 1 and 1/2, he is eating his homemade adult food and loving every bite.

James Bond thanks Hilary Watson from the bottom of his heart for sharing her recipes with us.

Jess Madgwick

Coming Next Month

- **Research – what it is and why is it important?**
- **The placebo effect – does it apply to pet nutrition research?**
- **Product testing, quality assurance – why is it important?**



Hilary's Blend 700g Jar

Introducing – new 700g jar size.
Now available from your veterinarian!

	Cookbook	Hilary's Blend 350g	Hilary's Blend 700g
VP (ON)	5910050	5910040	5910045
CDMV	108092	108091	109549
WDDC (AB)	116922	116921	119656
AVP (BC)	2121922	2121920	2121918

Cooking Workshops for Dog Owners

The Satisfied Canine (a division of The Satisfied Soul Inc), has entered into a licensing agreement with HW Veterinary Nutrition Inc (Hilary Watson), in order to provide 3-hour cooking workshops for dog owners who want to prepare healthy home-made meals for their dogs. Instruction is provided by a licensed chef, following complete & balanced recipes formulated by Hilary Watson. Students are asked to bring Hilary's Blend supplement to the workshop (available from your veterinarian) but all other ingredients are provided by the chef. 4 kilograms of prepared dog food is included in the registration fee. No experience necessary – novices always welcome! Workshops will be offered on Monday evenings and Tuesday afternoons in downtown Toronto beginning in early July. Watch for more information at www.satisfiedcanine.com and www.completeandbalanced.com or send me an email (hwatson@completeandbalanced.com) to have your name added to our cooking workshop mailing list - we'll send you more information as it becomes available.

Subscribe to Newsletter, click here

HW Veterinary Nutrition Inc.
304 Stone Road West, Suite 108,
Guelph, ON, N1G 4W4
(519) 821-8884

www.CompleteandBalanced.com