CANINE DIABETES
What is the difference between diabetes mellitus and diabetes insipidus?

There are two types of diabetes in dogs. **Diabetes mellitus (DM)** is also called **sugar diabetes** and results from a disruption of pancreas function and abnormal regulation of blood sugar. The term, meaning 'sweetened with honey', originated from the fact that the urine of these patients was 'sweet' due to high amounts of sugar excreted from the body.
Diabetes insipidus (DI) gets its name from the fact that the urine of these patients is dilute enough to be 'tasteless' or 'insipid'. Diabetes insipidus (DI) is rare in dogs, and is characterized by excessive thirst/drinking and the production of enormous volumes of extremely dilute urine. Some dogs may produce so much urine that they become incontinent (incapable of controlling their urine outflow). The irony of this disease is that despite drinking large volumes of water, the dog can become dehydrated from urinating so much.

My dog is drinking and urinating a lot. Is DI the likely cause?

There are many causes of increased thirst (polydipsia) and increased urine production (polyuria), including diabetes insipidus, diabetes mellitus, liver problems, and kidney disease, to name a few. It is essential that several diagnostic tests be performed to determine the cause of your dog's problem.

How is DI diagnosed?


A refractometer measures the specific gravity (or the concentration) of the urine.

Part of diagnosing DI involves first eliminating other potential explanations for increased drinking and increased urinating. Typical laboratory testing will include a complete blood count (CBC), blood chemistry panel to evaluate liver and kidney parameters and blood sugar, and a urinalysis. The urine concentration (**specific gravity**) is quite low in these dogs. A more advanced test involves calculating normal daily water intake, measuring how much the dog is truly drinking in 24 hours, depriving him of a portion of the volume he is consuming (closer to the normal volume), and then measuring the urine concentration to assess whether or not the urine can be concentrated. This is called a water deprivation test.

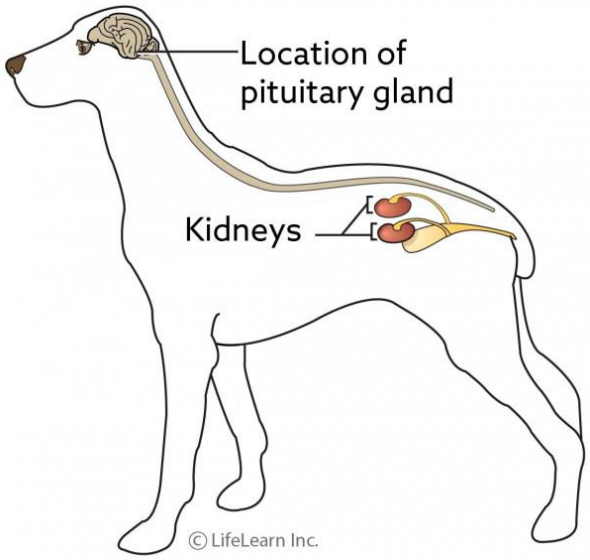
Your veterinarian may recommend a CT or MRI if there is any suspicion of a tumor in the pituitary gland. Likewise, your veterinarian may recommend a trial treatment with a medication to assess his response to this therapy.

What causes DI?

Part of kidney function is to continually filter the blood that passes through them and to maintain the balance of the body's water by excreting or reabsorbing fluid as required. Efficient reabsorption requires an adequate level of a hormone called **antidiuretic hormone** (ADH), or vasopressin, which is produced by the pituitary gland at the base of the brain, and which has its effects in the kidneys. DI may be caused by inadequate production of ADH - this is called **central DI (CDI)** - or by kidney resistance to the hormone - this is called **nephrogenic DI (NDI)**.

Inadequate production of ADH, as in CDI, can be caused by a birth defect, brain trauma, a tumor in the pituitary gland, or there may be no specific cause found (idiopathic).

Lack of kidney response to ADH, as in NDI, can result from a birth defect, an adverse reaction to certain medications, or secondary to certain diseases (like severe infection, metabolic disorders, or advancing kidney disease).



How is DI treated?

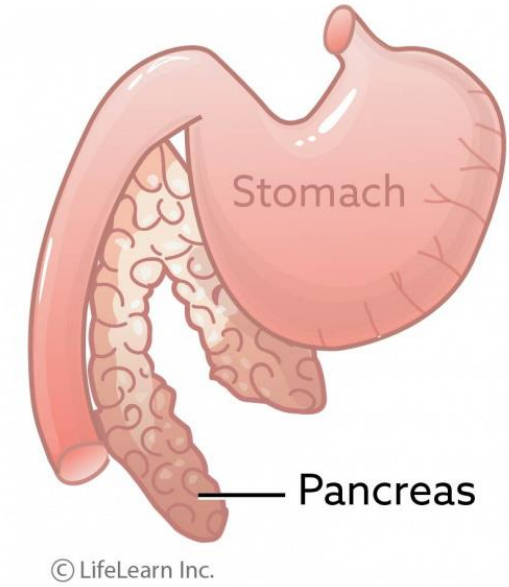
CDI is treated using a synthetic formulation of ADH called desmopressin (also known as DDAVP) that is applied either as eye drops or by injection under the skin. NDI is treated using oral hydrochlorothiazide and a low-salt diet. The treatment depends upon the definitive diagnosis. The underlying disease leading to NDI should be determined to be able to provide more specific treatment.

Can DI be cured?

Diabetes insipidus cannot be cured except in the rare patient whose DI is caused by trauma; however, it can usually be successfully controlled. Without treatment, this disease results in dehydration leading to stupor, coma, and death.

What is diabetes mellitus?

Diabetes mellitus is a disease of the pancreas, a small but vital organ located near the stomach. The pancreas has two significant types of cells. One group of cells produces the enzymes necessary for proper digestion. The other group, called beta cells, produces the hormone **insulin**. Insulin regulates the level of glucose (sugar) in the bloodstream and controls the delivery of glucose to the tissues of the body. In simple terms, diabetes mellitus is caused by the failure of the pancreas to regulate blood sugar.



The clinical signs of diabetes mellitus are related to elevated concentrations of blood glucose and the inability of the body to use glucose as an energy source.

What are the clinical signs of diabetes and why do they occur?

The four main symptoms of uncomplicated diabetes mellitus are increased thirst, increased urination, weight loss, and increased appetite.

Glucose is a vital substance that provides much of the energy needed by cells, but it must first be absorbed by the cells. Insulin tells the body's cells to absorb glucose from the bloodstream. Without an adequate amount of insulin to 'open the door,' glucose is unable to get into the cells and accumulates in the blood, causing hyperglycemia.

When there isn't enough insulin, the cells of the body become starved for their primary source of energy - glucose. In response to this apparent starvation, the body starts breaking down stores of fat and protein for energy, causing weight loss. The apparent starvation stimulates hunger and the dog eats more, resulting in weight loss in a dog with a ravenous appetite. The body tries to eliminate the excess glucose by excreting it in the urine. Since glucose attracts water, it increases the volume of urine produced. To avoid dehydration, the dog drinks more and more water.

Some people with diabetes take insulin by injection, and others take oral medication. Is this true for dogs?

There are three types of diabetes mellitus. In all types there is a failure to regulate blood sugar, but the basic mechanisms of disease differ.

Type I diabetes mellitus (sometimes also called insulin-dependent diabetes mellitus) results from total or near-complete destruction of the insulin-producing beta cells.

This is the most common type of diabetes in dogs. As the name implies, dogs with this type of diabetes require insulin injections to stabilize blood sugar.

In type II diabetes mellitus (sometimes called non-insulin-dependent diabetes mellitus), some insulin-producing cells remain, but the amount of insulin produced is insufficient, there is a delayed response in secreting it, or the tissues of the dog's body are relatively insulin resistant. Type II diabetes may occur in older obese dogs. People with this form can often be treated with an oral drug that stimulates the remaining functional cells to produce or release insulin in an adequate amount to normalize blood sugar. Unfortunately, dogs do not respond well to these oral medications and usually need some insulin to control their disease.

Type III diabetes results from insulin resistance caused by other hormones and can be due to pregnancy or hormone-secreting tumors.

How is diabetes mellitus diagnosed?

Diabetes mellitus is diagnosed by the presence of the typical clinical signs (excess thirst, excess urination, excess appetite, and weight loss), a persistently high level of glucose in the blood, and the presence of glucose in the urine.

Diabetes is the only common disease that will cause the blood glucose level to rise substantially.

To conserve glucose within the body, the kidneys do not filter glucose out of the blood stream into the urine until an excessive level is reached. This means that dogs with normal blood glucose levels will not have glucose in the urine. Diabetic dogs, however, have excessive amounts of glucose in the blood, so it spills into the urine. Once blood glucose reaches a certain level, the excess is removed by the kidneys and enters the urine. This is why dogs and people with diabetes mellitus have sugar in their urine (glucosuria) when their insulin levels are low.

How is diabetes mellitus treated in dogs? Is treatment expensive?

Dogs with diabetes mellitus generally require two insulin injections each day, and nutrition is an important component of disease management. In general, they must be fed the same food in the same amount on the same schedule every day. Although a dog can go a day or so without insulin without a crisis, this should not be a regular occurrence. Treatment must be looked upon as part of the dog's daily routine. This means that you, as the dog's owner, must make both a financial and personal commitment to treat your dog. If you must be out of town or go on vacation, your dog must receive proper treatment while you are away. Once your dog is well regulated, the treatment and maintenance costs are reasonable. The special diet, insulin, and syringes are not overly expensive, but the financial commitment may be significant during the initial regulation process or if complications arise.

Initially, your dog may be hospitalized for a few days to deal with any immediate crisis and to begin insulin regulation. One example of an 'immediate crisis' is a dog that is so sick he has stopped eating and drinking for several days. Dogs in this state, called **diabetic ketoacidosis,** may require several days of hospitalization with intensive care. Otherwise, the initial hospitalization may be only for a day or two while the dog's initial response to insulin injections is evaluated. At that point, your dog returns home for you to administer medication. During the initial phase of insulin therapy, regular return visits are required to monitor progress. New technology has allowed the adoption of home glucose monitoring with the use of a simple device such as an AlphaTrak® 2 glucometer. Additional home monitoring can involve the evaluation of urine for the presence of glucose, although this is not a very sensitive way to monitor glucose levels. It may take a month or more to achieve good insulin regulation.

The financial commitment may again be significant if complications arise. Your veterinarian will work with you to try to achieve consistent diabetes regulation, but some dogs are difficult to regulate. It is important to pay close attention to all instructions related to administering medication, nutrition, and home monitoring. One serious complication that can arise is hypoglycemia, or low blood sugar, which can be fatal. This may occur due to inconsistencies in treatment.

What is the prognosis for a dog with diabetes mellitus?

Once canine diabetes mellitus is properly regulated, the dog's prognosis is good as long as treatment and monitoring are consistent. Most dogs with controlled diabetes live a good quality of life with few symptoms of disease.

What specifically is the treatment of diabetes?

Consistent treatment is a vital component of the proper management of the diabetic dog. Your dog needs consistent administration of insulin, consistent feeding, and a stable, stress-free lifestyle. Although it is not essential, your dog should live indoors to minimize uncontrollable variables that can disrupt regulation.

What your dog eats can be important in the treatment of diabetes mellitus. In dogs, with diabetes mellitus, diets with high insoluble fiber may help stabilize blood glucose levels. Diets high in insoluble fiber may reduce the peaks of blood sugar related to eating a high-carbohydrate, low fiber diet. High fiber diets can also have the effect of promoting weight loss, which can be beneficial in overweight dogs but not thin dogs. Dogs with underlying conditions contributing to diabetes, such as pancreatitis, may require different diets such as ultra-low-fat diets. Your veterinarian will discuss specific diet recommendations for your pet's needs.

Your dog's feeding routine is also important. Some owners feed their dogs by leaving food in the bowl at all times, so that the dog can eat whenever it wants (called free-choice feeding). However, this is not the best way to feed a diabetic dog. The preferred way is to feed twice daily, just before each insulin injection.

If your dog is currently eating on a free-choice basis, it is important to try to make the change to twice- daily meals. If a two-meals-per-day feeding routine will not work for you, you must find some way to accurately measure the amount of food that is consumed and ideally to encourage your dog to eat the majority of the food at or around the time of insulin administration.

How often do diabetic dogs need to be monitored?

Your dog's progress must be checked on a regular basis. Monitoring is a joint project on which owners and veterinarians must work together. Most dogs will require more frequent monitoring initially. After the dog is stabilized and you are comfortable administering insulin and feeding the recommended diet, blood and urine testing will typically be performed every one to three months.

What is involved in home monitoring?

Your part in the monitoring process can involve several types of monitoring. First, you need to be constantly aware of your dog's appetite, weight, water consumption, and urine output. You should be feeding a consistent amount of food each day, which will allow you to be aware of changes in consumption. You should weigh your dog at least monthly and notify your veterinarian if there is any weight loss. It is best to use the same scales each time.

Any significant change in your dog's food intake, weight, water intake, or urine output may be an indicator that the diabetes is not well controlled. If you observe changes, schedule an appointment with your veterinarian for blood testing.

Another method of home monitoring is to determine the presence of glucose in the urine. This can be valuable in cases where there is concern for hypoglycemia. No glucose in the urine often indicates hypoglycemia.

Some dogs may also have their blood glucose monitored at home. This requires special veterinary (pet) blood glucose monitors (AlphaTrak 2™). Your veterinarian will recommend this type of monitoring to you if your dog is a suitable candidate. Not all pet parents or dogs will allow, or enjoy, this type of monitoring that requires you to obtain small blood samples from your dog.

A new option for home monitoring is a continuous glucose monitor (FreeStyle Libre™) that is inserted into the skin and stays in place for up to 14 days. The sensor tracks glucose every minute and stores up to 8 hours of data. The owner passes a scanner over the device several times a day and this records glucose levels reflective of blood glucose. Ask your veterinarian if this is a good option for your dog.

How will my veterinarian monitor my dog's diabetes?

There are two common blood tests that can be used to monitor your dog, the blood glucose curve and the fructosamine test. New tests are also becoming available that can aid your veterinarian in accurately monitoring your dog's diabetes. One of these tests may be recommended at periodic intervals for monitoring, even if your dog is well regulated. Testing should also be done any time clinical signs of diabetes are present.

The most common diabetes monitoring test, a blood glucose curve, involves monitoring the level of glucose in the blood over a 12-24 hour period. Blood glucose curves generally start around the time of insulin administration and continue until the next dose or, in some cases, for a full 24 hours. Blood samples may be collected every 1-2 hours during this period and will reflect how the pet is responding to insulin on that day.

The usual procedure for measuring a blood glucose curve is as follows:

1) Feed your dog its normal morning meal and then bring your dog to the hospital immediately before administering insulin. If you cannot get your dog to the hospital within thirty minutes, do not feed him and bring your dog's food with you. Also be sure to bring your insulin to the veterinary hospital.

2) A blood sample will be taken immediately to assess your dog's pre-insulin glucose level.

3) The veterinarian will give your dog's dose of insulin and feed your dog if necessary.

4) Blood samples will be taken every one to three hours throughout the day, generally for an eight- to ten-hour period or longer. This will allow your veterinarian to determine the peak insulin effect and how your pet is responding to insulin over the course of the day. This is often referred to as an "insulin-response curve."

If your dog gets too excited or is very nervous when riding in the car or being in the hospital, the glucose readings may be falsely elevated. If this occurs, it is best to admit your dog to the hospital the morning (or afternoon) before testing so it can settle down for testing the next day. Other methods of monitoring daily fluctuations in glucose may also be considered, such as home glucose curves or continuous glucose monitoring.

An alternative test is called a fructosamine test. Fructosamine gives your veterinarian an approximate average of the blood glucose levels for the last two weeks. Stress and inconsistencies in diet and exercise have less effect on this test than on the blood glucose test. If no glucose curve options work for your dog, this may be the preferred test. It does not require fasting and can be performed at any time of the day. It can also be useful if there is worry about hypoglycemia. Your veterinarian will discuss this test and if it is appropriate for your dog's monitoring program.

Does hypoglycemia occur in dogs?

Hypoglycemia means low blood sugar. If the blood sugar falls below 40 mg/dl, it can be life threatening. Hypoglycemia generally occurs under two conditions:
1) **When the insulin dose is too high.** Although most dogs will require the same dose of insulin for long periods of time, it is possible for the dog's insulin requirements to suddenly change. The most common causes for change are a reduction in food intake and an increase in exercise or activity. The dog should eat before giving the insulin injection, because once the insulin is administered it can't be removed from the body. If your dog does not eat, skip that dose of insulin. If only half of the food is eaten, give only a half dose of insulin. Always remember that it is better in the short term for the blood sugar to be too high than too low. Ask your veterinarian for specific guidance on what to do if your pet fails to eat or eats only a portion of its food. These are only general guidelines and may vary in your dog.
2) **When too much insulin is given.** This can occur because the insulin was not properly measured in the syringe or because two doses were given. You may forget that you gave it and repeat the dose or two people in the family may each give a dose. A chart to record insulin administration will help to prevent the dog being treated twice.

The most likely time that a dog will become hypoglycemic is the time of peak insulin effect (generally 5 to 8 hours after an insulin injection). When the blood glucose is only mildly low, the dog will **act very tired and unresponsive**. You may call your dog and get little or no response. Within a few hours, the blood glucose will rise, and your dog will return to normal. Since many dogs sleep a lot during the day, this important sign is easily missed. Watch for any subtle signs of hypoglycemia. It is the first sign of impending problems. If you see it, please bring your dog in for blood glucose testing. If severe hypoglycemia occurs, a dog may have **seizures or lose consciousness. Ultimately, untreated hypoglycemia will lead to coma and death. THIS IS AN EMERGENCY** that can only be reversed with intravenous administration of glucose. If it occurs during office hours, take your dog to the veterinarian's office immediately. If it occurs at night or on the weekend, call your veterinarian's emergency phone number for instructions.

Reference range for ideal blood glucose:

The blood glucose range is from **3 mmol/L – 8 mmol/L.** Speak to your veterinary staff team if the numbers are maintaining above or below.

If the blood glucose monitor reads in the ideal reference range or lower after a meal, **DO NOT GIVE** the dose of insulin.

Please be aware that all pets respond differently to insulin. There are multiple types of insulin and it may require trying a few of them prior to stabilizing diabetes mellitus. Treatment can be costly and is required life-long.

Date	AM	PM	Diet fed/Ate	Insulin Units	Comment
Sample	8 am	8 pm	1 can RC diabetic / All	2 units	Active
1					
2					
3					
4					
5					
6					
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Where to obtain a blood glucose sample:

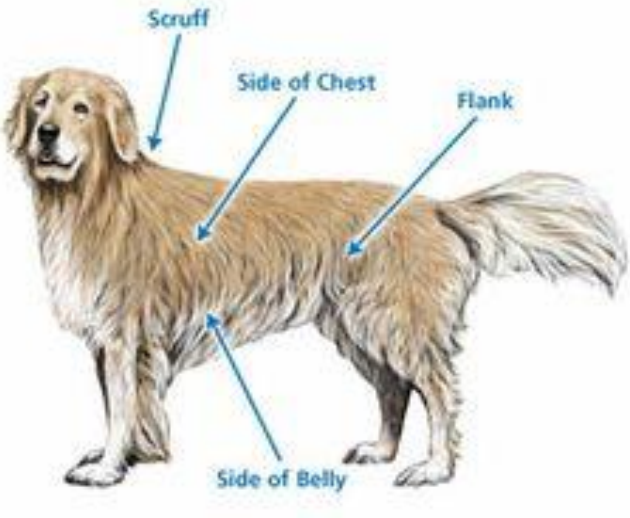
The red X's indicate the locations on the ears that can be poked to obtain a droplet of blood.

Be sure to inspect the ear pinna before collecting a sample that there is no blood vessel being directly poked.

Touch the blood glucose monitor's strip to the formed droplet of blood until it beeps.

If the ear produces more blood than required for the test, firmly apply pressure to the spot until bleeding stops. Alternate ears each time a blood glucose reading is needed.

Injection sites for insulin:



Insulin is to be given following a meal unless otherwise directed by a veterinarian.

Gently pinch the skin in one of these marked areas to form a skin tent. Using the index finger as a guide, the needle of the insulin syringe is to be inserted beneath the index finger into the skin at an approximate 45 degree angle.

Draw back on the syringe to confirm no air or blood is drawn into the syringe. Inject and remove syringe. Dispose of into a sharps container.

Preparing the insulin:

Insulin should be stored in the refrigerator and pulled out at the time of use. Prepare the insulin by gently rolling the vial back and forth between each palm.

Draw up the required amount of insulin units and return vial back to the refrigerator.