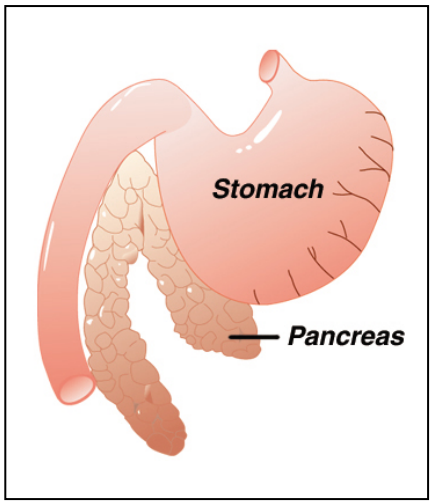
# DIABETES MELLITUS IN DOGS

## What is Diabetes Mellitus?

There are two forms of diabetes in dogs: diabetes insipidus and diabetes mellitus. Diabetes insipidus is a very rare disorder that results in failure to regulate body water content. Your dog has been diagnosed with the more common type of diabetes, diabetes mellitus, commonly just called "diabetes." Diabetes mellitus is frequently diagnosed in dogs five years of age or older. This is also known as Type II or adult-onset diabetes. There is a congenital form that occurs in puppies called Type I or juvenile diabetes, but this is rare in dogs.




Diabetes mellitus is a disease of the pancreas. This is a small but vital organ that is located near the stomach. It has two significant populations of cells. One group of cells produces the enzymes necessary for proper digestion. The other group, called beta-cells, produces the hormone insulin. Insulin is a hormone that allows all the cells in the body to absorb and utilize glucose. Simply put, diabetes mellitus is a failure of the pancreas to produce enough insulin.

We use the words glucose and sugar interchangeably when referring to blood or urine. Blood sugar and blood glucose are the same thing.

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

In humans and cats, two types of diabetes mellitus have been discovered. Both types are similar in that there is a failure to regulate blood sugar, but the basic mechanisms of disease differ somewhat between the two groups.

**Type I** or Insulin Dependent Diabetes Mellitus, results from total or near-complete destruction of the 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.

**Type II** or Non-Insulin Dependent Diabetes Mellitus, is different because some insulin-producing cells remain. However, the amount produced is insufficient, there is a delayed response in secreting it, and the tissues of the dog's body are relatively resistant to it. Type II most commonly occurs in older obese dogs. People with this form may 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.

## Why is insulin so important?

The role of insulin is much like that of a gatekeeper: it stands at the surface of body cells and opens the door, allowing glucose to leave the blood stream and pass inside the cells. Glucose is a vital substance that provides much of the energy needed for life, and it must work *inside* the cells. Without an adequate amount of insulin, glucose is unable to get into the cells. It accumulates in the blood, setting in motion a series of events that can ultimately prove fatal.

When insulin is deficient, the cells become starved for a source of energy. In response to this, the body starts breaking down stores of fat and protein to use as alternative energy sources. As a consequence, the dog eats more; thus, we have weight loss in a dog with a ravenous appetite. The body tries to eliminate the excess glucose by excreting it in the urine. However, glucose (blood sugar) attracts water, resulting in the production of a large amount of urine. To avoid dehydration, the dog drinks more and more water. Thus, we have the four classical signs of diabetes:

1. ***Weight loss***
2. ***Increased water consumption***
3. ***Increased appetite***
4. ***Increased urination***

**How is diabetes mellitus diagnosed?**

The diagnosis of diabetes mellitus is based on three criteria: the four classical clinical signs, the presence of a persistently high level of glucose in the blood stream, and the presence of glucose in the urine.

The normal level of glucose in the blood is 80-120 mg/dl. Diabetes is the only common disease that will cause the blood glucose level to rise above 300 mg/dl.

To keep the body from losing glucose, the kidneys do not allow glucose to be filtered out of the blood stream until an excessive level is reached. This means that dogs with a normal blood glucose level will not have glucose in the urine. Diabetic dogs, however, have excessive amounts of glucose in the blood, so excess glucose will also be present in the urine.

**What are the implications for me and my dog?**

Blood glucose cannot be normalized in a diabetic dog without insulin. Although the dog can go a day or so without treatment and not have a crisis, treatment should be looked upon as part of the dog's daily routine. Treatment always requires some dietary changes and administration of insulin.

As for you, the owner, there are two implications: financial commitment and personal commitment.

When your dog is well regulated, the maintenance costs are minimal. The special diet, insulin, and syringes are not expensive. However, the financial commitment is significant during the initial regulation process and if complications arise.

Initially, your dog may need to be hospitalized for a few days to deal with the immediate crisis and to begin the regulation process. The "immediate crisis" occurs if your dog is so sick that it has quit eating and drinking for several days. Dogs in this state,

called *ketoacidosis*, may require a week or more of hospitalization with quite a bit of laboratory testing.

Otherwise, if your pet is still eating, we teach you how to administer insulin and measure urine glucose with test strips and your dog goes home with you. We start with a low dose of insulin and gradually increase the dosage until the urine glucose readings drop to the low positives. Then we start monitoring more accurately for blood glucose.

It may take a month or more to achieve good regulation. Regulation means using urine and blood testing to determine the correct amount and type of insulin that keeps the blood glucose stable between about 80 and 150. After every insulin dose or diet adjustment we wait to see how your pet responds and then adjust again if necessary. Giving insulin twice a day will never achieve the precise control that a normal pancreas can achieve but we try to get as close as we can.

Once we have your dog fairly well regulated we will need to check blood sugars at least every few months and urine sugars at least twice a month. If changes occur in your dog's health, diet or routine that can change how much insulin is needed.

**Home Monitoring**

> The key to successful diabetes treatment is consistency. Your dog needs consistent administration of medication, consistent feeding, and a stable, stress-free lifestyle if possible. Changes in diet and exercise cause fluctuations in blood sugar levels and the amount of insulin required.

There are three ways 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 the same food each day, and pay careful attention if your dog does not eat all of it or is unusually hungry after the feeding. You should weigh your dog at least monthly. It is best to use the same scale each time.

Weight loss or increased thirst and urination usually means blood sugars are running too high and the insulin amount needs to be adjusted.

You should develop a way to measure water consumption. The average dog should drink no more than 7 1/2 oz. (225 ml) of water per 10 pounds (4.5 kg) of body weight per 24 hours. Since this is highly variable from one dog to another, keeping a record of your dog's water consumption for a few weeks will allow you to establish what is normal for your dog. Another way to measure water consumption is based on the number of times it drinks each day. When properly regulated, it should drink no more than six times per day. If this is exceeded, you should take steps to make an actual measurement.

**Any significant change in your dog's food intake, weight, water intake, or urine output is an indicator that the diabetes is not well controlled. We should see your dog at that time for blood testing.**

**Urine Monitoring**

The second method of home monitoring, as mentioned above, is determining the presence of glucose in the urine. Urine will need to be checked frequently initially and then a few times a month long term. You may purchase urine glucose test strips in

any pharmacy. They are designed for use in humans with diabetes, but they also work in the dog. A fresh urine sample should be collected and tested with the test strip.

The unit of measurement in urine is different from that of blood. A urine glucose of 1000 does not equal a blood glucose of 1000. We are basically looking for none, a little or a lot of glucose, whereas blood glucose readings are exact numbers.

When your dog is initially diagnosed, urine glucose will be high all the time. As your dog becomes regulated on insulin, the urine glucose should gradually come down, from 1000 to small amounts, a trace amount or none at all. Urine glucose is not nearly as accurate as blood glucose is but it gives us a rough approximation of blood glucose. If your dog is properly regulated, there should be no or only a little glucose present in the urine. If more than a trace of glucose is detected, the test should be repeated several times over the next two days. If glucose is present each time, your dog will need blood glucose testing.

The urine test strips you will use also test for ketones. Ketone is a toxin that builds up when the blood glucose is too high over a significant period of time. **Any increase in the amount of ketones in the urine needs to be addressed, before your dog becomes severely ill and ends up in the emergency clinic.**

The urine test strips require only a small amount of urine. Because the female dog usually squats to urinate, a shallow pan or dish may be placed under the hindquarters when she begins to urinate. For male dogs, urine can be collected as soon as the dog lifts the leg to void. Male dogs often urinate small amounts in several different places and often on vertical objects, such as bushes and trees. A ladle or large spoon may work best to catch the sample, or you can hold the test strip in the urine stream to wet it.

Diabetic pets are prone to urinary tract infections, so regular urine screening will be needed to check for those, in addition to checking for glucose and ketones.

Always wear gloves when handling urine. Leptospirosis is a serious bacterial infection that is shed in the urine and is transmissible to humans.

**Monitoring of Blood**

Determining the level of glucose in the blood is the most commonly used blood test. The timing of blood sugar readings in relation to when insulin is given is important. Blood glucose will be at its highest about the time the insulin injection is given. The insulin will be absorbed slowly and should hit its peak activity about 6 hours after it is injected. This means the lowest blood glucose readings will be at this time. So highest readings at insulin time, lowest readings halfway between injections.

There are different types of insulin that are absorbed at different rates. How fast insulin is absorbed and used up depends somewhat on the metabolism of the pet. When we are first starting your dog on insulin, we need frequent glucose readings to follow the curve as the glucose decreases, bottoms out and then gradually goes back up again. If your dog absorbs insulin too quickly, he or she may need a longer lasting type of insulin. If insulin lasts too long in your dog, we need something shorter-acting.

We are trying to end up with a curve that is just right, so that giving insulin injections every 12 hours works out. It is virtually impossible to administer

There are two main types of insulin used in dogs. NPH insulin contains 100 units per ml. PZI contains 40 units per ml. You must use 100u syringes for 100 u/ml insulin and 40u syringes for 40 u/ml.

injections every 9 hours or every 15 hours, for example, and keep track of injection times. We have to be able to get an acceptable curve giving insulin twice a day.

When spot-checking testing blood glucose levels in a pet who is well-regulated, we want to know the highest and lowest glucose readings for the day. The low point is the most critical. High blood glucose is life-threatening in the long run but low blood glucose, or hypoglycemia, can be fatal very quickly. A blood glucose less than 50 or so usually will cause a pet to seem confused, uncoordinated or weak. A blood sugar less than 20 will lead to seizures, coma and death.

**If you notice your pet has these symptoms you will need to administer first aid immediately.** This means administration of oral sugar, to bring the blood sugar back up again. You will want to keep Karo™ corn syrup in your house, as well as an appropriate syringe to use to administer it by squirting it a little at a time into your pet's mouth. If symptoms are mild, this may be all you need to do. You will give more Karo every 10-15 minutes until your pet seems to be recovering, and then feed some actual food to maintain the effect.

If your pet is seizuring or non-responsive, do your best to get some Karo in before rushing your pet here or to an emergency clinic for IV dextrose administration.

Once your pet is doing better again, something will need to be changed. Usually we will decrease the amount of insulin given, along with treating or modifying anything else that has gone wrong. More frequent glucose monitoring may be needed for a while in order to get back on track.

**Monitoring Blood Glucose Levels**

Blood for testing can be obtained in several ways. Here in the hospital we will often draw blood from a vein to test. Many clients doing long term monitoring at home use a little meter and prick the ear with a stylet to get a drop of blood for testing.

The best way to test when we are initially stabilizing a dog and adjusting insulin dosages is with a patch called a Freestyle Libre. It's a plastic disc about 1" in diameter with a small needle at the center. The patch is placed and glued to the skin so the tiny needle penetrates the skin. The little sensor obtains blood sugar readings every few minutes. You read the glucose numbers with a meter we provide, or with an app you can download onto an iPhone (version 7 or higher) or to your Android phone. We can get continuous blood sugar readings for up to two weeks with a single patch.

Patches come in a pack of two and are obtained from a human pharmacy. Bring the patches to us and we will place them on your pet. Be aware that dogs can sometimes get the patches off, by rolling on carpeting, rubbing against something or scratching at it. It can be frustrating to spend the money for a patch that is supposed to last two weeks and it's off in two days. Sometimes we will cover the patch with a T-shirt or Onesie to make it harder to dislodge.

**Food and Feeding**

Consistency is vital to proper management of the diabetic dog. Your dog needs consistent administration of medication, consistent feeding, and consistent exercise. The second step in treatment, after starting insulin, is to alter your dog's diet. Diabetes mellitus is known as a "fiber-responsive disease". Diets high in fiber are preferred because they are generally lower in sugar and slower to be digested. Fiber slows

absorption of glucose from food. This means that the dog does not have to process a large amount of sugar at one time. This will usually be a prescription diet made specifically for diabetic pets.

Any change in brand or formulation of food likely will change how much fiber is in the food, which will in turn affect how much insulin is needed. Soft moist diets, those that come in a pouch, usually contain sugars that are absorbed very rapidly, causing blood glucose spikes after meals. The only time you should feed a diabetic dog a soft-moist food is if the blood glucose has dropped too low and you are trying to get it back up again. Otherwise, a higher-fiber diet will usually get you the best glucose control, and this can be dry or canned.

Your dog's feeding routine is also important. You should feed your dog twice daily, just **before** each insulin injection. If your dog does not eat and you give insulin anyway, the blood glucose will drop too low. Make sure your dog isn't feeling ill before you give a dose of insulin that you can't take back! Diabetic pets are more prone to pancreatitis, inflammation of the pancreas. Pancreatitis causes nausea and abdominal pain. It can come on quickly and at random. Be aware this can happen and take this little precaution of checking for decreased appetite before giving your regular dose of insulin.

When your pet is not able to eat because of illness, anesthesia or surgery, we will usually have you give half doses of insulin but this varies with the patient. **Always check with us before giving insulin if anything doesn't seem right to you!**

**Giving Injections**

The foundation for regulating blood glucose is the administration of insulin by injection. Many people are initially fearful of giving insulin injections. If this is your initial reaction, consider these points:

**A.** Insulin does not cause pain when it is injected.

**B.** The injections are made with very tiny needles that your dog hardly feels.

**C.** The injections are given just under the skin in areas in which it is almost impossible to cause damage to any vital organ.

Please do not decide whether to treat your dog with insulin until we have demonstrated the injection technique. You will be pleasantly surprised at how easy it is and how well your dog tolerates the injections.

The injection technique is as follows:

Insulin comes in an airtight bottle that is labeled with the insulin type and the concentration. It is important to make sure you match the insulin concentration with the proper insulin needles. Most dogs receive U-100 insulin. Make sure that the insulin needles you use are designed for your pet's insulin.

Before using the insulin, mix the contents. Roll or rock the bottle gently between your hands; do not shake it. This is to prevent foam formation, which will make accurate measuring difficult. Some types of insulin used in dogs have a strong tendency to settle

out of suspension. If it is not shaken properly, it will not mix well and dosing will be inaccurate. Therefore, the trick is to shake it vigorously enough to mix it without creating foam. When you have finished mixing the insulin, turn the bottle upside down to see if any white powder adheres to the bottom of the bottle. If so, more rocking is needed.

**Insulin will lose its effectiveness if exposed to direct sunlight or high temperatures.** It should be kept in the refrigerator, but it should not be frozen. If you have any question about your pet's insulin and how it was stored, we recommend replacing it instead of risking using ineffective insulin. Insulin is safe as long as it is used as directed, but it should be kept out of the reach of children.

***Drawing up the Insulin***. Have the needle and syringe, insulin bottle, and dog ready. Then, follow these steps:


1. Remove the guard from the needle, and draw back the plunger to the appropriate dose level.

2. Carefully insert the needle into the insulin bottle.

3. Inject air into the bottle. This prevents a vacuum from forming within the bottle.

4. Withdraw the correct amount of insulin into the syringe.

Before injecting your dog with the insulin, check that there are no air bubbles in the syringe. If you get an air bubble, draw twice as much insulin into the syringe as you need. Then withdraw the needle from the insulin bottle and tap the barrel of the syringe with your fingernail to make the air bubble rise to the nozzle of the syringe. Gently and slowly expel the air bubble by moving the plunger upward.

When this has been done, check that you have the correct amount of insulin in the syringe. The correct dose of insulin can be assured if you measure from the needle end, or "0" on the syringe barrel, to the end of the plunger nearest the needle.

***Injecting the Insulin***. The steps to follow for injecting insulin are:

1. Hold the syringe in your right hand (switch hands if you are left-handed).

2. Have someone hold your dog while you pick up a fold of skin from somewhere along your dog's back in the "scruff" region with your free hand. Try to pick up a different spot each day.

3. Quickly push the very sharp, very thin needle through your dog's skin. This should be easy and painless. However, take care to push the needle through only one layer of skin and not into your finger or through two layers of skin. The latter will result in injecting the insulin onto your dog's haircoat or onto the floor. The needle should be directed parallel to the backbone or angled slightly downward.

4. To inject the insulin, place your thumb on the plunger and push it all the way into the syringe barrel.

5. Withdraw the needle from your dog's skin. Immediately place the needle guard over the needle and discard the needle and syringe.

6. Stroke your dog to reward it for sitting quietly.

7. Be aware that some communities have strict rules about disposal of medical waste material so don't throw the needle and syringe into the trash until you know if this is permissible. If it is not, we can dispose of them for you.

If you purchase a sharps container from us, disposal once it is full is included.

It is neither necessary nor desirable to swab the skin with alcohol to "sterilize" it. There are four reasons:

1. Due to the nature of the thick hair coat and the type of bacteria that live near the skin of dogs, brief swabbing with alcohol or any other antiseptic is not effective.

2. Because a small amount of alcohol can be carried through the skin by the needle, it may actually carry bacteria with it into the skin.

3. The sting caused by the alcohol can make your dog dislike the injections.

4. If you have accidentally injected the insulin on the surface of the skin, you will not know it. If you do not use alcohol and the skin or hair is wet following an injection, the injection was not done properly.

5. Although the above procedures may at first seem complicated and somewhat overwhelming, they will very quickly become second nature. Your dog will soon learn that once or twice each day it has to sit still for a few minutes. In most cases, a reward of stroking results in a fully cooperative dog that eventually may not even need to be held.

**Is continual or periodic monitoring needed?**

It is critical to check blood glucose and urine glucose on a regular basis. Monitoring is a joint project on which owners and veterinarians must work together.

The financial commitment to treat diabetes is ongoing, but usually not too bad once the test is may again be significant if complications arise. We will work with you to try and achieve consistent regulation, but some dogs are difficult to keep regulated. It is important that you pay close attention to our instructions related to administration of medication, diet, and home monitoring. Another complication that can arise is *hypoglycemia*, or low blood sugar, which can be fatal. This may occur due to inconsistencies in treatment. This will be explained in subsequent paragraphs.

Your personal commitment to treating your dog is very important in maintaining regulation and preventing crises. Most diabetic dogs require insulin injections twice daily. They should receive injections as close to 12 hours apart as possible, and never less than 10 or more than 13 hours apart. They must be fed the same food in the same amount on the same schedule every day. If you are out of town, your dog must receive proper treatment while you are gone. These factors should be considered carefully when your pet has been diagnosed with diabetes mellitus.

The financial commitment may again be significant if complications arise. We will work with you to try and achieve consistent regulation, but some dogs are difficult to keep regulated. It is important that you pay close attention to our instructions related to administration of medication, diet, and home monitoring. Hypoglycemia may occur due to inconsistencies in treatment.

**Does hypoglycemia occur in dogs?**

As previously mentioned, hypoglycemia means low blood sugar. If it is below 40 mg/dl, it is life threatening. Hypoglycemia occurs when t***he 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 change. The most common causes for change are a reduction in food intake or an increase in exercise or activity.

The reason for feeding before the insulin injection is for the purpose of knowing when the appetite changes. *If your dog does not eat, skip that dose of insulin*. If only half of the food is eaten just give a half dose of insulin. *Always remember that it is better for the blood sugar to be too high than too low.*

Insulin overdosage can also 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 it, 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 (5-8 hours after an insulin injection). When the blood glucose is only mildly low, the dog will be very tired and unresponsive. You may call it and get 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 it. It is the first sign of impending problems. If you see it, please bring your dog in for blood testing.

If your dog is slow to recover from this period of lethargy, you should give it corn syrup (1 tablespoon by mouth). If there is no response in 15 minutes, repeat the corn syrup. If there is still no response, contact us immediately for further instructions.

**SUMMARY OF INSTRUCTIONS**

1. Read and reread this material so that you understand the specifics of proper regulation and how to recognize and treat hypoglycemia.
2. Purchase the supplies for treatment.
3. Give the first injection of insulin of _____units at about _____ AM/PM.