**Diabetes mellitus**

Learn about the types of diabetes and the advancement in treating the diseaseAn overview of diabetes mellitus and advances in treatment.(more)

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**diabetes mellitus**, disorder of [carbohydrate](https://www.britannica.com/science/carbohydrate) metabolism characterized by impaired ability of the body to produce or respond to [insulin](https://www.britannica.com/science/insulin) and thereby maintain proper levels of [sugar](https://www.britannica.com/science/sugar-chemical-compound) ([glucose](https://www.britannica.com/science/glucose)) in the blood.

Diabetes is a major cause of [morbidity](https://www.merriam-webster.com/dictionary/morbidity) and mortality, though these outcomes are not due to the immediate effects of the disorder. They are instead related to the diseases that develop as a result of chronic diabetes mellitus. These include diseases of large [blood vessels](https://www.britannica.com/science/blood-vessel) (macrovascular [disease](https://www.britannica.com/science/disease), including [coronary heart disease](https://www.britannica.com/science/coronary-heart-disease) and [peripheral](https://www.merriam-webster.com/dictionary/peripheral) arterial disease) and small blood vessels (microvascular disease, including retinal and renal vascular disease), as well as diseases of the nerves.

**Causes and types**

[The role of the islets of Langerhans](https://cdn.britannica.com/17/74317-050-026954C8/enzymes-cells-Structures-ducts-Acinar-clusters-pancreatic.jpg)The islets of Langerhans are responsible for the endocrine function of the pancreas. Each islet contains beta, alpha, delta, and pancreatic polypeptide (PP) cells that are responsible for the secretion of pancreatic hormones. Beta cells secrete insulin, a well-characterized hormone that plays an important role in regulating glucose metabolism.(more)

[Insulin](https://www.britannica.com/science/insulin) is a [hormone](https://www.britannica.com/science/hormone) secreted by beta cells, which are located within clusters of cells in the [pancreas](https://www.britannica.com/science/pancreas) called the [islets of Langerhans](https://www.britannica.com/science/islets-of-Langerhans). Insulin’s role in the body is to trigger cells to take up glucose so that the cells can use this energy-yielding sugar. Patients with diabetes may have dysfunctional beta cells, resulting in decreased insulin secretion, or their muscle and adipose cells may be resistant to the effects of insulin, resulting in a decreased ability of these cells to take up and metabolize glucose. In both cases, the levels of glucose in the blood increase, causing [hyperglycemia](https://www.britannica.com/science/hyperglycemia) (high blood sugar). As [glucose](https://www.britannica.com/science/glucose) accumulates in the blood, excess levels of this sugar are excreted in the [urine](https://www.britannica.com/science/urine). Because of greater amounts of glucose in the urine, more water is excreted with it, causing an increase in urinary volume and frequency of urination as well as thirst. (The name *diabetes mellitus* refers to these symptoms: *diabetes*, from the Greek *diabainein*, meaning “to pass through,” describes the [copious](https://www.merriam-webster.com/dictionary/copious) urination, and *mellitus*, from the Latin meaning “sweetened with honey,” refers to sugar in the urine.) Other symptoms of diabetes include itching, hunger, weight loss, and weakness.

There are two major forms of the disease. Type 1 diabetes, formerly referred to as insulin-dependent diabetes mellitus (IDDM) or juvenile-onset diabetes, usually arises in childhood. Type 2 diabetes, formerly called non-insulin-dependent diabetes mellitus (NIDDM) or adult-onset diabetes, usually occurs after age 40 and becomes more common with increasing age.

## [Type 1 diabetes mellitus](https://www.britannica.com/science/insulin-dependent-diabetes-mellitus)

Learn about type I and type II diabetes mellitus, the genetic and environmental risk factors and ways to manage itA discussion of type I and type II diabetes mellitus.(more)

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Type 1 diabetes accounts for about 5 to 10 percent of cases of diabetes. Most cases of type 1 diabetes develop in children or [adolescents](https://www.britannica.com/dictionary/adolescents), but about 20 percent of new patients are adults. The frequency of type 1 diabetes varies widely in different countries, from less than 1 case per 100,000 people per year in China and parts of [South America](https://www.britannica.com/place/South-America) to more than 20 cases per 100,000 people per year in places such as Canada, Finland, Norway, Sweden, and the United Kingdom. Most patients present with symptoms of hyperglycemia, but some patients present with [diabetic ketoacidosis](https://www.britannica.com/science/diabetic-ketoacidosis), a clear indication that insulin secretion has significantly deteriorated.

Type 1 diabetes is usually caused by [autoimmune](https://www.britannica.com/science/autoimmunity) destruction of the islets of Langerhans of the pancreas. Patients with type 1 diabetes have [serum](https://www.britannica.com/dictionary/serum) [antibodies](https://www.britannica.com/science/antibody) to several components of the islets of Langerhans, including antibodies to insulin itself. The antibodies are often present for several years before the onset of diabetes, and their presence may be associated with a decrease in insulin secretion. Some patients with type 1 diabetes have genetic variations associated with the [human leukocyte antigen](https://www.britannica.com/science/human-leukocyte-antigen) (HLA) complex, which is involved in presenting antigens to immune cells and initiating the production of antibodies that attack the body’s own cells (autoantibodies). However, the actual destruction of the islets of Langerhans is thought to be caused by immune cells sensitized in some way to components of islet tissue rather than to the production of autoantibodies. In general, 2 to 5 percent of children whose mother or father has type 1 diabetes will also develop type 1 diabetes.

[**Type 2 diabetes mellitus**](https://www.britannica.com/science/non-insulin-dependent-diabetes-mellitus)

Type 2 diabetes is far more common than type 1 diabetes, accounting for about 90 percent of all cases. The frequency of type 2 diabetes varies greatly within and between countries and is increasing throughout the world. Most patients with type 2 diabetes are adults, often older adults, but it can also occur in children and adolescents. There is a stronger genetic component to type 2 diabetes than to type 1 diabetes. For example, identical twins are much more likely to both develop type 2 diabetes than to both develop type 1 diabetes, and 7 to 14 percent of people whose mother or father has type 2 diabetes will also develop type 2 diabetes; this estimate increases to 45 percent if both parents are affected. In addition, it is estimated that about half of the adult Pima Indian population in Arizona has type 2 diabetes, whereas in the entire [United States](https://www.britannica.com/place/United-States) it is estimated that about 10 percent of the population has type 2 diabetes.

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Many patients with type 2 diabetes are asymptomatic, and they are often diagnosed with type 2 diabetes when routine measurements reveal high blood glucose concentrations. In some patients the presence of one or more symptoms associated with the long-term complications of diabetes leads to a [diagnosis](https://www.merriam-webster.com/dictionary/diagnosis) of type 2 diabetes. Other patients present with symptoms of hyperglycemia that have been present for months or with the sudden onset of symptoms of very severe hyperglycemia and vascular collapse.

How was the leptin protein in mice discovered and how has it benefited diabetes and obesity treatment in humans?Learn about the discovery of the leptin protein in mice and its connection to diabetes and obesity.(more)

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Type 2 diabetes is strongly associated with [obesity](https://www.britannica.com/science/obesity) and is a result of insulin resistance and insulin deficiency. Insulin resistance is a very common characteristic of type 2 diabetes in patients who are obese, and thus patients often have serum insulin concentrations that are higher than normal. However, some obese persons are unable to produce sufficient amounts of insulin, and thus the compensatory increase in response to increased blood glucose concentrations is [inadequate](https://www.britannica.com/dictionary/inadequate), resulting in hyperglycemia. If blood glucose concentration is increased to a similar level in a healthy person and in an obese person, the healthy person will secrete more insulin than the obese person.

People with type 2 diabetes can control blood glucose levels through diet and exercise and, if necessary, by taking insulin injections or oral medications. Despite their former classifications as juvenile or adult, either type of diabetes can occur at any age.

**Gestational diabetes**

Diabetes mellitus also may develop as a secondary condition linked to another [disease](https://www.britannica.com/science/disease), such as pancreatic disease; a genetic syndrome, such as myotonic dystrophy; or drugs, such as [glucocorticoids](https://www.britannica.com/science/glucocorticoid). [Gestational diabetes](https://www.britannica.com/science/gestational-diabetes-mellitus) is a temporary condition associated with [pregnancy](https://www.britannica.com/science/pregnancy). In this situation, blood [glucose](https://www.britannica.com/science/glucose) levels increase during pregnancy but usually return to normal after delivery. However, gestational [diabetes](https://www.britannica.com/science/diabetes) is recognized as a risk for type 2 diabetes later in life. Gestational diabetes is diagnosed when blood glucose concentrations measure between 92 and 125 mg per 100 ml (5.1 and 6.9 millimoles [mmol] per litre) after fasting or when blood glucose concentrations equal or [exceed](https://www.britannica.com/dictionary/exceed) 180 mg per 100 ml (10 mmol per litre) one hour after ingesting a glucose-rich solution.

**Acute clinical manifestation**

[Hyperglycemia](https://www.britannica.com/science/hyperglycemia) itself can cause symptoms but usually only when blood glucose concentrations are approximately 180 mg per 100 ml (10 mmol per litre) or higher. When blood glucose concentrations increase, more glucose is filtered by the glomeruli of the [kidneys](https://www.britannica.com/science/kidney) than can be reabsorbed by the kidney tubules, resulting in glucose excretion in the [urine](https://www.britannica.com/science/urine). High glucose concentrations in the urine create an osmotic effect that reduces the reabsorption of water by the kidneys, causing [polyuria](https://www.britannica.com/science/polyuria) (excretion of large volumes of urine). The loss of water from the circulation stimulates thirst. Therefore, patients with moderate or severe hyperglycemia typically have polyuria and polydipsia (excessive thirst). The loss of glucose in the urine results in weakness, [fatigue](https://www.britannica.com/science/fatigue-physiology), weight loss, and increased appetite (polyphagia). Patients with hyperglycemia are prone to infections, particularly vaginal and [urinary tract infections](https://www.britannica.com/science/urinary-tract-infection), and an infection may be the presenting [manifestation](https://www.merriam-webster.com/dictionary/manifestation) of diabetes.

There are two [acute](https://www.merriam-webster.com/dictionary/acute) life-threatening complications of diabetes: hyperglycemia and [acidosis](https://www.britannica.com/science/acidosis) (increased acidity of the blood), either of which may be the presenting manifestation of diabetes. In patients with type 1 diabetes, [insulin](https://www.britannica.com/science/insulin) deficiency, if not recognized and treated properly, leads to severe hyperglycemia and to a marked increase in lipolysis (the breakdown of [lipids](https://www.britannica.com/science/lipid)), with a greatly increased rate of release of [fatty acids](https://www.britannica.com/science/fatty-acid) from [adipose tissue](https://www.britannica.com/science/adipose-tissue). In the [liver](https://www.britannica.com/science/liver), much of the excess fatty acid is converted to the keto acids beta-hydroxybutyric acid and acetoacetic acid. The increased release of fatty acids and keto acids from adipose, liver, and muscle tissues raises the acid content of the blood, thereby lowering the pH of the [blood](https://www.britannica.com/science/blood-biochemistry). The combination of hyperglycemia and acidosis is called [diabetic ketoacidosis](https://www.britannica.com/science/diabetic-ketoacidosis) and leads to [hyperventilation](https://www.britannica.com/science/hyperventilation) and to impaired [central nervous system](https://www.britannica.com/science/central-nervous-system) function, [culminating](https://www.britannica.com/dictionary/culminating) in coma and [death](https://www.britannica.com/science/death). Patients with diabetic ketoacidosis must be treated immediately with insulin and intravenous fluids.

In patients with type 2 diabetes, high blood glucose concentrations can lead to very severe and prolonged hyperglycemia and to marked polyuria, with the loss of a large volume of fluid and a very high serum osmolality. These factors place patients with type 2 diabetes at a high risk of developing central nervous system dysfunction and vascular collapse (hyperglycemia coma). Ketoacidosis is usually not a problem in patients with type 2 diabetes because they secrete enough insulin to restrain lipolysis. Patients with hyperglycemic coma should be treated aggressively with intravenous fluids and insulin.

**Diagnosis and**[**treatment**](https://www.britannica.com/science/therapeutics)

Many people are unaware that they have diabetes. In 2012, for example, it was estimated that 8.1 million of 29.1 million American cases were undiagnosed. The disease is usually discovered when there are typical symptoms of increased thirst and urination and a clearly elevated blood [sugar](https://www.britannica.com/science/sugar-chemical-compound) level. The [diagnosis](https://www.merriam-webster.com/dictionary/diagnosis) of diabetes is based on the presence of blood glucose concentrations equal to or greater than 126 mg per 100 ml (7.0 mmol per litre) after an overnight fast or on the presence of blood glucose concentrations greater than 200 mg per 100 ml (11.1 mmol per litre) in general. People with fasting blood glucose values between 100 and 125 mg per 100 ml (6.1 to 6.9 mmol per litre) are diagnosed with a condition called impaired fasting glucose (prediabetes). Normal fasting blood glucose concentrations are less than 100 mg per 100 ml (6.1 mmol per litre).

While the blood glucose concentrations used to define diabetes and impaired fasting glucose are somewhat arbitrary, they do correlate with the risk of macrovascular and microvascular disease. Patients with impaired fasting glucose are likely to have diabetes later in life. Oral glucose tolerance tests, in which blood glucose is measured hourly for several hours after ingestion of a large quantity of glucose (usually 75 or 100 grams), are used in pregnant women to test for gestational diabetes. The [criteria](https://www.merriam-webster.com/dictionary/criteria) for diagnosing gestational diabetes are more stringent than the criteria for diagnosing other types of diabetes, which is a reflection of the presence of decreased blood glucose concentrations in healthy pregnant women as compared with nonpregnant women and with men.

The duration and severity of hyperglycemia can be assessed by measuring levels of advanced glycosylation end products (AGEs). AGEs are formed when [hemoglobin](https://www.britannica.com/science/hemoglobin) molecules in [red blood cells](https://www.britannica.com/science/red-blood-cell) undergo [glycosylation](https://www.britannica.com/science/glycosylation) (binding to glucose), and the bound substances remain together until the red blood cell dies (red blood cells live approximately 120 days). AGEs are believed to inflict the majority of vascular damage that occurs in people with diabetes. A glycosylated hemoglobin called hemoglobin subtype A1c (HbA1c) is particularly useful in monitoring hyperglycemia and the [efficacy](https://www.merriam-webster.com/dictionary/efficacy) of diabetes treatments.

**Treatment**

Before the isolation of insulin in the 1920s, most patients died within a short time after onset. Untreated diabetes leads to [ketoacidosis](https://www.britannica.com/science/ketoacidosis), the accumulation of [ketones](https://www.britannica.com/science/ketone) (products of [fat](https://www.britannica.com/topic/fat) breakdown) and acid in the blood. Continued buildup of these products of disordered carbohydrate and fat metabolism result in nausea and vomiting, and eventually the patient goes into a diabetic [coma](https://www.britannica.com/science/coma-pathology).

Treatment for diabetes mellitus is aimed at reducing blood glucose concentrations to normal levels. Achieving this is important in promoting well-being and in minimizing the development and progression of the long-term complications of diabetes. Measurements of HbA1c can be used to assess whether an individual’s treatment for diabetes is effective. Target values of HbA1c levels should be close to normal.

[**Diet**](https://www.britannica.com/science/diet-nutrition)**and**[**exercise**](https://www.britannica.com/topic/exercise-physical-fitness)

All diabetes patients are put on diets designed to help them reach and maintain normal body weight, and they often are encouraged to exercise regularly, which [enhances](https://www.merriam-webster.com/dictionary/enhances) the movement of glucose into muscle cells and blunts the rise in blood glucose that follows carbohydrate ingestion. Patients are encouraged to follow a diet that is relatively low in fat and contains adequate amounts of protein. In practice about 30 percent of calories should come from fat, 20 percent from protein, and the remainder from carbohydrates, preferably from complex carbohydrates rather than simple [sugars](https://www.britannica.com/science/sugar-chemical-compound).

The total caloric content should be based on the patient’s nutritional requirements for growth or for weight loss if the patient is obese. In overweight or obese patients with type 2 diabetes, caloric restriction for even just a few days may result in considerable improvement in hyperglycemia. In addition, weight loss, preferably [combined](https://www.britannica.com/dictionary/combined) with exercise, can lead to improved insulin sensitivity and even restoration of normal glucose metabolism.

[**Insulin**](https://www.britannica.com/science/insulin)**therapies**

Diabetics who are unable to produce insulin in their bodies require insulin therapy. Traditional insulin therapy entails regular injections of the [hormone](https://www.britannica.com/science/hormone), which are often customized according to individual and variable requirements. Beef or pork insulin, made from the pancreatic extracts of cattle or pigs, can be used to treat humans with [diabetes](https://www.britannica.com/science/diabetes). However, in the [United States](https://www.britannica.com/place/United-States), beef and pork forms of insulin are no longer manufactured, having been discontinued in favour of human insulin production. Modern human insulin treatments are based on [recombinant DNA technology](https://www.britannica.com/science/recombinant-DNA-technology). Human insulin may be given as a form that is identical to the natural form found in the body, which acts quickly but transiently (short-acting insulin), or as a form that has been biochemically modified so as to prolong its action for up to 24 hours (long-acting insulin). Another type of insulin acts rapidly, with the hormone beginning to lower blood glucose within 10 to 30 minutes of administration; such rapid-acting insulin was made available in an inhalable form in 2014.

The optimal [regimen](https://www.merriam-webster.com/dictionary/regimen) is one that most closely mimics the normal pattern of insulin secretion, which is a constant low level of insulin secretion plus a pulse of secretion after each meal. This can be achieved by administration of a long-acting insulin preparation once daily plus administration of a rapid-acting insulin preparation with or just before each meal. Patients also have the option of using an insulin pump, which allows them to control variations in the rate of insulin administration. A satisfactory [compromise](https://www.britannica.com/dictionary/compromise) for some patients is twice-daily administration of mixtures of intermediate-acting and short-acting insulin. Patients taking insulin also may need to vary food intake from meal to meal, according to their level of activity; as exercise frequency and intensity increase, less insulin and more food intake may be necessary.

Research into other areas of insulin therapy include [pancreas](https://www.britannica.com/science/pancreas) transplantation, beta cell transplantation, implantable mechanical insulin infusion systems, and the generation of beta cells from existing exocrine cells in the pancreas. Patients with type 1 diabetes have been treated by transplantation of the pancreas or of the [islets of Langerhans](https://www.britannica.com/science/islets-of-Langerhans). However, limited quantities of pancreatic tissue are available for transplantation, prolonged immunosuppressive therapy is needed, and there is a high likelihood that the transplanted tissue will be rejected even when the patient is receiving immunosuppressive therapy. Attempts to improve the outcome of transplantation and to develop mechanical islets are ongoing.

**Drugs used to control blood**[**glucose**](https://www.britannica.com/science/glucose)**levels**

There are several classes of oral drugs used to control blood glucose levels, including sulfonylureas, biguanides, and thiazolidinediones. [Sulfonylureas](https://www.britannica.com/science/sulfonylurea), such as glipizide and glimepiride, are considered hypoglycemic agents because they [stimulate](https://www.britannica.com/dictionary/stimulate) the release of insulin from beta cells in the pancreas, thus reducing blood glucose levels. The most common side effect associated with sulfonylureas is [hypoglycemia](https://www.britannica.com/science/hypoglycemia) (abnormally low blood glucose levels), which occurs most often in elderly patients who have impaired [liver](https://www.britannica.com/science/liver) or kidney function.

Biguanides, of which [metformin](https://www.britannica.com/science/metformin) is the primary member, are considered antihyperglycemic agents because they work by decreasing the production of glucose in the liver and by increasing the action of insulin on muscle and adipose tissues. A potentially fatal side effect of metformin is the accumulation of [lactic acid](https://www.britannica.com/science/lactic-acid) in blood and tissues, often causing vague symptoms such as nausea and weakness.

[Thiazolidinediones](https://www.britannica.com/science/thiazolidinedione), such as rosiglitazone and pioglitazone, act by reducing insulin resistance of muscle and adipose cells and by increasing glucose transport into these tissues. These agents can cause [edema](https://www.britannica.com/science/edema) (fluid accumulation in tissues), liver toxicity, and adverse cardiovascular events in certain patients. Furthermore, oral hypoglycemic agents lower mean blood glucose concentrations by only about 50–80 mg per 100 ml (2.8–4.4 mmol per litre), and sensitivity to these drugs tends to decrease with time.

There are several other agents that can be highly effective in the treatment of diabetes. Pramlintide is an injectable [synthetic](https://www.merriam-webster.com/dictionary/synthetic) hormone (based on the human hormone amylin) that regulates blood glucose levels by slowing the absorption of food in the stomach and by [inhibiting](https://www.merriam-webster.com/dictionary/inhibiting) [glucagon](https://www.britannica.com/science/glucagon), which normally stimulates liver glucose production. Exenatide is an injectable antihyperglycemic drug that works similarly to incretins, or gastrointestinal hormones, such as [gastric inhibitory polypeptide](https://www.britannica.com/science/gastric-inhibitory-polypeptide), that stimulate insulin release from the pancreas. Exenatide has a longer duration of action than incretins produced by the body because it is less susceptible to [degradation](https://www.merriam-webster.com/dictionary/degradation) by an enzyme called dipeptidyl peptidase-4 (DPP-4). A drug called sitagliptin specifically [inhibits](https://www.merriam-webster.com/dictionary/inhibits) DPP-4, thereby increasing levels of naturally produced incretins. Side effects associated with these drugs are often mild, although pramlintide can cause profound hypoglycemia in patients with type 1 diabetes.

**Glucometer monitoring**

All patients with [diabetes](https://www.britannica.com/science/diabetes) mellitus, particularly those taking [insulin](https://www.britannica.com/science/insulin), should measure blood [glucose](https://www.britannica.com/science/glucose) concentrations periodically at home, especially when they have symptoms of [hypoglycemia](https://www.britannica.com/science/hypoglycemia). This is done by pricking a finger, obtaining a drop of blood, and using an instrument called a glucometer to measure the blood glucose concentration. Using this technology, many patients become skilled at evaluating their diabetes and making appropriate adjustments in therapy on their own [initiative](https://www.merriam-webster.com/dictionary/initiative).

**Long-term complications of diabetes mellitus**

The prolonged survival of patients with diabetes mellitus has led to an increasing [incidence](https://www.britannica.com/science/incidence-epidemiology) of long-term complications. The most common complications are vascular complications, which may involve large arteries, small arteries, or capillaries. Large-vessel disease generally presents as atherosclerotic vascular disease ([atherosclerosis](https://www.britannica.com/science/atherosclerosis)). Atherosclerosis in diabetic patients does not differ from that which occurs in nondiabetic patients, although it may occur sooner and progress more rapidly in diabetic than nondiabetic patients. It involves the [coronary arteries](https://www.britannica.com/science/coronary-artery), the [cerebral](https://www.merriam-webster.com/dictionary/cerebral) arteries, and the large arteries (iliac and femoral arteries) that supply blood to the legs. Thus, nonfatal and fatal [myocardial infarction](https://www.britannica.com/science/myocardial-infarction) (heart attack), [stroke](https://www.britannica.com/science/stroke-disease), and ulceration and [gangrene](https://www.britannica.com/science/gangrene) of the feet, often necessitating [amputation](https://www.britannica.com/science/amputation), are common in patients with diabetes.

[Cataract formation can occur as a complication of diabetes (shown here in a person affected by type I diabetes).](https://cdn.britannica.com/60/106460-004-2C5972BB/Cataract-formation-complication-diabetes.jpg)

Small-artery disease (microangiopathy) consists of thickening of the walls of small arteries and capillaries, which initially renders them permeable (leaky) to fluids and subsequently renders them prone to obstruction (thrombosis or [embolism](https://www.britannica.com/science/embolism)). These changes occur primarily in the [retina](https://www.britannica.com/science/retina) (diabetic retinopathy) and kidneys (diabetic nephropathy), and as a result diabetes is the most common cause of [blindness](https://www.britannica.com/science/blindness-medicine) and end-stage [kidney disease](https://www.britannica.com/science/renal-system-disease/Diseases-and-disorders-of-the-kidney#ref58655). Vascular complications are [aggravated](https://www.britannica.com/dictionary/aggravated) by [hypertension](https://www.britannica.com/science/hypertension) and hyperlipidemia (high serum levels of [lipids](https://www.britannica.com/science/lipid)), both of which are common in patients with diabetes.

There are other, nonvascular complications of diabetes, including [cataract](https://www.britannica.com/science/cataract-eye) formation and neuropathy (diabetic neuropathy). The most common type of neuropathy is symmetric polyneuropathy. This causes abnormal [sensation](https://www.britannica.com/topic/sensation) (numbness or tingling) or loss of sensation, loss of position sense and vibratory sense, and weakness of the muscles of the feet, lower legs, and hands. Other patients have single-nerve neuropathy, such as loss of function of a nerve to the muscles of one eye, causing visual disturbances, or of a nerve to the muscles of the forearm, causing wrist drop. They may also have autonomic neuropathy, which may result in postural [hypotension](https://www.britannica.com/science/hypotension) (fainting upon sitting up or standing), gastric [retention](https://www.britannica.com/dictionary/retention), [erectile dysfunction](https://www.britannica.com/science/impotence), or urinary [bladder](https://www.britannica.com/science/bladder) dysfunction. These complications may be caused by glycosylation of ocular tissue or nervous tissue, accumulation of osmotically active glucose metabolites in these tissues, or disease of the small vessels in these tissues.

The development or progression of the small-vessel complications of diabetes, such as diabetic retinopathy, [diabetic nephropathy](https://www.britannica.com/science/diabetic-nephropathy), and diabetic neuropathy, can be slowed or prevented by control of [hyperglycemia](https://www.britannica.com/science/hyperglycemia). It is less clear whether the control of hyperglycemia has a similar effect in controlling large-vessel complications. The onset and progression of the vascular complications of diabetes can be delayed by controlling high [blood pressure](https://www.britannica.com/science/blood-pressure) ([hypertension](https://www.britannica.com/science/hypertension)). Many antihypertensive treatments are aimed specifically at preventing the actions of [angiotensin](https://www.britannica.com/science/angiotensin) II, a peptide that stimulates [blood vessel](https://www.britannica.com/science/blood-vessel) constriction to increase blood pressure. The increase in blood pressure can be prevented by drugs that [inhibit](https://www.merriam-webster.com/dictionary/inhibit) angiotensin-converting enzyme (drugs known as ACE inhibitors), which converts inactive angiotensin I to active angiotensin II, or by drugs that block the angiotensin [receptor](https://www.britannica.com/science/receptor-nerve-ending), which prevents angiotensin II from stimulating blood vessels to constrict. Cessation of [smoking](https://www.britannica.com/topic/smoking-tobacco) and lowering serum lipid concentrations are also helpful in slowing progression of vascular disease in patients with diabetes.

**Prevention**

Attempts to prevent type 1 diabetes have been unsuccessful. On the other hand, in people with impaired fasting glucose, progression to type 2 diabetes can be prevented by weight loss and exercise and by [treatment](https://www.britannica.com/dictionary/treatment) with metformin, an ACE inhibitor, or a [statin](https://www.britannica.com/science/statin) (a type of [cholesterol](https://www.britannica.com/science/cholesterol)-lowering drug).

*This article was most recently revised and updated by*[*Kara Rogers*](https://www.britannica.com/editor/Kara-Rogers/6713)*.*

[diabetes](https://www.britannica.com/science/diabetes)

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**diabetes**, either of two disorders of the [endocrine system](https://www.britannica.com/science/endocrine-system). For information about the disorder caused by the body’s inability to produce or respond to insulin and [characterized](https://www.britannica.com/dictionary/characterized) by abnormal glucose levels in the blood, *see* [diabetes mellitus](https://www.britannica.com/science/diabetes-mellitus). For information about the disorder characterized by excessive thirst and dilute urine, caused by lack of the [antidiuretic hormone](https://www.britannica.com/science/vasopressin) vasopressin, *see* [diabetes insipidus](https://www.britannica.com/science/diabetes-insipidus).

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[gestational diabetes mellitus](https://www.britannica.com/science/gestational-diabetes-mellitus)