Lyme disease is caused by the bacterium *Borrelia burgdorferi* and is transmitted to humans by the bite of infected blacklegged ticks. Typical symptoms include fever, headache, fatigue, and a characteristic skin rash called *erythema migrans*. If left untreated, infection can spread to joints, the heart, and the nervous system.

Lyme disease is diagnosed based on symptoms, physical findings (e.g., rash), and the possibility of exposure to infected ticks; laboratory testing is helpful in the later stages of disease. Most cases of Lyme disease can be treated successfully with a few weeks of antibiotics. Steps to prevent Lyme disease include using insect repellent, removing ticks promptly, landscaping, and integrated pest management. The ticks that transmit Lyme disease can occasionally transmit other tick-borne diseases as well.

**Prevention**

Reducing exposure to ticks is the best defense against Lyme disease and other tick-borne infections. There are several approaches you and your family can use to prevent and control Lyme disease.

- Protect yourself from tick bites
  [http://www.cdc.gov/ncidod/dvbid/lyme/Prevention/ld_Prevention_Avoid.htm](http://www.cdc.gov/ncidod/dvbid/lyme/Prevention/ld_Prevention_Avoid.htm)
- Control ticks around your home
  [http://www.cdc.gov/ncidod/dvbid/lyme/Prevention/ld_Prevention_Control.htm](http://www.cdc.gov/ncidod/dvbid/lyme/Prevention/ld_Prevention_Control.htm)
- Manage deer populations and movement
- Consult your doctor after tick bites
  
  [Link](http://www.cdc.gov/ncidod/dvbid/lyme/Prevention/ld_Prevention_Antibiotics.htm)

- Learn the early signs of tick-borne illness
  
  [Link](http://www.cdc.gov/ncidod/dvbid/lyme/ld_humandisease_symptoms.htm)

A Lyme disease vaccine is no longer available. The vaccine manufacturer discontinued production in 2002, citing insufficient consumer demand. Protection provided by this vaccine diminishes over time. Therefore, if you received the Lyme disease vaccine before 2002, you are probably no longer protected against Lyme disease.

**Transmission**

The Lyme disease bacterium, *Borrelia burgdorferi*, normally lives in mice, squirrels and other small animals. It is transmitted among these animals – and to humans – through the bites of certain species of ticks. In the northeastern and north-central United States, the black-legged tick (or deer tick, *Ixodes scapularis*) transmits Lyme disease. In the Pacific coastal United States, the disease is spread by the western black-legged tick (*Ixodes pacificus*). Other major tick species found in the United States have not been shown to transmit *Borrelia burgdorferi*.

Blacklegged ticks transmit Lyme disease

Blacklegged (or deer) ticks (*Ixodes scapularis* and *Ixodes pacificus*) can transmit several tick-borne diseases including anaplasmosis, babesiosis and Lyme disease. An adult tick is pictured at left, though it is the smaller nymphal stage ticks which most commonly bite humans.

Ticks not known to transmit Lyme disease

Lone star ticks (*Amblyomma americanum*) have been linked to transmission of ehrlichiosis, tularemia, and southern tick-associated rash illness (STARI). The saliva of these ticks is irritating, and can cause an allergic reaction at the site of the bite.

American dog tick (*Dermacentor variabilis*) as well as the Rocky Mountain wood tick (*Dermacentor andersoni*) can transmit many diseases including Rocky Mountain spotted fever and tularemia.
Life cycle of blacklegged ticks

Blacklegged ticks live for two years and have three feeding stages: larvae, nymph, and adult. Tick eggs are laid in the spring and hatch as larvae in the summer. Larvae feed on mice, birds, and other small animals in the summer and early fall. When a young tick feeds on an infected animal, the tick takes bacteria into its body along with the blood meal, and it remains infected for the rest of its life. After this initial feeding, the larvae become inactive as they grow into nymphs. The following spring, nymphs seek blood meals in order to fuel their growth into adults. When the tick feeds again, it can transmit the bacterium to its new host. Usually the new host is another small rodent, but sometimes the new host is a human. Most cases of human illness occur in the late spring and summer when the tiny nymphs are most active and human outdoor activity is greatest. Adult ticks feed on large animals, and sometimes on humans. In the spring, adult female ticks lay their eggs on the ground, completing the life cycle. Although adult ticks often feed on deer, these animals do not become infected. Deer are nevertheless important in transporting ticks and maintaining tick populations.

Other suggested modes of transmission

**Person-to-Person**
There is no evidence that Lyme disease is transmitted from person-to-person. For example, a person cannot get infected from touching, kissing or having sex with a person who has Lyme disease.

**During Pregnancy & While Breastfeeding**
Lyme disease acquired during pregnancy may lead to infection of the placenta and possible stillbirth,
however, no negative effects on the fetus have been found when the mother receives appropriate antibiotic treatment. There are no reports of Lyme disease transmission from breast milk.

**From Blood**
Although no cases of Lyme disease have been linked to blood transfusion, scientists have found that the Lyme disease bacteria can live in blood that is stored for donation. Individuals being treated for Lyme disease with an antibiotic should not donate blood. Individuals who have completed antibiotic treatment for Lyme disease may be considered as potential blood donors. Information on the current criteria for blood donation is available on the Red Cross website [http://www.redcross.org/donate/give/](http://www.redcross.org/donate/give/).

**From Pets**
Although dogs and cats can get Lyme disease, there is no evidence that they spread the disease directly to their owners. However, pets can bring infected ticks into your home or yard. Consider protecting your pet, and possibly yourself, through the use of tick control products for animals.

**Other Transmission**
You will not get Lyme disease from eating venison or squirrel meat, but in keeping with general food safety principles meat should always be cooked thoroughly. Note that hunting and dressing deer or squirrels may bring you into close contact with infected ticks.

There is no credible evidence that Lyme disease can be transmitted through air, food, water, or from the bites of mosquitoes, flies, fleas, or lice.

**Symptoms**
The Lyme disease bacterium can infect several parts of the body, producing different symptoms at different times. Not all patients with Lyme disease will have all symptoms, and many of the symptoms can occur with other diseases as well. If you believe you may have Lyme disease, it is important that you consult your health care provider for proper diagnosis.

The first sign of infection is usually a circular rash called *erythema migrans* or EM. This rash occurs in approximately 70-80% of infected persons and begins at the site of a tick bite after a delay of 3-30 days. A distinctive feature of the rash is that it gradually expands over a period of several days, reaching up to 12 inches (30 cm) across. The center of the rash may clear as it enlarges, resulting in a bull's-eye appearance. It may be warm but is not usually painful. Some patients develop additional EM lesions in other areas of the body after several days. Patients also experience symptoms of fatigue, chills, fever, headache, and muscle and joint aches, and swollen lymph nodes. In some cases, these may be the only symptoms of infection.

Untreated, the infection may spread to other parts of the body within a few days to weeks, producing an array of discrete symptoms. These include loss of muscle tone on one or both sides of the face (called facial or "Bell's palsy), severe headaches and neck stiffness due to meningitis, shooting pains that may interfere with sleep, heart palpitations and dizziness due to changes in heartbeat, and pain that moves from joint to joint. Many of these symptoms will resolve, even without treatment.

After several months, approximately 60% of patients with untreated infection will begin to have intermittent bouts of arthritis, with severe joint pain and swelling. Large joints are most often affected,
particularly the knees. In addition, up to 5% of untreated patients may develop chronic neurological complaints months to years after infection. These include shooting pains, numbness or tingling in the hands or feet, and problems with concentration and short term memory.

Most cases of Lyme disease can be cured with antibiotics, especially if treatment is begun early in the course of illness. However, a small percentage of patients with Lyme disease have symptoms that last months to years after treatment with antibiotics. These symptoms can include muscle and joint pains, arthritis, cognitive defects, sleep disturbance, or fatigue. The cause of these symptoms is not known. There is some evidence that they result from an autoimmune response, in which a person's immune system continues to respond even after the infection has been cleared.

**Diagnosis**

Lyme disease is diagnosed based on symptoms, objective physical findings (such as erythema migrans, facial palsy, or arthritis), and a history of possible exposure to infected ticks. Validated laboratory tests can be very helpful but are not generally recommended when a patient has erythema migrans.

When making a diagnosis of Lyme disease, health care providers should consider other diseases that may cause similar illness. Not all patients with Lyme disease will develop the characteristic bulls-eye rash, and many may not recall a tick bite. Laboratory testing is not recommended for persons who do not have symptoms of Lyme disease.

**Laboratory Testing**

Several forms of laboratory testing for Lyme disease are available, some of which have not been adequately validated. Most recommended tests are blood tests that measure antibodies made in response to the infection. These tests may be falsely negative in patients with early disease, but they are quite reliable for diagnosing later stages of disease.

CDC recommends a two-step process when testing blood for evidence of Lyme disease. Both steps can be done using the same blood sample.

1) The first step uses an ELISA or IFA test. These tests are designed to be very "sensitive," meaning that almost everyone with Lyme disease, and some people who don't have Lyme disease, will test positive. If the ELISA or IFA is negative, it is highly unlikely that the person has Lyme disease, and no further testing is recommended. If the ELISA or IFA is positive or indeterminate (sometimes called "equivocal"), a second step should be performed to confirm the results.

2) The second step uses a Western blot test. Used appropriately, this test is designed to be "specific," meaning that it will usually be positive only if a person has been truly infected. If the Western blot is negative, it suggests that the first test was a false positive, which can occur for several reasons. Sometimes two types of Western blot are performed, "IgM" and "IgG." Patients who are positive by IgM but not IgG should have the test repeated a few weeks later if they remain ill. If they are still positive only by IgM and have been ill longer than one month, this is likely a false positive.

CDC does not recommend testing blood by Western blot without first testing it by ELISA or IFA. Doing so increases the potential for false positive results. Such results may lead to patients being treated for
Lyme disease when they don't have it and not getting appropriate treatment for the true cause of their illness.

Other Types of Laboratory Testing

Some laboratories offer Lyme disease testing using assays whose accuracy and clinical usefulness have not been adequately established. These tests include urine antigen tests, immunofluorescent staining for cell wall-deficient forms of *Borrelia burgdorferi*, and lymphocyte transformation tests. In general, CDC does not recommend these tests. Patients are encouraged to ask their physicians whether their testing for Lyme disease was performed using validated methods and whether results were interpreted using appropriate guidelines.

Testing Ticks

Patients who have removed a tick often wonder if they should have it tested. In general, the identification and testing of individual ticks is not useful for deciding if a person should get antibiotics following a tick bite. Nevertheless, some state or local health departments offer tick identification and testing as a community service or for research purposes. Check with your health department; the phone number is usually found in the government pages of the telephone book.

Treatment

The National Institutes of Health (NIH) has funded several studies on the treatment of Lyme disease. These studies have shown that most patients can be cured with a few weeks of antibiotics taken by mouth. Antibiotics commonly used for oral treatment include doxycycline, amoxicillin, or cefuroxime axetil. Patients with certain neurological or cardiac forms of illness may require intravenous treatment with drugs such as ceftriaxone or penicillin.

Patients treated with antibiotics in the early stages of the infection usually recover rapidly and completely. A few patients, particularly those diagnosed with later stages of disease, may have persistent or recurrent symptoms. The authors of studies sponsored by the National Institutes of Health have concluded that these patients may benefit from a second 4-week course of therapy and that longer courses of antibiotic treatment are not beneficial. Longer courses of antibiotics have been linked to serious complications, including death.

Studies of women infected during pregnancy have found that there are no negative effects on the fetus if the mother receives appropriate antibiotic treatment for her Lyme disease. In general, treatment for pregnant women is similar to that for non-pregnant persons, although certain antibiotics are not used because they may affect the fetus. If in doubt, discuss treatment options with your health care provider.