LYME DISEASE:
What you need to know

- How it's spread
- Where it's found
- How it's prevented
- How it's diagnosed
- How it's treated

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention

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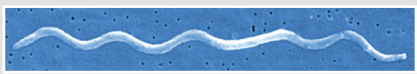
Lyme Disease

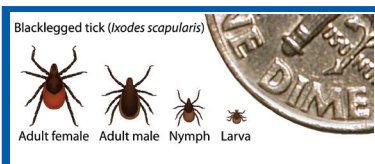
Lyme disease is caused by bacteria called *Borrelia burgdorferi* and is transmitted to humans through the bite of infected blacklegged ticks. Typical symptoms include fever, headache, fatigue, and a characteristic skin rash called erythema migrans. If left untreated, infection can spread to joints, the 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 if used correctly and performed with validated methods. 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, applying pesticides, and reducing tick habitat.



Lyme disease is an infection caused by the corkscrew-shaped bacterium Borrelia burgdorferi, a member of the family of spirochetes.

How ticks spread Lyme disease

Lyme disease bacteria, *Borrelia burgdorferi*, are spread through the bite of infected ticks. The blacklegged tick (or deer tick, I*xodes scapularis*) spreads the disease in the northeastern, mid-Atlantic, and north-central United States, and the western blacklegged tick (*Ixodes pacificus*) spreads the disease on the Pacific Coast. These ticks are usually found in wooded areas and have complex life cycles. In some regions, blacklegged ticks can spread other diseases in addition to Lyme disease, including babesiosis and anaplasmosis. In general, ticks need to be attached for 36 to 48 hours before they can transmit Lyme disease bacteria.



Ixodes ticks are much smaller than the common dog and cattle ticks. In their larval and nymphal stages, they are no bigger than a pinhead. Adult Ixodes ticks are larger, about the size of a small apple seed. Left to right: adult female, adult male, nymph, larva.

Most humans are infected through the bites of

Photo courtesy of Durland Fish.

Ticks can attach to any part of the human body but are often found in hard-to-see areas such as the groin, armpits, and scalp. In most cases, the tick must be attached for 36-48 hours or more before the Lyme disease bacterium can be transmitted. Shown is an attached *Ixodes* nymph.

immature ticks called nymphs. Nymphs are tiny (less than 2 mm) and difficult to see; they feed during the spring and summer months.

Adult ticks can also transmit Lyme disease bacteria, but they are much larger and may be more likely to be discovered and removed before they have had time to transmit the bacteria. Adult *Ixodes* ticks are most active during the cooler months of the year.

Ixodes ticks search for host animals from the leaf litter on the forest floor or from the tips of grasses and shrubs. Ticks crawl onto animals or people as they brush against them; ticks cannot jump or fly. Ticks found on the scalp usually have crawled there from lower parts of the body. Ticks feed on blood by inserting their mouth parts (not their whole bodies) into the skin of a person or animal. *Ixodes* ticks are slow feeders: one meal can take several days. As they feed, their bodies slowly enlarge.

The risk of exposure to ticks is greatest in the woods and in the edge area between lawns and woods; however, ticks can also be carried by animals onto lawns and gardens and into houses by pets. Campers, hikers, outdoor workers, and others may be exposed to infected ticks in wooded, brushy, and grassy places. People who spend time in heavily wooded areas where infected ticks are common are at higher risk for exposure.

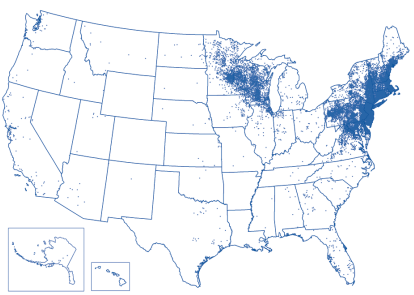
Although in theory Lyme disease could be spread through blood transfusions or other contact with infected blood, there are no known cases of this happening. There is no evidence that Lyme disease is transmitted from person-to-person through touching, kissing or having sex with a person who has Lyme disease. There are no reports of Lyme disease transmission from breast milk.

Places where you are most likely to get infected

Lyme disease is distributed over a wide geographic area in northern temperate regions of the world. In the United States, most infections occur in the following areas:

- Northeast, from Virginia to Maine
- North-central states, mostly in Wisconsin and Minnesota
- West Coast, particularly northern California

Reported Cases of Lyme Disease - United States, 2011



1 dot placed randomly within county of residence for each confirmed case

Though Lyme disease cases have been reported in nearly every state, cases are reported from the infected person's county of residence, not the place where they were infected.

For Lyme disease to exist in an area, three elements must be present in the natural environment: 1) animals that are infected with Lyme disease bacteria, 2) ticks that can transmit the bacteria, and 3) animal hosts (such as mice and deer) that can provide food for the ticks in their various life stages. Ticks that transmit Lyme disease bacteria need constant high relative humidity at ground level.

What you can do to protect yourself

You can decrease the chances of being bitten by a tick with a few precautions.

Avoid tick-infested areas. This is especially important in May, June, and July. Many local health departments and park or

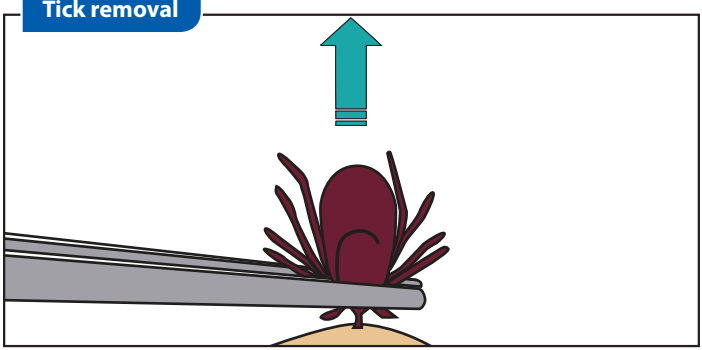
extension services have information on the local distribution of ticks. If you are in tick-infested areas, walk in the center of trails to avoid contact with overgrown grass, brush, and leaf litter at trail edges.

Use insect repellent. Spray repellent containing a 20% concentration of DEET on clothes and on exposed skin. You can also treat clothes (especially pants, socks, and shoes) with permethrin, which kills ticks on contact, or buy clothes that are pre-treated. Permethrin can also be used on tents and some camping gear. Do not use permethrin directly on skin. Always follow the manufacturer's instructions when applying any repellent.

Repellent use

Perform daily tick checks. Always check for ticks after being outdoors, even in your own yard. Because ticks must usually be attached for at least a day before they can transmit the bacteria that cause Lyme disease, early removal can reduce the risk of infection. Inspect all body surfaces carefully, and remove attached ticks with tweezers. Avoid crushing the tick's body. DO NOT use petroleum jelly, a hot match, nail polish, or other products. Grasp the tick firmly and as closely to the skin as possible. With a steady motion, pull the tick's body away from the skin. Do not be alarmed if the tick's mouthparts remain in the skin. Cleanse the area with an antiseptic.

Tick removal



Bathe or shower. Bathe or shower as soon as possible after coming indoors (preferably within 2 hours) to wash off and more easily find ticks that are crawling on you.

Ticks can get a ride indoors on your clothes. After being outdoors, wash and dry clothing at a high temperature to kill any ticks that may remain on clothing.

Recognize the signs and symptoms of Lyme disease and act quickly

The early diagnosis and proper treatment of Lyme disease are important strategies to avoid the costs and complications of infection and late-stage illness. As soon as you notice a characteristic rash or other possible symptoms, consult your health care provider.

Erythema migrans (bull's eye) rash.

Early Lyme disease: The early stage of Lyme disease is usually marked by one or more of the following signs and symptoms:

- a characteristic skin rash, called erythema migrans
- fatigue
- chills and fever
- headache
- muscle and joint pain
- swollen lymph nodes

Erythema migrans is a red circular rash that appears at the site of the tick bite, usually within 3 to 14 days after the bite of an infected tick. The rash then grows larger. Sometimes many rashes appear, varying in shapes and sizes. Common sites are the thighs, groin, trunk, and armpits. The center of the rash may clear as it enlarges, resulting in a "bull's-eye" appearance. The rash may be warm, but it usually is not painful. Not all rashes that occur at the site of a tick bite are due to Lyme disease, however. An allergic reaction to tick saliva can also occur and be confused with the "bull's-eye" rash of Lyme disease. Allergic reactions to tick saliva usually appear within hours to a few days after the tick bite, usually do not expand, and disappear within a few days.

Late Lyme disease: Some signs and symptoms of Lyme disease may not appear until weeks, months, or years after a tick bite:

- Arthritis is most likely to appear as brief bouts of pain and swelling, usually in one or more large joints, especially the knees.
- Nervous system symptoms can include numbness, pain, nerve paralysis (often of the facial muscles, usually on one side), and meningitis (fever, stiff neck, and severe headache).
- Rarely, irregularities of the heart rhythm may occur.
- Problems with memory or concentration, fatigue, headache, and sleep disturbances sometimes persist after treatment.

Different people exhibit different signs and symptoms of Lyme disease. Some people never develop a bull's eye rash. Some people only develop arthritis, and for others nervous system problems are the only symptom of Lyme disease.

Many of the symptoms of Lyme disease are similar to those of other diseases. The fever, muscle aches, and fatigue of Lyme disease can be mistaken for viral infections, such as influenza or infectious mononucleosis. Joint pain can be mistaken for other types of arthritis, such as juvenile rheumatoid arthritis, and neurologic signs can mimic those caused by other conditions, such as multiple sclerosis. Other infections, arthritis, or neurologic diseases can also be misdiagnosed as Lyme disease.

How Lyme disease is diagnosed

Diagnosis of Lyme disease should take into account the following factors:

- History of possible exposure to ticks in areas where Lyme disease is known to occur
- Signs and symptoms of the illness
- The results of blood tests used to detect whether the patient has antibodies to Lyme disease bacteria

Currently, a two-stage testing process to measure the body's production of antibodies to Lyme disease bacteria is recommended:

1) an enzyme-linked immunosorbent assay (ELISA) or indirect immunofluorescence assay (IFA), followed by
2) a Western immunoblot of samples that tested positive or equivocal by ELISA or IFA.

These tests measure antibodies that the body makes against Lyme disease bacteria. It can take 2-4 weeks after infection for the body to produce measurable levels of antibodies. Therefore, laboratory tests for Lyme disease must be interpreted based on the length of infection. Patients who were recently infected and have erythema migrans may test negative even though they are infected (false negative). On the other hand, patients who have been infected

for longer than 4 weeks and have arthritis will almost always test positive. A negative test in a patient with arthritis or long standing symptoms is strong evidence that Lyme disease is not the cause of their illness.

How Lyme disease is treated

Several antibiotics are effective for treating Lyme disease. These are usually given by mouth but may be given intravenously in more severe cases. Patients treated with antibiotics in the early stages of the infection usually recover rapidly and completely. Most patients who are treated in later stages of the disease also respond well to antibiotics. A few patients may have persistent or recurrent symptoms and may require an additional course of antibiotic treatment. Longer courses of antibiotics have not been shown to be beneficial in patients who have been previously treated and have chronic symptoms. Varying degrees of permanent damage to joints or the nervous system can develop in patients with late Lyme disease. Typically these are patients in whom Lyme disease was unrecognized in the early stages or for whom the initial treatment was inadequate. Lyme disease is rarely life-threatening.

For the Guidelines of the Infectious Diseases Society of America, see: http://cid.oxfordjournals.org/content/43/9/1089.full

Post-exposure antibiotics

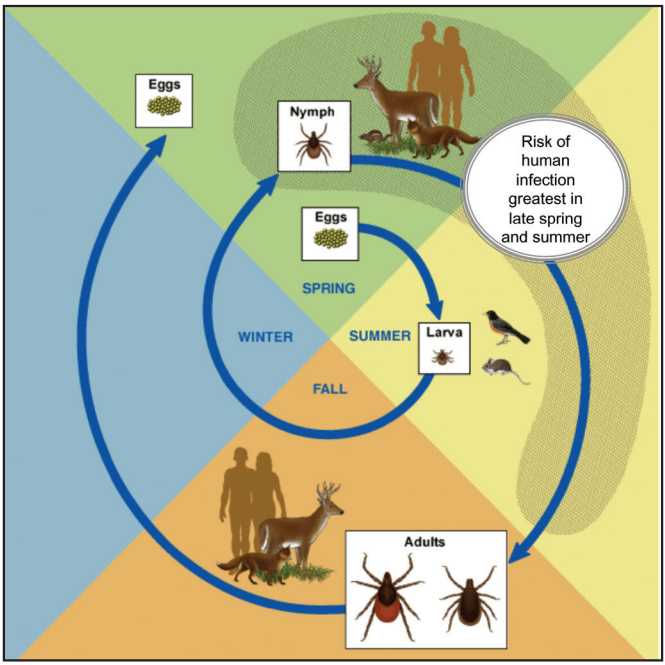
Recent studies have examined the value of giving antibiotics to prevent Lyme disease after a known tick bite. While giving antibiotics for tick bites is not routinely practiced, it may be beneficial in some cases, depending on disease presence in the local area and duration of tick attachment. Physicians must determine whether the advantages of using antibiotics outweigh the disadvantages in any particular instance.

What to do if you suspect Lyme disease during pregnancy

Prevention and early diagnosis of Lyme disease are important during pregnancy. Rarely, Lyme disease acquired during pregnancy may lead to infection of the placenta and may possibly lead to stillbirth. Studies of women infected during pregnancy have found that there are no negative effects on the fetus when the mother receives appropriate antibiotic treatment for her Lyme disease.

Life cycle of Lyme disease ticks

Knowing the complex life cycle of the ticks that transmit Lyme disease bacteria can help in understanding the risk of getting the disease and how to prevent it.



The complete life cycle of *Ixodes* ticks requires 2 years. 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. The larvae may become infected with Lyme disease bacteria when feeding on these animals. Once a tick becomes infected, it stays infected for the rest of its life and can transmit the bacteria to other hosts. After this initial feeding, the larvae usually become inactive until the following spring, when they change into nymphs. Nymphs seek blood meals in order to fuel their growth into adults.

Nymphs feed on small rodents, birds, and other small mammals in late spring and early summer. Nymphs will also feed on humans, and if previously infected with Lyme disease bacteria, they can transmit the disease to humans. Nymphs molt into adult ticks in the fall. In the fall and early spring, adult ticks feed and mate on large animals, such as deer. Adult female ticks will sometimes also feed on humans. In spring, adult female ticks lay their eggs on the ground, completing the 2-year life cycle.

Lyme disease vaccine

A vaccine for Lyme disease is not currently available.

Tick control

Landscaping to create tick-safe zones. "Tick-Safe Landscaping" techniques should be considered for homes, parks, fields, and recreational areas. *Ixodes* ticks need the higher humidity levels

of the woodland to survive; they die quickly in drier environments. Removing leaf litter and clearing tall grass and brush around houses and at the edges of lawns will reduce the numbers of ticks. Placing wood chips or gravel between lawns or play areas and wooded areas creates a dry barrier that is difficult for ticks to cross.

Photo courtesy of K. Stafford, Connecticut Agricultural Experiment Station

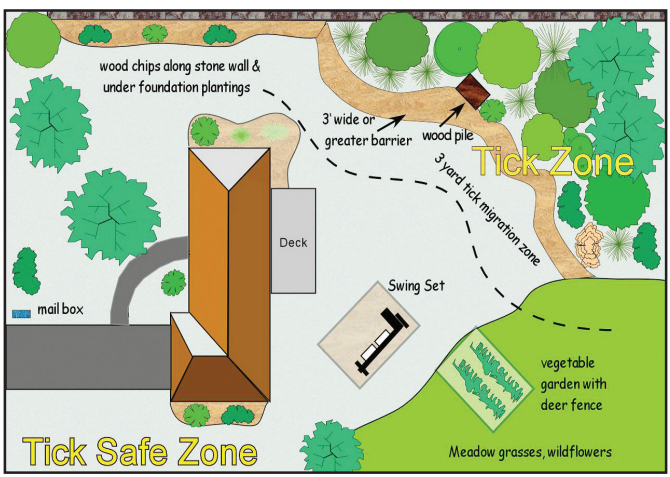


Diagram courtesy of K. Stafford, Connecticut Agricultural Experiment Station

Chemical control. The use of pesticides to control tick populations is another option. Pesticide application to residential properties should be supervised by a licensed professional pest control expert and should be conducted when nymphal tick populations are at their local peaks.

Discourage deer. A relationship exists between the abundance of deer and the abundance of *Ixodes* ticks in the eastern United States. Tick populations do not decrease substantially unless deer are eradicated or severely reduced. Removing plants that attract deer and constructing fences or other barriers may help discourage tick-infested deer from coming near homes. Lists of deer-resistant plantings are available from garden centers, nurseries, or local extension agents.

Lyme disease in domestic animals

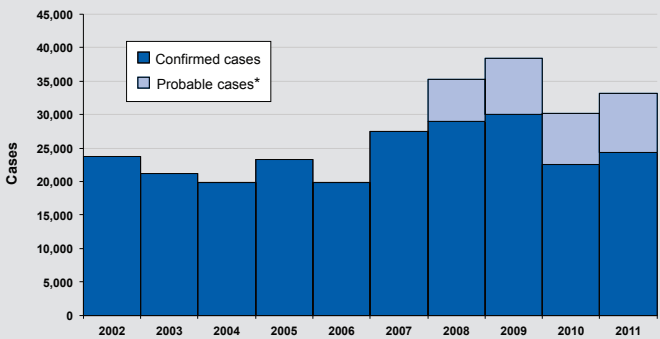
Domestic animals may become infected with Lyme disease bacteria and some of these (dogs, for instance) may develop arthritis. Domestic animals can carry infected ticks into areas where people live. Studies to determine whether pet owners have an increased risk of Lyme disease have been inconclusive. Veterinary tick control products may help to reduce the presence of ticks on pets.

Lyme disease—past, present, and future

Lyme disease was first recognized in the United States in 1975 after an unusual outbreak of arthritis near Lyme, Connecticut. Today, over 30,000 cases of Lyme disease are reported to CDC each year. Research continues to address the following concerns:

- Where ticks are most likely to be and how best to protect against them.
- Which chemicals and other alternative strategies are best for controlling ticks in each kind of habitat.
- Ways of making diagnostic tests more accurate.
- Better understanding post-treatment Lyme disease syndrome.

Reported Cases of Lyme Disease by Year, United States, 2002 - 2011



*National Surveillance case definition revised in 2008 to include probable cases; details at http://wwwn.cdc.gov/nndss/

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