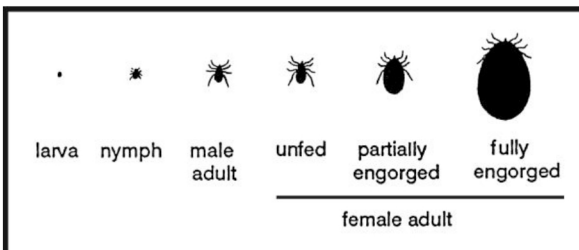




# LYME DISEASE BASICS

## Motile Stages of Blacklegged Tick



Actual size

# FACTS ABOUT LYME DISEASE

**Lyme disease** (Ld) is caused by the bacterium, *Borrelia burgdorferi* (Bb), and is typically transmitted by certain ticks. This stealth pathogen has several diverse forms, and these forms shift from one to another in a dynamic equilibrium. They can side-step the human immune system (Fig. 1). Since Bb is a genetically complex microorganism, it can be persistent and, therefore, patients must be treated as clinically required. Ld has been a reportable disease in Ontario since November 1988.

## CAUSAL ORGANISM

When an infected tick feeds, it regurgitates spirochete-laden fluids into the host. Not only does Bb move via blood, it migrates through skin and connective tissue. Bb has different physical and biochemical characteristics depending on whether it is residing in a vector tick, or present in a warm-blooded host.

## VECTORS

Ticks are neither “insects” nor “bugs;” they are arachnids (spider-like creatures). Ticks do not jump, fly, or drop out of trees. They wait on low vegetation to attach to suitable hosts.

The life cycle of the blacklegged tick, *Ixodes scapularis*, is 2-5 years, and consists of 4 life stages: egg, larva, nymph, and adult (male, female) (Fig.2). The immature (larva, nymph) stages require a blood meal to molt to the next stage, and the female needs blood as nourishment to produce eggs. When the larva attaches, and becomes fully engorged in 3-5 days, it drops off and molts to a nymph. As a nymph, it again quests for a host (i.e., mouse, chipmunk, songbird), and feeds for 3-5 days, drops off, and molts to an adult (male, female). In late spring, a mated female lays approximately 1000 eggs in moist leaf litter. After 35 days, the eggs hatch into larvae in late July, which promptly seek a host (i.e., mouse, chipmunk, songbird). While feeding on a Bb-infected host, the ticks typically acquire Bb spirochetes. Whenever the blacklegged tick becomes infected with Bb, it is infected for life. A gravid *I. scapularis* female does not pass Bb to her eggs.

In Ontario, there are at least 71 known established populations of blacklegged ticks. These tick colonies are located from Leamington (Point Pelee National Park) to Chippewa to Toronto to Kingston to Cornwall to Ottawa and, in northwestern Ontario, in Rainy River and Kenora Districts. Our 10-year tick-host study of blacklegged ticks in Ontario pinpoints this tick species as far north as the 50th parallel, which transects Minaki in northwestern Ontario (Fig. 3, see last page). One population on Corkscrew Island has a mean Bb infection prevalence of 73%—the highest ever reported in Canada. Blacklegged ticks carry and transmit at least 10 different tick-borne, zoonotic pathogens.

In Ontario, there are other tick species that harbour and transmit Bb. Of these, there are at least 5 species that are known to bite humans.

## HOSTS

Both mammals and birds play a vital role in the maintenance and dispersal of Lyme vector ticks. In North America, blacklegged ticks have been reported on at least 54 mammalian hosts and 82 avian species. Rodents (e.g., mice, chipmunks) and shrews are primary reservoirs of Bb. Adult blacklegged ticks seek large hosts, including people, and conduct host-seeking activity when the temperature is above 0°C; they peak in May and, again, in October (Fig. 4, see last page). Blacklegged ticks have antifreeze-like compounds in their bodies, and overwinter successfully in the leaf litter under an insulating blanket of snow.

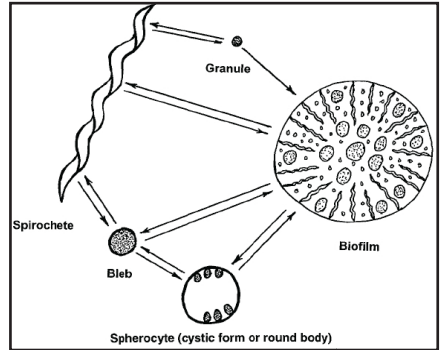


Fig. 1. Diverse forms

# Life Cycle of Blacklegged Tick, Lyme Disease Vector

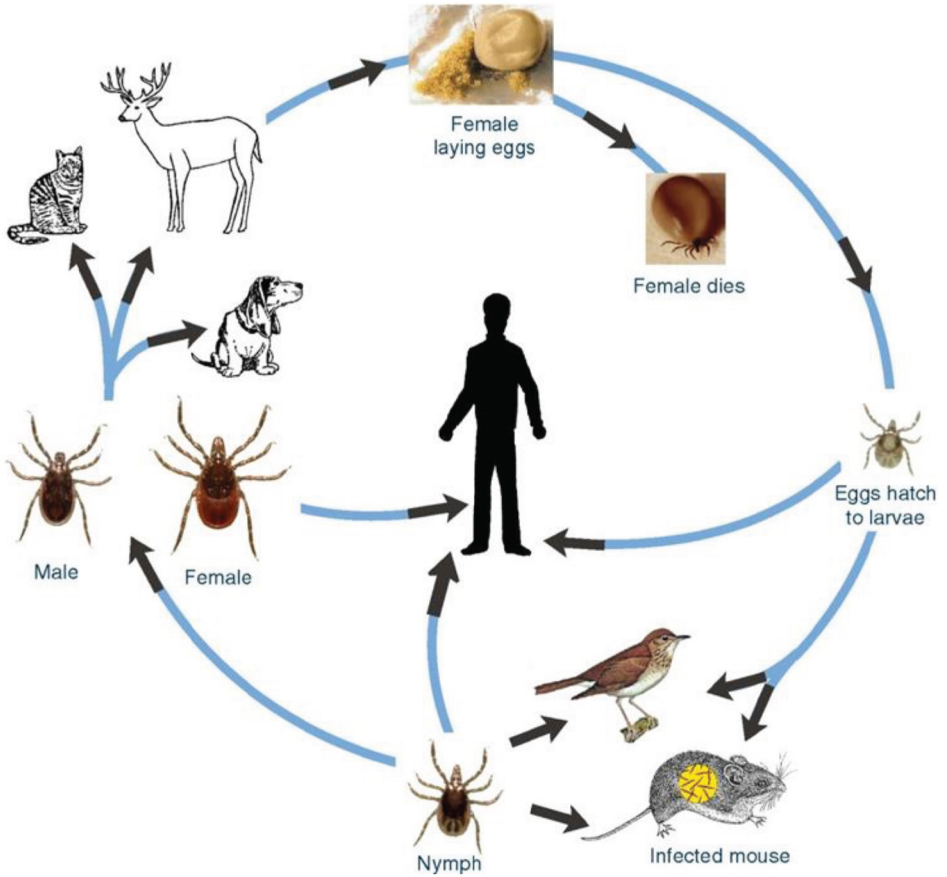


Figure 2. In Lyme disease endemic areas, Bb cycles enzootically between vector ticks and reservoir hosts on a continuous basis.

White-tailed deer support reproduction of blacklegged ticks, and are hosts of all 3 motile life stages. However, deer are refractory to Bb and, because deer do not transmit Bb to ticks, they impede the Ld cycle. Of note, deer harbour *Babesia Odocoilei*, a malaria-like microbe.

Songbirds act as a short- and long-range dispersing hosts of larval and nymphal blacklegged ticks (Fig. 3). During northward spring migration, songbirds make landfall at stopovers to refuel and replenish their food reserves in Ld endemic areas and, while meandering through low-level vegetation, they become parasitized by Bb-infected ticks. Subsequently, these engorged ticks are transported hundreds of kilometres northward, and released across Canada.



Fig. 3. Common Yellowthroat parasitized by three blacklegged tick nymphs. The fully engorged nymph is located anterior to the left eye. Photo credit: Ana Morales.

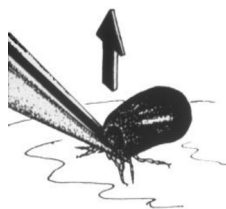
Our studies confirmed that songbirds carry Bb-infected ticks across the Canada-U.S. border. We have documented immature *I. scapularis* on songbirds as far west and as far north as northern Alberta, and some of them are infected with Bb. Some songbirds (i.e., American Robin, Song Sparrow) can harbour Bb, and act as reservoir hosts. Blacklegged ticks can be coinfecting with any combination of at least 10 different tick-borne pathogens including: *Anaplasma phagocytophilum* (human granulocytic anaplasmosis [HGA]), *Babesia* spp. (i.e., *Babesia duncani*, *Babesia microti* [human babesiosis]), *Bartonella* spp. (i.e., *Bartonella henselae* [cat scratch disease]), *Mycoplasma fermentans* (Chronic Fatigue), *Borrelia miyamotoi* (relapsing fever group spirochete), *Ehrlichia muris-like agent*, *Protomyxzoa rheumatica*, relapsing fever group spirochetes, Deer Tick Virus (Powassan virus group), and multiple other viruses (i.e., HHV-6, EBV, CMV). Recently, *A. phagocytophilum* was detected in ticks collected from songbirds in southern Canada. Because songbirds disperse ticks widely across Ontario, one does not have to go to an endemic area to contract Lyme disease.

## TICK BITE

Ticks do not “burrow” in or under the skin. Instead, the tick attaches itself to the host with its hypostome (piercing mouthpart), and draws a blood meal (see front cover). This feeding structure has backward-pointing barbs, which provides a temporary steadfast grip. Before entry, the hypostome injects a painkiller, an antihistamine to anaesthetize the skin. During entry, the hypostome produces an anesthetic to de-sensitize the bite site, and an anticoagulant to prevent blood clotting. After entry, the hypostome produces a cement-like compound, which holds the tick firmly attached. When engorgement is finished, the tick softens this substance, and releases itself from the host. Ticks often bite in non-conspicuous areas of the body; 85% do not remember a tick bite. Although Bb transmission normally takes 24-48 hours, anecdotal experience provides instances of spirochetal transfer by *I. scapularis* adults in less time. Notably, other pathogens (i.e., HGA), which often are harboured by this tick species, can be transmitted in less than 24 hours. Powassan virus can be transmitted within 15 minutes. *Babesia* is transmitted once the tick starts to feed.

## TICK REMOVAL

Various “home remedies” for tick removal have not been proven effective. Under no circumstance should a flame, ointment, flammable liquid (gasoline, oil, lighter fluid, acetone, nail polish, etc.) or caustic material be used in removal attempts. When removing a tick, approach the tick from the side with superfine, stainless steel forceps. Grip the hypostome (piercing mouthpart) firmly, as close to the skin as possible, and pull straight out with steady pressure. If the hypostome is twisted, it will break off, and leave the tip in the host.



A sterilized needle also works well for removal. After removal, wash your hands with soap and water. Note in your medical records: date of removal, location on the body, and geographic area. Put the tick in a vial containing rubbing alcohol or ethanol, and make sure the vial will tightly seal. Instruction: Request identification and, if it is a blacklegged tick, test for Bb and tick-associated pathogens. Remember that other tick species may be infected with Bb, and cause Ld.

For prompt tick testing, use an independent lab, such as Geneticks Canada.  
[www.geneticks.ca](http://www.geneticks.ca)



## PICTURE OF RASH

If a rash develops at the bite site, take a close-up colour picture of the rash in bright light. See Rashes section. Place a ruler beside the rash to show the actual size. Record the measurements (length and width) of the rash. Also, include a card in the photo with the date.



## ALTERNATIVE TRANSMISSION

During pregnancy, Bb can cross the placenta to the unborn child. Bb may also be transmitted during breastfeeding via the mother's milk to the infant. Likewise, spirochetes can be transmitted to a person by drinking unpasteurized, Bb-infected milk. Bb can be transmitted to the recipient during a blood transfusion. Sexual transmission in humans may occur; Bb has been detected in canine and human semen and vaginal secretions. Safe sex is advised.

## LYME DISEASE TESTING

Routine Ld testing lacks reliability. Since it takes 4-6 weeks for Ld antibodies to show positivity, serological (blood) testing after tick bite needs to be delayed to obtain more reliable results. Antibodies peak at 6-8 weeks after initial infection, and then subside to a lower level. By year 2, less than 50% of patients still have a strong antibody response. Serological tests (i.e., ELISA, EIA, and Western blot) are commonly employed; however, other tests are available. PCR testing may be used for tissue and certain body fluids (i.e., whole blood, synovial fluid, urine). Western blot, a qualitative test, is suggested initially because it is more specific in detecting IgM and IgG antibodies produced by the body in response to Bb infection. Culturing of blood and semen/vaginal secretions can be done. Direct detection shows promise.

Preliminary serological screening tests (e.g., ELISA) measure the quantity of antibodies, and often show negative results; 4-65% accuracy has been reported. If the sample is obtained too early (e.g., within 4 weeks after tick bite), or the patient does not have a strong enough immune response, **a false negative test can result**. Since antibody tests (i.e., ELISA) has low sensitivity, Ld remains a **clinical diagnosis**.



**Note:** Ld is a “great masquerader.” Physicians have been known to label Ld as other diseases/disorders such as chronic fatigue, fibromyalgia, stress, depression, mononucleosis, ADHD, autism, Q-fever, tularemia, scleroderma, Crohn's disease, multiple chemical sensitivities, POTS, sarcoidosis, and psychiatric disorders. Ld mimics a litany of neuro-generative diseases (i.e., Alzheimer's diseases, Parkinson's disease, Lou Gehrig's [ALS], multiple sclerosis, Rasmussen's encephalitis, brain tumour), and connective-tissue diseases (e.i., systemic lupus erythematosus, rheumatoid arthritis, nodular fasciitis, Parsonage-Turner syndrome). Based on a brain study of Alzheimer's patients living in the New England states, 7 of 10 tested positive for Bb. Similar results have been noted elsewhere.

Testing for other diseases is very important in determining the diagnosis. Bb is a “stealth pathogen,” that slips by the immune system, and sequesters and hides in the eye, bone, brain, ligaments, tendons, nerve cells, lymph nodes, and scar tissue; Bb is hard to detect and difficult to treat, especially when established. If left undiagnosed and untreated, Ld can spread throughout the body and become a persistent, life-destroying disease.

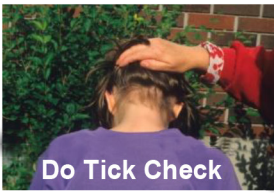
Since Bb has pleomorphic forms (i.e., spirochetes, round bodies, blebs, granules), plus biofilms (Fig. 1), different therapeutic treatment is often needed for an extended period of time. Post-treatment, patients may have recurring symptoms. Ld may be acute, recurrent, or persistent; this zoonosis can be fatal.

Early treatment of Lyme disease is paramount. Treatment delay can result in treatment failure, worse patient outcomes, unnecessary suffering, and increased medical expenses.

## PREVENTATIVE MEASURES

In order to see ticks on outdoor clothing, wear light-coloured long pants, long-sleeve shirt, closely knitted socks, and fully closed shoes or boots. Tuck shirt into pants and pants into socks to help prevent upward crawling ticks from getting under clothing. After outings, do a full-body tick check. Put clothes in dryer, on high, for 10 minutes to kill ticks. Tick repellants, containing DEET, act as a deterrent. Effective, bio-friendly, non-DEET repellents, include: picaridin (Natrepel®, www.rei.com). Avoid getting repellants in eyes, mouth, or on hands. Plant oils, such as lemon eucalyptus extract, are effective. Permethrin is effective on clothing, but should not be applied to skin. Permethrin-treated outdoor wear (e.g., Windriver brand) is available at certain stores (i.e., Mark's Work Warehouse Ltd.).

Appearance of Blacklegged Tick Female:  
Before and During Engorgement



Unfed



Partial (3 days)



Full (5-7 days)

## SYMPTOMS OF LYME DISEASE

The following symptoms are associated with Ld;

**RASHES** (less than 40% have rash; 30-50% in adults; less than 10% in children)

### Typical

- i) bull's-eye rash (erythema migrans [EM]); has red circumference with central clearing (5-70 cm in diameter)
  - often starts in 3-30 days; may start weeks or months later
  - gradually expands, and eventually disappears (a)
  - duration: average 27 days (4-100 days)
  - sometimes warm to touch



- ii) homogeneous (a type of EM rash, which has uniform reddish colour)
  - expands as Bb infection spreads
  - more people have this type (b) than those with the bull's-eye rash (a)



- iii) rash on dark skin (c)

### Atypical

- i) multiple blotchy/erythema multiforme rashes (slides d, e)
  - occur later as secondary rashes
  - indicates dissemination of Bb
- ii) reddish rash, darker in centre
  - the darker central area hints of secondary infection from tick feeding (not shown)
- iii) painless, bluish-red swelling or nodule on ear lobe of children (slide f), or on nipple/areola of breast (more common in Europe)
- iv) combination of rashes: multiple, homogeneous rash on dark skin (g)
- iv) Acrodermatitis chronica atrophicans (ACA)
  - bluish-red inflammatory lesions on extremities: buttocks, limbs, hands (h), legs, (i)
  - develops slowly; atrophy (wasting away) of skin; becomes grayish-tan; patchy (i)
  - rash duration of 1-17 yr; common over age 40



## LATE SYMPTONS

Any of the following can occur with Ld; patients may have any combination of them, and onset occurs in **any month**. They may occur months/years after initial infection.

## ENDOCRINE

- Loss of sustained energy
- Re-occurring “flu-like” symptoms; weakness
- Contant low body temperature, cold hands
- Profound fatigue
- Low-grade fever
- Intolerance to cold/heat
- Symptoms that wax and wane
- Loss of libido

## MUSCULOSKELETAL

- Muscle ache (myalgia), backache
- Muscles pulled into uncontrollable “knots”
- Muscle spasms, twitching (paresthesias)
- Migratory joint/muscle & pain
- Ongoing muscle weakness
- Temporal-mandibular joint (TMJ) pain
- “Heavy” legs, restless legs
- Stiff creaky neck
- Stiff joints
- Joint ache, joint pain (arthralgias)
- Swollen joints
- Dental pain

## EARS

- Hearing loss
- Ear pain; ringing in ears (tinnitus), buzzing
- Hypersensitivity to loud noise

## EYES

- Conjunctivitis; swelling around eyes
- Blurred vision, double vision, difficulty focusing
- Change in colour vision; blindness
- Sensitivity to bright &/or fluorescent light
- Dry eyes; inflammation
- Prickly or itchy sensations, optic neuritis
- Difficulty with night vision; “Lazy eye”

## NEUROLOGICAL

- Headaches, head pressure
- Lightheadness, dizziness, “space-out” feeling
- Loss of balance (ataxia), “tipsy” feeling
- Tremours, seizures, “insides” shake
- Peripheral neuropathy (nerve cramping)
- Tingling, prickly, or burning sensations
- Twitch of face or other muscles
- Increased motion sickness; clumsiness
- Fasciculations (small muscle contractions)
- Unilateral or bilateral facial nerve palsy
- Sleep difficulties
- Disturbed or fractionated sleep
- Excessive sleep; flashing lights
- Brain “fog”, “heavy” head
- Early awakening
- Pain in chest, shin pain
- Facial paralysis
- Vertigo (whirling head)
- Vasculitis/phlebitis
- Spinal or radicular pain
- Migratory pain, pelvic pain

## NEUROPSYCHIATRIC MANIFESTATIONS

- Moody and irritable; less able to cope
- Unusual depression, suicidal thoughts
- Feeling I’m going “crazy,” hallucinations
- Anxiety, panic attacks, anger, rage
- Delusions, paranoia, bipolar
- Emotional lability
- Dementia; psychosis
- Depersonalization (losing touch)

## COGNITIVE FUNCTION PROBLEMS

- Loss or inability to concentrate or comprehend
- Short-term memory loss, short attention span
- Difficulty with synthesis of new information
- Letter/word reversal, speech difficulty, name block
- Calculations difficulties
- Disorientation, forgetful, lose patience, confusion
- Getting lost, lose track
- Working memory impairments
- Attention span impairments

## GASTROINTESTINAL

- Diarrhea, constipation
- Decreased appetite
- Itchy anus, irritable bowel
- Unexplained weight loss/gain
- Queasy stomach or nausea
- Low abdominal pain, cramps

## UROGENITAL

- Increased thirst, frequent urination
- Bladder irritation/dysfunctional cystitis
- Irregular menstrual cycle; genital pain
- Slow to urinate; urinary retention
- Urethral soreness/burning urinary infections
- Newborn: birth defects; miscarriage

## CARDIAC

- Heart palpitations heart murmur
- "Heart block" on EKG
- Arrhythmias (irregular heartbeat)
- Tachycardia (very rapid heartbeat)
- Bradycardia (low heart rate)
- Exhaustion; shortness of breath

## OTHER SYMPTOMS

- Persistent swollen glands
- Chest wall pain or rib soreness
- Unexplained hair loss
- Symptoms flare every 4 weeks
- Tender lymph nodes
- Degree of disability ("summer flu")

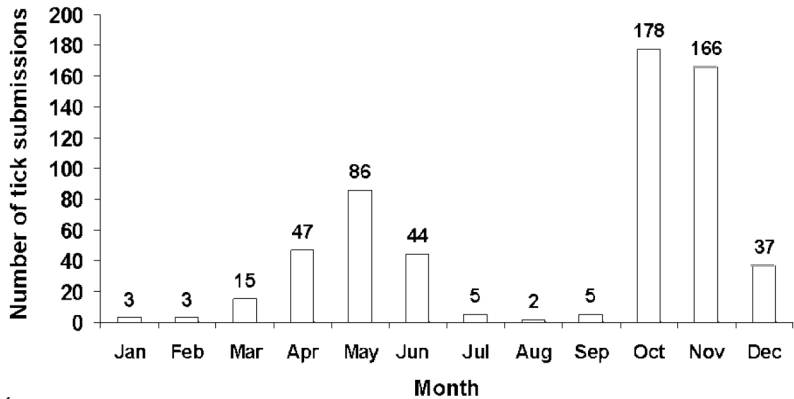


Figure 4.

Questing pattern of *I. scapularis* adults in Ontario. During a 10-year, tick-host study, adults were collected from humans and domestic animals.

ILADS guidelines are the only Lyme disease guidelines listed with the National Guideline Clearinghouse. They are available on the Health Canada website.

Google: "For health professionals: Lyme disease-Canada.ca" Scroll to bottom.



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