Ticks!



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Oregon Health & Sciences University

GENERAL HEMATOLOGY
OHSU

Discloser

- Author: UpToDate (Fe Def)

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Outline of Talk

- Basic Tickology
- Types of ticks
- Tick borne diseases
- Prevention of tick diseases

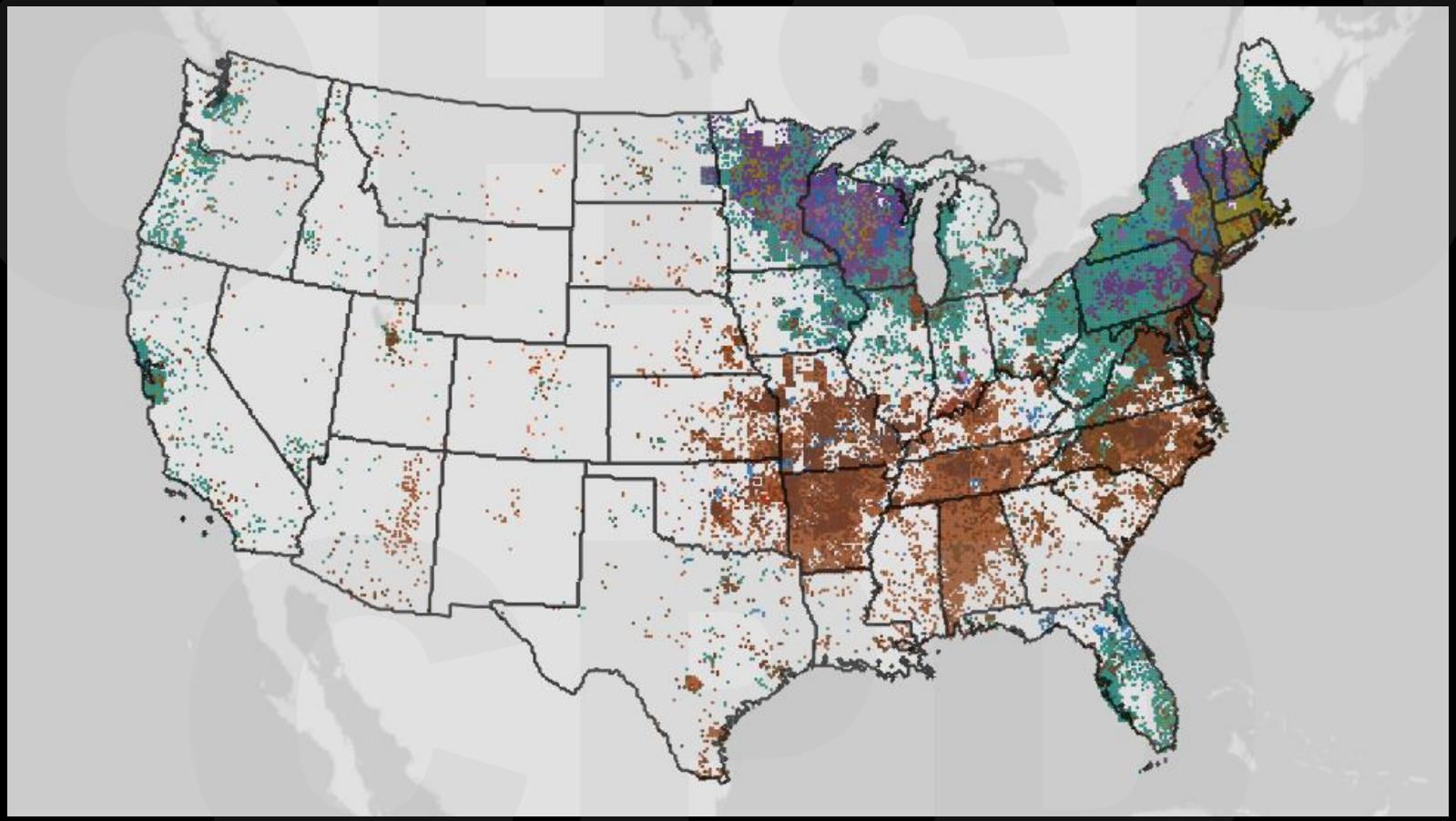
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TICKS SWARM POWELL BUTTE

» MULTNOMAH COUNTY HEALTH DEPT.:

- Fever
- Headache
- Body aches
- Flu-like symptoms
- Rash around bite area





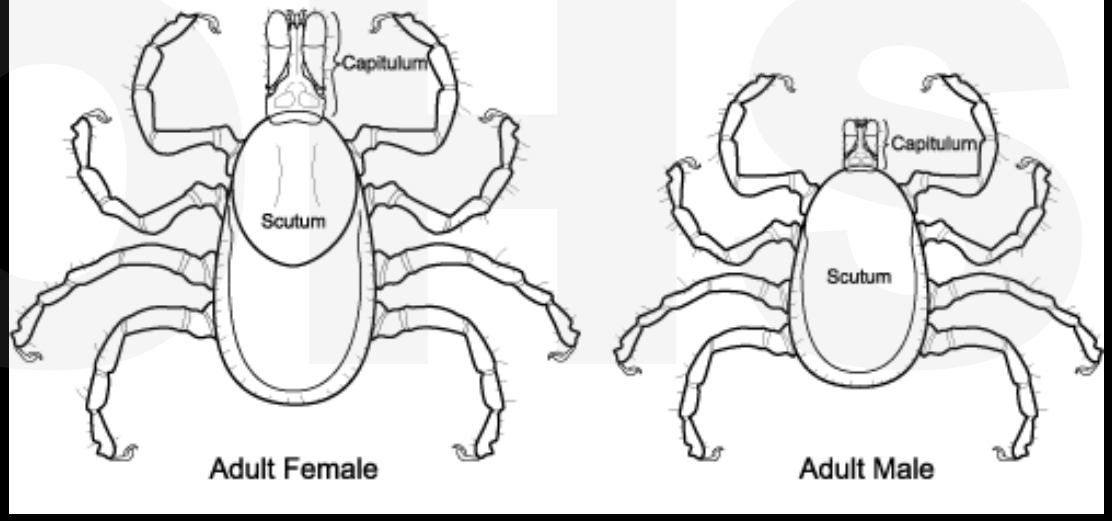
Ticks

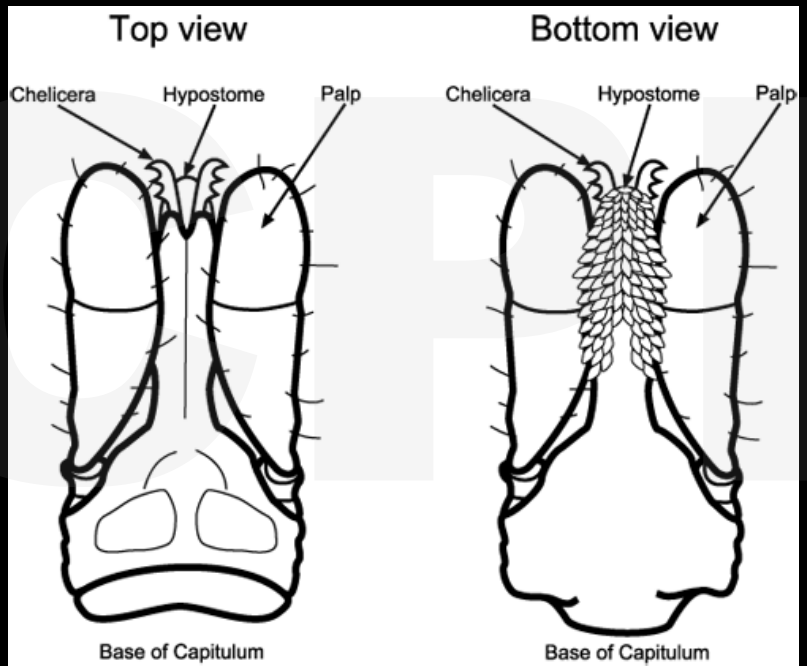
- Ubiquitous blood sucking parasites
- Prime spreader of infections

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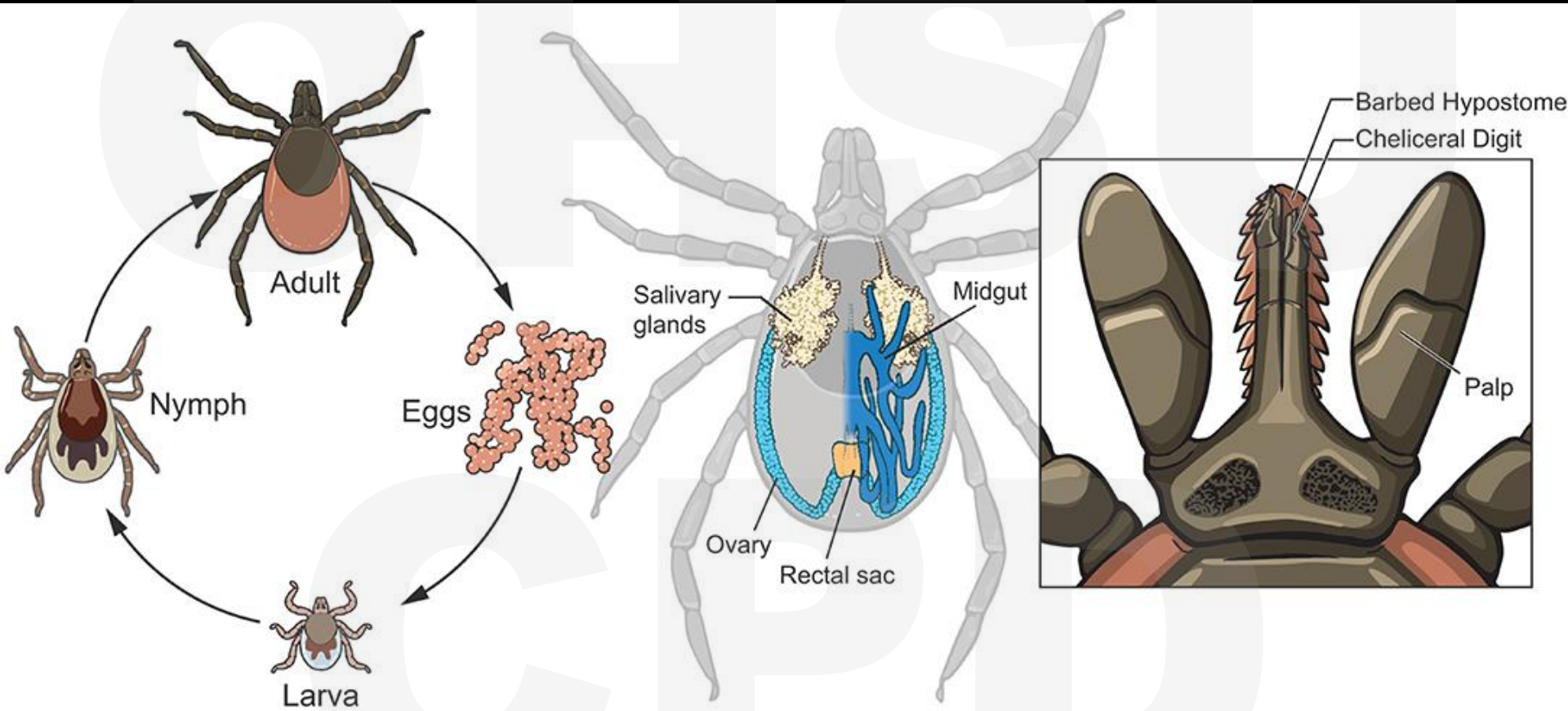
Ixodes scapularis
(Black-legged tick)

Note: Drawing is to scale
Actual Size:





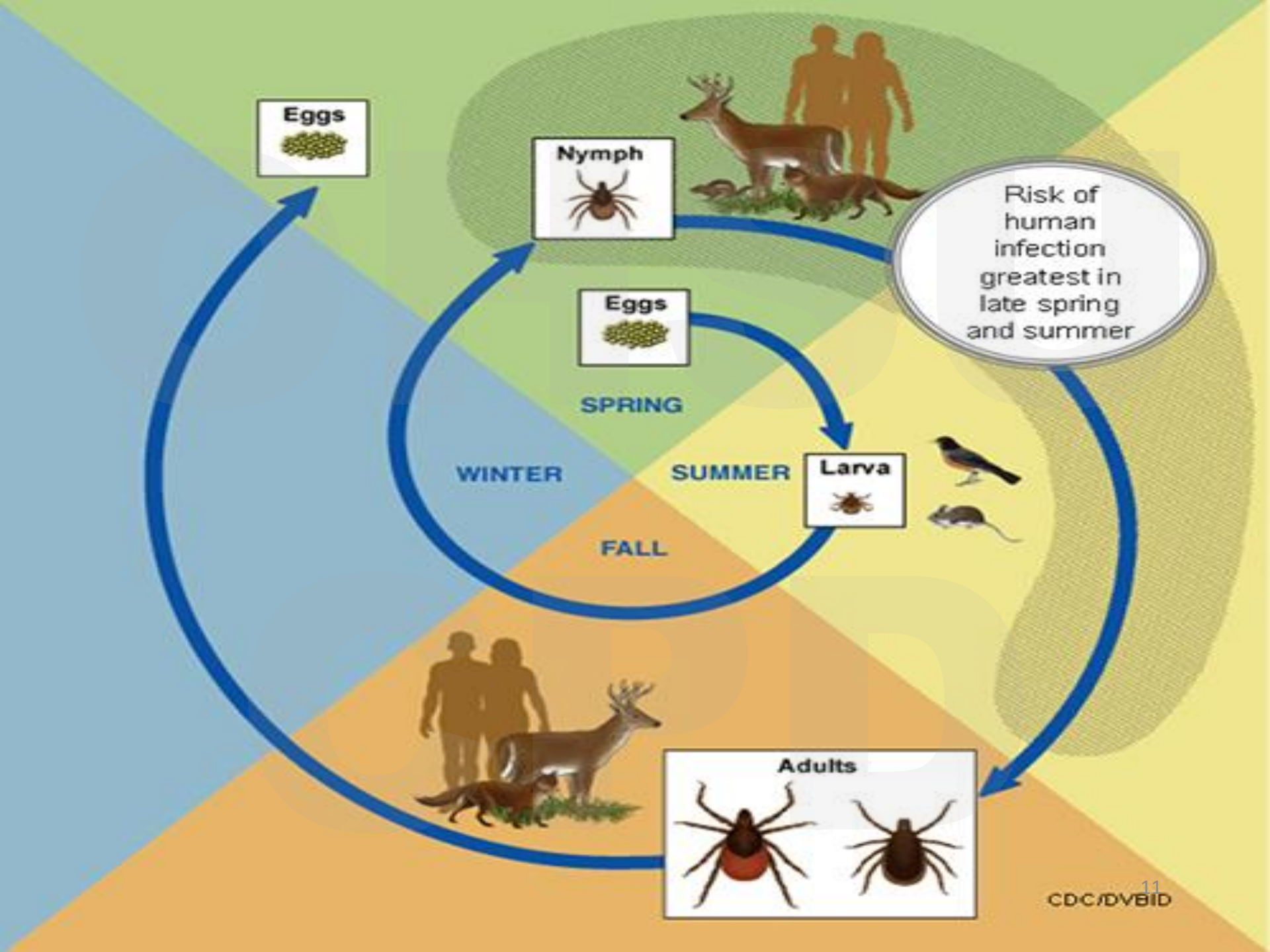



Adult
Nymph
Eggs
Larva
Salivary glands
Midgut
Ovary
Rectal sac
Barbed Hypostome
Cheliceral Digit
Palp

Tick Life Cycle

- Hard ticks have four life stages
  - Egg
  - Six-legged larvae
  - Eight-legged nymph
  - Adult
- Most ticks prefer to feed on different hosts at each life stage
- Ticks can feed on any land animal

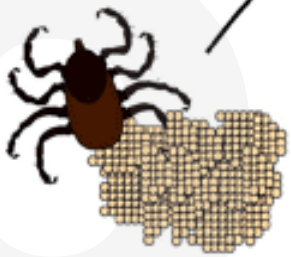
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Eggs
Nymph
Risk of human infection greatest in late spring and summer
Eggs
SPRING
WINTER
SUMMER
Larva
FALL
Adults
CDC/DVBID

Life Cycle of 3-Host Tick

Note: The life cycle of a 3-host tick may take 1-2 years depending on whether or not the tick can find a suitable host between life stages.

1



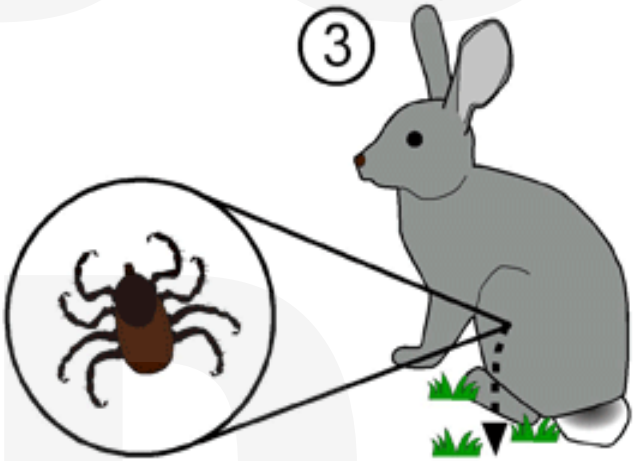
Female tick lays eggs on ground.

2



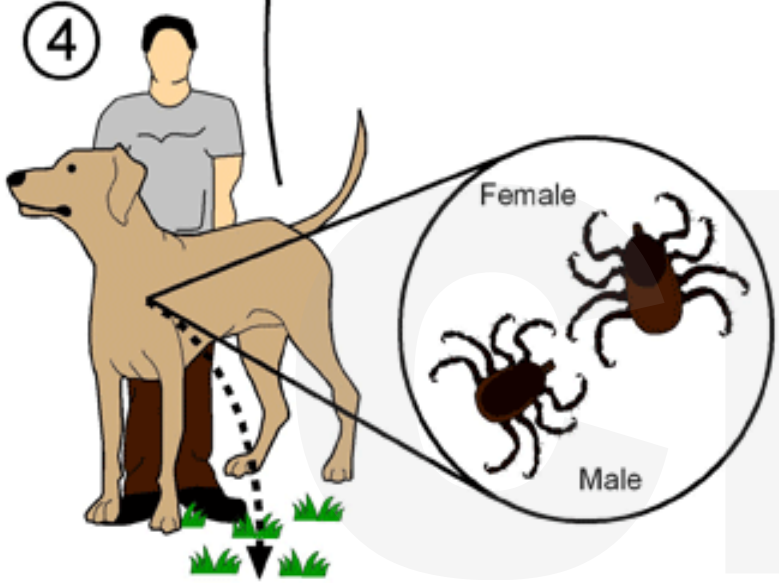
Six-legged larva feeds on a small mammal, then drops off to the ground and molts.

3



Eight-legged nymph feeds on a small mammal, then drops off to the ground and molts.

4



Eight-legged adults feed and mate on a larger mammal, including livestock and pets, then drop off to the ground. Males die soon thereafter and females begin to develop eggs.





J Am Acad Dermatol
June 2004

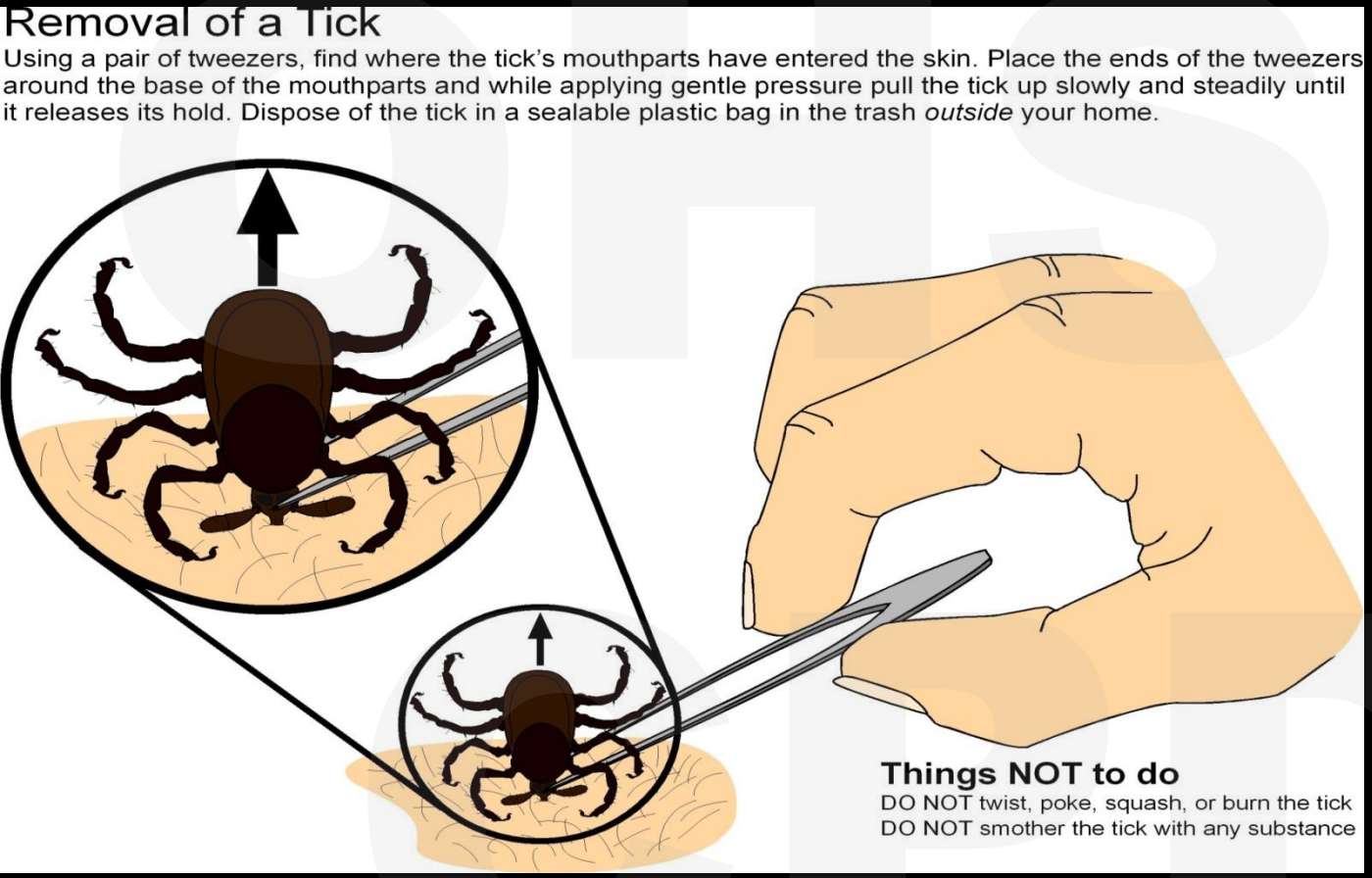

DermNet
All about the skin

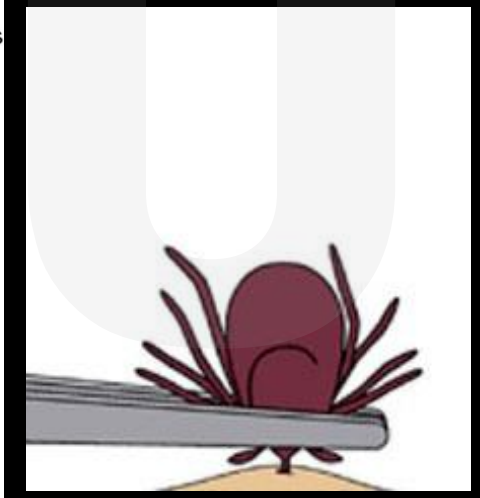
Tick Removal

- Don’t!
  - Matches
  - Gasoline
  - Nail polish
  - Crush
  - Freeze
  - Vaseline
  - Cheap OTC devices

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Safe Tick Removal





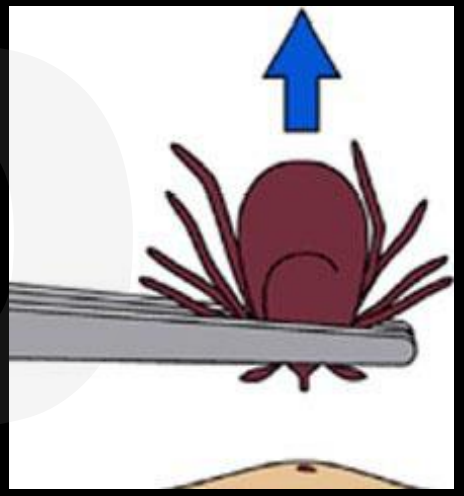


Photo provided by: extension.entm.purdue.edu



Know Your Ticks!

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Brown Dog Tick

Diseases:

1. RMSF





American Dog Tick

Diseases:

1. **RMSF**
2. **Tularemia**




University of Florida


4 8 12
32
64
8 16 24 32 40 48 56
1





Black Legged Tick

Diseases:

1. Anaplasmosis
2. Babesioses
3. Lyme

22% with more than one disease



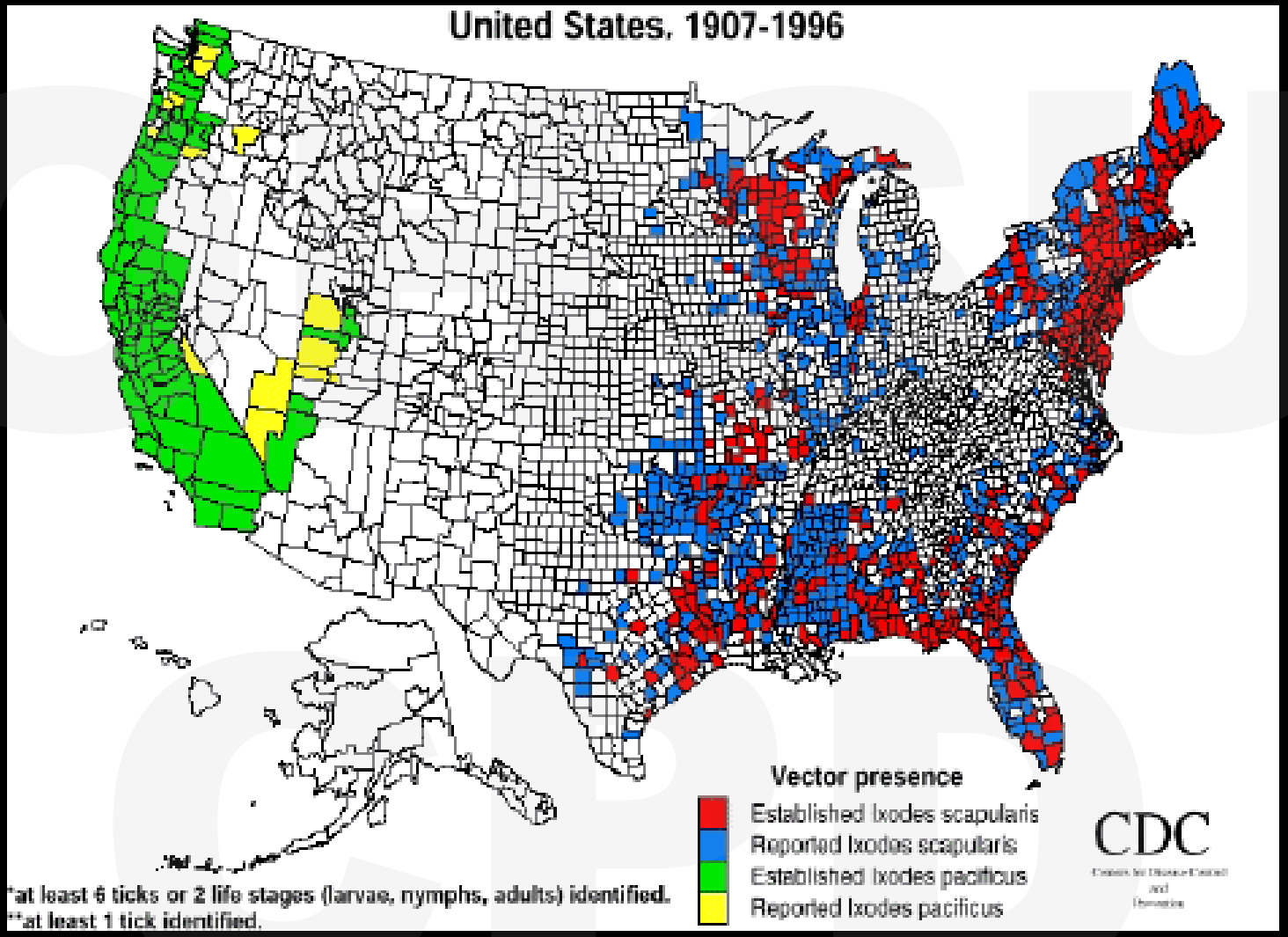


Western Black Legged Tick

Diseases:

1. Lyme Disease
2. Anaplasmosis



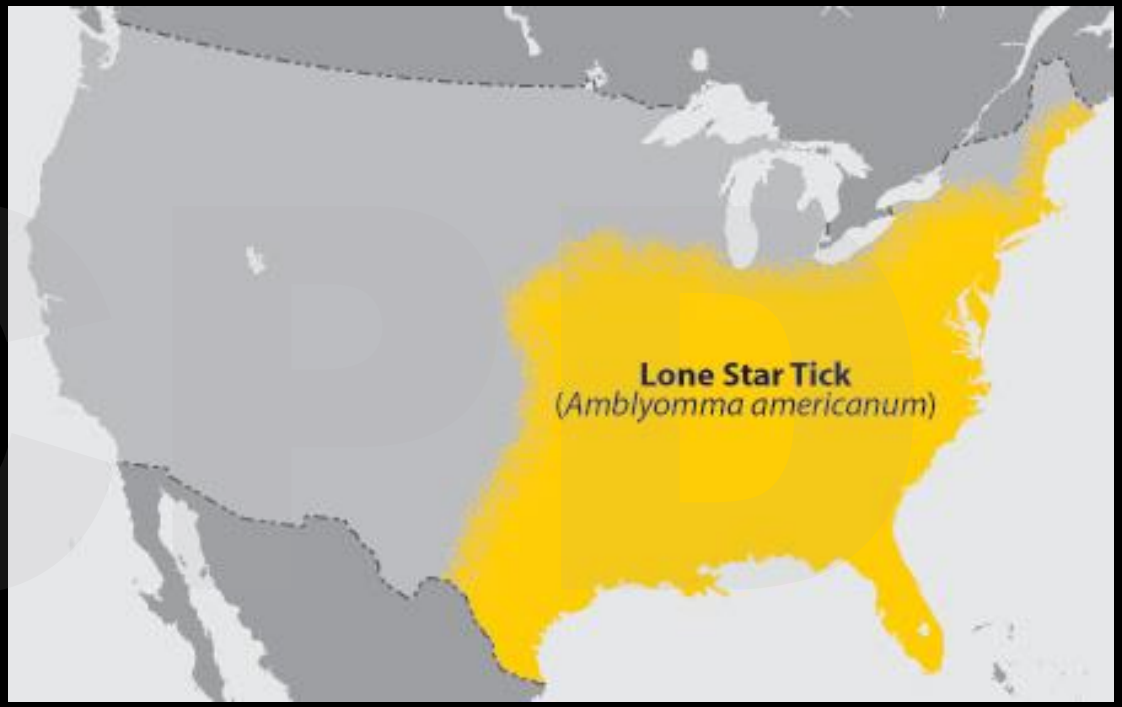

United States, 1907-1996
Vector presence
Established Ixodes scapularis
Reported Ixodes scapularis
Established Ixodes pacificus
Reported Ixodes pacificus
CDC
*at least 6 ticks or 2 life stages (larvae, nymphs, adults) identified.
**at least 1 tick identified.



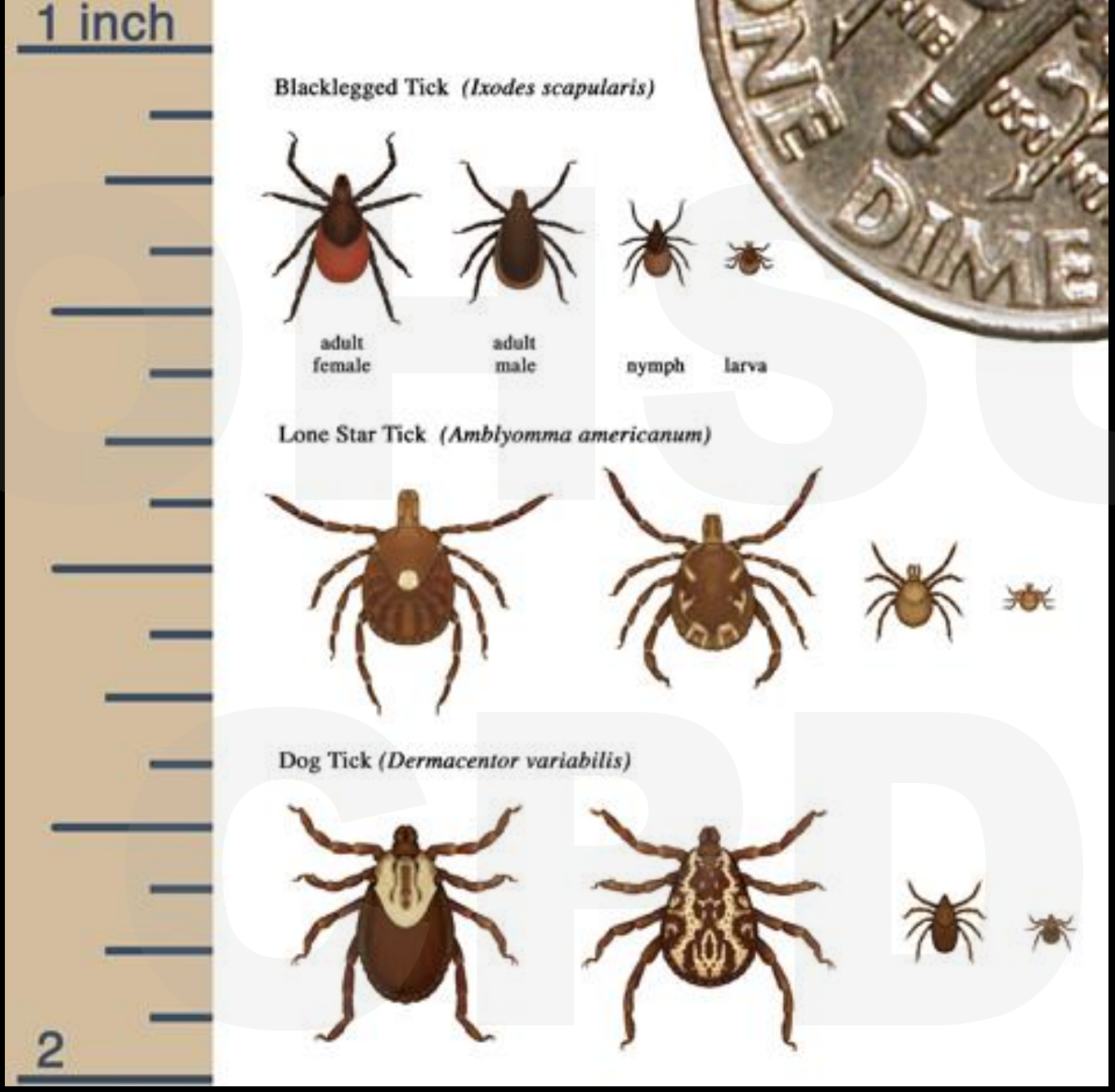
Lone Star Tick

Diseases:

1. STARI
2. Ehrlichiosis
3. Tularemia
4. Alpha-Gal






1 inch
2
Blacklegged Tick (Ixodes scapularis)
adult female
adult male
nymph
larva
Lone Star Tick (Amblyomma americanum)
Dog Tick (Dermacentor variabilis)



Rocky Mountain Wood Tick

Diseases:

1. **RMSF**
2. **Tularemia**
3. **Colorado tick fever**



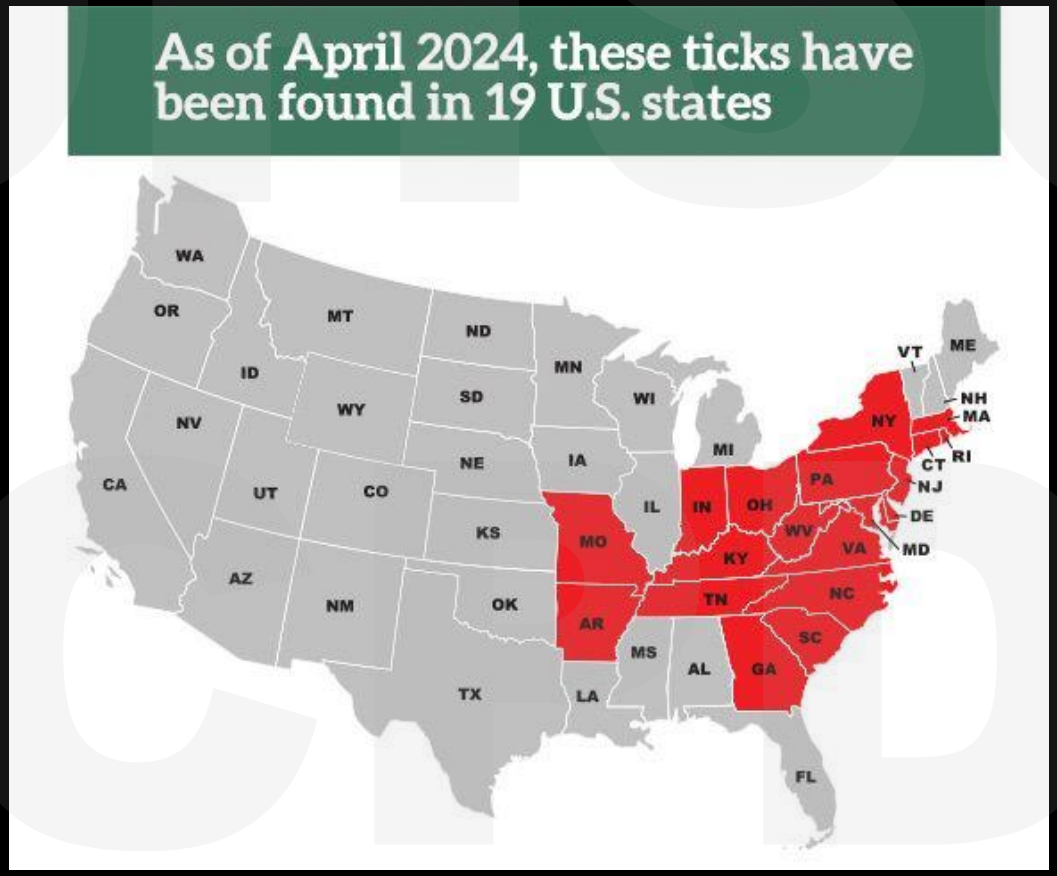
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Asian Longhorn Tick

Diseases:



Asian Longhorn Tick

- Lead to massive infestation of cattle
  - 27 adults, 41 nymphs and 1,058 larva
- Parthenogenesis
- No disease (yet) but can be vector to many

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Tick Borne Disease

- Lyme disease
- Rickettsial
- Anaplasmosis/Ehrlichiosis
- Babesiosis
- Tularemia
- Relapsing Fever
- STARI
- Viral

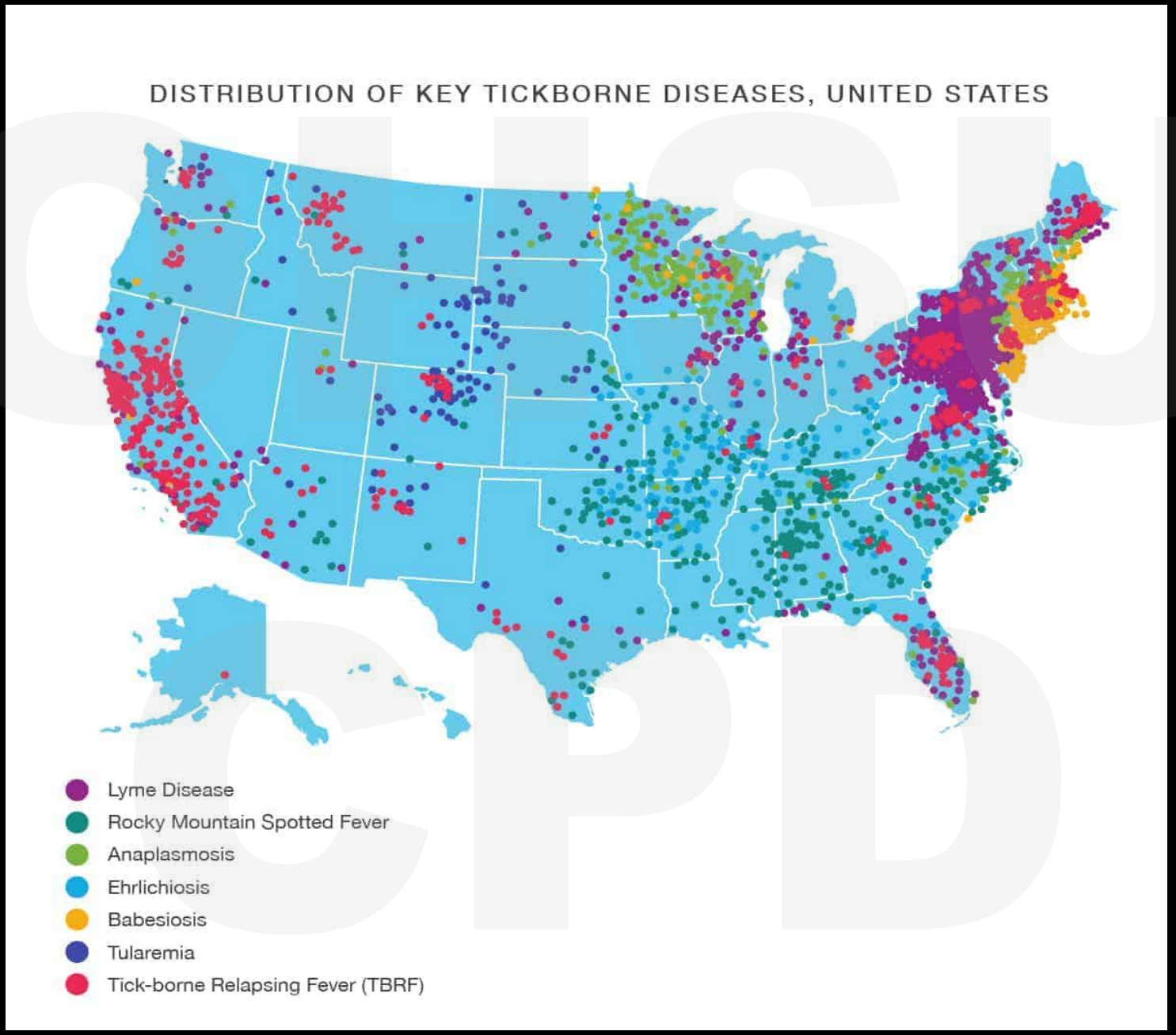
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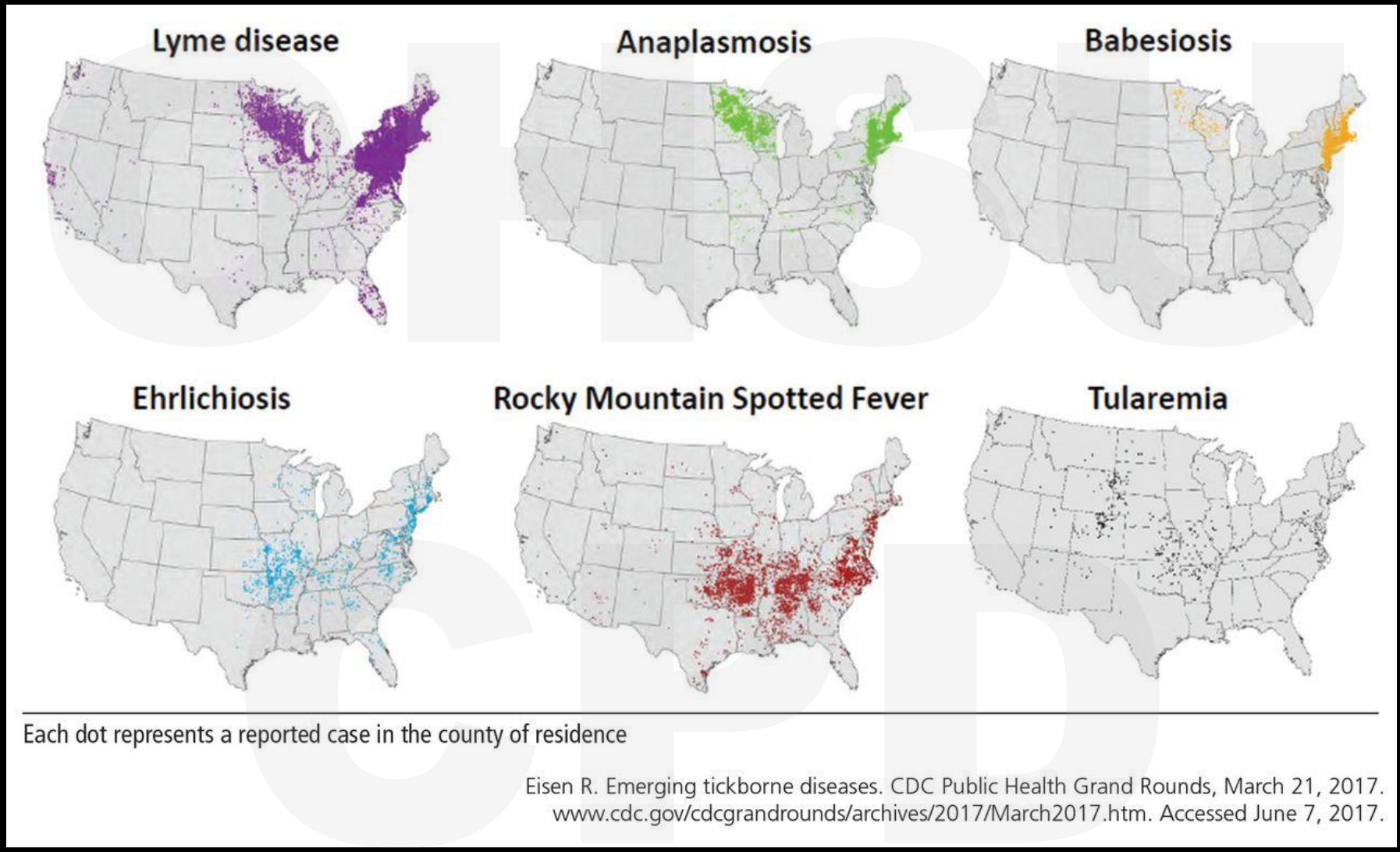
Incidence 2004-16

- Lyme 402,502
- Ehrlichiosis/Ana 39,959
- RMSF 37,376
- Babesiosis 9,631
- Tularemia 2,102
- Powassan 101

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DISTRIBUTION OF KEY TICKBORNE DISEASES, UNITED STATES





Each dot represents a reported case in the county of residence

Eisen R. Emerging tickborne diseases. CDC Public Health Grand Rounds, March 21, 2017. www.cdc.gov/cdcgrandrounds/archives/2017/March2017.htm. Accessed June 7, 2017.



Lyme

- Everywhere
- Spread by ticks common all over US
  - 3% of bites
- 3 Stages
- “New” Disease
  - Increase in deer population

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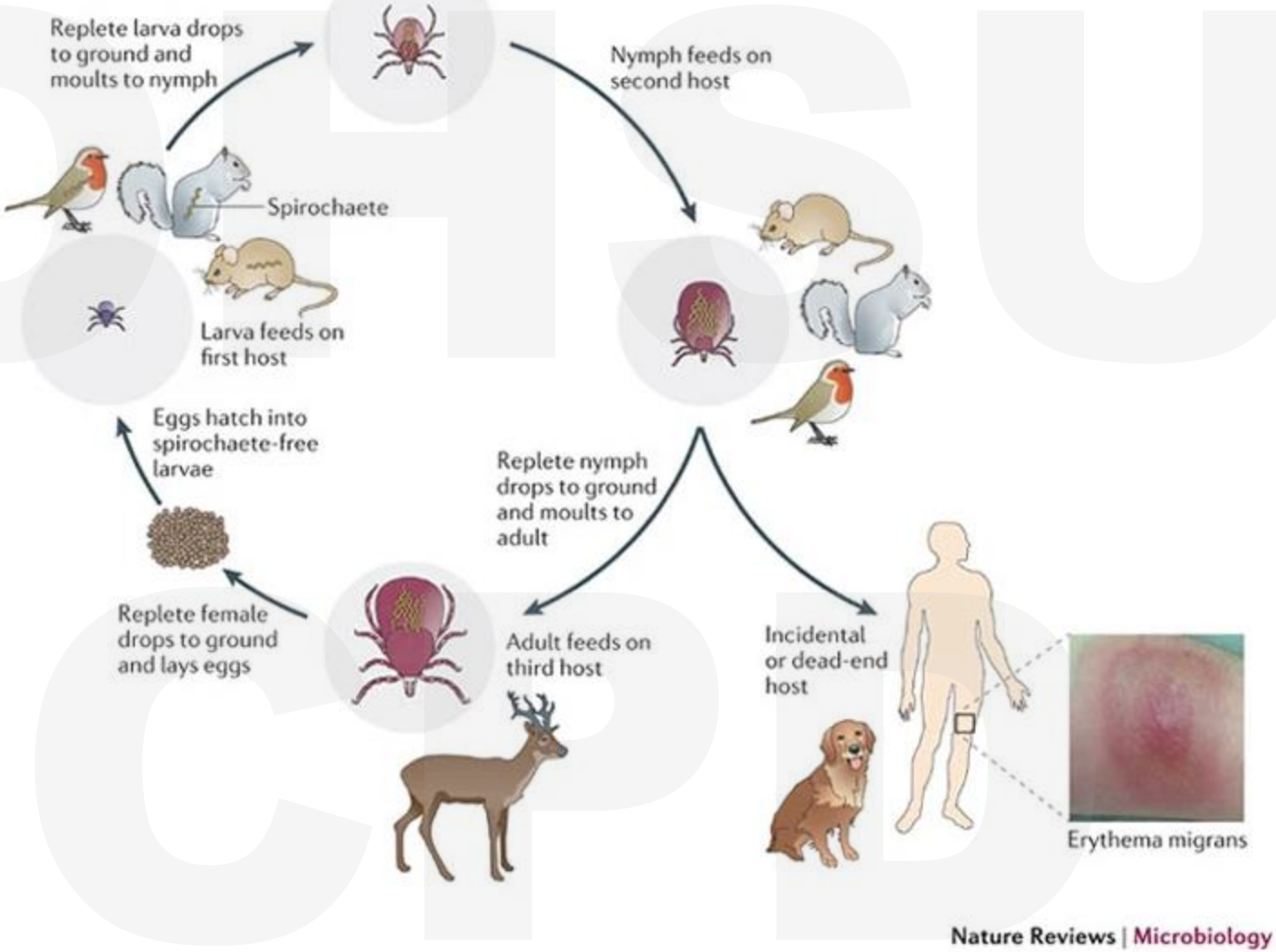
Reservoirs and Hosts

- White-footed mouse (*Peromyscus leucopus*)
  - Important in maintaining pathogen in nature



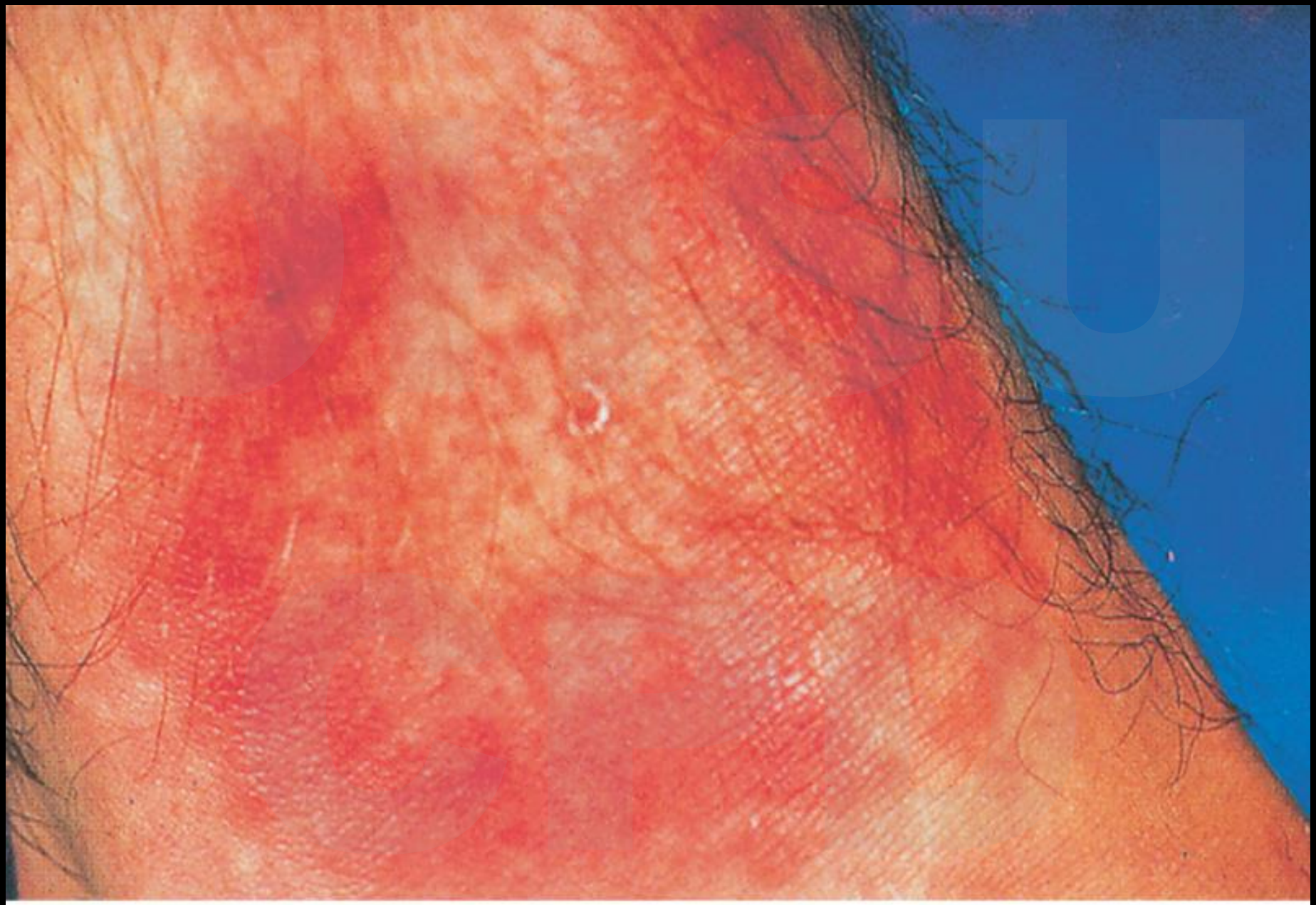
- White-tail deer (*Odocoileus virginianus*)




Replete larva drops to ground and moults to nymph
Nymph feeds on second host
Spirochaete
Larva feeds on first host
Eggs hatch into spirochaete-free larvae
Replete nymph drops to ground and moults to adult
Replete female drops to ground and lays eggs
Adult feeds on third host
Incidental or dead-end host
Erythema migrans
Nature Reviews | Microbiology

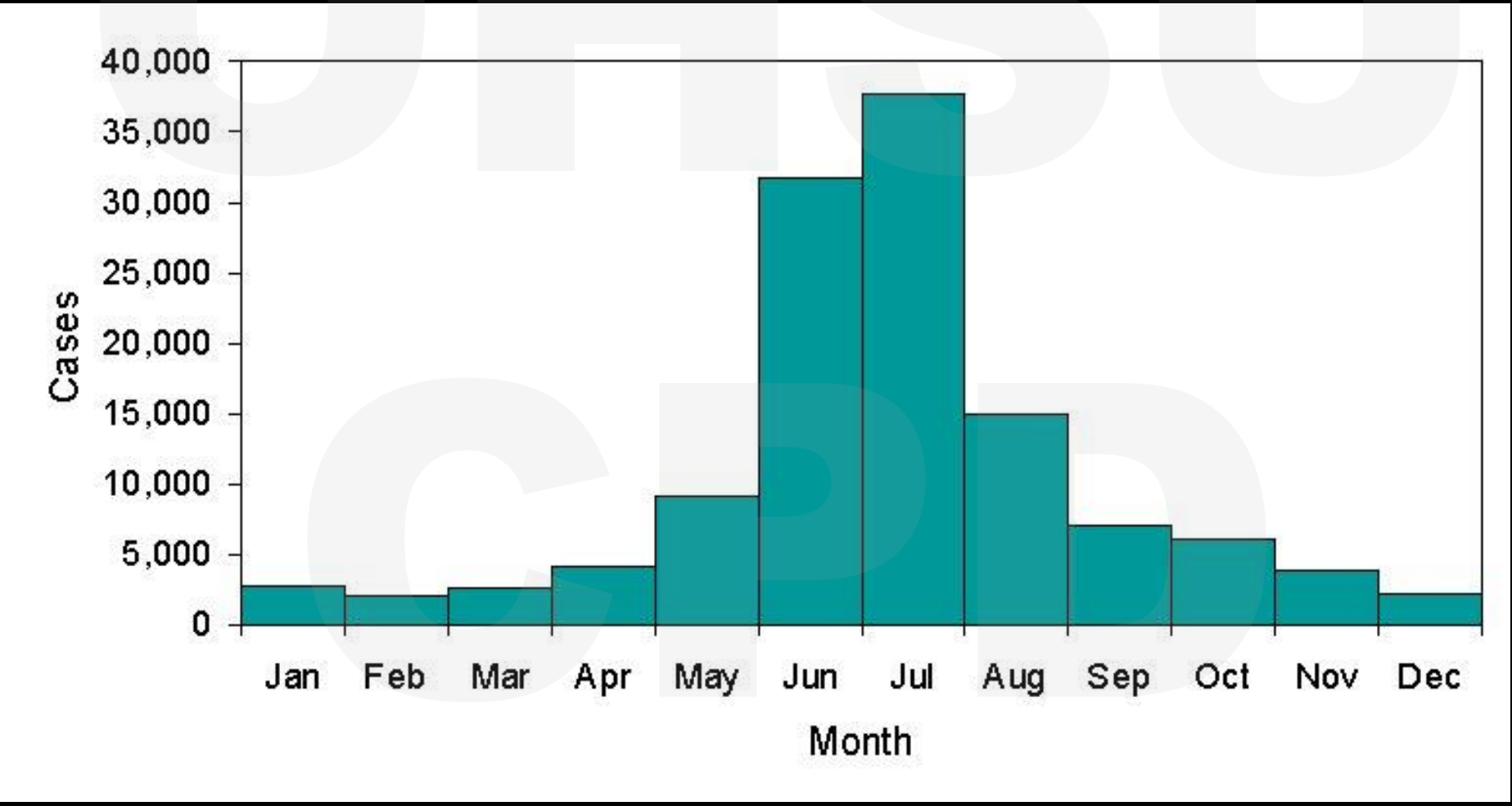
Erythema Migrans



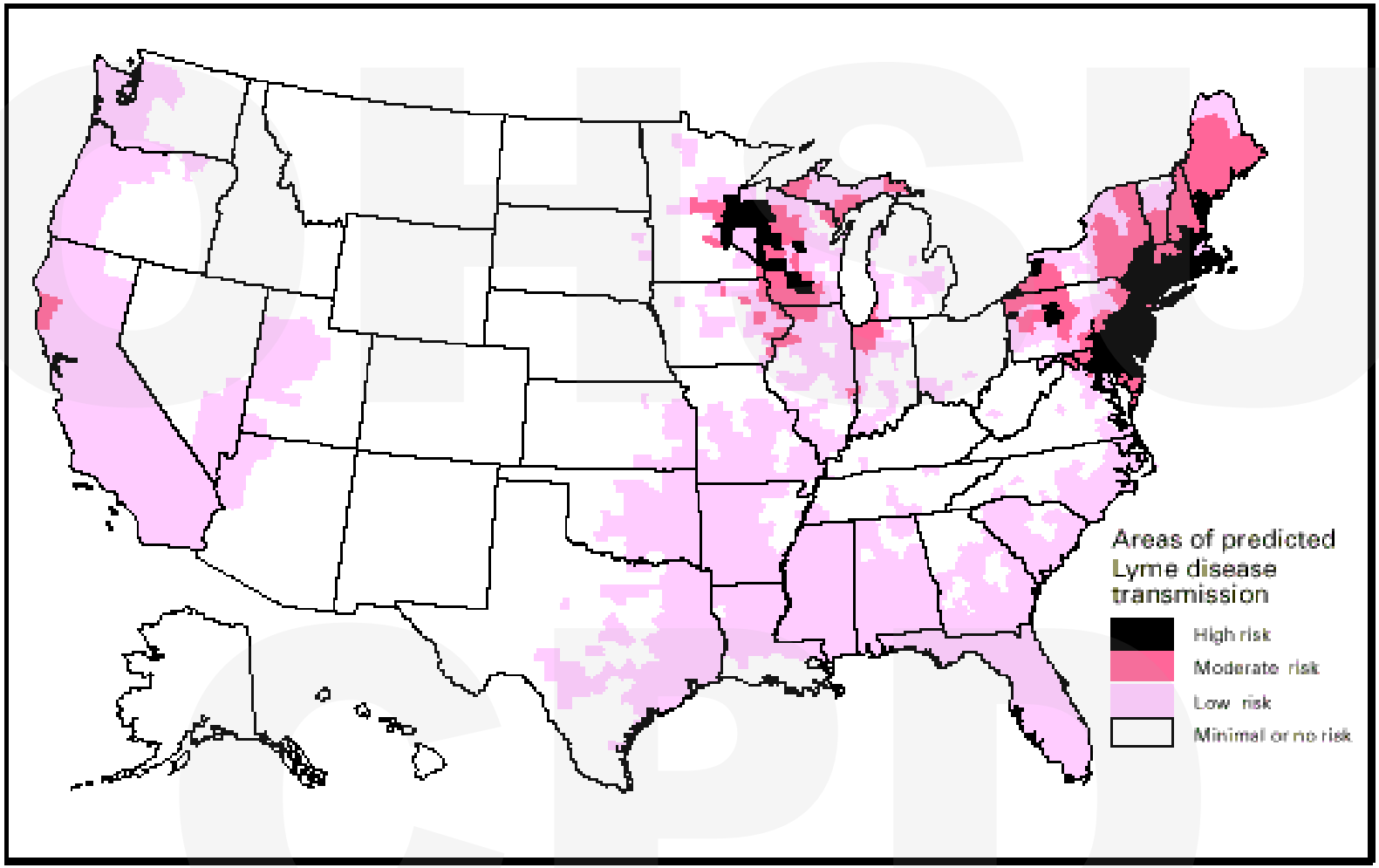


Peters and Pasvol: Atlas of Tropical Medicine and Parasitology 6th edition © 2006 Elsevier Ltd

Cases by Month (U.S., 1994–2004)



National Lyme disease risk map with four categories of risk



Note: This map demonstrates an approximate distribution of predicted Lyme disease risk in the United States. The true relative risk in any given county compared with other counties might differ from that shown here and might change from year to year. Risk categories are defined in the accompanying text. Information on risk distribution within states and counties is best obtained from state and local public health authorities.

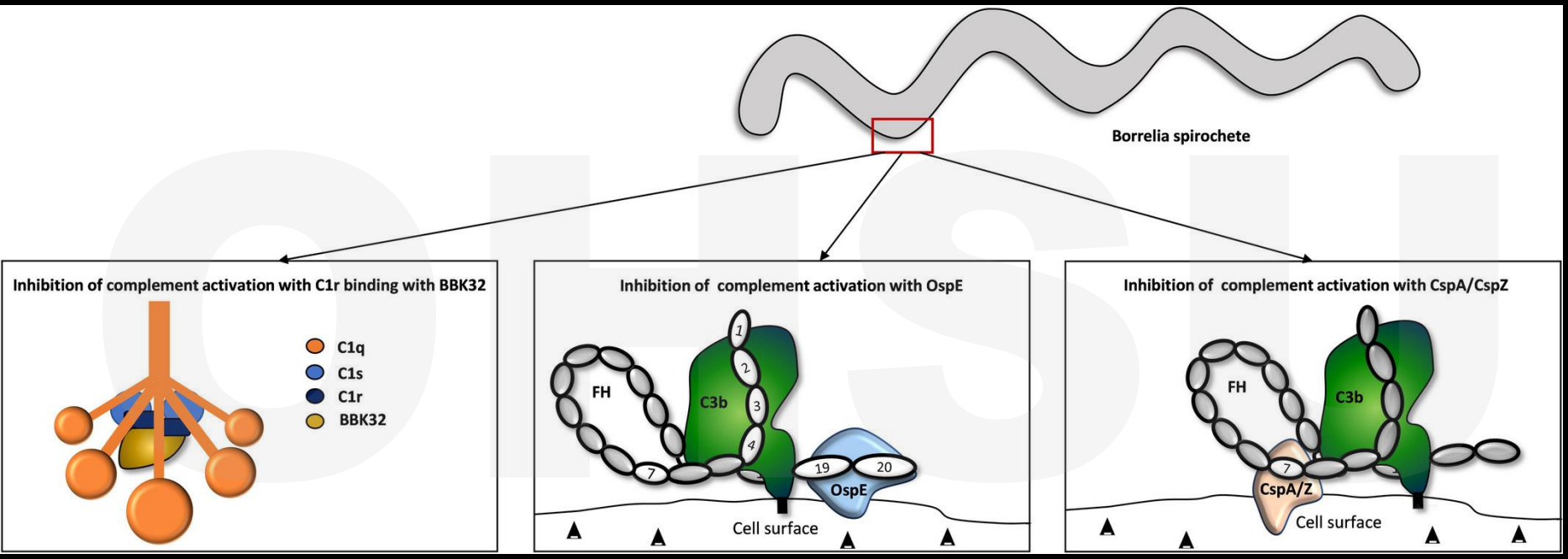
Lyme Borrelia

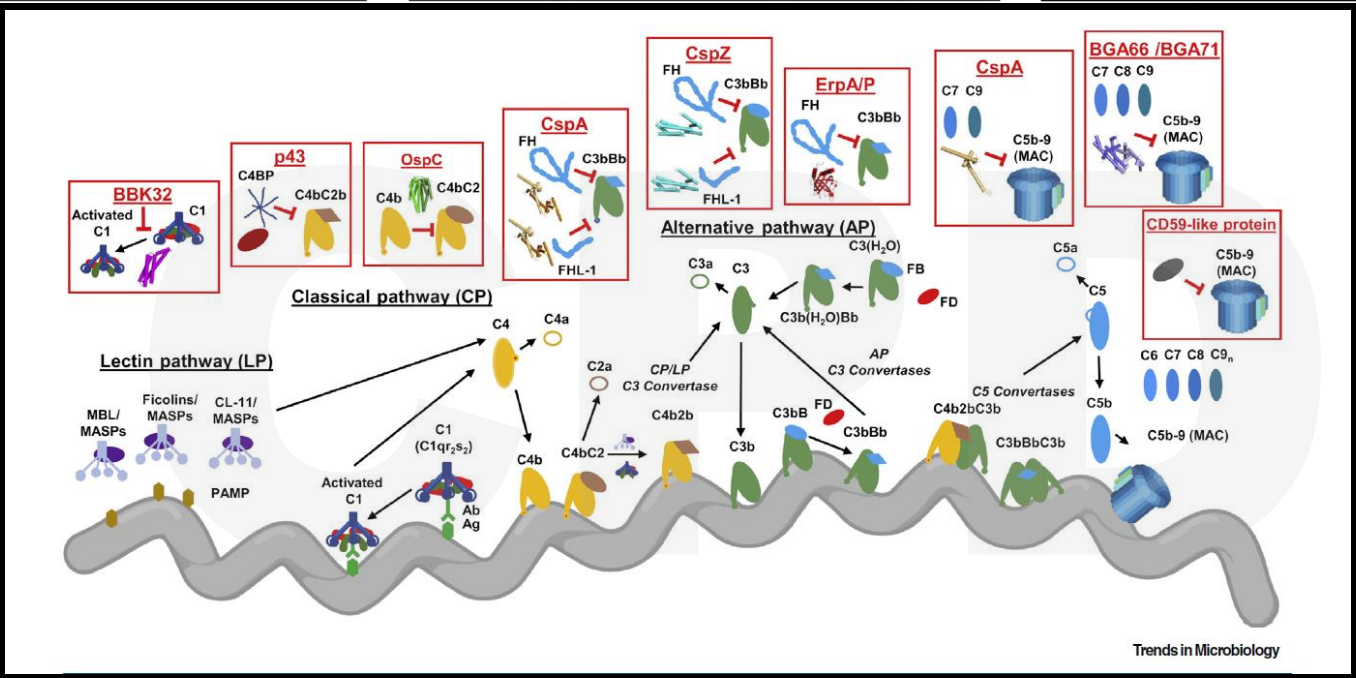
- Borrelia carried in tick midgut
- Most commonly nymphs
- Exposure to blood express OspC which targets tick salivary gland
- Introduced into host while taking blood meal

Evading Immunity

- Borreliosis evolved surface proteins to inactive complement
  - Binds factor H
  - Binds C4b-BP
  - Blocks C1r

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FEBS Letters, Volume: 594, Issue: 16, Pages: 2645-2656, First published: 04 August 2020, DOI: (10.1002/1873-3468.13894)

Lyme Borrelia

- Borrelia burgdorferi
- Borrelia afezelii
- Borrelia garinii
- Borrelia spielmanii
- Borrelia barvariensis

Clinical Differences

- Borrelia burgdorferi
  - N America, arthrogenic
- Borrelia afezelii
  - Cutaneous manifestations
- Borrelia garinii
  - Neutrotropic

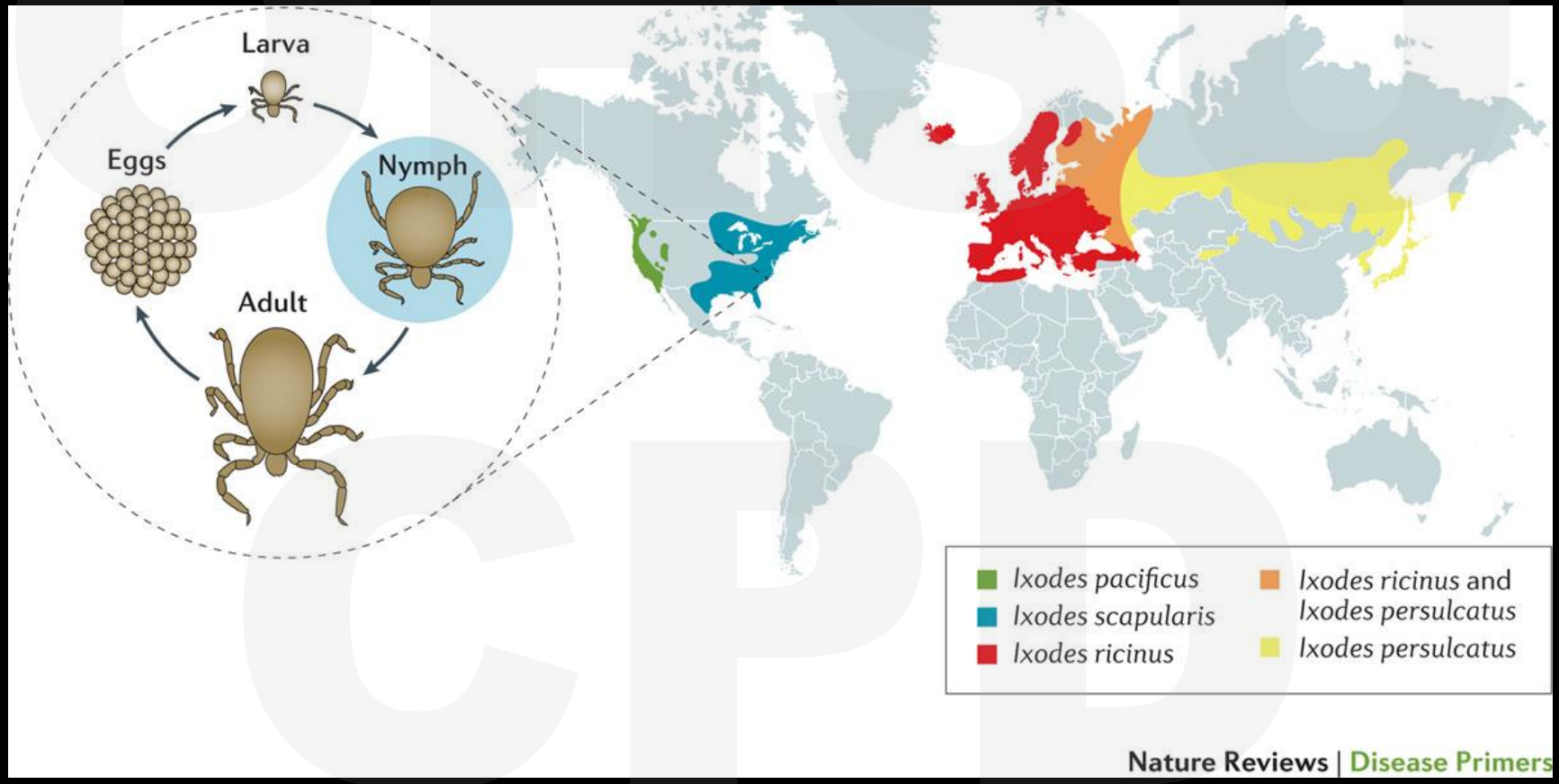
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Feeding Period

- B burgdorferi > 36 hours
- B afzelii – may be shorter
  - < 24 hrs?

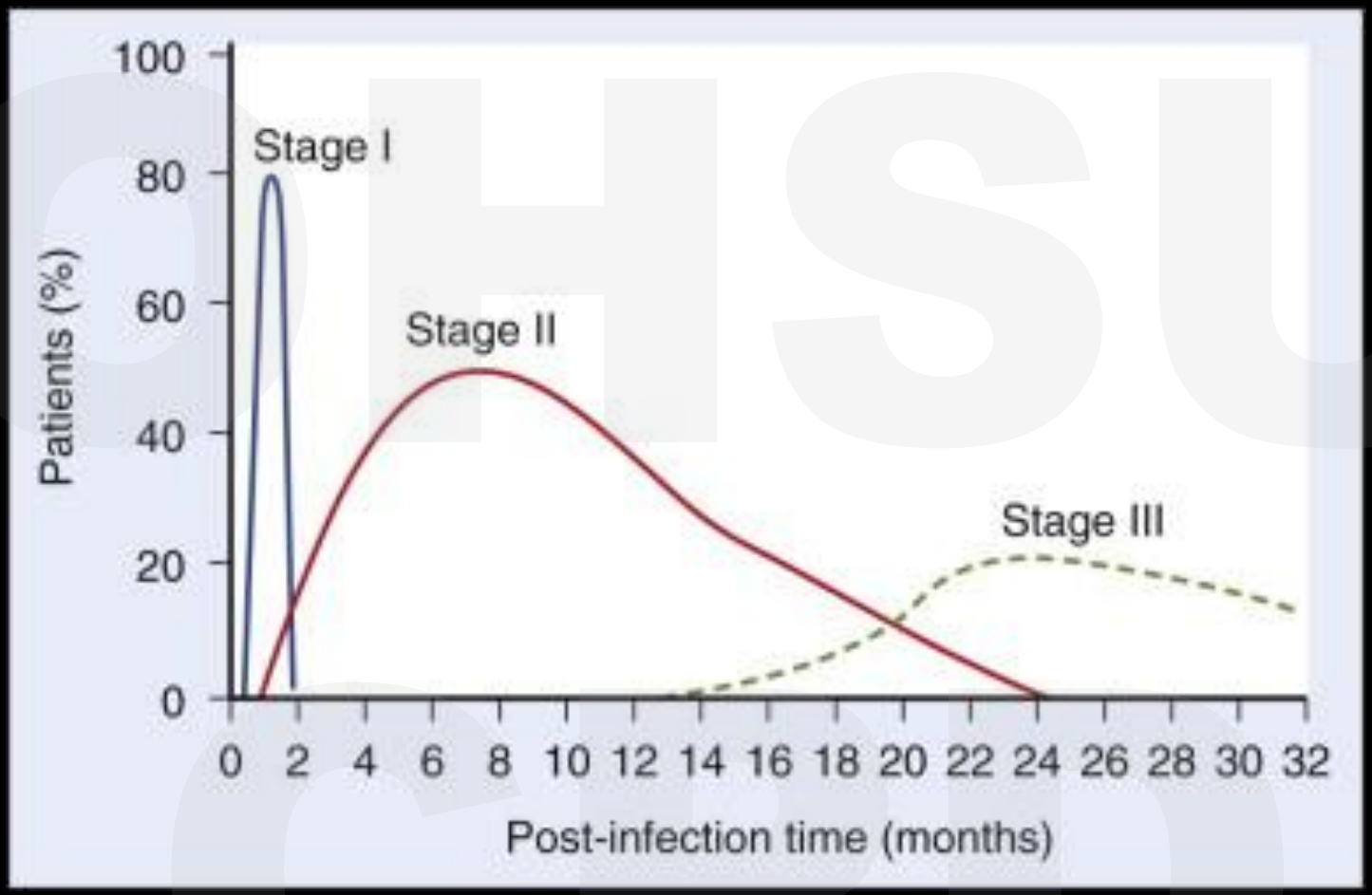
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Distribution of *Ixodes* ticks that transmit *Borrelia burgdorferi* to humans

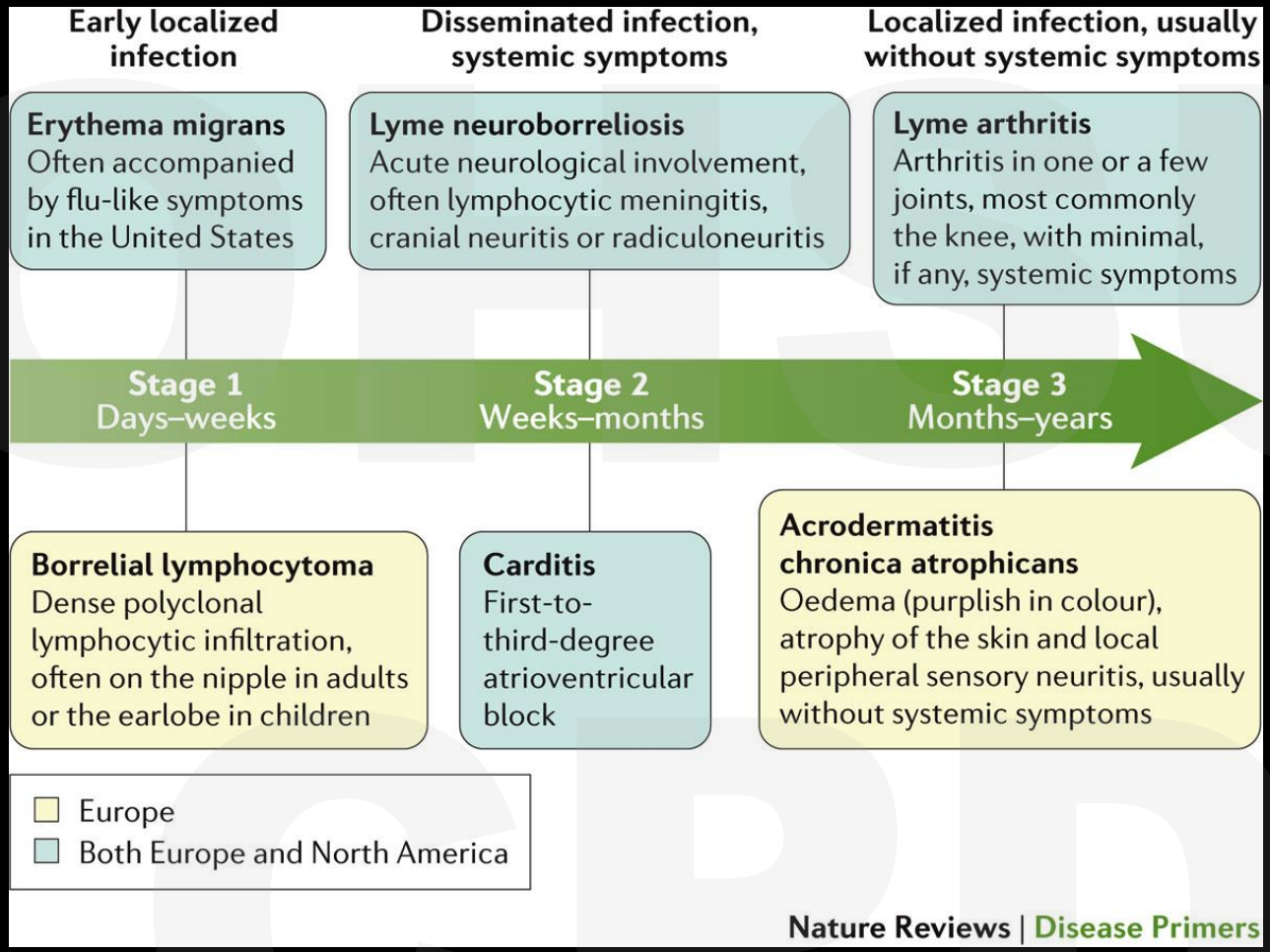


Steere, A. C. *et al.* (2016) Lyme borreliosis
Nat. Rev. Dis. Primers doi:10.1038/nrdp.2016.90




100
80
60
40
20
0
Patients (%)
Stage I
Stage II
Stage III
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
Post-infection time (months)

Auerbach



Steere, A. C. *et al.* (2016) Lyme borreliosis
Nat. Rev. Dis. Primers doi:10.1038/nrdp.2016.90

Early Localized

- Erythema migrans
  - 80% of patients
  - Bite in center
- “Viral syndrome”

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Early Disseminated

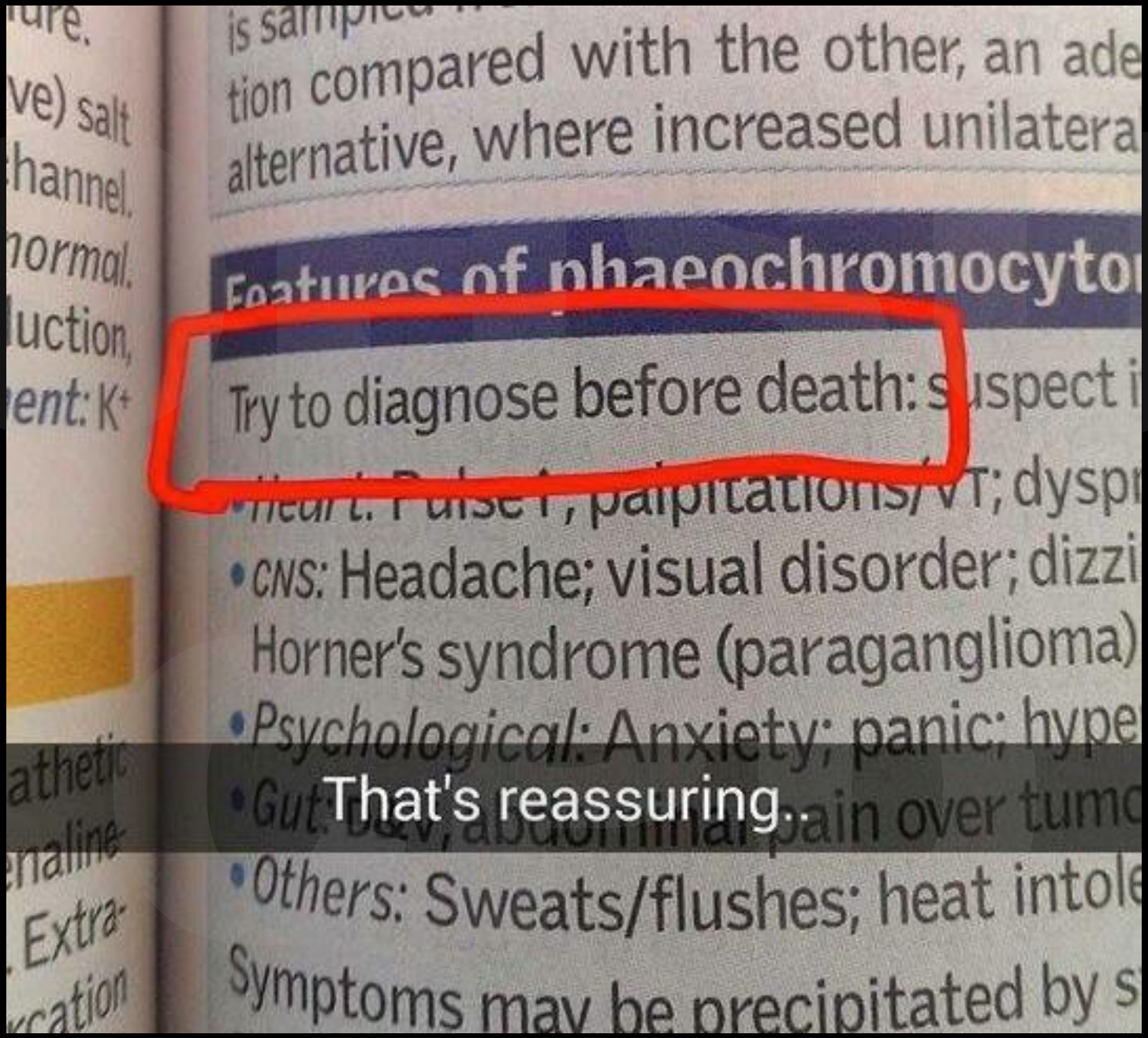
- Cardiac
  - AV nodal block
- Dermatological
  - Erythema migrans
- Neurological
  - Facial nerve palsy, meningitis
- Musculoskeletal
  - Myalgias, arthritis

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Late

- Arthritis
- Neurologic
  - Neuropathies

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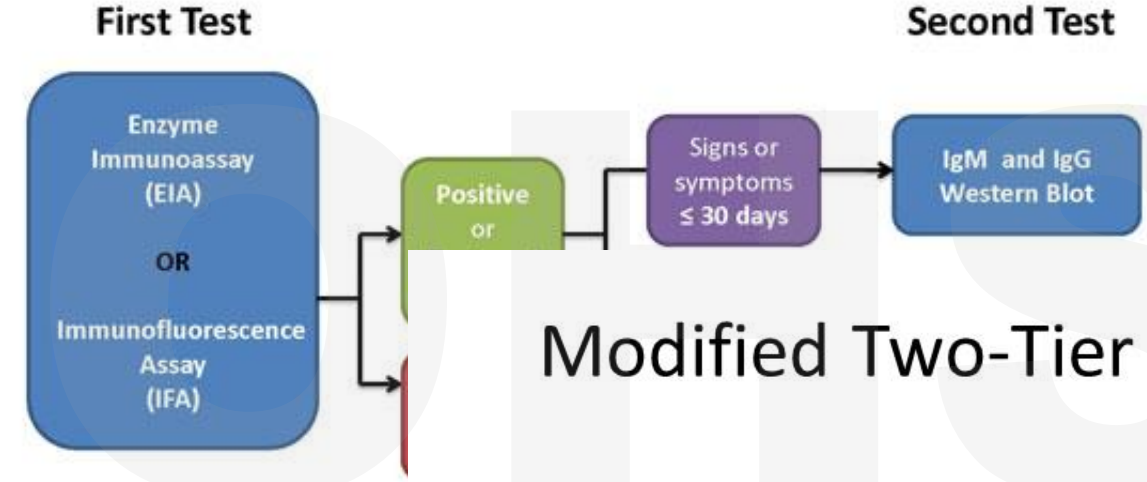

tion compared with the other, an ade
alternative, where increased unilatera
Features of phaeochromocyto
Try to diagnose before death: suspect i
• CNS: Headache; visual disorder; dizzi
Horner's syndrome (paraganglioma)
• Psychological: Anxiety; panic; hype
• Others: Sweats/flushes; heat intole
Symptoms may be precipitated by s
That's reassuring..

Diagnosis

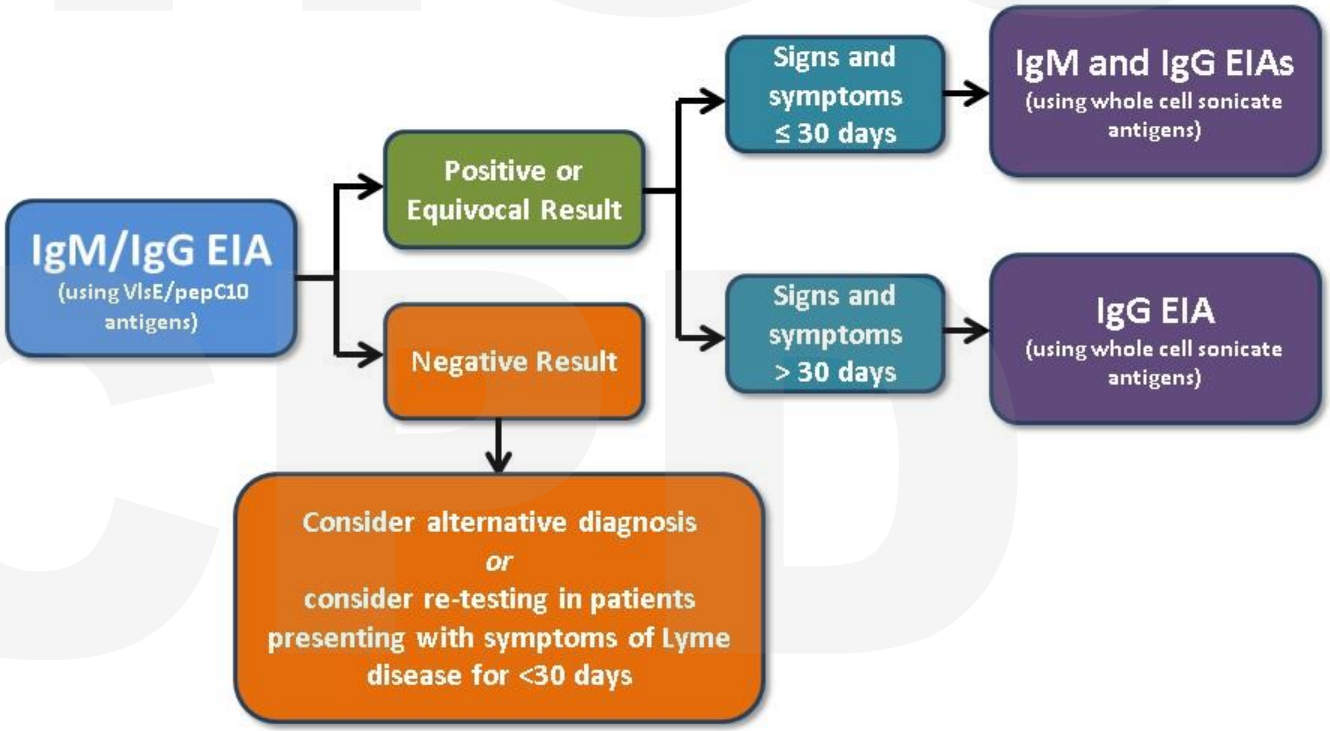
- Erythema migrans
  - 80% of patients
  - Only criteria to make clinical diagnosis
- Testing
  - Two-tier approach
  - IgM and IgG stay elevated for years even with cure

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Two-Tiered Testing for Lyme Disease



Modified Two-Tier Testing Algorithm



Treatment

- Early
  - Doxycycline, amoxicillin, cefuroxime, azithromycin
- Disseminated
  - Ceftriaxone, cefotaxime, doxycycline
- Late
  - Same

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Lyme Disease

- Prophylaxis (engorged tick found)
  - Doxy 200mg po x 1

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Rickettsial Disease

- Intracellular pathogens spread by ticks, fleas, mites
- Most cause abrupt febrile illness with intense systemic symptoms
- Many have associated rash due to vasculitis
- May also have headaches, conjunctivitis, hepatosplenomegaly

RMSF

- Leading Rickettsial disease in USA
- *Rickettsia rickettsii*
  - 1:1000 ticks infected
  - Need to feed for 6-10 hours

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Clinical

- Abrupt fevers, headache, and rash
- Intense myalgias with fevers
- Rash: out -> in
- No eschar at bite site
- Clinical diagnosis
  - Titers establish diagnosis

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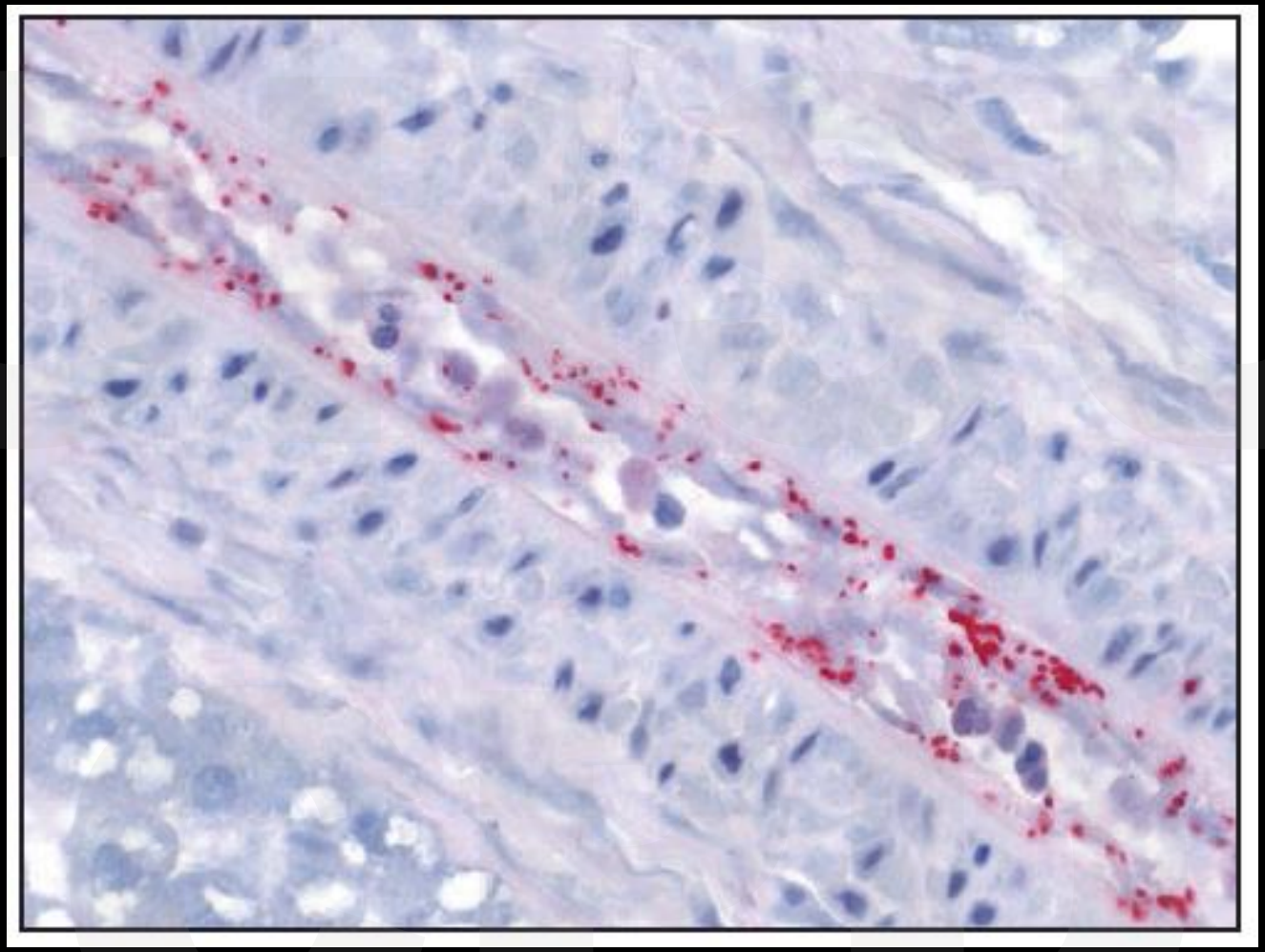


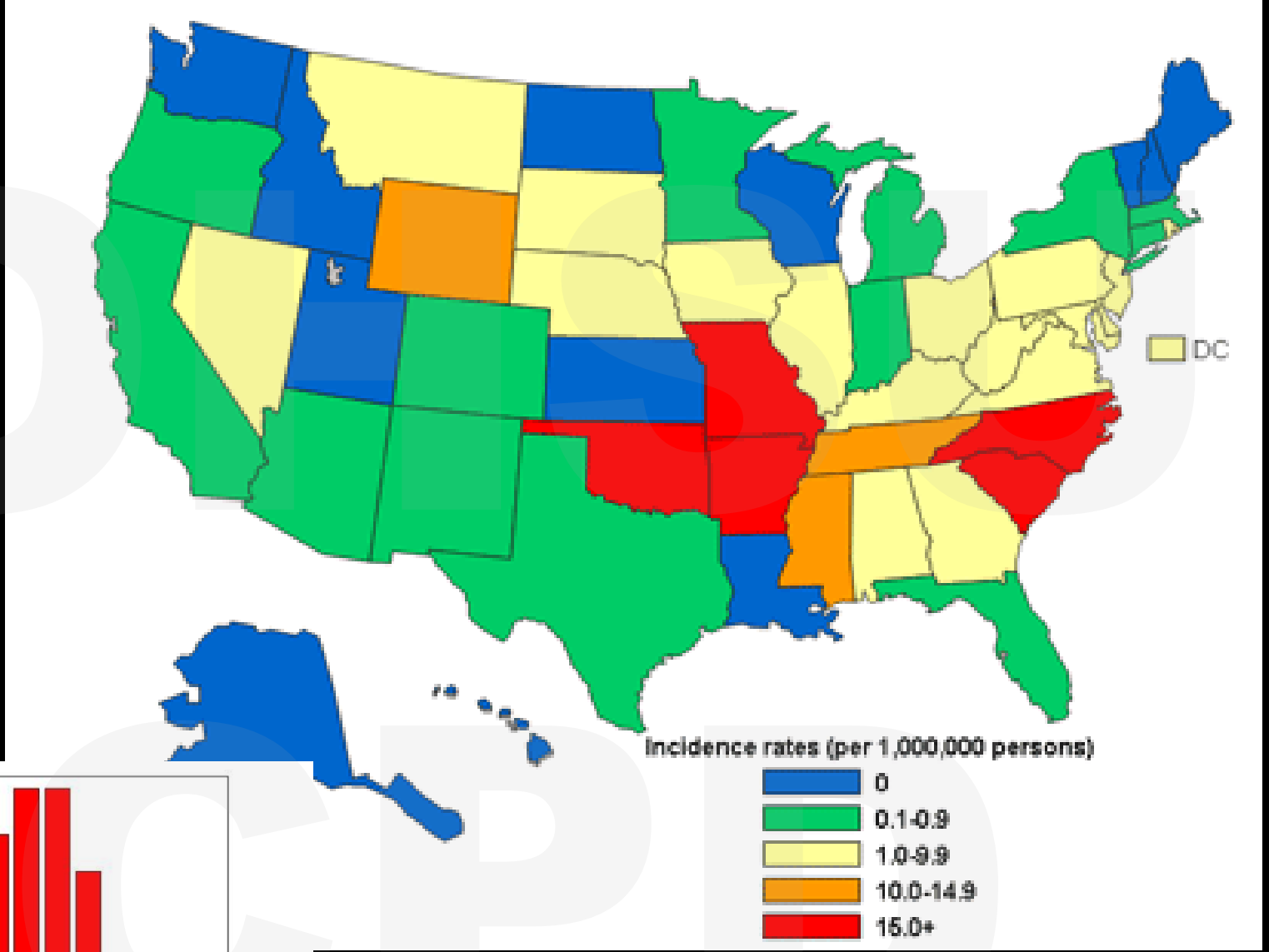


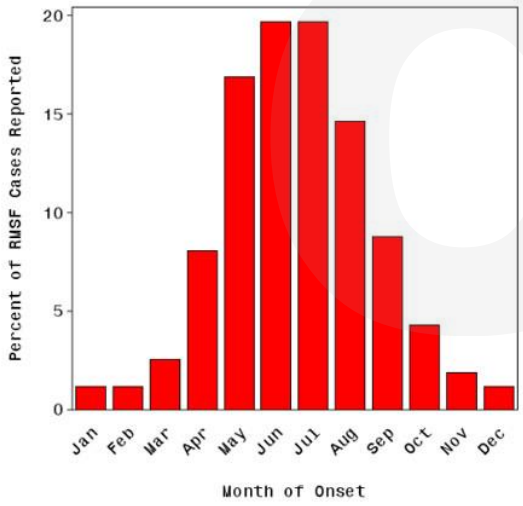


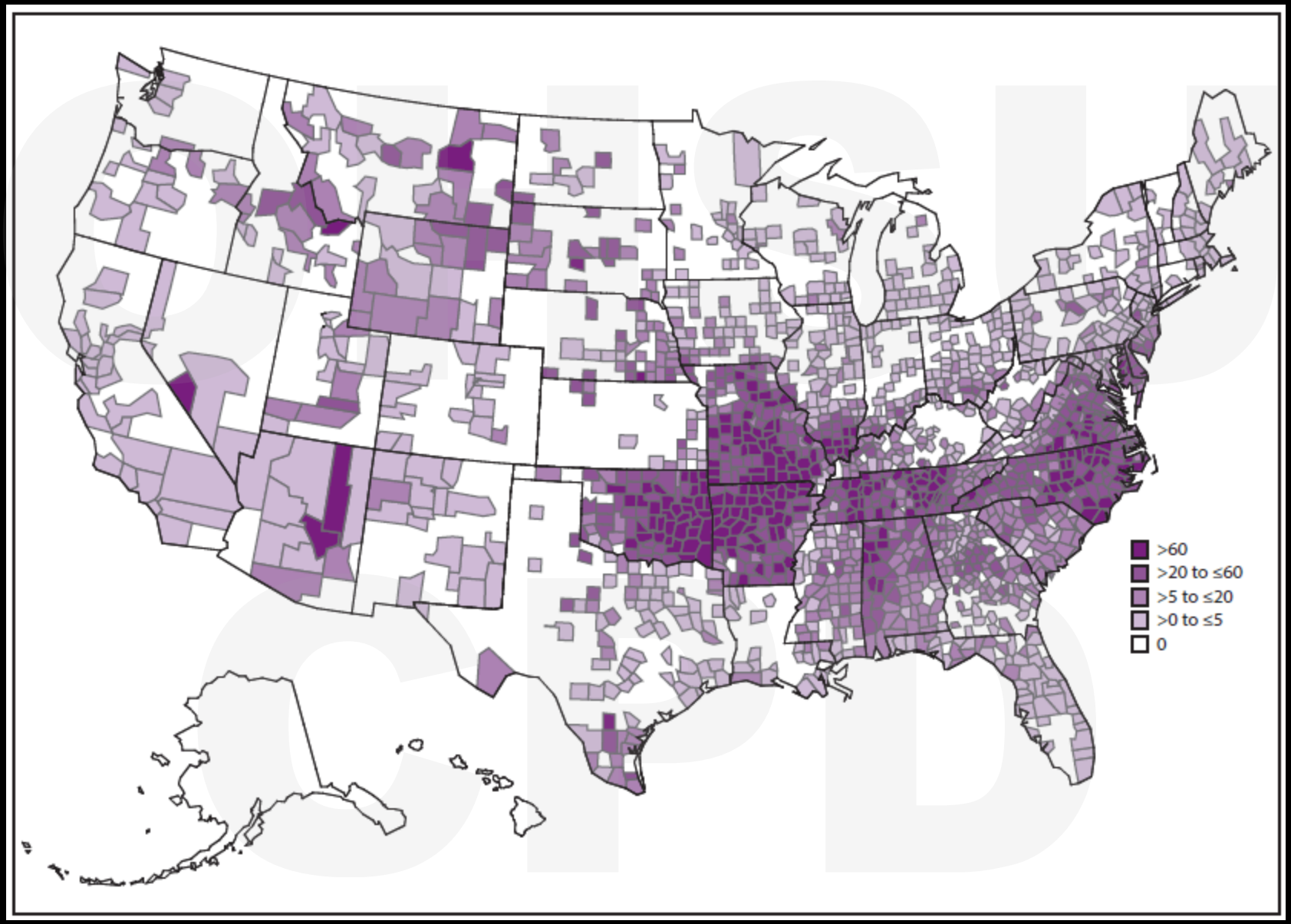
http://www.justchromatography.com/biochemistry/rocky-mountain-spotted-fever






DC
Incidence rates (per 1,000,000 persons)
0
0.1-0.9
1.0-9.9
10.0-14.9
15.0+


Percent of RMSF Cases Reported
20
15
10
5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month of Onset


>60
>20 to ≤60
>5 to ≤20
>0 to ≤5
0

Treatment

- Empirical treatment key!
  - Mortality increases with > 5 day delay
- Doxycycline 100 mg bid x 7
  - Short course will not discolor teeth

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Ehrlichiosis/Anaplasmosis

- Intracellular organism
- Common in South and Midwest but spreading
  - Very under reported
- Fevers, thrombocytopenia and leukopenia.
- Can see critters on blood smear.

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Ehrlichiosis/Anaplasmosis

- Human Monocyte Ehrlichiosis (HME) and Human Granulocyte Anaplasmosis (HGA)
- HME: southern USA
- HGA: upper Midwest but reported in more than 32 states
- New species being identified

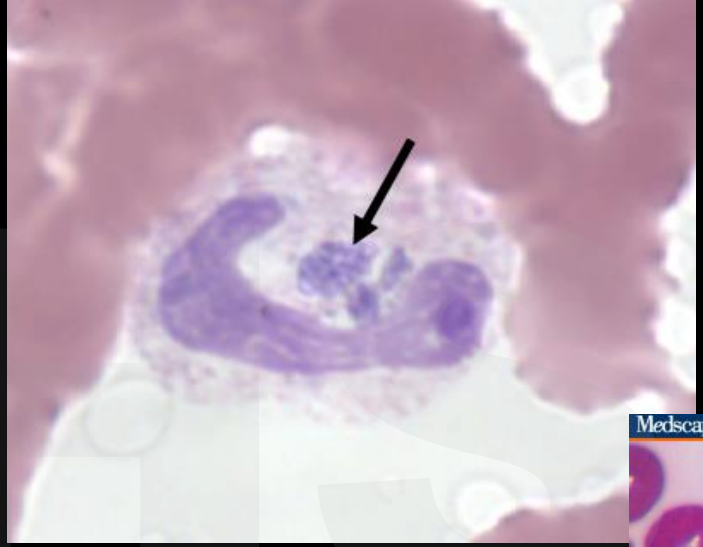
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Clinical Picture

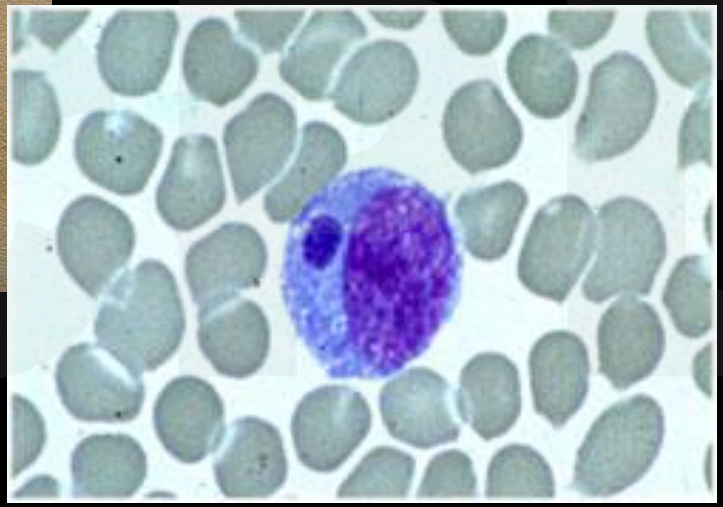
- High fevers, headaches and myalgias
  - Many undiagnosed
- Marked liver function test elevation
- Toxic shock syndrome
  - Immunosuppressed
  - Fatality rate is 2-5%

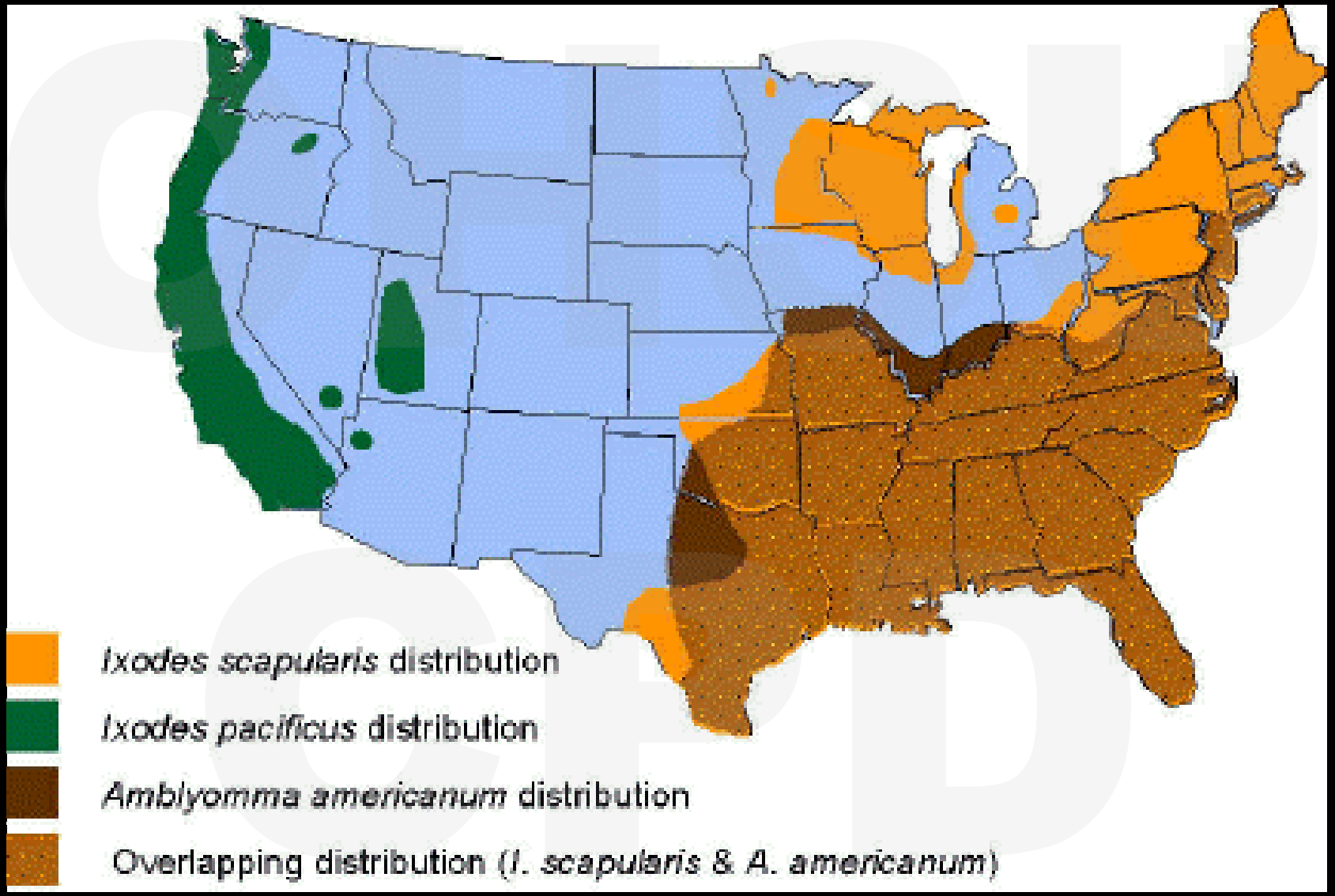
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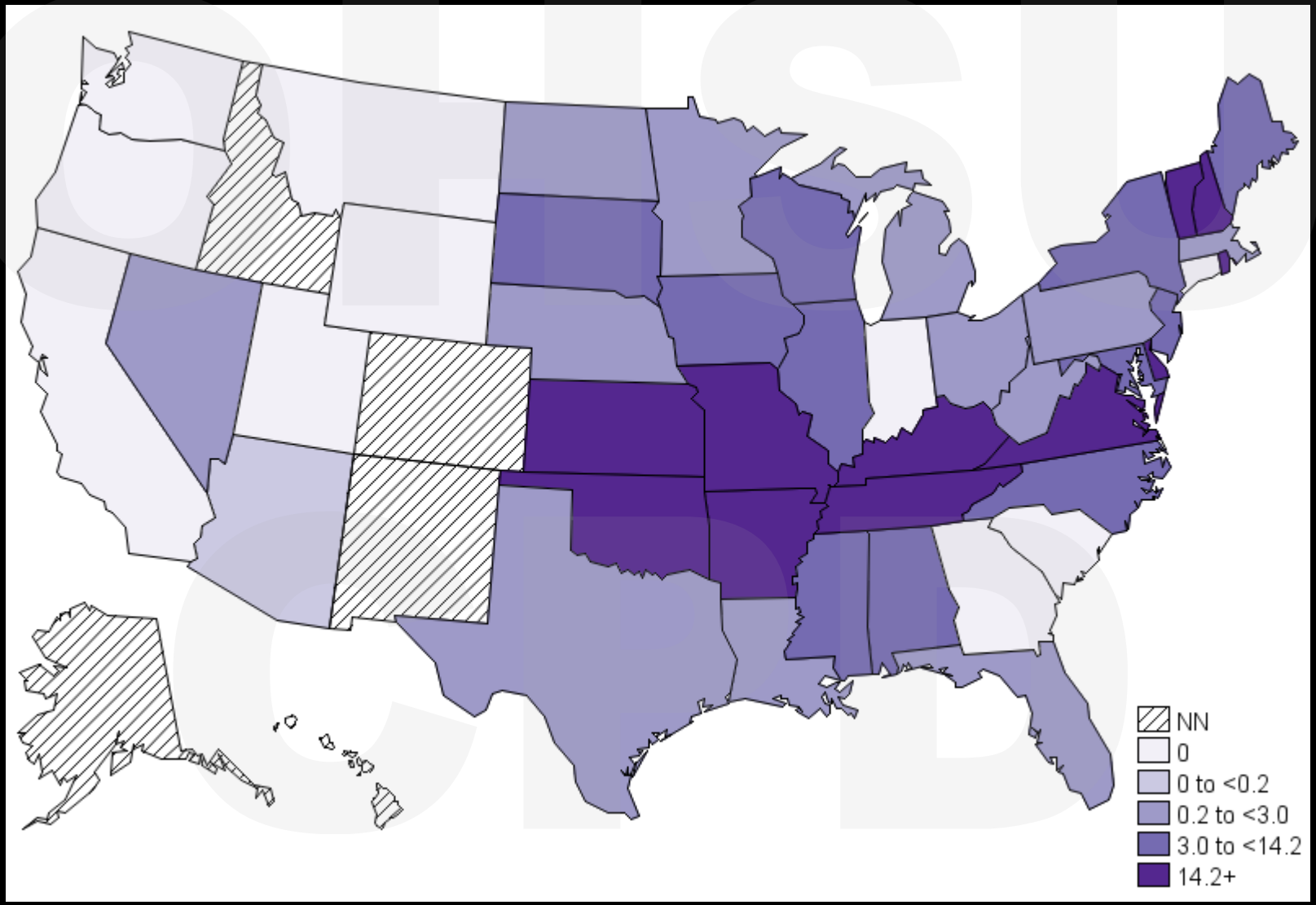



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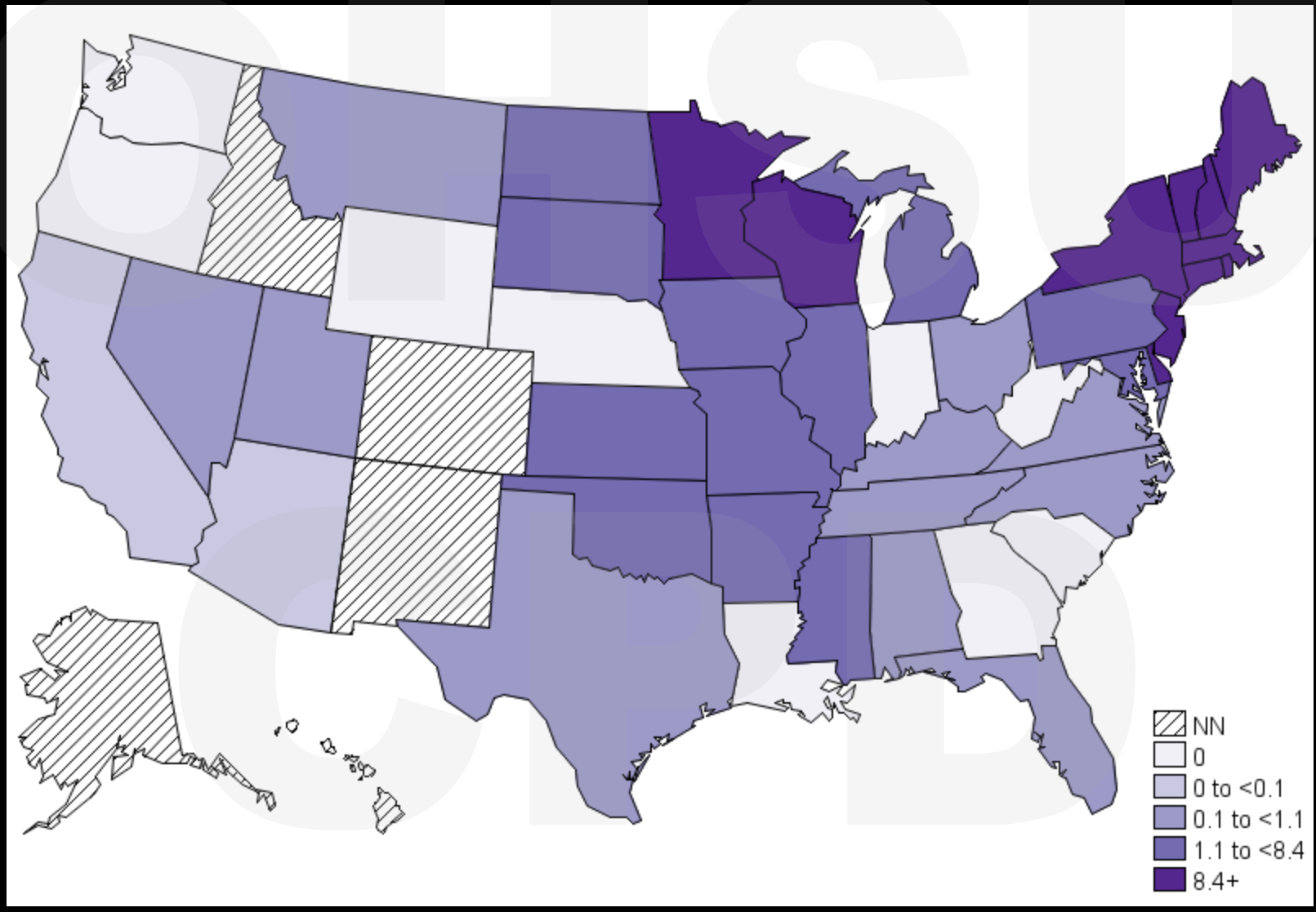



Ixodes scapularis distribution
Ixodes pacificus distribution
Amblyomma americanum distribution
Overlapping distribution (*I. scapularis* & *A. americanum*)

Ehrlichiosis



Anaplasmosis



Ehrlichiosis/Anaplasmosis

- Hematologic picture
  - Leucopenia (1300-4000/ul)
  - Mild thrombocytopenia
  - 2-5 um morula seen in leukocytes
- Doxycycline 100mg bid x 10-14 days

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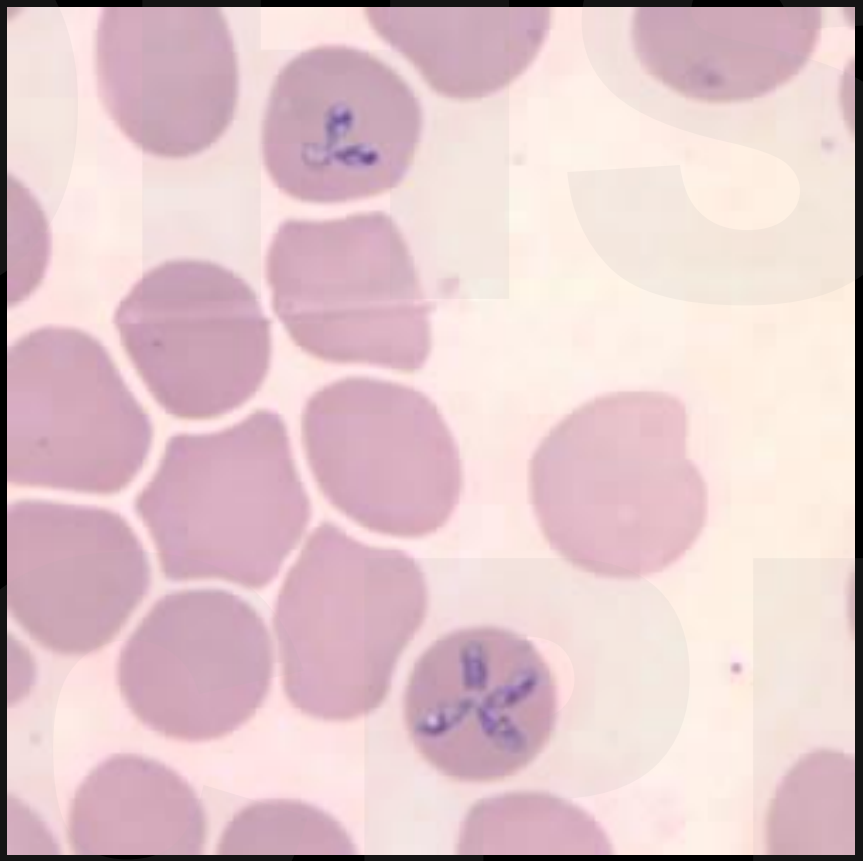


Babesiosis

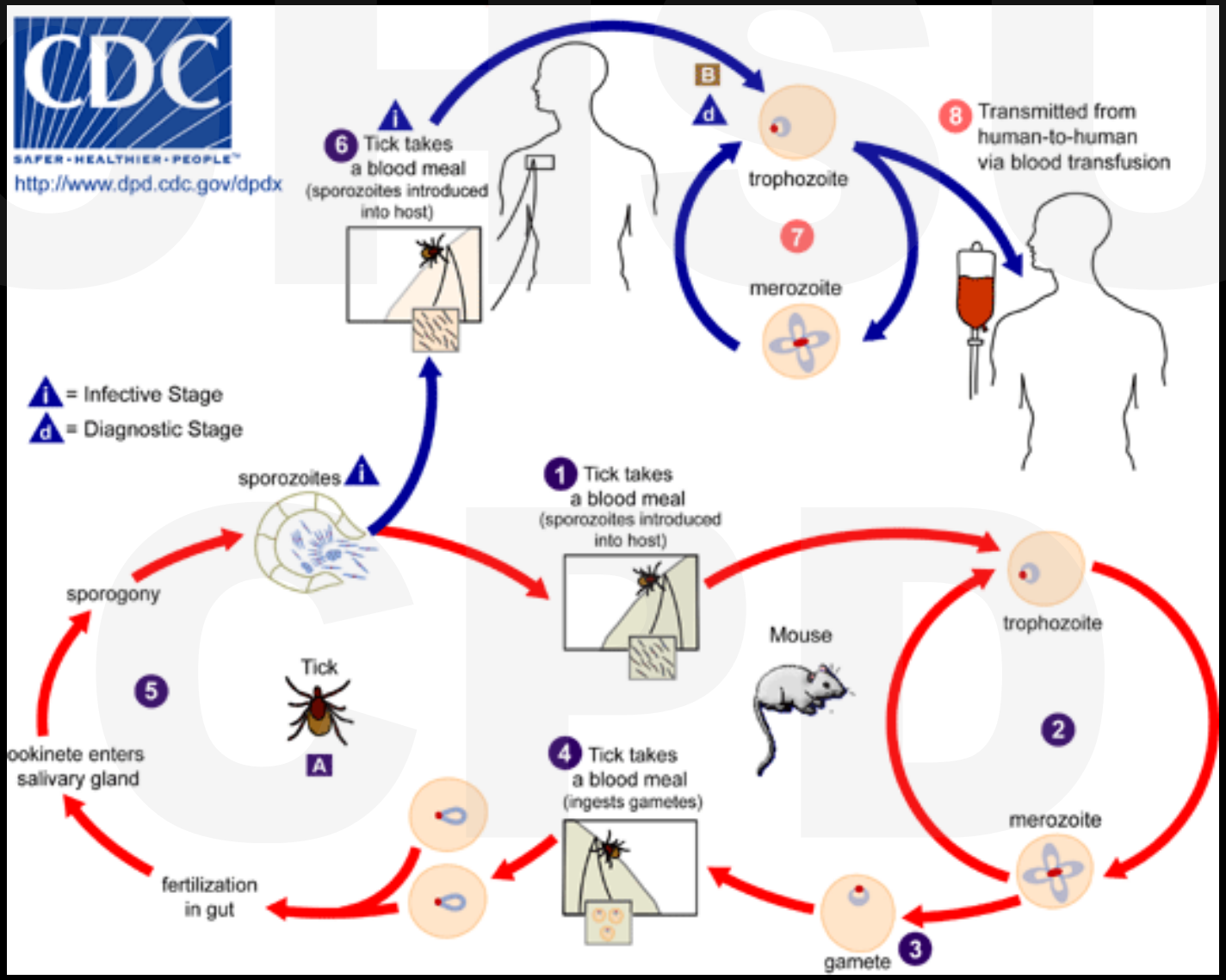
- Protozoan parasite
- 8 specific infect humans – *microti* most common
- Mice main hosts
  - 2/3 infected
- 9-20% of ticks infected

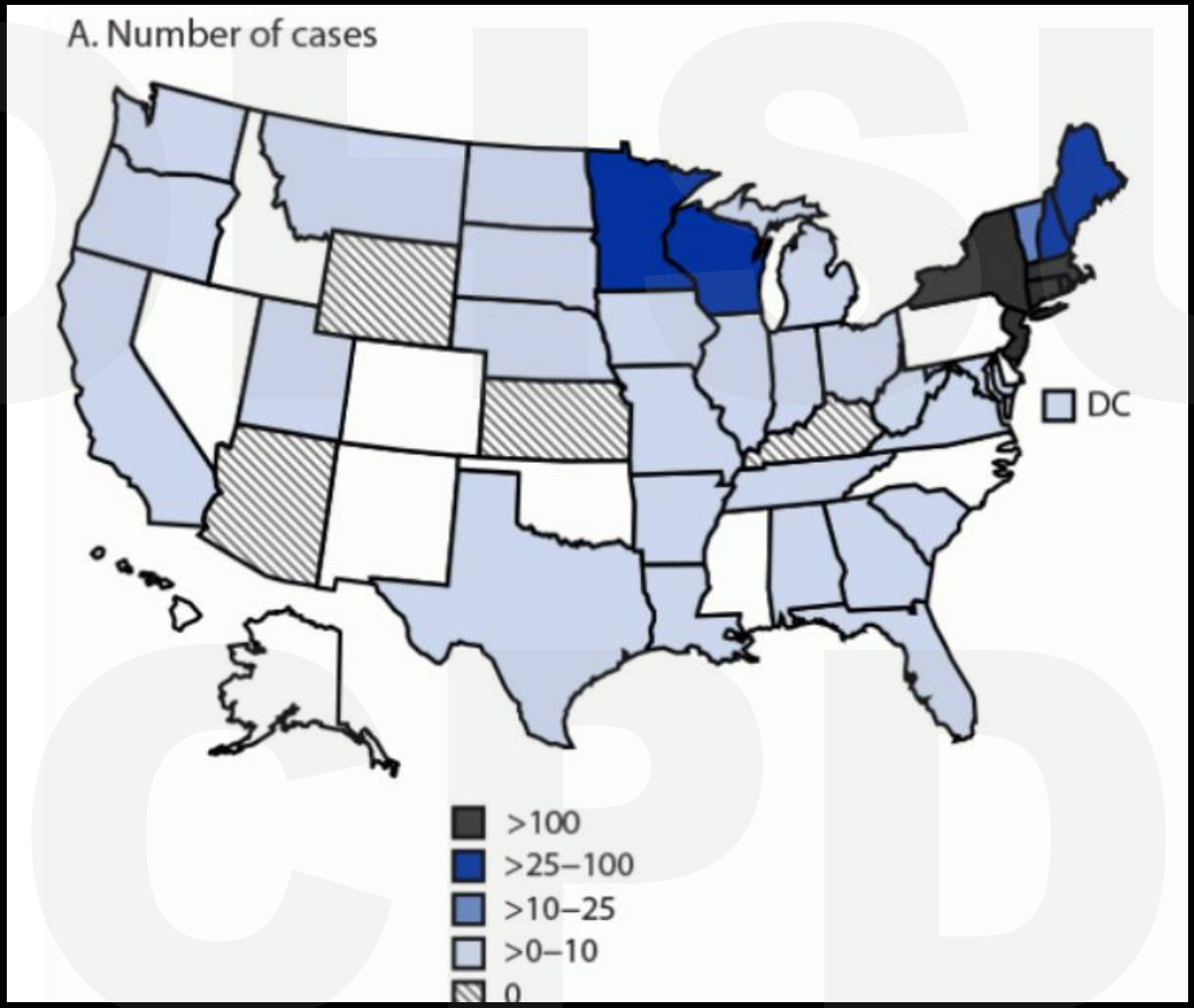
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Babesiosis Smear



Babesiosis


CDC
SAFER·HEALTHIER·PEOPLE™
http://www.dpd.cdc.gov/dpdx
i = Infective Stage
d = Diagnostic Stage
6 Tick takes a blood meal (sporozoites introduced into host)
B
d
trophozoite
8 Transmitted from human-to-human via blood transfusion
7
merozoite
sporozoites i
1 Tick takes a blood meal (sporozoites introduced into host)
sporogony
Tick
Mouse
trophozoite
5
A
2
ookinete enters salivary gland
4 Tick takes a blood meal (ingests gametes)
merozoite
fertilization in gut
gamete
3


A. Number of cases
DC
>100
>25–100
>10–25
>0–10
0

Babesiosis

- Asymptomatic to severe infection
  - Asymptomatic infection common
  - Severe in immunosuppressed and splenectomy
- Fever, myalgias, sweats, fatigue, jaundice
  - Severe cases: Hemolytic anemia, thrombocytopenia, elevated liver enzymes, splenic rupture

Risk Factors

- Asplenic
- Immunomodulation agents
  - Anti-TNF agents
- Organ transplant
- Advanced age

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Diagnosis

- Thick and thin blood smears
- Antibody detection: detects even low levels of parasitic invasion
  - Antibodies
- PCR
  - Can help identify new species

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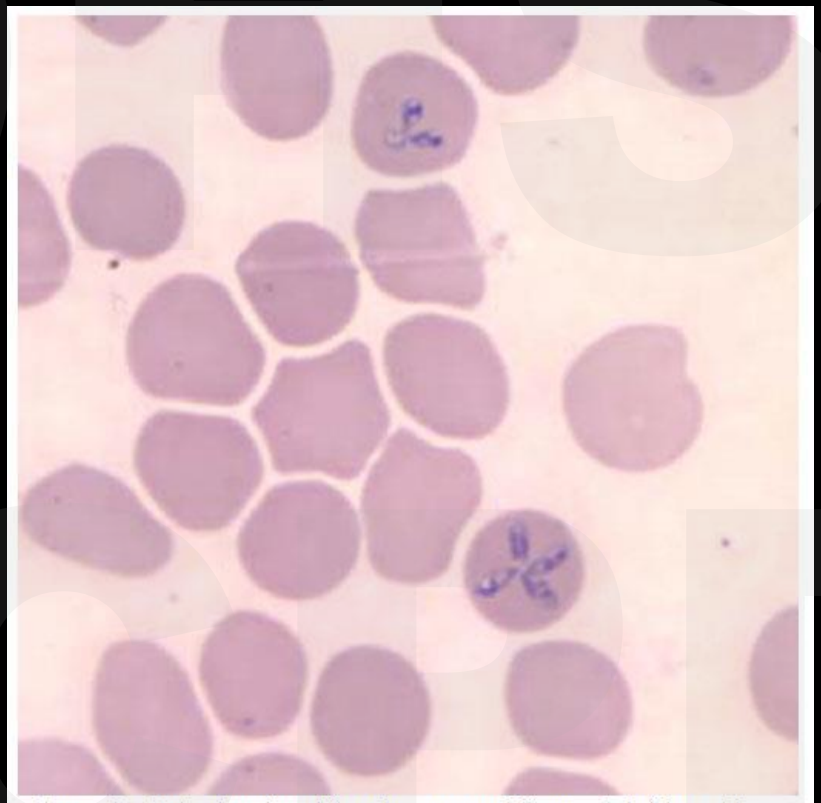


Figure 7 – *Babesia microti* forming a tetrad (lower right) in a thin blood smear (From www.cdc.gov).

Treatment

- Mild to moderate:
  - Atovaquone + Azithromycin 7- 10 days
  - Clindamycin + quinine
- Severe (> 4% Parasitemia)
  - Azithromycin (IV) + Atovaquone
  - Consider exchange transfusion

Babesioses: AIHA

- Seen in asplenic patients
- 2-6 weeks after infection
- Responds to immunosupression

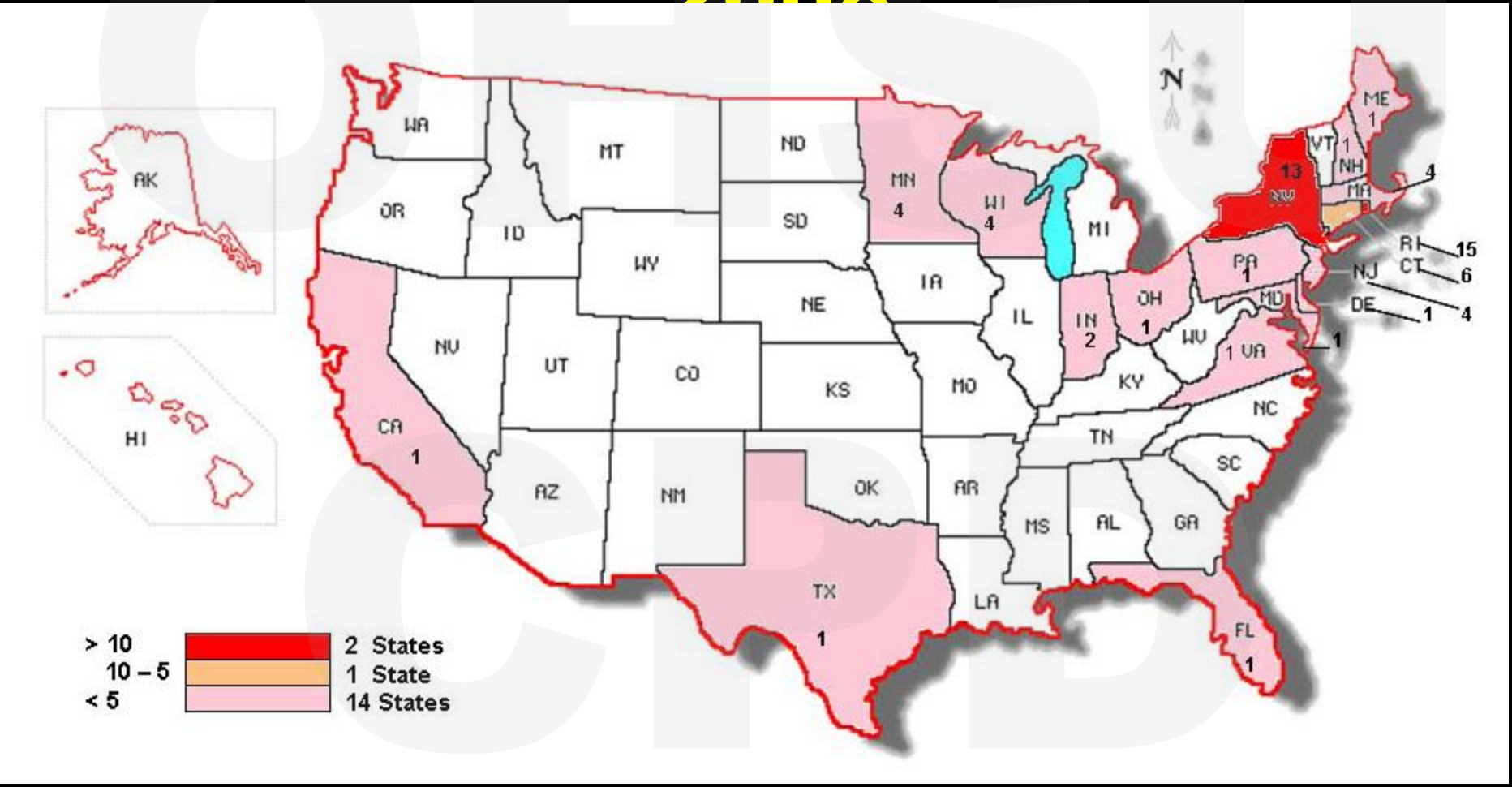
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Babesiosis: Transfusion-Transmitted

- Being in red cells can be transmitted via transfusions
- Over 100 cases of TTB documented since 1980
  - 11 deaths
- NO screening – donor defer

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TTB Distribution 2004–2008

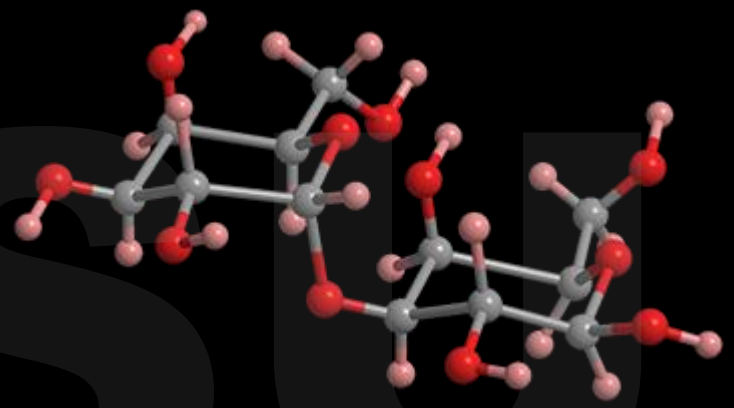


STARI

- Southern Tick–Associated Rash Illness
- Cause is unknown
- Rash appearance similar to Lyme disease
- Has not been linked to arthritic, neurologic, or chronic symptoms
- May respond to doxycycline



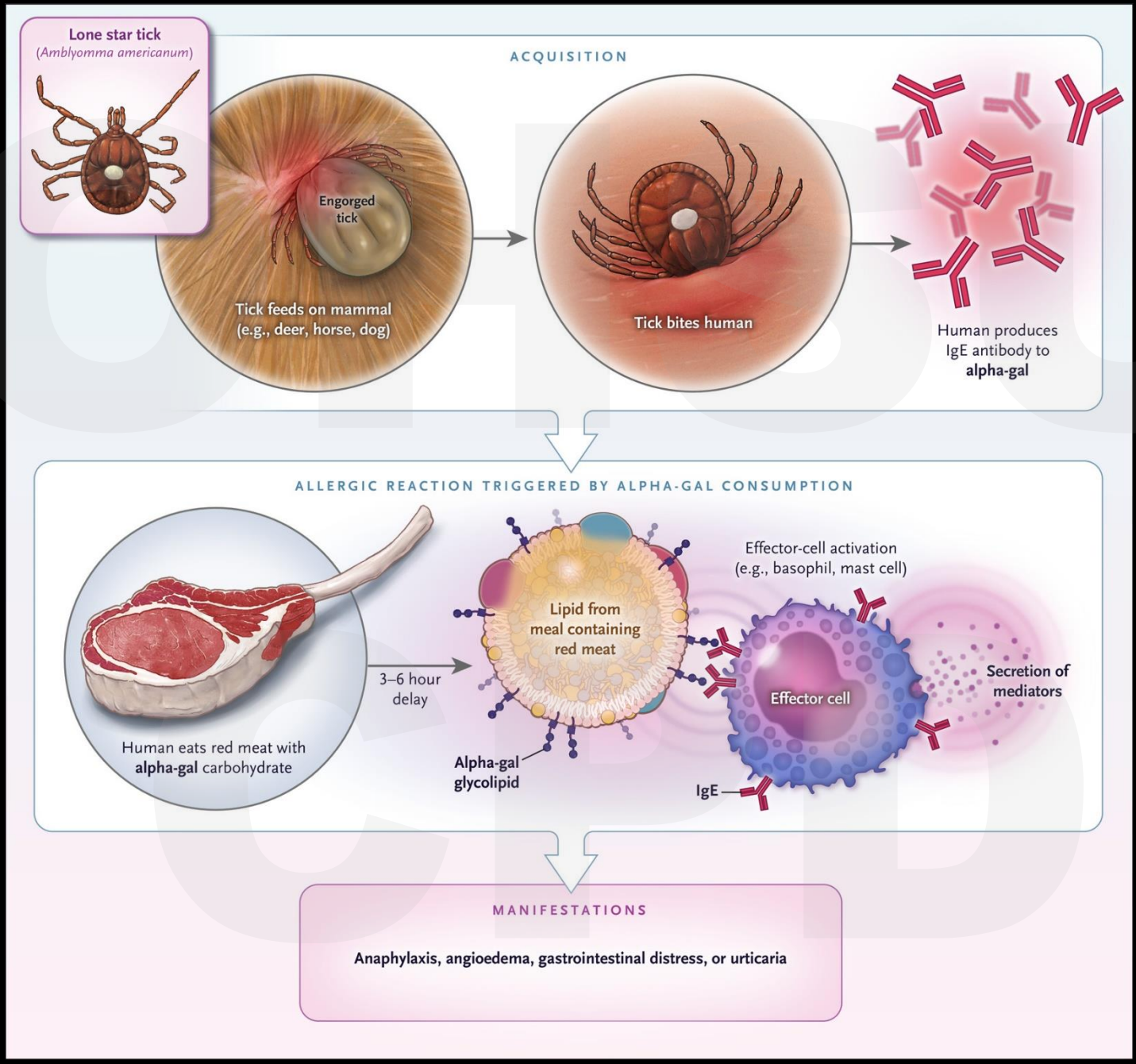
Meat Allergy

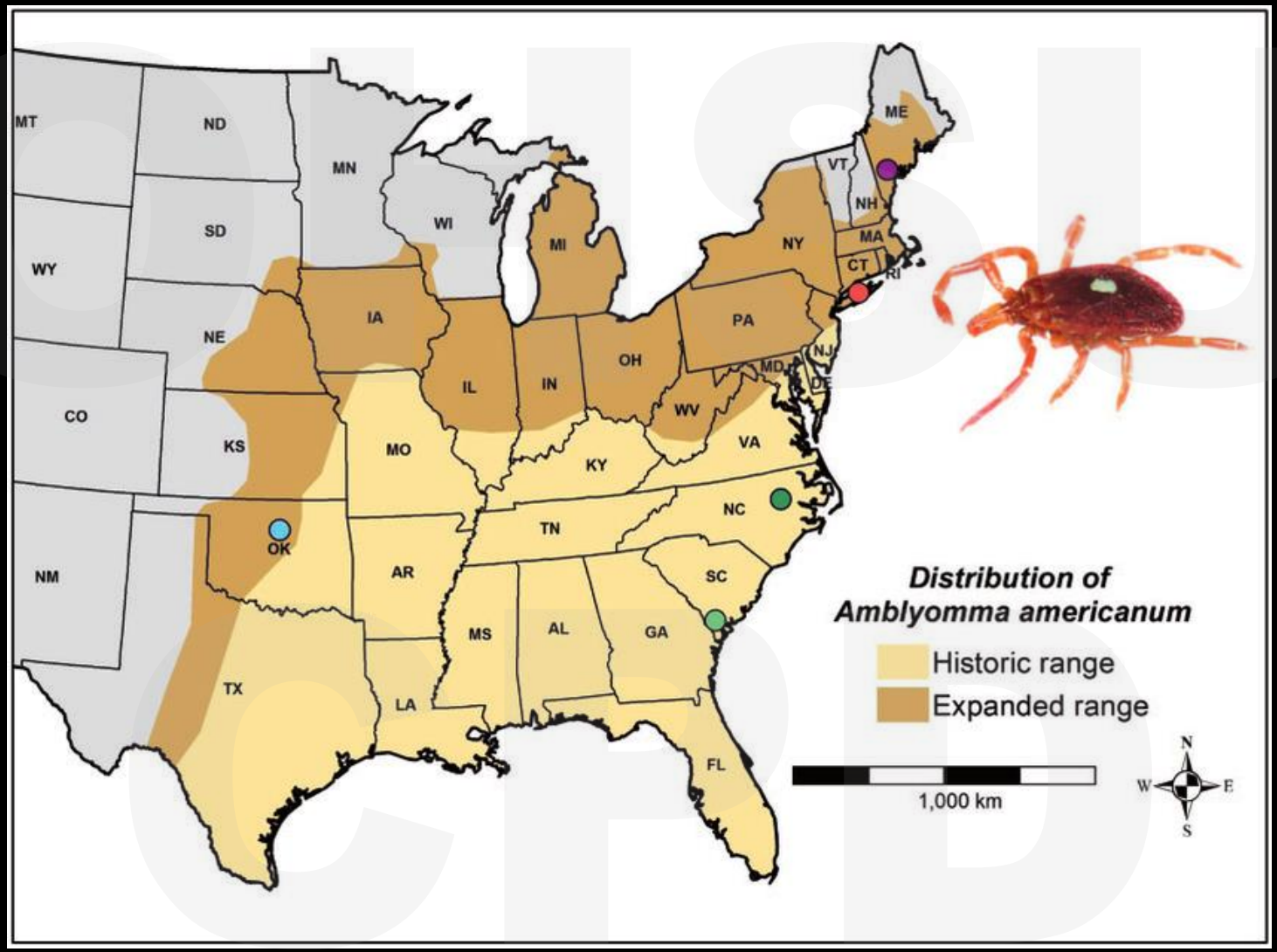


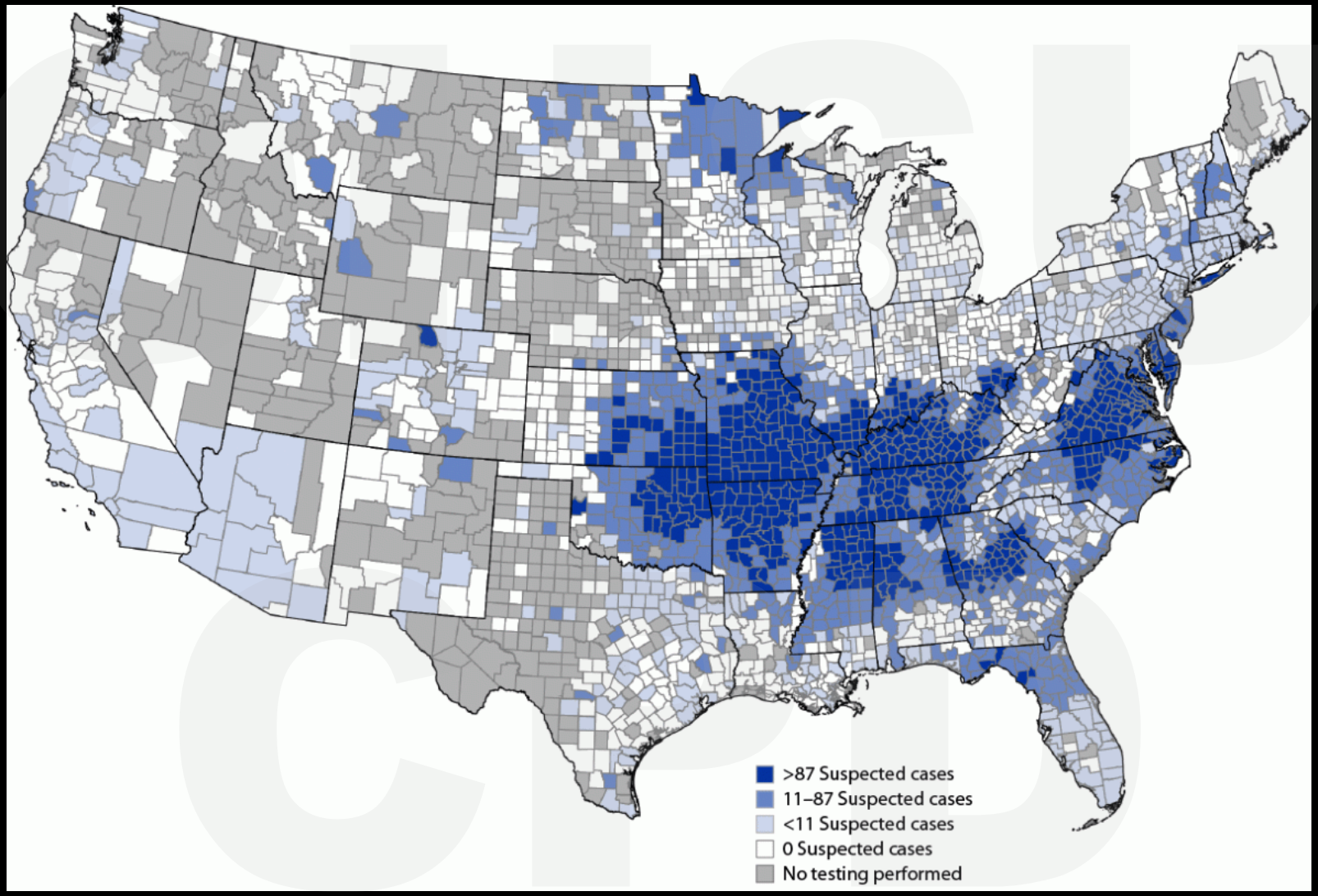
- Rising in incidence
  - Increase recognition
  - Increased ticks
- Allergy to galactose-alpha-1,3-galactose (alpha-gal)
- Alpha-gal not found in primates

Meat Allergy

- Seen after tick bites
  - Lone star tick main culprit
  - Alpha gal in saliva
- Urticaria/pruritus after meat ingestion
  - Can be delayed 3-6 hours
  - Anaphylaxis rare


Lone star tick
(Amblyomma americanum)
ACQUISITION
Engorged tick
Tick feeds on mammal (e.g., deer, horse, dog)
Tick bites human
Human produces IgE antibody to alpha-gal
ALLERGIC REACTION TRIGGERED BY ALPHA-GAL CONSUMPTION
Human eats red meat with alpha-gal carbohydrate
3–6 hour delay
Lipid from meal containing red meat
Alpha-gal glycolipid
Effector-cell activation (e.g., basophil, mast cell)
Effector cell
IgE
Secretion of mediators
MANIFESTATIONS
Anaphylaxis, angioedema, gastrointestinal distress, or urticaria


MT
ND
MN
WI
MI
SD
WY
NE
IA
IL
IN
OH
NY
PA
ME
VT
NH
MA
CT
RI
NJ
MD
DE
WV
VA
CO
KS
MO
KY
NC
TN
OK
NM
AR
SC
MS
AL
GA
TX
LA
FL
Distribution of
Amblyomma americanum
Historic range
Expanded range
1,000 km
N
W
E
S


>87 Suspected cases
11–87 Suspected cases
<11 Suspected cases
0 Suspected cases
No testing performed

Clinical

- Beef, pork, lamb most common reactions
- Sometimes gelatin and milk
- Can be only GI symptoms without urticaria
- Reactions to cetuximab, heparin and animal heart valves
- Transfusion reactions

Diagnosis and Treatment

- GI symptoms wake up patient at night
- Urtica, rashes hours after eating
- Ige to Alpha-Gal
- Avoid meat
  - Symptoms can resolve with time

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Dispatch

Alpha-Gal Syndrome after *Ixodes scapularis* Tick Bite and Statewide Surveillance, Maine, USA, 2014–2023

EMERGING INFECTIOUS DISEASES®

Volume 31, Number 4—April 2025

Dispatch

Onset of Alpha-Gal Syndrome after Tick Bite, Washington, USA



Diagnosis

- Many patients (40-60%) do not recall tick bite
- High clinical suspicion!
- Empiric therapy while waiting for tests

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Tests

- Lyme – two stage testing (exam)
- RMSF – titers (PCR less sensitive)
- Anaplasma/Ehrlichia – PCR
- Babesiosis – smear/PCR

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Clinical Clues

- "Tick Triad"
  - Leukopenia*
  - Thrombopenia
  - High LFT's
- Abrupt onset of fevers/headaches

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Tick Dx NOS

- Suspect
  - Recent tick exposure
  - Leukopenia and thrombocytopenia
  - Rash
  - Myalgia
  - Contact CDC

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Ticks can be Anywhere!

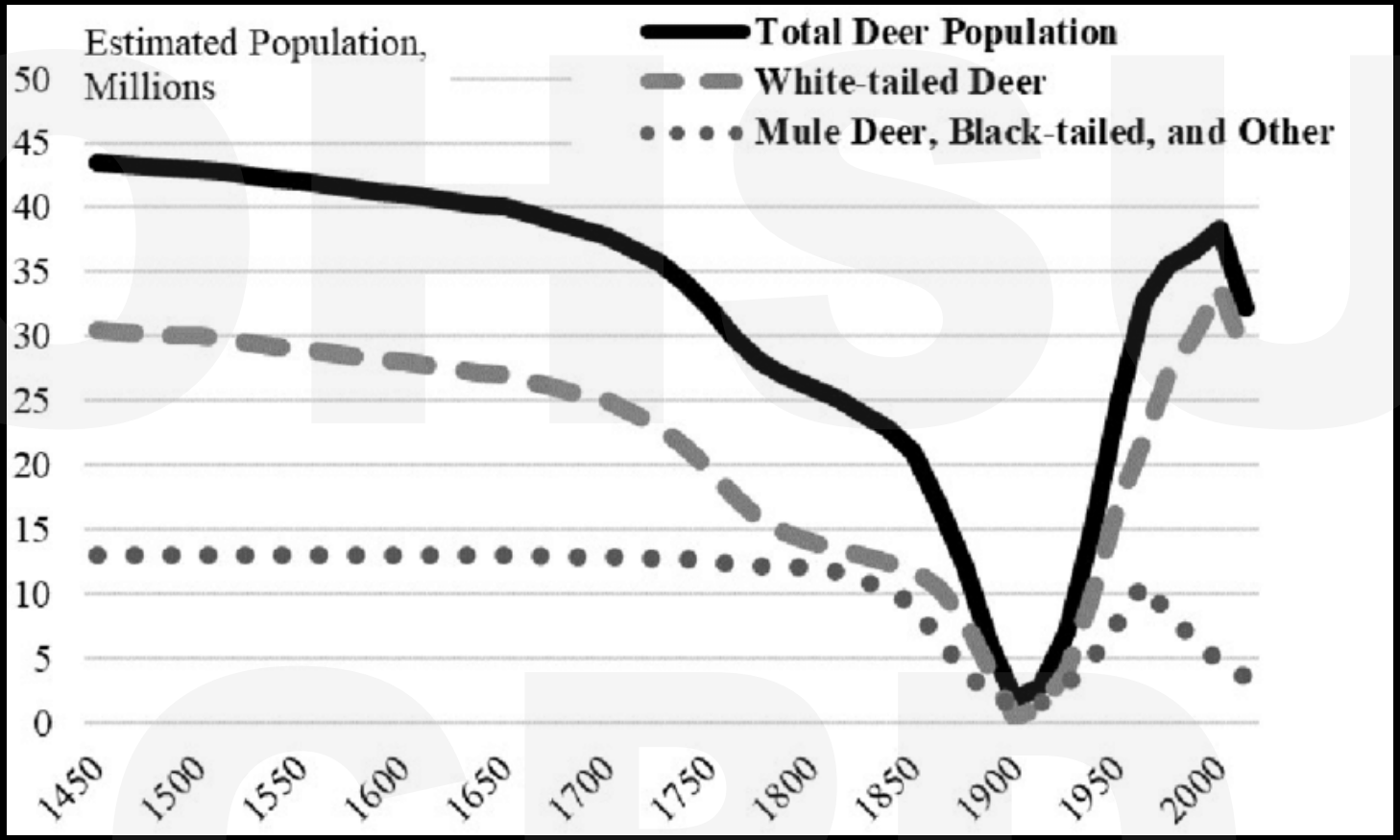
- Ranges of ticks are expanding
- People traveling
- Dogs importing ticks

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Expanding Range

- Increase in deer population
- Ticks introduced to new habitats
- Warmer climates

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Issues in Information Systems
Volume 19, Issue 2, pp. 163-173, 2018

Travel

Babesia species by PCR	Not Detected	
Babesia microti by PCR	Not Detected INTERPRETIVE INFORMATION: A negative result does no inhibitors in the patient in concentrations below t This test was developed a determined by ARUP Labora approved by the US Food a performed in a CLIA certi clinical purposes.	
Anaplasma phagocytophilum by PCR	Not Detected	
Ehrlichia chaffeensis by PCR	Detected	*
Ehrlichia ewingii/canis by PCR	Not Detected	
Ehrlichia muris-like by PCR	Not Detected	

Texas

- 20 years of tick ID founds ticks from 11 countries and 37 states

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Table 1. Number of Records and Ticks Submitted Through the Alaska Submit-A-Tick Program — Alaska, 2010–2022

Species	# of Records	# of Ticks
Native tick species		
Haemaphysalis leporispalustris	40	499
Ixodes angustus	638	903
Ixodes auritulus	9	9
Ixodes signatus	22	75
Ixodes uriae	80	381
Non-native tick species		
Amblyomma americanum	26	42
Amblyomma sabanerae	1	1
Dermacentor andersoni	9	9
Dermacentor variabilis	73	81
Ixodes gregsoni	3	4
Ixodes pacificus	4	4
Ixodes ricinus	4	4
Ixodes scapularis	15	19
Ixodes texanus	2	6
Rhipicephalus sanguineus[a]	54	97
Species only identified to genus		
Haemaphysalis spp.	2	45
Ixodes spp.	6	28
TOTAL*	988	2207

**Two records (representing 1 tick each) were identified as Rhipicephalus sanguineus tropical lineage.*

Micah Hahn, PhD, MPH



Prevention: BLAST

- **B**ath or shower after exposure
- **L**ook for tick or rashes
- **A**pply repellent
- **S**pray edge of yards
- **T**reat pets

- Ridgefield Health Department

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Bathe or Shower soon after coming indoors

- Soon after coming in doors
- Exam for and wash off critters
- Good for poison ivy also
- Clothes in hot dryer

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Look for Ticks and Rashes

- Tick bites are usually painless so need to look
- Do a tick check every night!
- Check all over due to small size

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Repellents

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DEET

- Great for all bugs
  - Need higher concentration for ticks
  - Little advantage of > 50%
  - Apply after sunscreen
  - Safe for all populations > 2 years

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Picaridin

- Used world-wide
- Equal to DEET
  - 5-20% concentrations
- Feels better on skin
  - Odorless and not greasy
- Used in all ages

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IR3535

- Better protection with higher concentrations
- Repel ticks for 9-12 hours
- Can damage clothing

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Oil of Lemon Eucalyptus

- Need PMD not essential oil
- Combination of this and picaridin may be better for ticks

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Permethrin Clothing

- Neurotoxin
  - Kills ticks in 2.5 hours
- Binds to fabric in clothing
  - Reapply after 5 washings
- Can buy factory impregnated clothes
- Very long lasting

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Key with Repellents

- Apply freely
- Consider reapply if wet/sweaty
- Avoid combination sunscreen/repellent products

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Spray the Edges of Your Yard

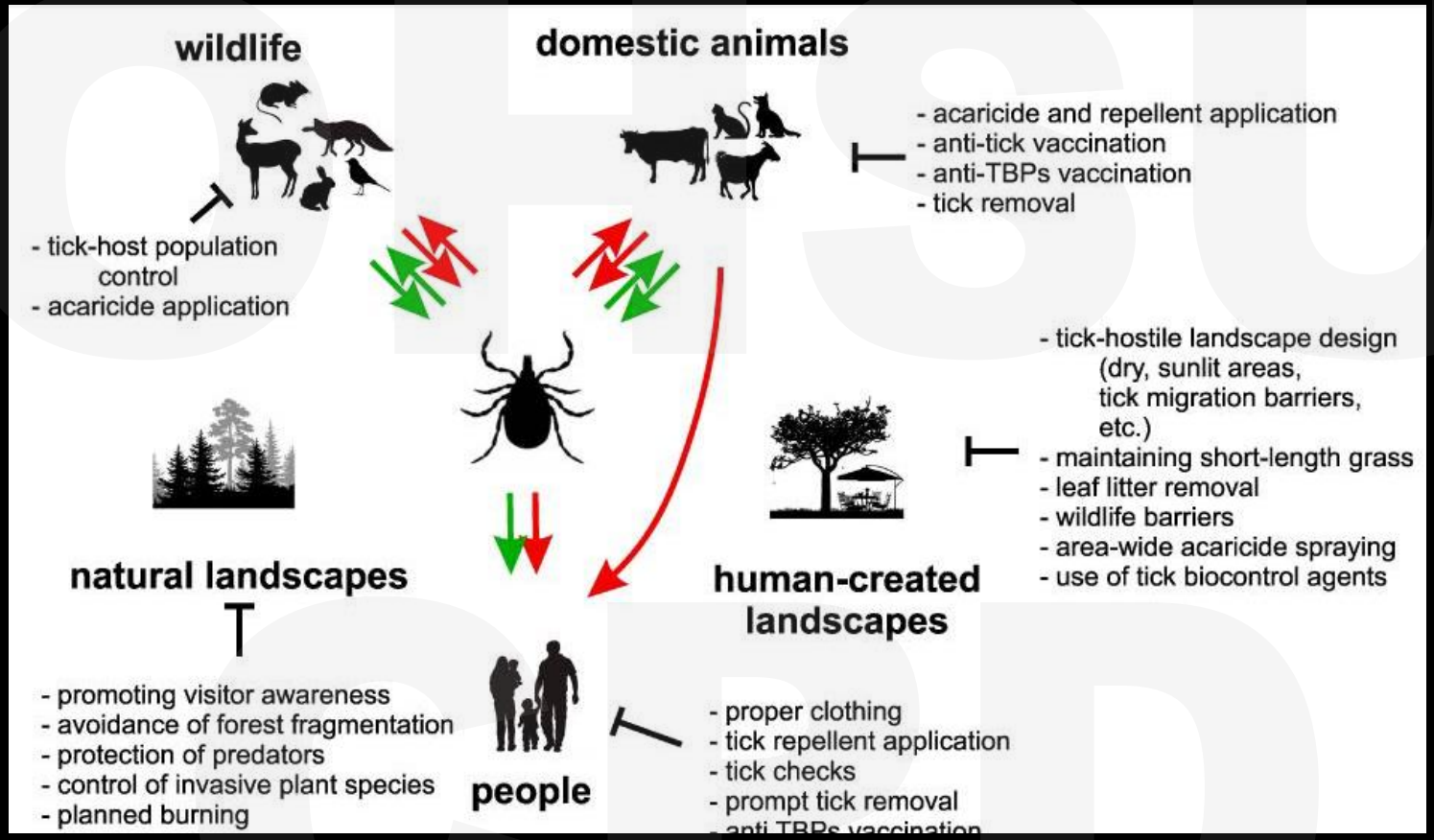
- In tick infested areas a good perimeter spray can reduce ticks for a year

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Treat Your Pets

- Check your pets for ticks after coming indoors
- Use long-acting tick collars
  - Very effective and long lasting

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wildlife
- tick-host population control
- acaricide application
domestic animals
- acaricide and repellent application
- anti-tick vaccination
- anti-TBPs vaccination
- tick removal
natural landscapes
- promoting visitor awareness
- avoidance of forest fragmentation
- protection of predators
- control of invasive plant species
- planned burning
human-created landscapes
- tick-hostile landscape design (dry, sunlit areas, tick migration barriers, etc.)
- maintaining short-length grass
- leaf litter removal
- wildlife barriers
- area-wide acaricide spraying
- use of tick biocontrol agents
people
- proper clothing
- tick repellent application
- tick checks
- prompt tick removal

Bottom Line: Prevention

- 30 to 50% DEET on exposed skin
- Permethrin on clothing
- Examine self after in woods
  - Ticks need to be attached for while to infected
    - Lyme – 36 hours

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Outline of Talk

- Basic Tickology
- Types of ticks
- Tick borne diseases
- Prevention of tick diseases

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