

Zoonoses, Vector-borne Diseases, and One Health

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Disclosure statement

Dr. Marzec has no financial relationships with commercial interests to disclose.

Any unlabeled or unapproved uses of drugs or products referenced will be disclosed.

Learning objectives

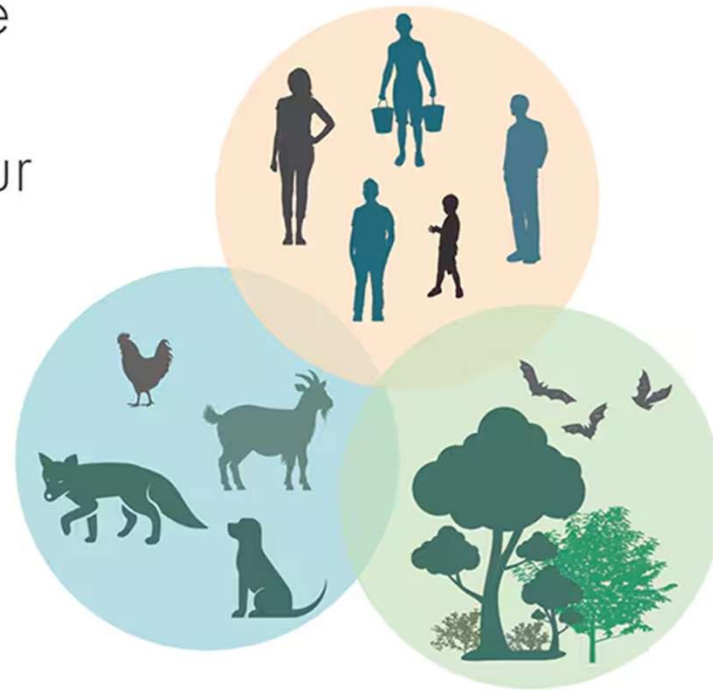
After this presentation attendee should be able to:

1. Describe the symptoms of some zoonotic diseases in humans.
2. Discuss how to test and treat these diseases, including where to find the latest guidance.
3. Identify public health infrastructure and methods by which diseases are reported.

Terminology

One Health is the idea that the health of people is connected to the health of animals and our shared environment.

When we protect **one**,
we help protect **all**.



www.cdc.gov/onehealth



CS110004

<https://www.cdc.gov/one-health/media/images/images/social-media/what-is-one-health-fb.jpg>
(accessed 5/24/2024)

Why **ONE HEALTH** is Important

As Earth's population grows, our connection with animals and the environment changes:



People live closer together



Changes in climate and land use



More global travel and trade



Animals are more than just food

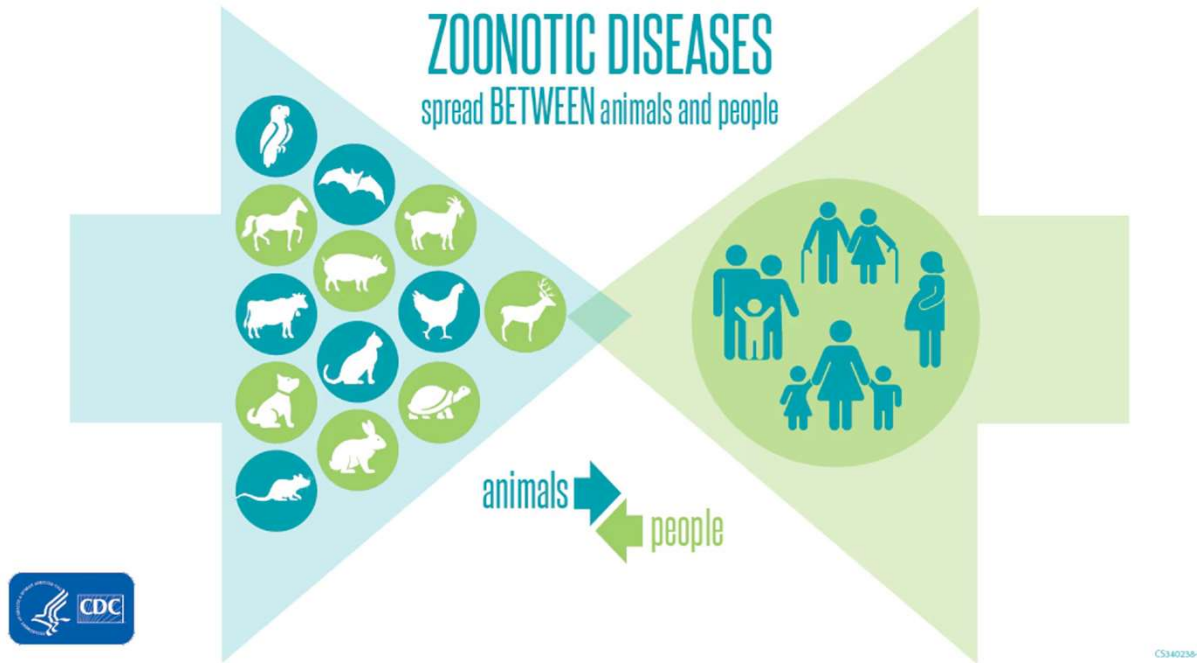
These factors make it easier for diseases to spread between animals and people.

A One Health approach tackles shared health threats by looking at all angles—human, animal, plant, and environmental

www.cdc.gov/onehealth



<https://www.cdc.gov/one-health/media/images/social-media/why-one-health-is-important-twitter.jpg> (accessed 5/24/2024)



>60% of human infectious diseases can be spread from animals.

75% of new or emerging human infectious diseases come from animal

<https://www.cdc.gov/one-health/media/images/social-media/zoonotic-diseases-spread-between-animals-and-people-twitter.jpg> (accessed 5/24/2024)

Zoonoses

- Disease or infection that is naturally transmissible from vertebrate animals to humans.
- May be bacterial, viral, or parasitic, or unconventional agents (such as prions).
- Spread to humans through direct contact, or through food, water, or environmental exposure.

<https://www.who.int/news-room/fact-sheets/detail/zoonoses#:~:text=A%20zoonosis%20is%20an%20infectious,food%2C%20water%20or%20the%20environment>. (accessed 5/17/2024)

Vector-borne diseases

- Living organisms that can transmit infectious pathogens between humans, or from animals to humans.
- Bloodsucking insects ingest disease-producing microorganisms from an infected host and then transmit it to a new host.
- Vector examples:
 - Mosquitoes.
 - Aquatic snails.
 - Blackflies.
 - Fleas.
 - Lice.
 - Sandflies.
 - Ticks.
 - Triatomine bugs.
 - Tsetse flies.

What is public health?

“Public health promotes and protects the health of all people and their communities.

This science-based, evidence-backed field strives to give everyone a safe place to live, learn, work and play.”

(From the American Public Health Association)

<https://www.apha.org/What-is-public-health> (accessed 5/17/2024)

Public health

Primary focus on **populations**

Emphasis on **disease prevention and health promotion for entire communities**

Predominant emphasis on **promoting healthy behaviors and environments**

Specializations organized, for example, by **analytical method** (epidemiology, toxicology); **setting and population** (occupational health, global health); **substantive health problem** (environmental health, nutrition)

Biological sciences central, with a prime focus on **major threats to the health of populations**, such as epidemics and noncommunicable diseases; research moves between **laboratory and field**

Social and public policy disciplines an integral part of public health education

Medicine

Primary focus on **individuals**

Emphasis on **disease diagnosis, treatment, and care of the individual patient**

Predominant emphasis on **medical care**

Specializations organized, for example, by **organ system** (cardiology, neurology); **patient group** (obstetrics, pediatrics); **etiology and pathophysiology** (infectious disease, oncology); **technical skill** (radiology, surgery)

Biological sciences central, stimulated by **needs of patients**; research moves between **laboratory and bedside**

Social sciences generally an elective part of medical education

<https://www.hsph.harvard.edu/communications-guide/what-is-public-health/> (accessed 5/17/2024)

Case surveillance

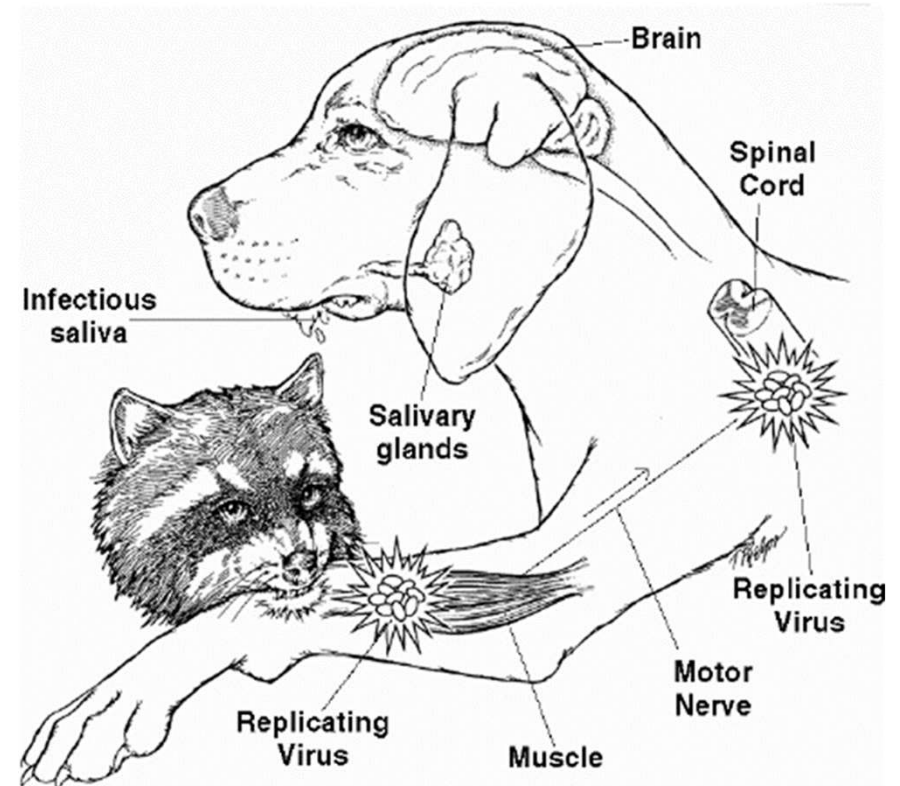
- Reportable diseases:
 - Determined by state, territorial, and local public health departments.
 - Reporters include healthcare providers, laboratories, hospitals, and others.
 - Patient level data are used to monitor disease activity, control spread, and prevent infections in a community.
- Notifiable diseases:
 - Set by the Council of State and Territorial Epidemiologists (CSTE) and the Centers for Disease Control and Prevention (CDC).
 - Voluntary reporting of non-personally identifiable case information by states.

Disease examples

Rabies

How is rabies spread?

- Infectious saliva gets past skin:
 - Bite.
 - Mucous membranes.
- Bats and skunks are *reservoirs* in Colorado, but any mammal can be infected.
- Rabies vaccination prevents death.

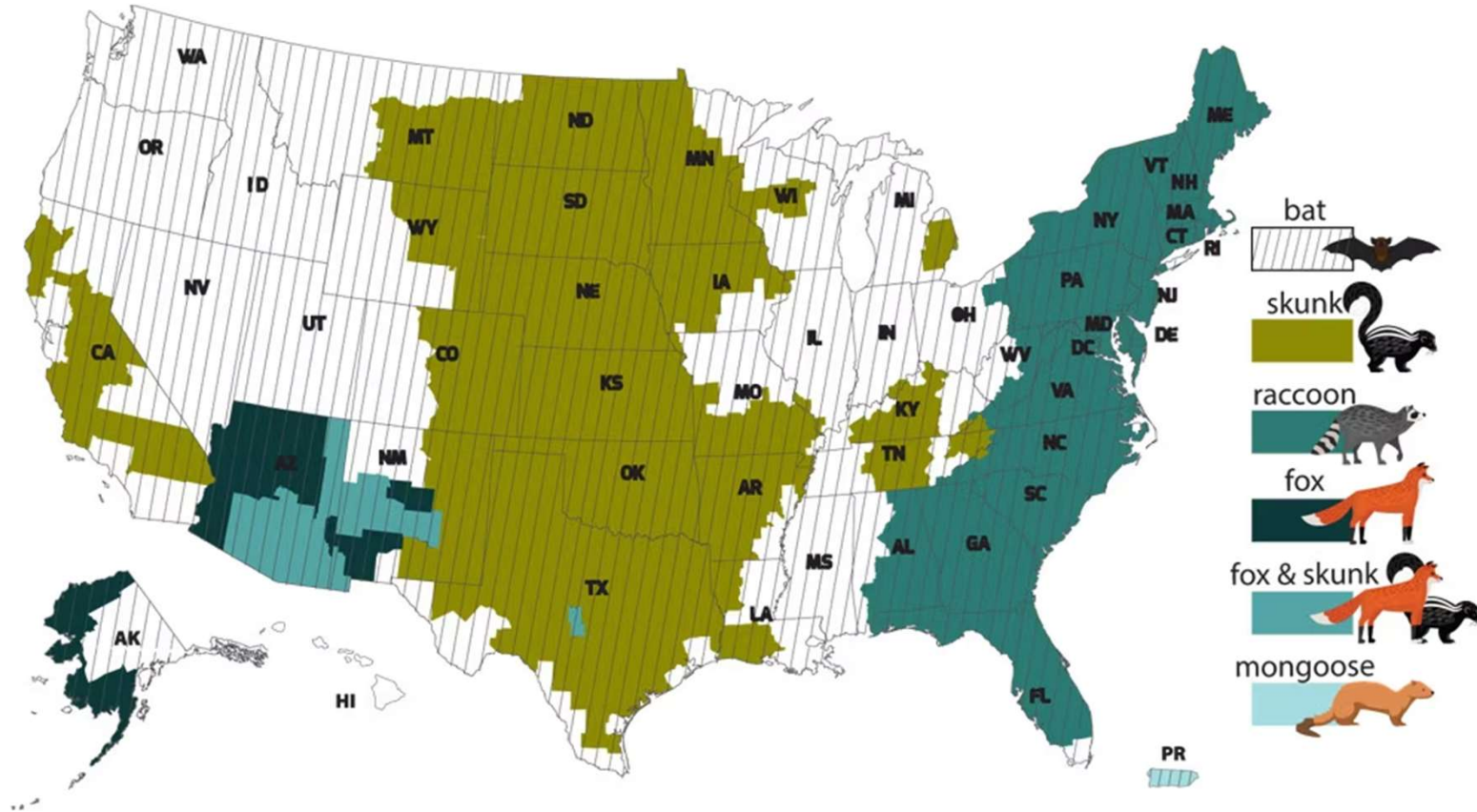


<https://www.worcesterhealth.org/images/stories/bite2.gif> (accessed April 6, 2023)

Variants, reservoirs, cases

- *Variant*: a strain of rabies virus adapted to a specific mammalian species.
- *Reservoir*: a mammalian species that has a rabies variant associated with it.
 - Virus variant is maintained in a population of the reservoir species.
- *Case*: any mammal infected with rabies virus.
 - Not necessarily a reservoir species.
- Colorado rabies reservoir species:
 - Skunks (South central skunk variant)
 - Bats (Multiple bat species variants)

Rabies virus variants in the United States



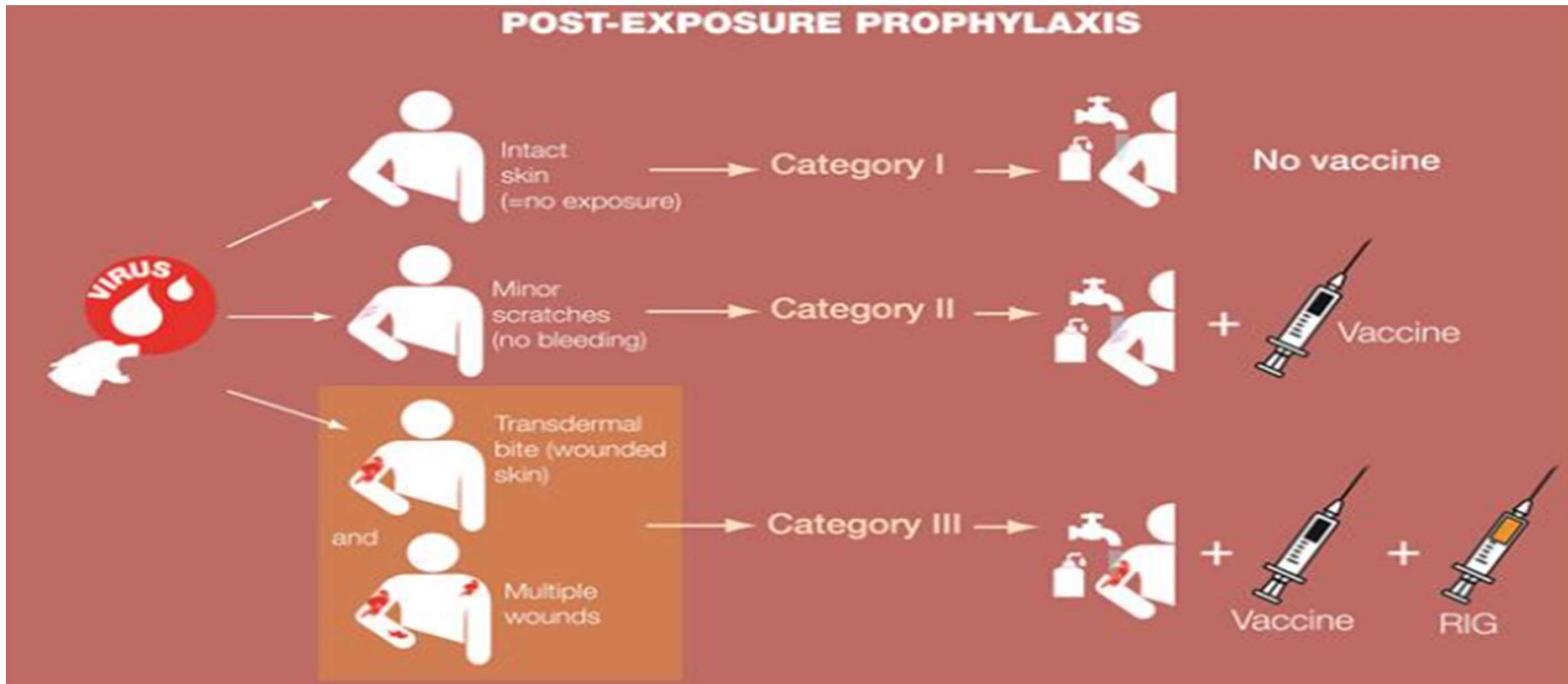
<https://www.cdc.gov/vitalsigns/rabies/index.html> (accessed 5/24/2024)

Rabies worldwide

- Up to 99% of human rabies cases are due to domestic dog bites.
- Human rabies cases are under-reported.
- 95% of human rabies deaths occur in Asian and African countries.
 - About 40% of these are children under 15 years old.
- Post-exposure prophylaxis series vary by country and risk of transmission.

<https://www.who.int/news-room/fact-sheets/detail/rabies> (accessed 5/17/2024)

WHO bite classification



<https://www.who.int/teams/control-of-neglected-tropical-diseases/rabies/vaccinations-and-immunization>
(accessed 5/17/2024)

Hantavirus

Two main categories of hantaviruses

New World hantaviruses

- Hantavirus pulmonary syndrome.
- North and South America.

Old World hantaviruses

- Hemorrhagic fever with renal syndrome.
- Europe and Asia.

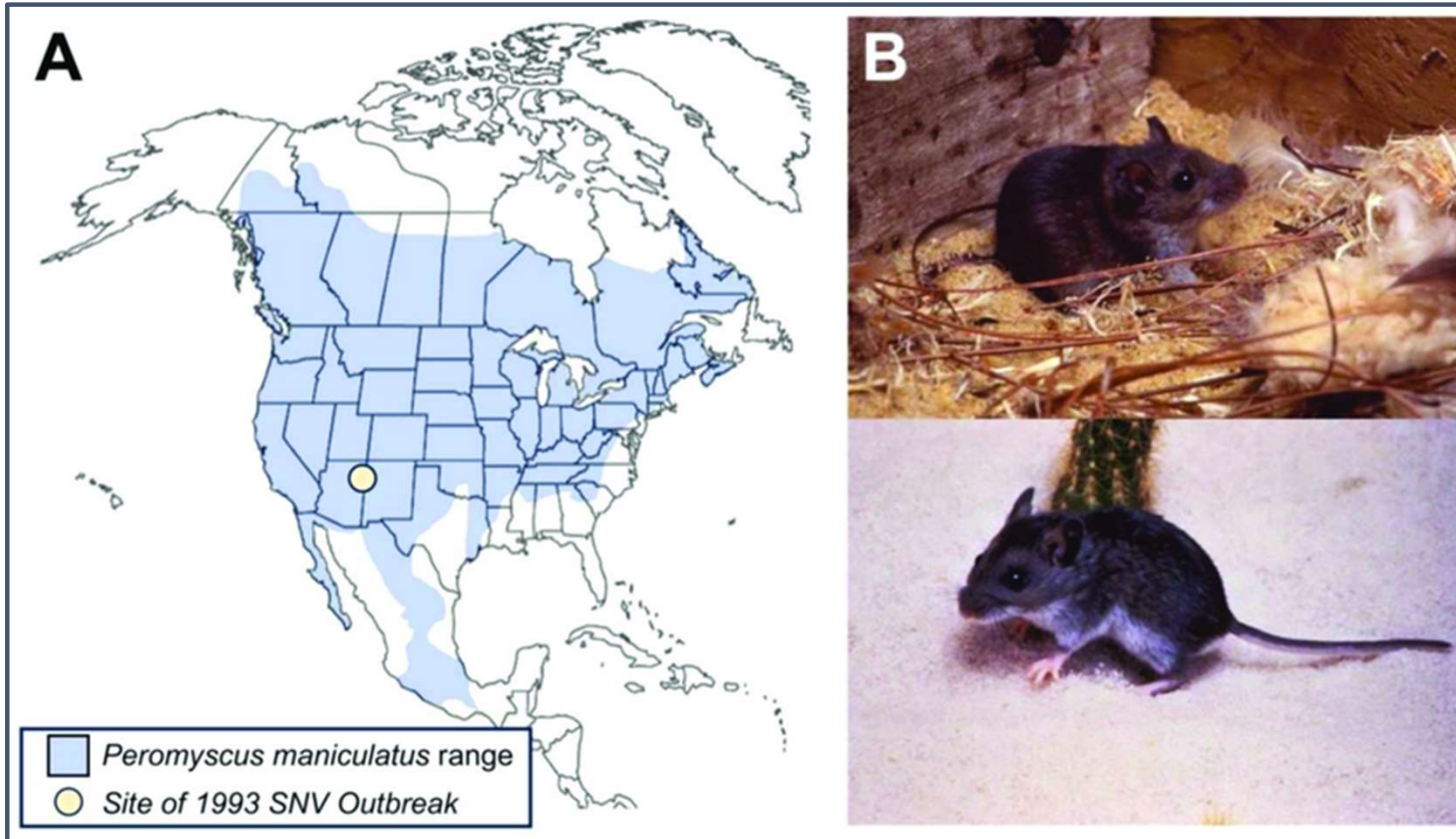
<https://www.cdc.gov/hantavirus/index.html> (accessed May 2, 2023)

Hantavirus transmission

- Reservoir: Rodents.
- Each hantavirus has a single primary host.
- Most important hantavirus in the United States is Sin Nombre virus.

<https://www.cdc.gov/hantavirus/technical/hanta/ecology.html> (accessed 5/24/2024)

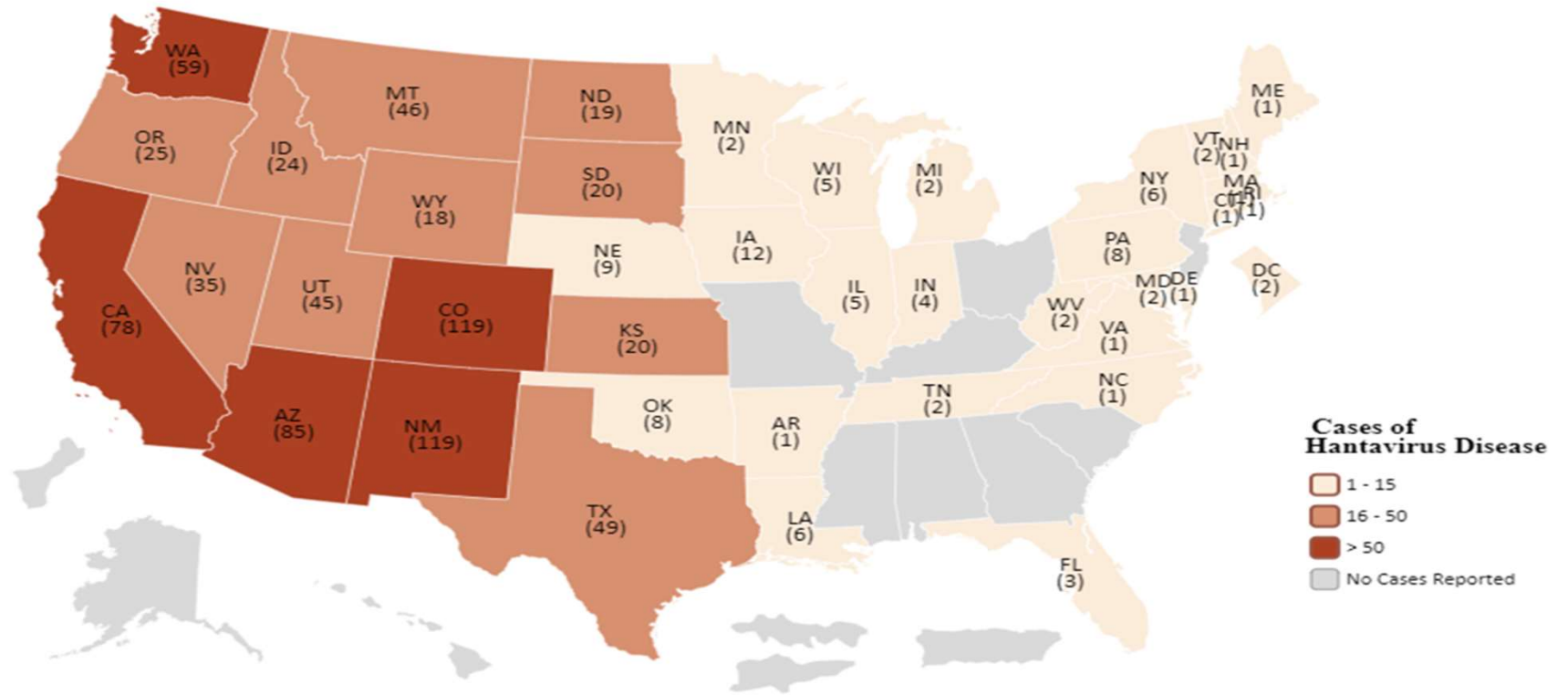
Deer mouse: Sin Nombre virus



Preferred habitat:
Woodlands, desert
areas

Jacob, AT et al. Sin Nombre Virus and the Emergence of Other Hantaviruses: a Review of the Biology, Ecology, and Disease of a Zoonotic Pathogen. *Biology* 2023, 12;1413.

U.S. cumulative cases of hantavirus by state through 2021



<https://www.cdc.gov/hantavirus/surveillance/reporting-state.html> (accessed 5/24/2024)

Sin Nombre virus

- Discovered in 1993.
- Outbreak of respiratory disease in the Four Corners area.
- 30-40% mortality rate.
- >90% of cases occur in states west of the Mississippi River.

Symptoms

- Prodromal phase: Onset 1-8 weeks after rodent exposure.
 - Fatigue, fever, myalgias.
 - Sometimes headaches, dizziness, chills, GI symptoms.
- HPS: 4-10 days into illness.
 - Coughing, shortness of breath.
 - Progression to respiratory failure in 4-12 hours.
 - A “...tight band around my chest and a pillow over my face” (pulmonary edema).

<https://www.cdc.gov/hantavirus/about/index.html> (accessed 5/24/2024)

Chagas disease

Epidemiology

- CDC estimates 8 million people infected in Mexico, Central America, South America.
 - >300,000 people in the U.S. are living with Chagas disease.
- Transmission:
 - Congenital.
 - Contaminated blood products.
 - Organ transplant.
 - Laboratory accident.
 - Contaminated food or drink.



The disease is endemic in **21** countries, and affects **6 million** people



About **70 million** people are at risk of becoming infected



6 million people are already infected, with **30 thousand** new cases annually for all forms of transmission,

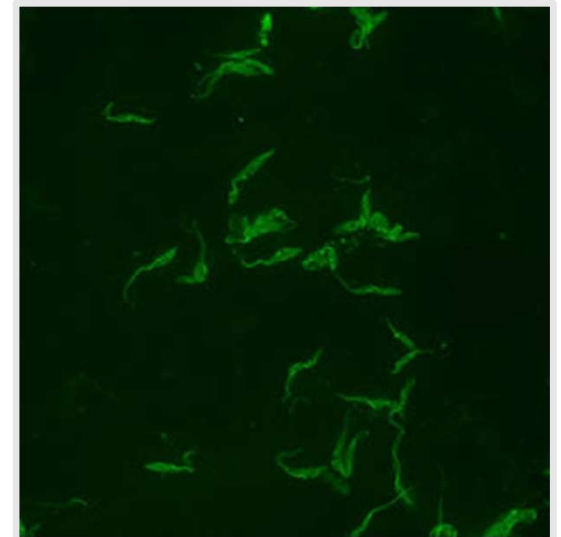
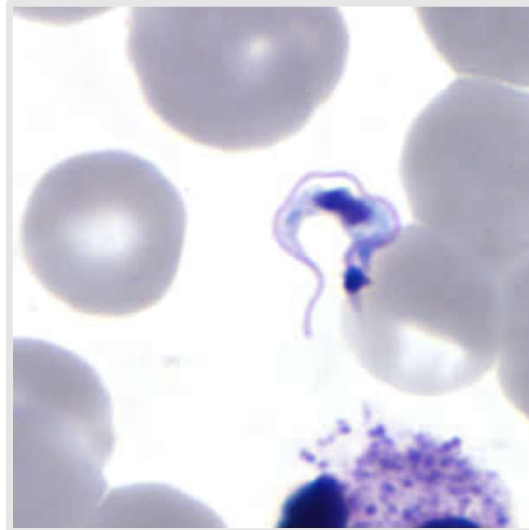
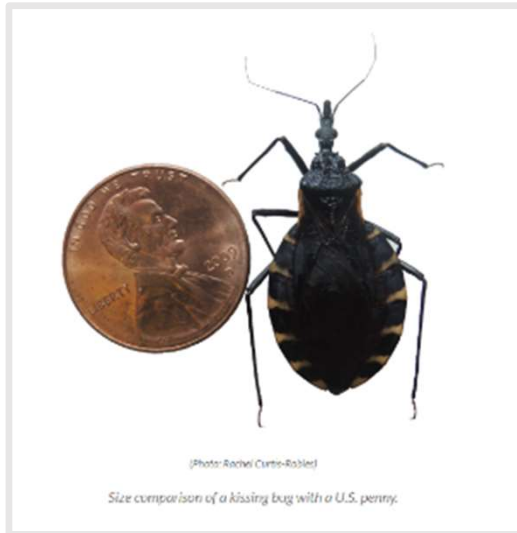


causing **12 thousand** annual deaths

<https://www.cdc.gov/parasites/chagas/epi.html> &
<https://www.paho.org/en/topics/chagas-disease> (accessed 5/24/2024)

Surveillance

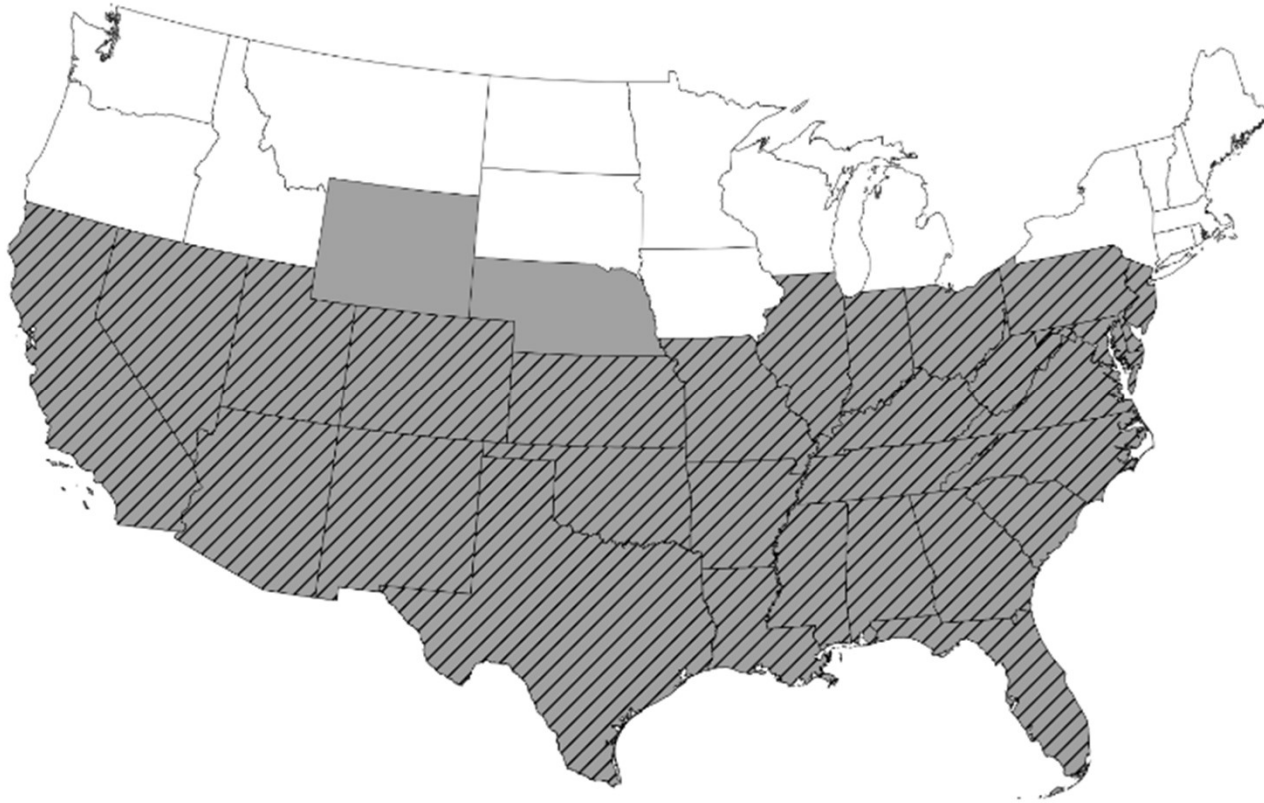
- Blood supply monitoring.
- Limited access to treatment via CDC investigational protocol.
 - Benznidazole.
 - Nifurtimox.
- Kissing bug reports.
- Domestic dog infections.



<https://kissingbug.tamu.edu/> (accessed 11/1/2023)

<https://www.cdc.gov/dpdx/trypanosomiasisamerican/index.html> (accessed 11/3/2023)

Triatomine bugs presence in the U.S.

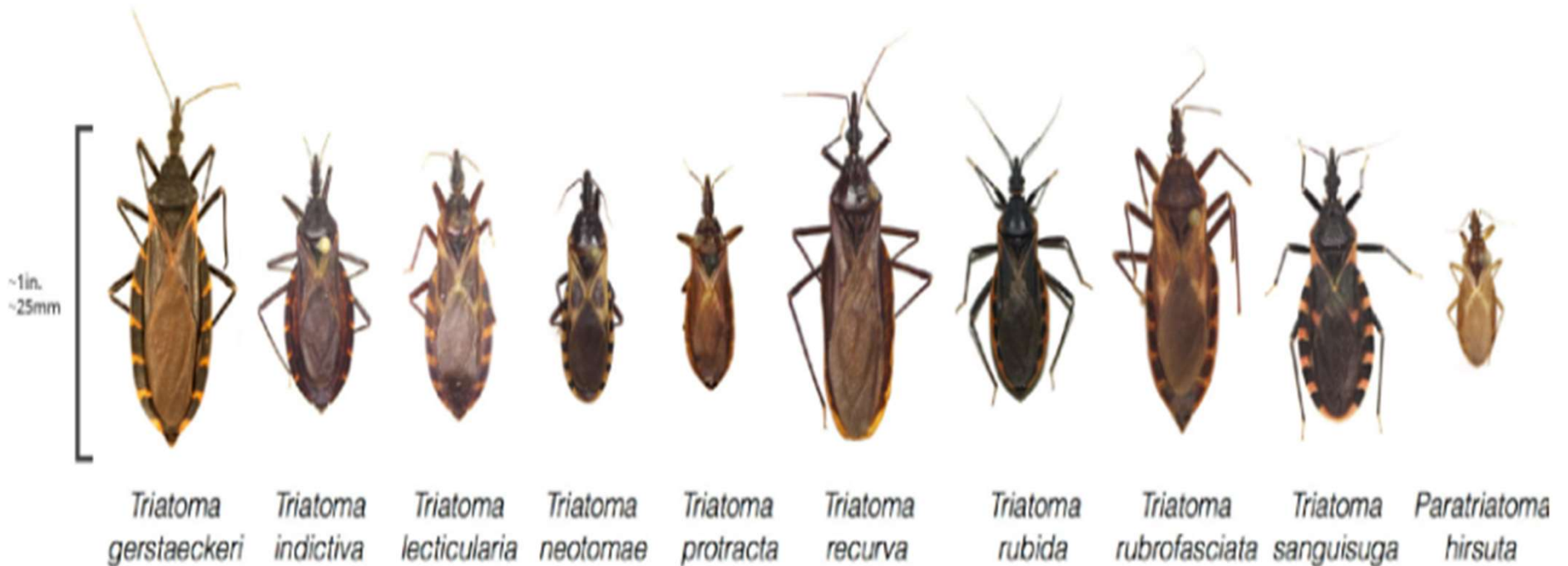


Shaded states have at least one historical record of kissing bugs.

Striped states represent states from which Texas A&M has received kissing bug specimens.

<https://kissingbug.tamu.edu/> (accessed 5/17/2024)

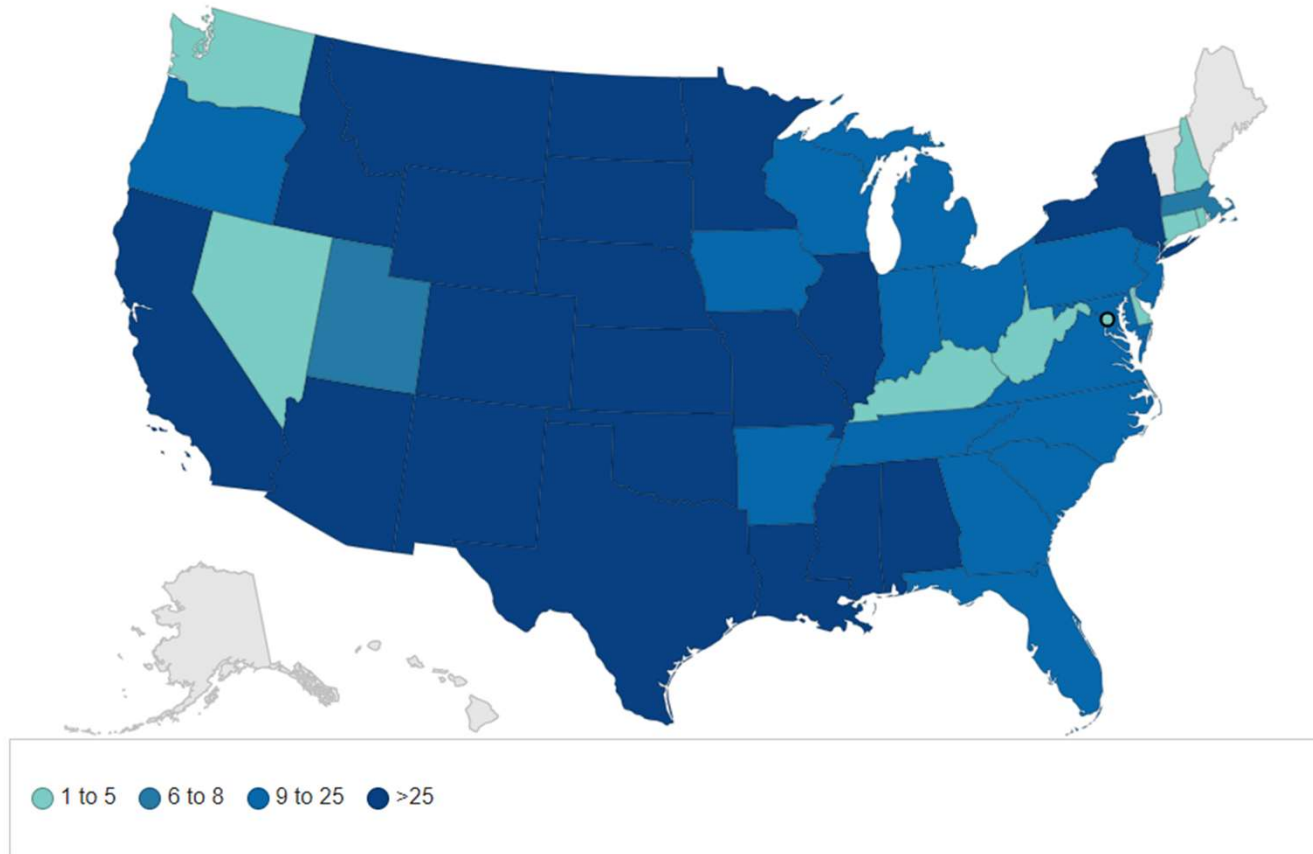
Kissing bugs species in the United States



<https://kissingbug.tamu.edu/> (accessed 5/17/2024)

West Nile virus

West Nile virus human disease cases, 2023

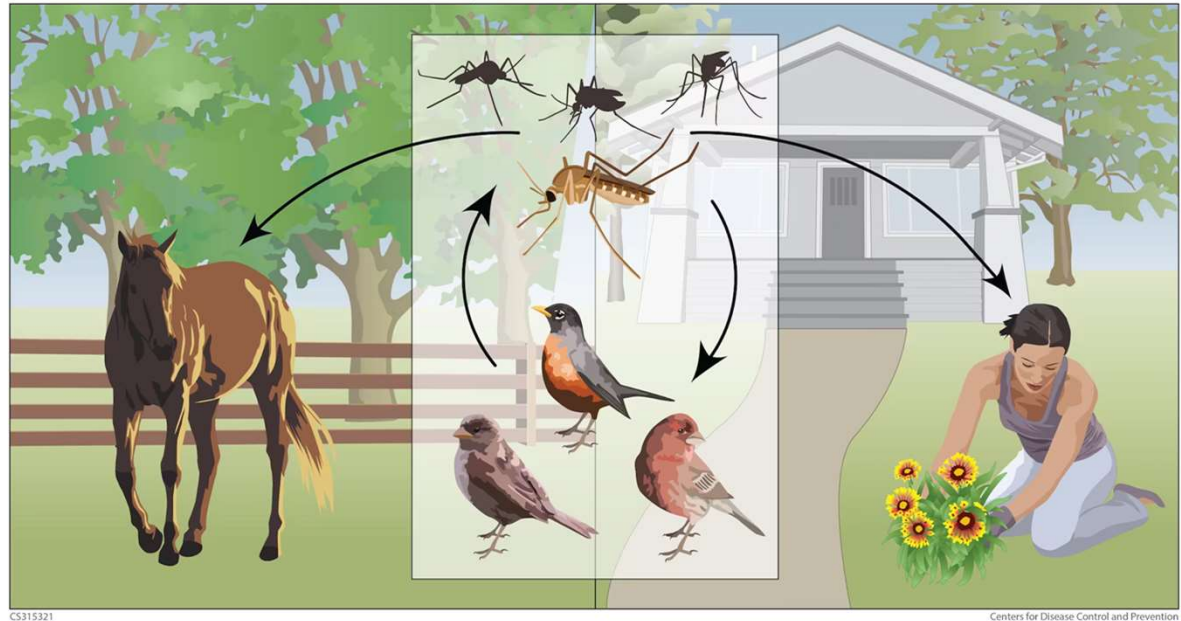


<https://www.cdc.gov/west-nile-virus/data-maps/current-year-data.html> (accessed 5/17/2024)

Case burden determinants

- Mosquito abundance and infection.
- Bird availability to complete sylvan cycle.
- Mosquito/human interaction.

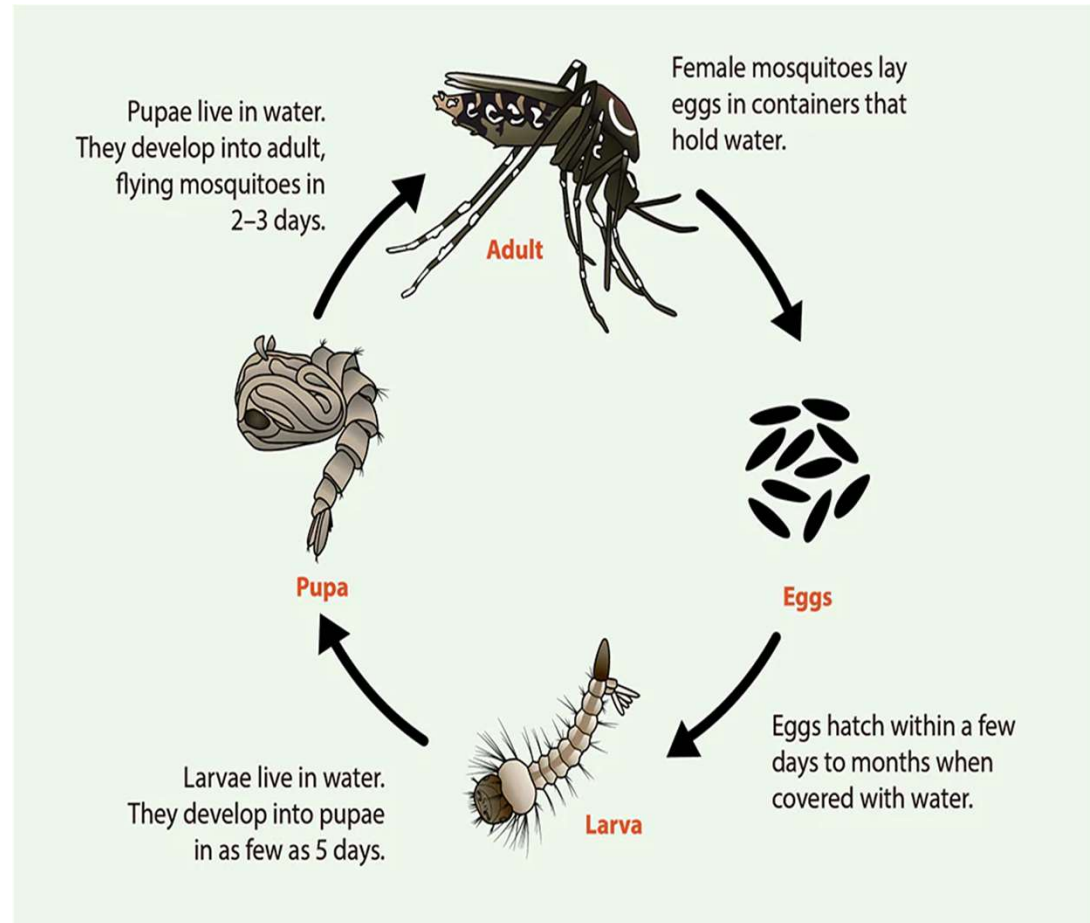
West Nile Virus Transmission Cycle



<https://www.cdc.gov/west-nile-virus/php/transmission/index.html> (accessed 5/24/2024)

Determining risk to public

- Positive viremic blood donors.
- Positive mosquito pools.



<https://www.cdc.gov/mosquitoes/about/life-cycle-of-aedes-mosquitoes.html> &
<https://www.fda.gov/vaccines-blood-biologics/blood-blood-products> (accessed 5/24/2024)

Prevention

- Use insect repellent. (EPA resource: <https://www.epa.gov/insect-repellents>)
- Wear loose-fitting, long-sleeved shirts and pants.
- Control mosquitoes indoors and outdoors.



<https://www.cdc.gov/mosquitoes/prevention/index.html> & <https://www.cdc.gov/mosquitoes/mosquito-control/larvicides.html> (accessed 5/24/2024)

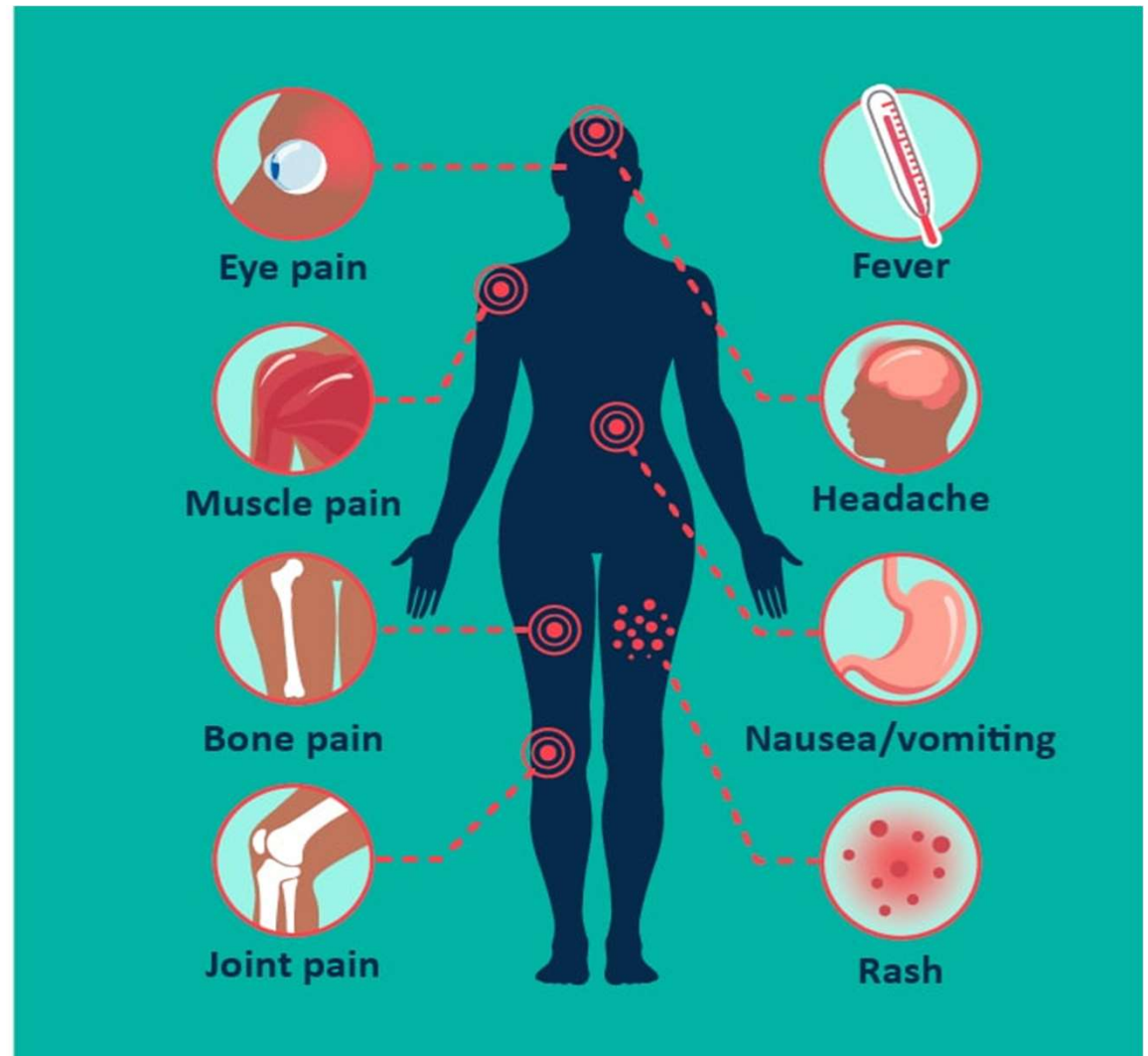
Dengue virus

DENGUE SYMPTOMS

Fever with any of the following



CS 337495-A 01/27/2023



<https://www.cdc.gov/dengue/signs-symptoms/index.html> (accessed 5/21/2024)

Severe dengue

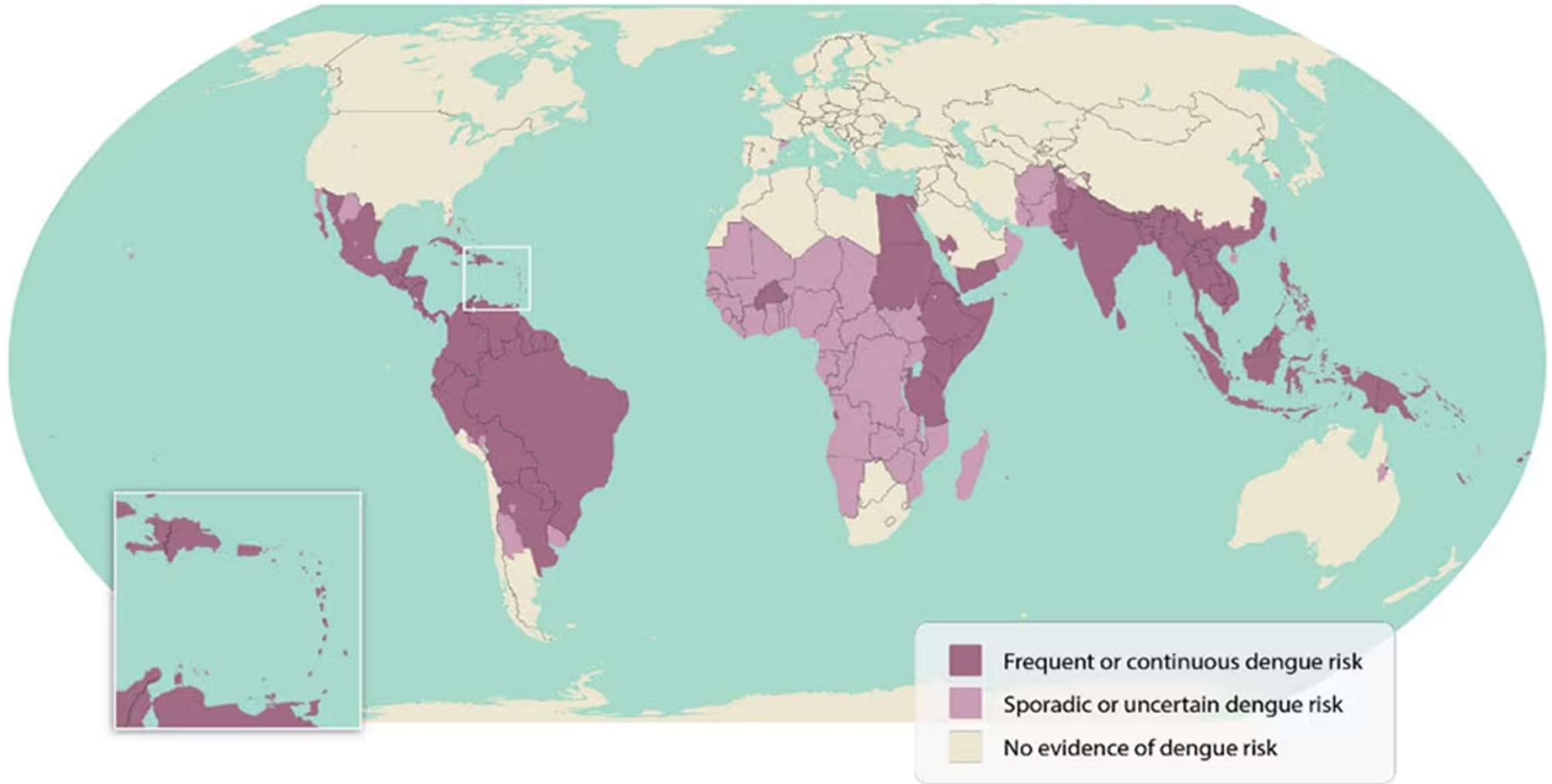
- 1 in 20 people with symptomatic dengue infection.
- Warning symptoms (begin 24-48 hours after resolution of fever):
 - Abdominal pain or tenderness.
 - Vomiting (3+ times in 24 hours).
 - Bleeding from the nose or gums.
 - Vomiting blood or presence of blood in the stool.
 - Extreme malaise or restlessness.

Transmission

- Mosquito bite (*Aedes aegypti* or *Aedes albopictus*).
- Vertically from pregnant person to fetus.
- Breastmilk.
- Blood transfusions, organ transplants, needlestick injuries (these are rare).
- Potential sexual transmission.

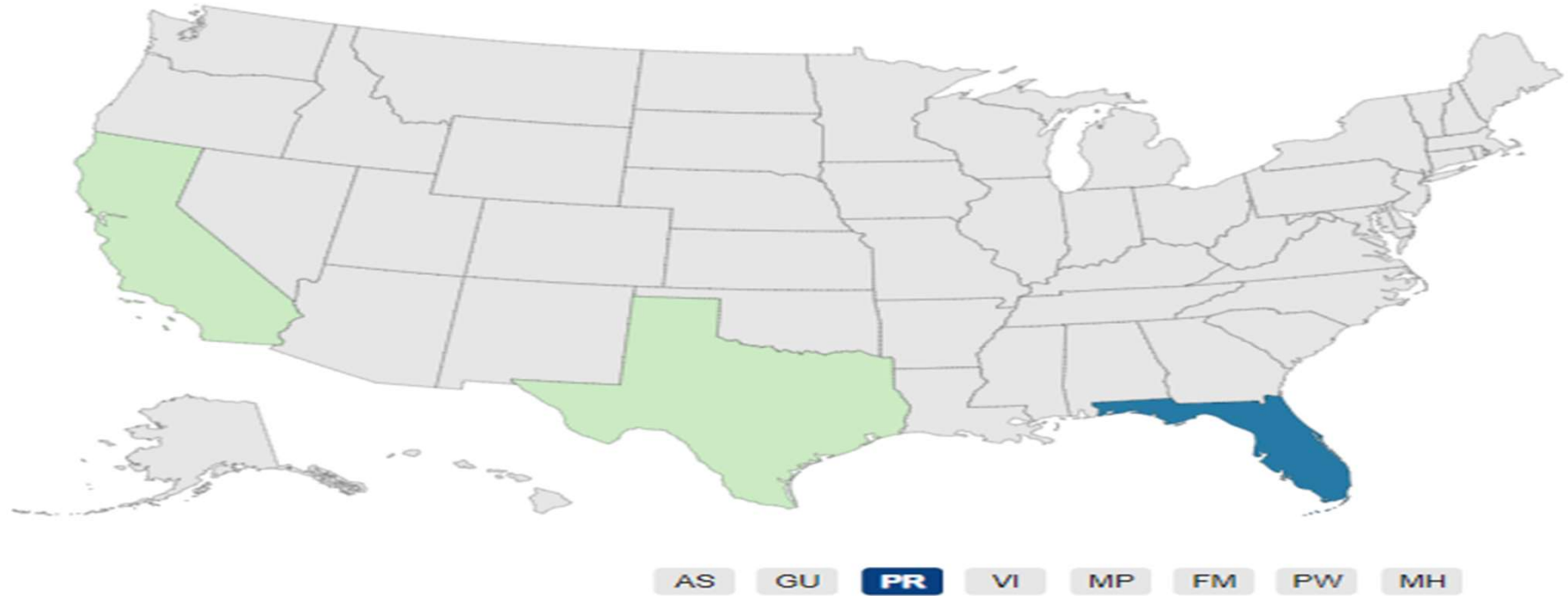
Testing

- Serologic testing for IgM antibodies.
 - Non-specific because of flavivirus cross-reactivity.
- PCR.
 - Can identify serotype.
 - Must be done within 7 days of symptom onset.
 - Negative tests should also be tested for IgM.



<https://www.cdc.gov/dengue/areas-with-risk/index.html> (accessed 5/21/2024)

Locally acquired dengue cases by jurisdiction of residence in US states and territories, 2023

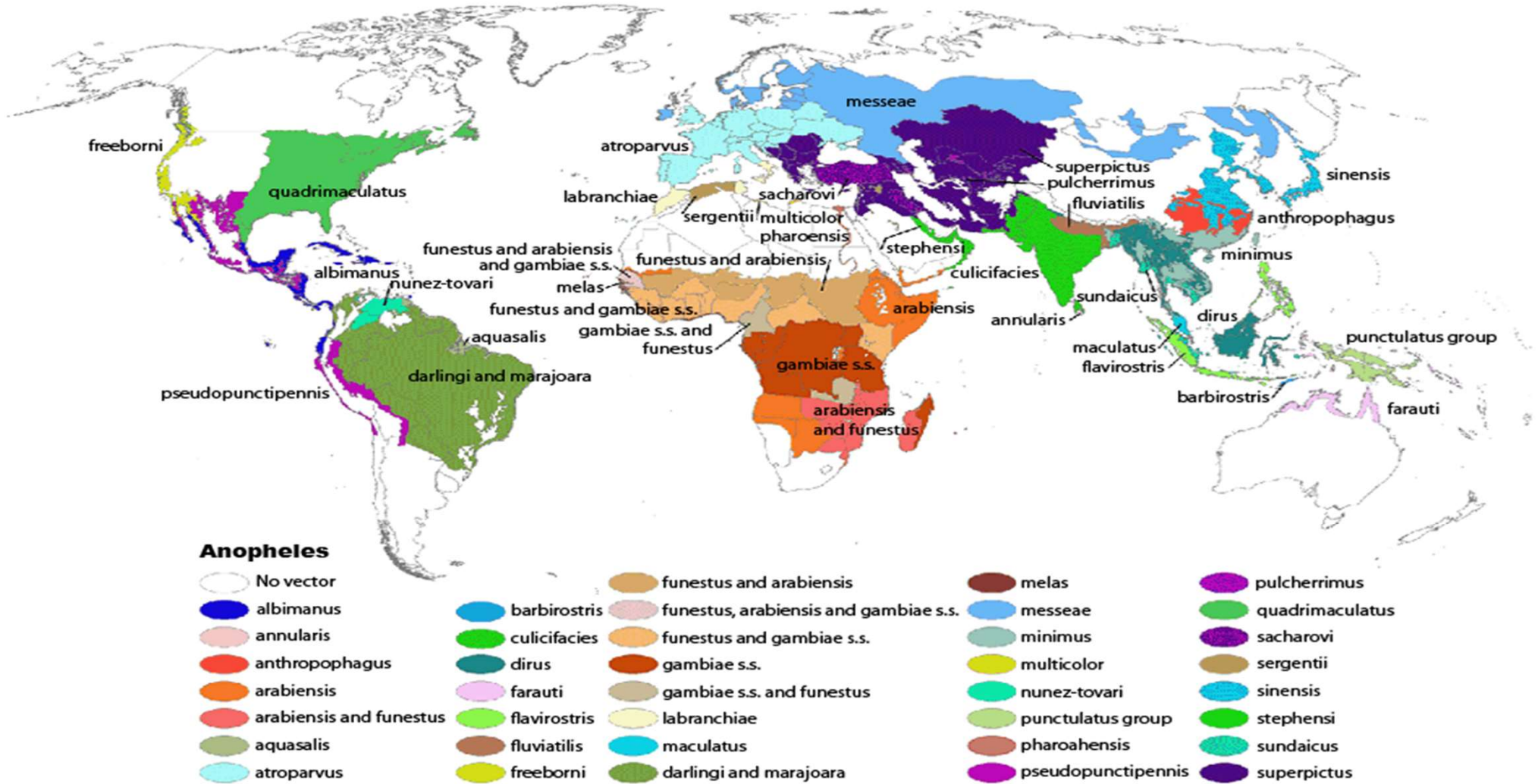


Legend

○ No reported cases ● 1 to 4 ● 5 to 49 ● 50 to 249 ● 250+

<https://www.cdc.gov/dengue/data-research/facts-stats/historic-data.html> (accessed 5/21/2024)

Malaria



<https://www.cdc.gov/dpdx/malaria/index.html> (accessed 5/21/2024)

Symptoms

Incubation period can be one week or a year or more, but is usually no more than 30 days.

- Fever, flu-like illness.
- Chills.
- Headache, muscle aches, fatigue.
- Nausea, vomiting, diarrhea.

Severe symptoms:

- Anemia, jaundice.
- Kidney failure.
- Seizures.
- Altered mental status.
- Coma

Transmission and risk factors

- **Mosquito bites.**
- Blood transfusions, organ transplants.
- Sharing needles or syringes.
- Vertically from pregnant person to fetus.

Populations at increased risk of severe illness:

- People with little to no recent exposure to malaria.
- People heavily exposed to malaria-infected mosquitoes.
- People in rural areas without access to healthcare.

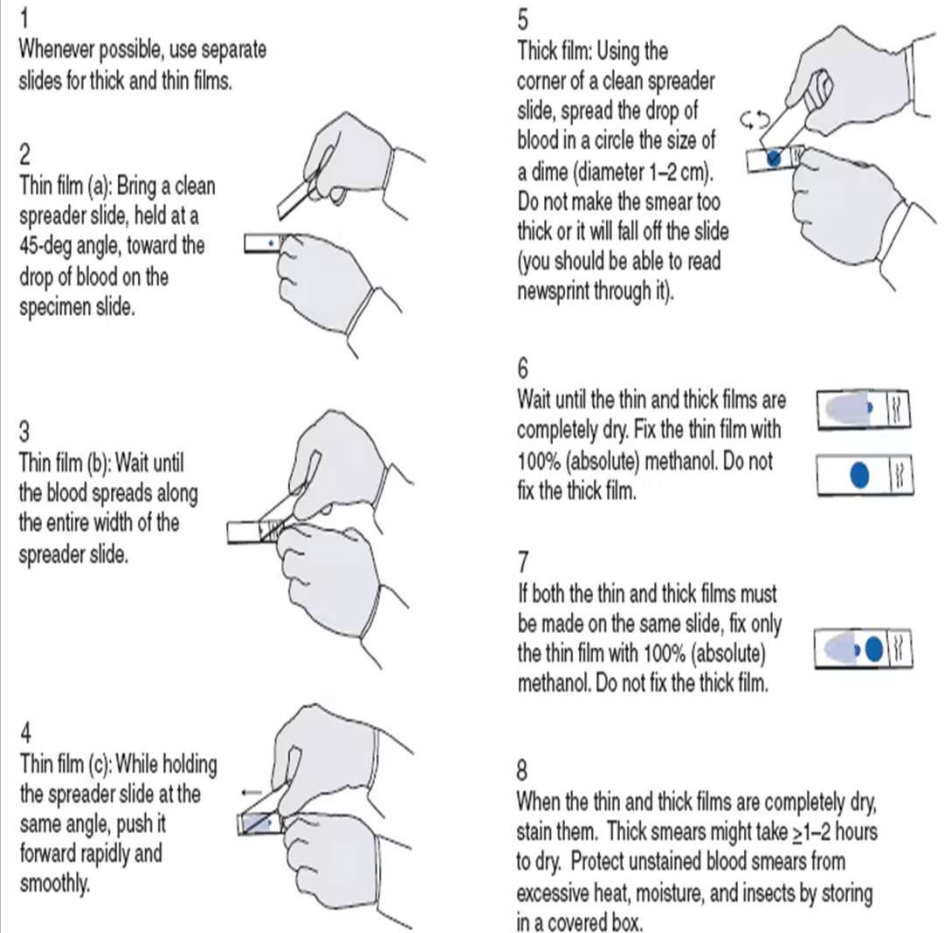
90% of malaria deaths occur in sub-Saharan Africa, primarily in children under 5 years old.

<https://www.cdc.gov/malaria/causes/index.html> (accessed 5/21/2024)

Testing

- Blood smear.
 - Confirmatory and species identifying.
- Rapid diagnostic tests.
 - Confirm with blood smear.
- PCR.
 - Confirmatory and species identifying.
 - Results take longer than the other methods.

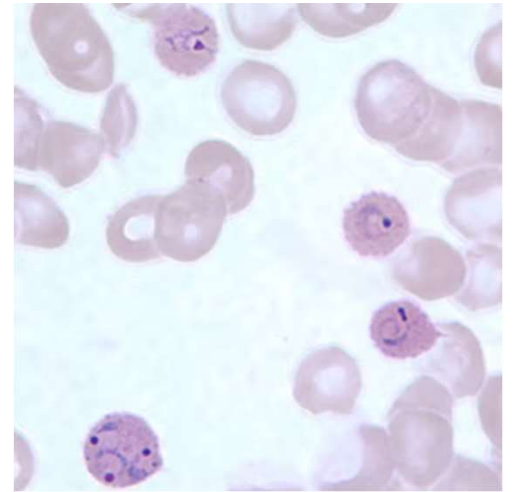
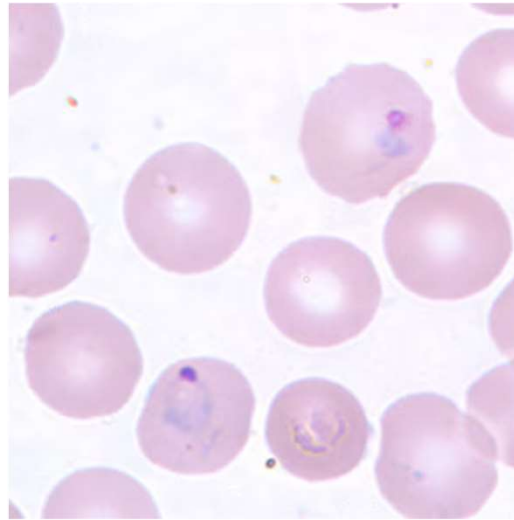
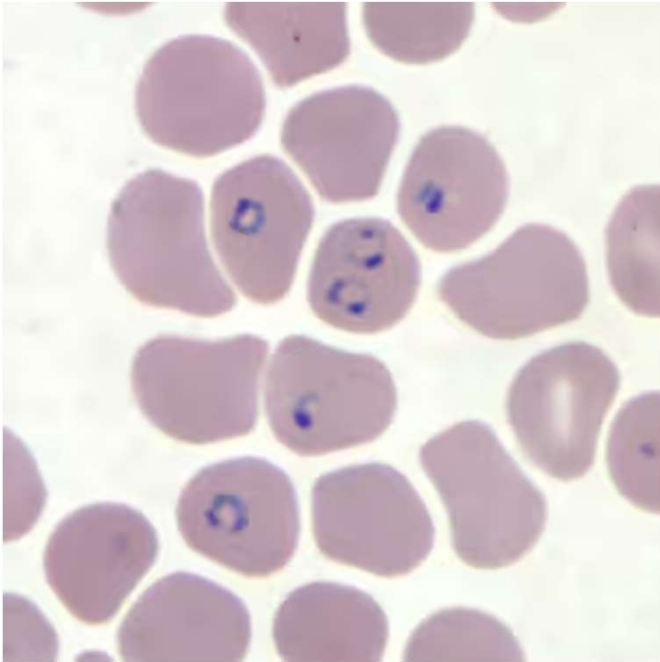
FIGURE A-2. Preparation of thin and thick blood films



<https://www.cdc.gov/malaria/testing/index.html> (accessed 5/21/2024)

<https://www.cdc.gov/mmwr/preview/mmwrhtml/ss5402a3.htm>

P. falciparum vs. *P. ovale* or *vivax*



<https://www.cdc.gov/dpdx/malaria/index.html> (accessed 5/21/2024)

Prophylaxis and treatment

- Prophylaxis is based on destination, planned activities, medical history and drug resistance.

Prevention resources:

<https://wwwnc.cdc.gov/travel/yellowbook/2024/infections-diseases/malaria#prevent>

- Treatment is based on malaria species, location of infection (and local drug resistance), and severity of illness.
 - *P. ovale* and *P. vivax* require two antiparasitic drug courses to prevent recurrence.

Treatment resources:

<https://wwwnc.cdc.gov/travel/yellowbook/2024/infections-diseases/malaria#treatment>

Questions?

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