Insects and Human Disease

Goals:
1. Define: vector, host, parasite, pathogen, disease, disease cycle, myiasis, envenomization, endemic, epidemic.
2. Know the impact of arthropod-borne disease on humans, other animals, and plants.
3. Learn current “in the news” diseases and disease cycles.

TOP 10 WAYS in which arthropods affect the health and well-being of man and animals...

1. Annoyance - Buzzing flies or feeding mosquitoes.
2. Mechanical pain from bites.
3. Envenomization - toxemia - Stinging of Wasps or Biting of Spiders

4. Stress:
   - Gadding, running, or milling of animals caused by insect-induced fright or extreme annoyance
   - Weight loss, loss of reproductive capacity, low milk production

5. Myiasis and mechanical pain associated with larval invasion of, and establishment in tissues. (Bot Flies, maggots)

6. Dermatosis - dermatitis
7. Allergy and related conditions
8. Vectoring of parasites causing diseases such as plague, malaria, yellow fever, and encephalitis
9. Vectoring of pathogens that threaten our food supply
10. Entomophobia--fear of insects or arthropods or imagined infestation
Arthropods as Transmitters of Disease Agents

**KEY VOCABULARY**

- **Pathogen:** An organism that causes disease
- **Vector:** An organism that carries a pathogen from one host to another
- **Host:** An organism that is attacked and used as a resource by a parasite/pathogen
- **Infection:** Invasion of a host by a pathogen
- **Disease:** Visible signs of infection by a pathogen
- **Disease Cycle:** The complete description of the movement of a pathogen from one host to another

**Protozoans:** Single-celled Eukaryotes

- **Leishmania spp.**
  - Leishmaniasis
  - Vector: sand fly

- **Trypanosoma spp.**
  - Human sleeping sickness, Chaga's disease
  - Vectors: Tsetse Fly and Assassin Bug

- **Plasmodium spp.**
  - Malaria
  - Vector: mosquitoes

**Malaria Disease Cycle**

1. In the gut of a female mosquito carrying the malarial parasite Plasmodium, zygotes develop into sporozoites, which migrate to her salivary gland.
2. In the gut of a female mosquito, sporozoites migrate to her salivary gland and are released into her saliva.
3. Female mosquito bites human, bloodstream carries sporozoites to liver.
4. Sporozoites enter liver, cause malaria episodes.
5. Some of the merozoites enter liver, cause more malaria episodes.
6. Others develop into male and female gametocytes, that are released into bloodstream.
7. Female mosquito bites, suctions blood from infected human. Gametocytes in blood enter her gut, mature into gametes which fuse to form oocysts.
8. Oocysts mature into sporozoites, which are released into her salivary gland.
9. Female mosquito bites, suctions blood from infected human. Gametocytes in blood enter her gut, mature into gametes which fuse to form oocysts.

**Helminths (Flatworms):**

- Multicellular parasites,
- Complex life cycles, multiple hosts
- Trematodes (flukes) and Cestodes (tapeworms)
- Arthropods may serve as intermediate hosts for these parasites

**Nematodes (Roundworms):**

- Multicellular parasites, complex life cycles
- Filarial nematodes are major parasites

- **Filarisis**
- **World distribution**
- **Elephantiasis**
- Vector: mosquitoes
Onchocerciasis (river blindness)  
- Vector: Black Fly

Heart Worm  
- Vector: Mosquito

Viruses: Non-cellular infectious agents

Yellow Fever  
- Vector: Aedes aegypti Mosquito  
- No cure

Dengue (breakbone) Fever  
- Vector: Aedes aegypti Mosquito  
- No cure

West Nile Virus – Flavivirus  
- Single stranded RNA  
- Virus found in Africa, West Asia, Middle East.  
- Imported in USA in the summer of 1999  
- Vector: Culex mosquitoes  
- No cure

West Nile Virus Transmission Cycle  
- Mosquito vector  
- Bird reservoir hosts  
- Human infection  
- Incidental infection
Most cases with no symptoms or mild flu-like symptoms
- Inflammation of brain (encephalitis)
- 13,491 cases and 533 deaths by Jan 1, 2004.

Survival
- Without symptoms but infected
- Neurologic disease
- Limb incoordination
- Death

West Nile Virus

- 30% exhibit any noticeable symptoms
- Less than 1% of these cases become life-threatening
- Most people have mild, flu-like symptoms, or no symptoms at all.
- Most susceptible are the elderly and those with compromised immune systems.
- West Nile Virus is not transmissible from person to person.

Updated 11/08/2002 2:00 PM
497 Cases of Human West Nile Virus in Michigan
41 Total Deaths in Michigan

% Female or Male

Cases by Age and Sex

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<td>121</td>
<td>276</td>
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<tr>
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<td>2</td>
<td>151</td>
<td>1</td>
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</table>

% Female or Male

- 43.4% of females
- 56.6% of males
- 0.20% unknown

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West Nile Virus

**Viruses**

*West Nile Virus*

WNV 2002 to 2003 in MI: What was different???

- **Encephalitides** (Eastern Equine Encephalitis, St. Louis, and Western Encephalitides)
  - **Vector:** Mosquito

- **Easten Equine Encephalitis – MICHIGAN!**
  - **Vector:** Mosquito - *Culiseta melanura*
  - **Symptoms:** fever, joint pain
  - **Treatment:** none

- Pathogenic in both mosquitoes and birds
- Virus sometimes leaves swamp setting and is transmitted to horses, game birds (penned pheasants), and people
- Highly pathogenic in these “dead-end” hosts
- Outbreaks occurred in the early 1940’s, 1973, 1980-83, 1989 and 1991
- Most serious mosquito borne disease in Michigan

**Bacteria**

- **Bacteria: Single-celled prokaryotes**
- **Rocky Mountain Spotted Fever and Colorado Tick Fever (Rickettsia spp.)**
  - **Vector:** Tick
  - **Seasonal transmission**
  - **Antibiotics are effective**
Epidemic Typhus (*Rickettsia spp.*)
- Vector: Human body louse
- Seasonal transmission
- Hygiene-dependent
- Antibiotics are effective

Bubonic Plague (*Yersinia pestis*)
- Vector: Flea
- Can be transmitted person-person
- Two forms — both with high mortality
- Treatment must be rapid, with powerful antibiotics

Western vector
Eastern vector

Plague (*Yersinia*) distribution

Tularemia (Rabbit fever)*Francisella tularensis*
- Transmitted by:
  - Ticks, deer flies
  - Direct inoculation from skinning rabbits
  - Inhalation
- Symptoms:
  - Skin ulcers, swollen lymph glands, inflamed eyes, sore throat, diarrhea or pneumonia.
  - Can be fatal without treatment (antibiotics)

Lyme Disease (*Borrelia burgdorferi*)
- Vector: Deer ticks, Lone star tick
- Symptoms: Bulls-eye rash, fever, joint pain
- Treatment: Antibiotics, long term care

Lyme Disease — *Borrelia burgdorferi*
- The tick feeds on small rodents, deer and man.
- In 1991, Michigan reported 46 cases of Lyme Disease, based on the new case definition. Michigan has reported 542 Lyme disease cases from 1982 to 2000 (only one case was reported in 1999, and none in 2000)
**Vectors: The Vehicle**

**Key Vector attributes:**
- Proximity to host(s)
- Mobility
- Faithful transmission to host
- Minimal harm from pathogen

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**Mosquitoes (Family Culicidae)**

Several species of mosquitoes bite man and animals in Michigan. Some species develop in pools while others develop in ponds and marshes. Occur during the spring and summer in Michigan.

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**Black Flies (Family Simuliidae)**

Immatures occur in clear streams with high oxygen concentration, and the adults emerge during late May and June, mainly in the Upper Peninsula.

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**Stable Flies (Family Muscidae)**

Spoiled feed or hay mixed with wastes from horses and other livestock on farms or in stables. Upper Peninsula of Michigan, particularly Porcupine Mountains and along Lake Superior beaches.

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**Deer and Horse Flies (Family Tabanidae)**

Swamps and marshes, along stream banks and ponds and lakes.

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**Ticks (Family Ixodidae)**

Until the discovery of Lyme disease and the deer tick, _Ixodes scapularis_ (formerly _dammin_), in Michigan, the American dog tick (_Dermacentor variabilis_) was the most pestiferous tick in Michigan. Both of these ticks are more abundant in the Upper Peninsula.
Vectors

Lyme disease cycle

Eliminate habitats

Insecticides

Vaccine development

Eliminate exposure

Vectors

Transmit bacterial pathogens to plants

Potato Aphid

Glassy Winged Sharpshooter

Bot Flies – Yummy

Direct Pests

Transmit viral pathogens to potato

Potato Aphid

Glassy Winged Sharpshooter

Human Bot

Review Tuesday
Test Thursday