

MEDICAL ENTOMOLOGY



Follicle mite

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OBJECTIVES

1. Describe the different types of medically related effects caused by arthropods (direct and indirect)
2. Define the terms associated with disease transmission
3. Describe the general characteristics of the 7 diseases covered including:

- Vector
- Where it is a problem
- Disease symptoms
- How it is treated and controlled
- Type of disease



Flannel moth caterpillar

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INTRODUCTION

-Dermatitis
-Allergic reactions
-Disease vectoring
 - Morbidity
 - Fatality



Blood loss from horn flies feeding on cattle.

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DIRECT EFFECTS - HOST REACTIONS

Some quantifiable, economic effects include:

- **Mechanical Reactions** (dermatosis, dermatitis, itching)
- **Exsanguination** (loss of blood, annoyance)
- **Myiasis** (dipterous larvae invading living tissues)
- **Toxins & Paralysis** (envenomization)
- **Allergic Reactions** (anaphylaxis)
- **Entomophobia** (psychological fear of insects)



Hemotobia irritans, Horn flies

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MECHANICAL REACTIONS (DERMATOSIS, DERMATITIS, AND ITCHING)

Scabies mite:

- Obligate parasite.
- Burrows under skin to lay eggs.



Sarcoptes scabiei

Sarcoptic mange:

- Basically the same as that in humans.
- Cattle, pigs, horses, and dogs, experience the same dermatitis leading to weight and hair loss.



Canine Mange

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MECHANICAL REACTIONS (CONTINUED)



Red bug bites

- Larval mites have six legs.
- Larvae feed on vertebrate hosts.
- Chiggers (red bugs) do not burrow under skin.
- Mites fall off skin after feeding.



Trombicula irritans - chigger, red bug

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EXSANGUINATION (LOSS OF BLOOD, ANNOYANCE)

Another direct effect of insect feeding can be exsanguination, or blood loss. One mouth type is rasping. The bites are very painful and the blood loss can be significant. Some results of feeding of this type can be a loss of weight or a reduction in milk production in cattle.

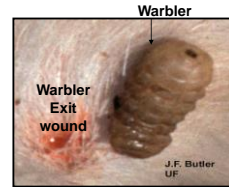


Horn flies on cattle causes annoyance and blood loss.

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MYIASIS

Fly (dipterous) larvae may invade and feed on living tissues of livestock and other animals including rabbits, squirrels, dogs, and humans. This is known as **myiasis**. The fly larvae must have access to the outside in order to breathe, so they create holes in the flesh of the host. The holes and tissue damage caused by the myiasis causes economic damage because it reduces the quality of the hide.



Northern Cattle Grub larva, *Hypoderma bovis*

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MYIASIS (CONTINUED)

Myiasis is generally one of 2 forms:

- 1) **Obligatory** - the parasite depends on the host for completion of a certain part(s) of its life cycle. One example is the bot fly we have previously discussed.
- 2) **Facultative** - the parasite is generally free-living but can utilize a host in certain circumstances. One example is urinary myiasis. This is caused when rat-tailed maggots from contaminated water enter the urethra of a human host. Facultative myiasis in humans is not as common as found in other vertebrate animals.



Northern Cattle Grub adult, *Hypoderma bovis*



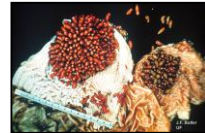
Eristalis tenax, Rat-tailed maggot

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SOURCE OF MYIASIS

- Flies lay their eggs around the mouth, legs and other areas of host.
 - Fly will annoy the host causing the host to lick the eggs.
 - Eggs hatch in the intestinal tract and develop.
 - Pupa is excreted with the host waste.
- ❑ Other flies lay their eggs on the hair shafts of its host.
 - ❑ Larvae hatch and burrow through skin into the host.
 - ❑ Make its way to the back of the host.
 - ❑ Cuts a whole through the hide of the host for respiratory purposes.
 - ❑ Exits through this hole when it pupates.

Intestinal Myiasis - found in the stomach and intestines of cattle and horses.



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SOURCES OF MYIASIS (CONTINUED)

A few flies hitch a ride.

Dermatobia hominis (human bot fly)

- Parasitizes other vertebrates including cattle, swine, cats, dogs, and horses.
- Captures another Dipteran fly (such as a mosquito).
- Glues its eggs along the abdomen of the carrier fly.
- While mosquito is feeding, bot larvae penetrate the skin.
- Life cycle takes 3 to 4 months.



Human bot warbler in the scalp

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ENVENOMIZATION AND ALLERGIC REACTIONS

Arthropod venoms typically do not cause death in humans or animals.

- Sensitivity to proteins (in the venom) can develop.
- Severe allergic reaction that results in death (anaphylaxis).

Venomous examples:

- Spider bites
- Scorpion stings
- Hymenoptera (ants, bees, and wasps) stings
- Lepidoptera larvae with "urticating hairs"
- Coleoptera - Blister beetles (causes painful blisters and can kill horses if ingested).
- Coleoptera - Stored product beetles (itching or respiratory problems from contact with the frass).



Red flour beetle

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EXAMPLES OF VENOMOUS ARTHROPODS - URTICATING



Saddleback caterpillar



Puss Caterpillar



Tussock moth caterpillar

Some Lepidoptera larvae have "urticating hairs" that produce burning and itching when touched.



Tent caterpillar

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EXAMPLES OF VENOMOUS ARTHROPODS - STINGING

Honeybee



Black widow spider



Brown recluse spider



Scorpion

White pustules occur within 1 to 2 days after sting



Fire ant, *Solenopsis invicta* – Notice that they bite for leverage and then sting.



Polistes wasp

Many arthropods including spiders, scorpions and hymenopterans have a defensive sting organ. In insects, the sting is a modified ovipositor.

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EXAMPLES OF VENOMOUS ARTHROPODS - BLISTERING



Striped Blister Beetle Effects



Striped Blister Beetle

Blister beetles in the order Coleoptera causes irritation with possible skin blistering by the toxic chemical Cantharidin.

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ENTOMOPHOBIA

Entomophobia is the psychological fear of insects. Many people fear insects, but some have an irrational fear. This fear may lead to psychological problems such as:

Delusory parasitosis This is when a person is mentally sure that insect infestation is real when in fact it does not exist. This condition can even bring on physical symptoms including welts and skin irritations.

Entomophobia The general fear of insects, or of becoming infested with something may bring about stress and high anxiety. This may result in careless use of insecticides in and outside of the home, on pets, on children, and on yourself.

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INDIRECT EFFECTS - DISEASE TRANSMISSION TERMS

Epidemiology - study and applied ecology of disease transmission where all factors of the natural history of the disease and vector are of interest.

Vectors - classes of arthropoda that have the capability of transmitting pathogenic organisms to its host causing minor and major debilitating diseases.

Host - houses the pathogen through one or more of its life cycles, specifically the infective stage during active transmission by the vector.

Pathogen - the organism that is passed by the vector and causes the disease.

Vertebrates that can house and maintain the pathogen during benign and infective stages of the pathogen's life cycle even when active transmission is not taking place, are termed **reservoirs**.



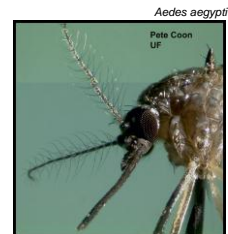
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Note: Arbo, as in arbovirus, stands for arthropod borne.

DISEASE TRANSMISSION - VECTORS

Three things are needed for most disease transmission:

- 1) Competent vector
- 2) Host
- 3) Pathogen (causal organism)



Depending on the pathogen's life cycle, a fourth entity necessary for the disease transmission would be a "reservoir."

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TYPES OF DISEASE TRANSMISSION

Mechanical - arthropod acquires the pathogen by passive means.

- House fly lands on dirty area, then lands on food.

Cyclo-Propagative - pathogen is actively delivered to host; pathogen undergoes lifecycle changes after transmission and multiplies.

- Malaria (mosquitoes); Chagas (kissing bugs)

Cyclo-developmental - similar to cyclo-propagative but pathogen does not multiply in the arthropod (vector).

- Elephantiasis from mosquitoes (obligate filariases [nematode])

Propagative - no cyclical changes but multiplies propagatively.

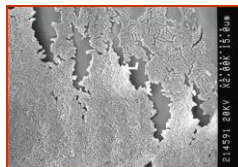
- Flea & *Yersinia pestis* (plague)
- Lice & *Borrelia recurrentis* (relapsing fever)
- Mosquitoes & Yellow Fever

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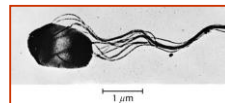
BACTERIAL REVIEW

Bacteria:

- Unicellular organisms that lack nuclei.
- DNA is not contained and is just free floating in their cytoplasm.
- Bacteria often resist immune defenses to begin growing.
- Some bacteria invade tissues.
- Others produce toxins that damage tissues.



Salmonella bacteria



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VIRAL AND PROTOZOAN REVIEW

Viruses:

- Microscopic agents that replicate themselves only within cells of living hosts. Many are pathogenic.

- ~100 known arthropod viruses (**arboviruses**);
 - Mainly isolated from mosquitoes.
 - Yellow Fever
 - West Nile Virus
 - Eastern Equine Encephalitis Virus
 - Western Equine Encephalitis Virus
 - Dengue Virus



Protozoa:

- Single celled organism with a nucleus.
- Contains its own structures needed for life functions.
- Large and diverse complex group with many shapes and sizes.
- Can be parasitic or free-living in moist habitats.
 - Malaria (mosquito)
 - African sleeping sickness (Tsetse fly)

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INSECT TRANSMITTED DISEASES

With this background knowledge, you will now learn about 7 insect transmitted diseases. They are:

1. Yellow Fever
2. Plague
3. Typhus
4. Dengue Fever
5. Trypanosomiasis (i.e. African sleeping sickness and Chagas' disease)
6. Encephalitis
7. Malaria

To learn about these diseases you will need to do a little exploring. Be sure read the textbook readings and fill out tables 1 & 2 on your study guide. The information contained in this table will be what you are tested on.

*If you are having trouble, you may find additional information at www.infoplease.com.

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YELLOW FEVER

- Vectored by mosquitoes.
- Tropical disease found mostly in Africa and South America.

- Jungle yellow fever - primarily found in monkeys
 - When humans enter the rain forest to work, they can be bitten by mosquitoes that have fed on infected monkeys.
- Urban yellow fever - found in humans.
 - Spread by container breeders (*Aedes aegypti*) in pots, discarded tires, etc.

Mild Symptoms: fever and headache

Severe Symptoms: rapid heartbeat, back pains, bleeding into the skin, nausea, and vomiting with internal hemorrhaging leading to coma and possible death.



Aedes aegypti

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PLAGUE

- Occurs where humans and large populations of rats and fleas coexist.
- Spread by flea bites (male or female can transmit).

When the flea tries to feed repeatedly, back pressure causes the regurgitation of blood meal to re-enter the bite wound. (Ok, that is pretty gross.)

- Bubonic
 - High fever and chills, delirium, bleeding under the skin, enlarged lymph glands (buboes), and prostration.
- Pneumonic
 - Infection has spread to lungs.
 - Human becomes contagious through coughs or sneezes.
 - Fatal within 24 hours untreated.
- Black
 - Hemorrhages are black and results in "black death".
 - Mortality rate is 50-60%.



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Treated with antibiotics such as streptomycin and tetracycline. rodent control is of vital importance in infected areas.

TYPHUS

- Mostly found in Europe, Africa, Asia, Mexico, and South America.

Louse Borne Typhus - transmitted by the human body louse, *Pediculus humanus humanus*, which houses the infective pathogen *Rickettsia prowazekii*.

- Louse feeds on infected person; pathogen multiplies in midgut.
- Midgut ruptures and *rickettsiae* move to digestive tract.
- Excreted in the louse's fecal matter
- Remain alive for more than 60 days.
- Infection is through fecal contamination.
- Scratching a bite smears the fecal pellet into the wound.

- *Rickettsiae* are pathogenic to the louse and the louse dies within 8 to 12 days. Louse remains infective for life.

Epidemic typhus - high fever with a rash and headache.

- Antibiotics (tetracycline, chloramphenicol) work, but considered proteobacteria.
- Vaccination available.
- Outbreaks occur in crowded, unsanitary conditions.
- Major killer in wartime.

Murine Typhus - transmitted by fleas and is much milder.

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DENGUE FEVER

- Caused by DEN virus.
- Primarily found in warm tropical areas.
- Vectored by six species of mosquitoes (genus *Aedes*).
- First reported epidemics in 1779-1780 in Asia, Africa, and North America.
- In Southeast Asia, Caribbean basin, Mexico, south Pacific, Central, and South America.
- Dengue was non-fatal disease, except for DEN-1 through 4.
 - Mild - known as "breakbone fever"
 - Rash, fever, and severe headaches, muscle and joint pains.
 - Typically a full recovery.
 - Severe - "Dengue Hemorrhagic Fever" and "Dengue Shock Syndrome"
 - Occurs when exposed to multiple serotypes within 5 years.
 - No specific treatment.
 - Requires replacement of lost fluids,
 - Most require transfusions to control blood loss.



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TRYPANOSOMIASIS (AFRICAN)

Protozoan African Trypanosomiasis (Sleeping Sickness)

Glossina species (Tsetse flies) of the order diptera are the chief vectors of the pathogens *Trypanosoma brucei gambiense* and *T. brucei rhodesiense* that cause African Sleeping Sickness.

- Gambian – Human reservoir; chronic, low parasitemia
- Rhodesian – Antelope and human reservoir; acute infection



Tsetse fly taking a blood meal

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TRYPANOSOMIASIS (AMERICAN)

Protozoan American Trypanosomiasis (Chagas Disease)

Conenose bugs belonging to the order Hemiptera and genus *Triatoma* are the chief vectors of Chagas disease. The pathogenic organism transferred is a flagellate protozoan known as *Trypanosoma*.

- Reservoir in humans, armadillos, rodents, monkeys and various mammals.
- Associated with the bite of the vector.
- Associated with vector fecal matter (dropped at bite site).
- Rapid disease progression.
- Recovery begins the chronic stage.
- Possible sudden death from cardiac destruction.

Blood-sucking conenose (*Triatoma* sp)



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ENCEPHALITIS

- Reservoir by wild birds.
 - Eastern Equine Encephalitis – 90% mortality within 3 days.
 - Western Equine Encephalitis – 50% mortality, no treatment.
 - Venezuelan Equine Encephalitis
 - St. Louis Encephalitis
 - West Nile Virus – infective to ~200 animal species.

➤ Symptoms - fever, drowsiness, paralysis, death.

The first recorded incidence of West Nile Virus was in Queens, New York in 1999. Since then with the high distribution of migrating birds, West Nile Virus has been found in most of the United States and areas neighboring North America.

For more information on West Nile Virus, please see:
<http://www.cdc.gov/ncidod/dvbid/westnile/surv&control03Maps.htm>

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MALARIA

- Four species
 - *Plasmodium falciparum* – severe; often fatal
 - *P. malariae*,
 - *P. vivax*
 - *P. Ovale*

➤ Vectored by genus *Anopheles*

The adult mosquito takes a blood meal containing the sexual stages (microgamete male and macrogamete female) from an infected host. These stages fertilize in the gut of the mosquito and bore through the gut wall making an oocyst. The oocyst develops into an infective stage called a sporozoite. The oocyst ruptures, and the infective sporozoites travel up to the salivary glands of mosquito and are injected into the next host during the blood meal.

- Symptoms - cycle of fever and chills that last several hours and **reoccur every three to four days**. If untreated, the spleen and the liver become enlarged, anemia develops, and jaundice appears.

- Death may occur, especially in infants, elderly, and pregnant women.



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Learning Game Placeholder
 Learning Game: Choices
 Title: Disease Quiz

CASE STUDY 1

The three case studies are to be read, so have no audio.

Laura Bush has been promoting her Foundation for America's Libraries to multicultural groups in front of the waterfront bookstores in the Tampa Bay area. On her way home, she unexpectedly drops in at your place to spend some time learning about the best college in the nation, UF. After a few precious hours of relaxation sitting on the couch, eating some Reptile Ripple ice cream and watching WRUF on TV, she begins to complain about flu-like symptoms including a headache, fever, and severe aches and pains. You notice she has some mild acne (red, swollen spots). You tell her to go lay down for a while and ask if she would like to take some of the tetracycline you never finished from that ingrown toenail infection you had. She gladly accepts and crawls into your bed to sleep. Three days later she is feeling even worse and now has bleeding gums, terrible bruises, and is vomiting. Her personal doctor is flown in from the Mayo clinic and says that he can't figure out what's wrong with her. The secret service men take you into the kitchen, turn on the stove, and demand you tell them what you have done and what really was in those pills. To save yourself from terrible "accidental" burns you must come up with a logical explanation of her symptoms, and do it fast. You can't blame this one on the Noles.

Which insect transmitted disease do you think she has?

Points:
 fever, headache, pain, skin rash, bruises,
 and bleeding gums (internal bleeding),
 Tampa waterfront area (mosquitoes), red swollen spots (bites?)



CASE STUDY 2

Your coach buddy, Will Muschamp, has just returned from a three-week tour of Africa where he taught the team how to be tough. He stopped in last Thursday to play a round of golf with you and soon began to complain of flu-like symptoms including a headache, fever, chills and body aches, as well as mild acne (red spots). By late Friday, his temperature had dropped, but yesterday, just before he was planning to leave, it rose back up sharply. Before you came to class this morning, his eyes were looking strange and he began to vomit blood. Your med-student roommate can't figure what the problem is and his large bodyguard, Doc, was beginning to look at you funny as you left. Before you go home today you had better have a good explanation of his symptoms or else!

Which insect transmitted disease do you think coach has?

Points:
 fever, chills, aches reoccurring symptoms, trip to Africa, red bites



CASE STUDY 3

Your uncle, Geraldo Rivera, has just returned from an extensive trip to Kosovo/Yugoslavia to interview rebels hiding out in the foothills. He then went on to Africa to interview the Gators on their toughening up tour. On his way home, he stops to visit you for the weekend and begins to complain of flu-like symptoms, high fever, aching joints, and mild acne. He tells you he had a strange rash on his leg in Africa but that it had gone away when a local medicine man applied elephant dung to it. You tell him to go lay down for a while and ask if he would like to take some of the tetracycline you never finished from that ingrown toenail infection you had. For the next couple of days he is extremely tired and spends most of the time sleeping in your bed. By the third day he is feeling better, though his left knee is still bothering him, and offers to pay off all your student loans if you can figure out what he had.

Which insect transmitted disease do you think he has?

Points:
 high fever, rash, aching joints, area of poor sanitation
 (rebel camp), cured with antibiotics



Learning Game Placeholder
 Learning Game: Choices
 Title: Review Quiz

CONCLUSION

Can you give an example of each of these?

- Mechanical Reactions
- Exsanguination
- Myiasis
- Toxins & Paralysis
- Allergic Reactions
- Entomophobia
- Arbovirus



Be sure to review all of the lesson objectives. This concludes unit 15 and this course. Remember to review all of your notes for the final exam and turn in your journal entries.

I know you are excited about the knowledge you have gained in Principles of Entomology. There are other distance courses offered in this department if you wish to further your entomological education. I hope you have enjoyed the class and good luck on the final exam.

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