**Leptospira**

*General*

- Gram-negative
- Aerobic
- Optimal growth temperature: 28-30°C
- Motile by periplasmic flagella

**General**

- Cork-screw shaped
  - Different from other spirochetes by the presence of end hooks
  - More tightly coiled than many other spirochetes

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**Leptospira**

- 13 pathogenic species in the genus
  - *Leptospira alexanderi*
  - *Leptospira alstonii*
  - *Leptospira borgpetersenii*
  - *Leptospira inadai*
  - *Leptospira interrogans*
  - *Leptospira fainei*
  - *Leptospira kirschneri*
  - *Leptospira licerasiae*
  - *Leptospira noguchii*
  - *Leptospira santorosai*
  - *Leptospira terpstrae*
  - *Leptospira weillii*
  - *Leptospira wolffii*

- 260 serovars within the species
  - *Leptospira interrogans*
  - *Salmonella enterica*

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*L. interrogans* is the most important pathogenic species

**General**

- *Salmonella enterica* serovar *Typhimurium*
**Leptospirosis**

- A systemic disease in humans and domestic animals, mainly dogs, cattle, and swine
- Fever, renal and hepatic insufficiency, reproductive failure

<table>
<thead>
<tr>
<th>Serovar</th>
<th>Hosts</th>
<th>Clinical conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>L. interrogans</em> serovar Harding</td>
<td>Cattle, sheep</td>
<td>Abortions, stillbirths, agalactia</td>
</tr>
<tr>
<td></td>
<td>Humans</td>
<td>Influenza-like illness; occasionally liver or kidney disease</td>
</tr>
<tr>
<td><em>L. interrogans</em> serovar Icterohaemorrhagiae</td>
<td>Cattle, sheep, pigs</td>
<td>Acute septicemic disease in calves, lambs, piglets; abortions</td>
</tr>
<tr>
<td></td>
<td>Dogs, humans</td>
<td>Peracute hemorrhagic disease; acute hepatitis with jaundice</td>
</tr>
<tr>
<td><em>L. interrogans</em> serovar Pomona</td>
<td>Cattle, sheep</td>
<td>Acute hemolytic disease in calves and lambs; abortions</td>
</tr>
<tr>
<td></td>
<td>Pigs</td>
<td>Reproductive failure</td>
</tr>
<tr>
<td></td>
<td>Horses</td>
<td>Abortions</td>
</tr>
</tbody>
</table>

**Habitat**

- Broad host spectrum
  - *Leptospira* have been isolated from 220 animal species
- Common in hot and humid climates
- *Leptospira* survive in ponds, surface water, and in moist soil
- Pathogenic *Leptospira* can persist in the proximal tubules of the kidney or in the genital tract of carrier animals

**Transmission**

- Leptospires in the proximal tubules of the kidney
  - (The natural habitat for most serovars)
  - Large numbers may be shed in the urine
  - Transmission occurs by:
    - Direct contact with urine
    - Indirectly through urinary contamination of food, water, or soil
- *Leptospira* survive in ponds and other small bodies of water
  - Leptospirosis is more common in ‘moist warm environments’
**Transmission**

- **Common entries:**
  - Through penetration of mucous membranes of **eyes**, **mouth**, **nose**, **abraded skin**
  - **Venereal transmission** is possible in animals
  - Ingestion of water or food contaminated with urine from infected animals

**Invasiveness**

- **Leptospira** aggressively invade tissues
  - A few seconds contact for penetration into mucous membranes

**Leptospirosis: Maintenance hosts**

- **Maintenance hosts (Reservoir hosts):**
  - Do not usually become clinically ill
  - Antibody titers are never high and fall rapidly
  - The organisms reside in the kidney and are shed in the urine
  - Shed the organisms for months to years
  - Common maintenance hosts and serovars:
    - Rats: Icterohaemorrhagiae
    - Dogs: Canicola
    - Cattle: Hardjo
    - Raccoons: Grippotyphosa
    - Swine: Pomona
**Leptospirosis: Incidental hosts**

- **Incidental hosts**
  - Can develop a high fever and become acutely ill
  - Hosts tend to develop high antibody titers
  - Shed the organism but not for long term
  - Disease may take the form of a severe hepatitis with jaundice
  - Disease is commonly manifested as an acute nephritis of varying severity that can be followed by a chronic nephritis

- **Reproductive disease**
  - Humans, most domestic animals and wildlife
  - Leptospires enter the placenta through maternal circulation
    - Migrate to the fetus
    - Abortion, stillbirth, animals born weak

**Pathogenesis**

- **Initial bacteremia (4-7 days)** in both hosts (maintenance and incidental)
  - Primary multiplication in the liver
  - Spread to various body sites

- **Initiation of immune response in both hosts**
  - Leptospires are cleared away from the blood

- The organisms may localize in the kidneys, brain and lungs

- **Leptospires enter placenta through maternal circulation**
  - Migrate to fetus
  - Abortion

- **Carrier state: after recovery** → shed bacteria in the urine
  - Most rodents, some mammals, not in humans

**Leptospirosis: Cattle & Swine**

- **Cattle**
  - Frequent abortion without premonitory signs
  - Stillbirths
  - Hemolytic anemia, icterus
  - Serovar: Hardjo, Pomona, Grippotyphosa, Icterohaemorrhagiae

- **Swine**
  - Clinically very similar to bovine leptospirosis
  - Abortion
  - Fever, icterus, anemia, meningencephalitis
  - Serovar: Pomona, Bratislava, Grippotyphosa, Icterohaemorrhagiae

**Leptospirosis: Dogs**

- **Dogs**
  - "Extremely severe disease"
  - Acute hepatitis, nephritis, meningitis and chronic nephritis
  - Serovar: Canicola, Icterohaemorrhagiae

- [Canine kidney images showing normal and chronic nephritis caused by Icterohaemorrhagiae]
Leptospirosis: Horses and others

- Horses
  - Abortions, stillbirths, weak foals
  - Serovar: Pomona, Brastislava

- Sheep and goats
  - Not recognized as being common

- Birds
  - Do not appear to be susceptible

- Cats
  - Contact with rodents quite often ➔ but rarely infected

Leptospirosis: Humans

- Humans
  - The organism enters through the skin (cuts or scratches) or through the nose, mouth, or eyes.
  - An occupational hazard: soldiers, slaughterhouse workers, farmers, veterinarians
  - Flood is frequently associated with large outbreaks of leptospirosis
  - Geographical distribution in tropical, subtropical zones
  - 1/3 human infections from dogs, 1/3 from rats, human-to-human transmission is rare

Humans

- Disease can be from mild to fatal
- Weil's disease (a severe form of human leptospirosis)
  - Adolf Weil (the University of Heidelberg) 1886
  - “…infectious disease accompanied by splenomegaly, jaundice and nephritis”
- Pink eye, fever, chills, headache, jaundice, aching muscles, respiratory distress
- Occasionally, severe hepatic or renal failure results in death ➔ mortality exceeding 15%
- Often associated with Icterohaemorrhagiae
- Canicola and Pomona often cause mild disease

Diagnosis

- Can be difficult
- Serological test
- Detect antibody against leptospires in serum of infected animals
- Microscopic Agglutination Test (MAT): most commonly used by mixing patient serum with a panel of Leptospira serovars
- ELISA
- Culture
  - Most accurate method, but very time consuming eg. 7-10 days to 16 weeks
  - Once the organisms are grown, they can be serotyped
  - Restriction Fragment Length Polymorphism (RFLP), Pulsed-Field Gel Electrophoresis (PFGE)
- Darkfield microscopy: relatively inaccurate
**Vaccination**

- Killed vaccines are available for humans and animals
  - However, vaccines give protection only against the serovar used in the vaccine

- Cattle and swine
  - Usually a pentavalent bacterin (Carnicola, Hardjo, Pomona, Grippotyphosa, Icterohaemorrhagiae)

- Dogs
  - Tetravalent (Carnicola, Pomona, Icterohaemorrhagiae, Grippotyphosa) or
  - Divalent (Carnicola, Icterohaemorrhagiae)

- Humans
  - In certain countries (e.g., China), human vaccines are available
  - No vaccine licensed in Canada

**Control and Prevention**

- **Antibiotics**
  - Penicillin and streptomycin may be useful
  - Doxycycline is often used in humans and dogs
  - The antibiotics alleviate clinical signs but do not clear leptospires from the kidneys
  - After clinically cured, animals can be a carrier

- **Prevention**
  - Elimination of carrier animals
  - Rodent control

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**Leptospira Story Time**

- Rodent carrier
- Vaccination
- Environment and Wildlife
- Domestic animals
  - Canicola
  - Icterohaemorrhagiae
  - Acute hepatitis, nephritis
  - Hardjo
  - Pomona
  - Grippotyphosa
  - Icterohaemorrhagiae
  - Abortion, stillbirth, icterus, hemoglobinuria
  - Pomona
  - Bratislava
  - Grippotyphosa
  - Icterohaemorrhagiae
  - Disease similar to cattle
  - Pink eye, jaundice, high fever, nephritis