Listeria

Erysipelothrix

**General**

- Gram-positive, non-spore forming rods
- Facultative anaerobes
- Grow over a wide temperature range (4 °C to 44 °C) tolerate pH (5.5 ~9.5) and 10% NaCl
- “Widely distributed” in herbage, feces of healthy animals, sewage etc
- Catalase (+), oxidase (-), H₂S (-)
**Motility**

- **Motile** via peritrichous flagella
  - Monotrichous
  - Lopotrichous
  - Amphitrichous
  - Peritrichous flagella

- **Tumbling motility**
  

**Presumptive Identification**

- **Gram stain**
  - Negative ?
  - Positive ?

- **Morphology**
  - Cocci ?
  - Bacilli ?

- **Spore formation**
  - Bacillus
  - Positive ?
  - Negative ?

- **Catalase**
  - Positive ?
  - Negative ?

- **Motility**
  - Positive ?
  - Negative ?

  ➔ Corynebacterium
Listeria species

- **Host range is wide**, with isolates from at least
  - 42 species of mammals + 22 species of birds
  - Others such as ticks, fish, crustaceans

- **Pathogenic**: *L. monocytogenes*, *L. ivanovii*

<table>
<thead>
<tr>
<th>Listeria species</th>
<th><em>L. monocytogenes</em></th>
<th><em>L. ivanovii</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep, cattle, goats</td>
<td>Encephalitis, abortion, septicemia</td>
<td>Abortion</td>
</tr>
<tr>
<td>Cattle</td>
<td>Mastitis (rare)</td>
<td></td>
</tr>
<tr>
<td>Dogs, cats, horses</td>
<td>Abortion, encephalitis (rare)</td>
<td></td>
</tr>
<tr>
<td>Pigs</td>
<td>Abortion, septicemia, encephalitis</td>
<td></td>
</tr>
<tr>
<td>Birds</td>
<td>Septicemia</td>
<td></td>
</tr>
<tr>
<td><em>L. ivanovii</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheep, cattle</td>
<td>Abortion</td>
<td></td>
</tr>
</tbody>
</table>

L. monocytogenes: Habitat

- **Ubiquitous in nature**
  - Capable of growth over a wide temperature range (4 ºC to 45 ºC)
  - Tolerate high salt

- **Primary habitat**
  - Soil, decaying vegetation (saprophyte)
  - Animal feed, silage, water, fecal material of domestic animals, sewage,, etc.

- **Asymptomatic fecal carriers in humans and many animal species**: About 1% of humans shed *L. monocytogenes*
Listeriosis in Ruminants

- Ingestion of contaminated silage
  - The organism can multiply in silage which has not fermented properly (pH > 5.0)

  Fermentation of silage
  1. To produce more nutrients
  2. Depletion of oxygen
     → Degradation of cellulose and hemicellulose to small sugars
     → Conversion of small sugars to lactic acids by lactic acid bacteria
     → Reduction of pH (about 4)
  3. Affected by oxygen and moisture content

- L. monocytogenes may enter via the nasal mucosa and conjunctivae

Listeriosis in Ruminants

- Encephalitis
  - Circling disease (may circle in one direction) in ruminants
  - Depression, weakness, fever, incoordination, blindness, push against objects, unilateral facial paralysis
  - High mortality (Death in 2-3 days)

- Abortion
  - Listeria may infect the uterus of domestic animals, especially ruminants
  - Mother is asymptomatic and recovers completely

- Ventral form
  - Occur in septicemic listeriosis
  - Small necrotic foci may be found in any organs especially the liver
**Listeriosis in Humans**

- Do not cause illness in general population
- Risk groups
  1. Pregnant women and their unborn/newborn babies
  2. Immunocompromised individuals
  3. Elderly individuals
- Diseases
  - GI disease, CNS disease, abortion, septicemia
- High mortality (15-40%)
  - Highest percentage of hospitalization among foodborne pathogens: 89.2% (FoodNet 2010, CDC)

**Listeriosis in Humans**

- Primarily a food-borne illness: zoonotic disease
  - Approximately 2,500 cases in the US annually resulting in 500 deaths
  - *Listeria* outbreak of Maple Leaf Foods in Canada 2008: caused 23 deaths including a death in PEI
Listeriosis: Pathophysiology

[Diagram showing the pathophysiology of Listeriosis, including ingestion of L. monocytogenes, septicemia, bacteremia, placenta, abortion, neonatal septicemia, and involvement in the liver.]

Vázquez-Boland, J.A. et al., 2001
**L. monocytogenes: Intracellular life**

- Capacity to invade and multiply within host cells including macrophages
- Internalin (InlA): host cell invasion
- Listeriolysin O (LLO): crucial role in escaping from the phagolysosome
- Phosphatidylinositol-specific phospholipase C (PI-PLC): escape from vesicle
- ActA: mediate actin polymerization

**Diagnosis and Treatment**

**Diagnosis**

1. Specimens: brain, aborted placenta and fetus
2. Listeriosis is confirmed by isolation of *L. monocytogenes*
   - *Listeria* can be enriched by incubating 4°C: “cold enrichment”
3. Various selective media available

**Vaccine**

1. Avirulent live vaccines have been used in some countries with reported good protection
2. Vaccination is equivocal since the disease is too sporadic

**Treatment**

1. Penicillin (the drug of choice), Ceftiofur, Erythromycin, Sulfonamide
2. High doses are required

- Discontinue the use of the particular silage
**L. monocytogenes**

- Penicillin
- Ceftriaxone
- Silage
- Vegetation
- Human consumption
- Listeria in milk
- Mastitis
- Intestinal colonization
- Soil
- Listeria in meat or from environment
- Septicemia
- CNS infection
- Abortion

**L. ivanovii**

- Different from *L. monocytogenes*
  - *L. monocytogenes*: wide range of animal species
  - *L. ivanovii*
    - Almost exclusively associated with infections in ruminants, particularly sheep
    - Abortion, enteritis, and neonatal septicemia, but not meningoencephalitis
- Produces a very wide, clear or double zone of hemolysis on sheep or horse blood agar

![L. monocytogenes](image1)

![L. ivanovii](image2)
### Characterization

<table>
<thead>
<tr>
<th>Species</th>
<th>Beta-Haemolysis</th>
<th>Nitrate reduction</th>
<th>Acid produced from</th>
<th>Virulence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mannitol</td>
<td>Rhamnose</td>
</tr>
<tr>
<td>L. monocytogenes</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>L. ivanovii</td>
<td>++</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>L. innocua</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>L. welshimeri</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>L. seeligeri</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>L. grayi</td>
<td>-</td>
<td>V</td>
<td>+</td>
<td>V</td>
</tr>
</tbody>
</table>

### CAMP test

- Christie, Atkin, and Munch-Peterson

<table>
<thead>
<tr>
<th></th>
<th>Hemolysis enhancement with</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Staphylococcus aureus (S)</td>
<td>Rhodococcus equi (R)</td>
</tr>
<tr>
<td>L. monocytogenes</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>L. ivanovii</td>
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<td>+</td>
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<td>L. seeligeri</td>
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![Diagram of CAMP test](image)

*: Hemolysis enhancement
**CAMP Test**

<table>
<thead>
<tr>
<th>S. aureus</th>
<th>R. equi</th>
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<tr>
<td>L. monocytogenes</td>
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<td>L. ivanovii</td>
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</tbody>
</table>

Hemolysis enhancement with

- **Biochemical identification**
- **Fluorescent antibody**
- **Nucleic acid**

**Various Commercial Kits**

- Microbact™ 12L
- MICRO-ID Listeria
- BioControl System
Listeria

Erysipelothrix

- **Gram-positive, slender rods**, tend to become filamentous in old cultures, \(\alpha\)-hemolysis

- **Habitat**
  - Sewage, soil, tonsils and intestines of many animal species, especially pigs, turkeys, sheep and cattle

- Survives for several months in animal tissues such as frozen or chilled meat, smoked ham, and dry blood
  - Survive in swine feces for up to 6 months at \(<12^\circ C\)
  - Resists drying and remains viable in soil many months
Compared with Listeria

- Similar to *L. monocytogenes*. In general, *E. rhusiopathiae* rods are longer

<table>
<thead>
<tr>
<th></th>
<th>Catase</th>
<th>Oxidase</th>
<th>Motility</th>
<th>β-hemolysis</th>
<th>H₂S</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>L. monocytogenes</em></td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td><em>E. rhusiopathiae</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

- Only few Gram-positive are H₂S pos
  sulfur+sulfur reductase → H₂S +iron → ferric sulfide (black)

Presumptive Identification

- **Gram stain**
  - Negative ?  Positive ?

- **Morphology**
  - Cocci ?  Bacilli?

- **Spore formation**
  - Bacillus

- **Catalase**
  - Positive ?  Negative ?

- **Motility**
  - Listeria  Positive  Negative  Corynebacterium
### E. rhusiopathiae: Diseases

| Pigs            | • Route of entry is not known, but associated with wounds  
|                 | • Three basic manifestations can occur in sequence or separately  
|                 | - Acute: Septicemia with acute lameness, high fever, deaths  
|                 | - Sub-acute: Skin form (diamond skin disease)  
|                 | - Chronic form: Endocarditis and arthritis  
| Turkeys         | • An important disease in turkeys  
|                 | • Enters via fight wounds  
|                 | • Septicemia, arthritis  
|                 | • See more often in males  
| Humans          | • Cause “erypsipeloid” (non-suppurative)  
|                 | • Enter via wounds, handling infected swine and pork, fishermen from fish  
| Lambs           | • Polyarthritis  
| Dolphins        | • Fatal septicemia  

### Erypsipelas

- An important disease in **pigs and turkeys** and a sporadic disease in many other animals  
- A disease mainly in growing pigs (>12 wks) ➔ Economic loss  
- Cause, fever, arthritis, and sudden death  
- “Diamond-shaped skin lesions” almost anywhere on the body  
  - If untreated, the lesion may become necrotic  
- Endocarditis: Bacteria within the blood system can cause heart disease  
- Arthritis
Erypsipeloid in humans

- *E. rhusiopathiae* causes:
  - “Erypsipelas” in swine and turkeys
  - “Erypsipeloid” in humans – occurring on the hands of individuals who handle infected animals eg. workers on farms and in slaughterhouses, veterinarians
- Enlarged red or purplish swollen area
- Rarely serious or life-threatening

Erysipelothrix rhusiopathiae

- **Diagnosis**
  - Clinical signs – typical diamond-shaped lesions
  - Cultures - organisms can be isolated from skin biopsy
  - ELISA test

- **Vaccination**
  - Routine in swine and turkeys
  - Killed bacterins or attenuated vaccines

- **Treatment:** Penicillin is very effective