THE UNIVERSITY OF VERMONT EXTENSION

What Is Johne's Disease?

by Whitney Hull and Julie Smith, DVM, PhD

Johne's disease results from a chronic bacterial infection of the intestines and other tissues. It is transmitted from an infected animal to herdmates primarily via the fecal-oral route. Johne's disease is predominantly subclinical, meaning infected animals do not show outward signs of illness. This makes identifying infected cattle and managing the disease difficult. However, with diligence and patience, a herd's level of infection can be reduced.

Weight loss, a sign of Johne's disease, is evident in this Guernsey cow. Signs of this disease are not always as obvious.

This Holstein cow does not have any apparent health problems, but could be shedding Johne's disease bacteria.

How Many Herds Are Infected?

Given the noteworthy subclinical nature of the disease, it is difficult to determine the exact number of herds infected with Johne's disease. Best estimates indicate that infection likely exceeds 50 percent in countries with significant dairy industries.[1]

Could My Herd Be Infected?

Johne's disease can be found on farms where cows are not showing clinical signs. Work with your veterinarian to assess your herd's risk and conduct appropriate tests. The best way to determine whether your herd is infected is to conduct an environmental screening test.

What Animals Get Johne's Disease?

Johne's disease typically affects domestic ruminants such as cattle, sheep, and goats. Camelids and ruminant wildlife such as deer and bison can also contract Johne's disease. Rabbits have been shown to excrete the bacteria that cause Johne's disease into the environment.[11]

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Johne's Disease Facts

Johne's is pronounced 'Yoh-neez' or 'Yo! knees'

Also called paratuberculosis, Johne's disease is caused by bacteria related to the cause of tuberculosis.

The bacterium's full name, *Mycobacterium avium* subspecies *paratuberculosis*, is sometimes abbreviated MAP.

Johne's disease is very difficult and cost prohibitive to treat. Practically speaking, it is incurable.

Johne's disease can affect domestic and wild ruminants.

Guernsey cow (L) photo credit: Michael Collins, DVM, Univ. of Wisconsin Johne's Information Center.

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THE UNIVERSITY OF VERMONT EXTENSION

Why Care About Johne's Disease?

by Whitney Hull and Julie Smith, DVM, PhD

The Benefits of Controlling Johne's Disease

Johne's disease imposes hidden costs on herd health and profitability.

1 MORE MILK IN THE TANK: MORE MONEY IN YOUR POCKET

Production declines rapidly for cows in the advanced stage of disease, and life-time production is reduced for clinical cows.[14] While the annual losses can be hard to quantify due to the subclinical nature of the disease, estimates indicate that Johne's disease costs U.S. dairy farmers $33 per cow each year in lost revenue.[12]

2 FEWER INVOLUNTARY CULLS: HIGHER VALUE CULLS

As the infection progresses, animals with high-positive test results are at a greater risk for culling. Reasons for premature culling include decreased milk production, poor pregnancy rates, and disease control.[15] Affected cattle with thin body condition have reduced value at slaughter.[7] Cows known to be infected should not be sold for dairy without disclosing their status.

3 HEALTHIER COWS

Biosecurity practices used to prevent the spread of Johne's disease also reduce the spread of other fecal -oral transmitted disease organisms such as Salmonella, E. coli, Coccidia, and Cryptosporidium (Crypto).[14]

4 INCREASED FOOD SAFETY

Organisms like Salmonella, E. coli, and Cryptosporidium pose a risk to human health as foodborne illnesses. Biosecurity practices to mitigate Johne's disease can also reduce the circulation of other pathogens and increase the safety of the food supply.

A healthy Jersey cow.

A healthy Jersey calf.

Is Johne's Disease a Risk to Human Health?

While difficult to prove cause and effect, the bacteria that cause Johne's disease have been associated with Crohn's disease in humans in some studies.[9] Further research is needed to better understand if there is a causal link between Johne's and Crohn's diseases.

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Johne's Disease Facts

Cows affected by Johne's disease suffer a costly yield drag of 5-15 percent.[7]

Managing Johne's disease simultaneously reduces the risk of spreading other costly diseases.

Your herd may be inadvertently affected by purchasing new animals.

Only awareness and management can prevent Johne's disease from further spread among ruminants.

Additional resources on Johne's & Crohn's diseases:

- Johne's Information Center - https://www.johnes.org/
- Crohn's and Colitis Foundation - https://go.uvm.edu/rb1ps

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THE UNIVERSITY OF VERMONT EXTENSION

What Causes Johne's Disease?

by Whitney Hull and Julie Smith, DVM, PhD

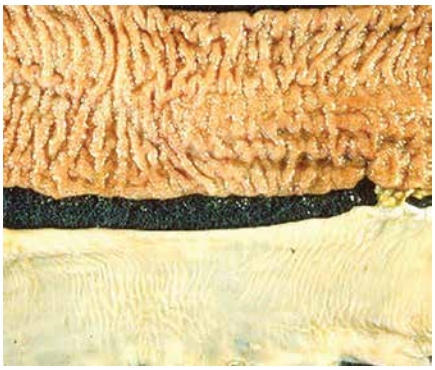
Mycobacterium avium subspecies *paratuberculosis* (abbreviated MAP) causes Johne's disease. MAP only reproduces inside of the cells of host animals. Many different strains of MAP exist, but all strains of MAP infect animals in a similar way.

MAP Is a Tough Bug

It is very difficult to eliminate MAP from a herd because it persists for a long time in the environment.

Survival of MAP in fields, pastures, and water can exceed one year. MAP bacteria have also proven to be resistant to the low pH of fermented feed.[5]

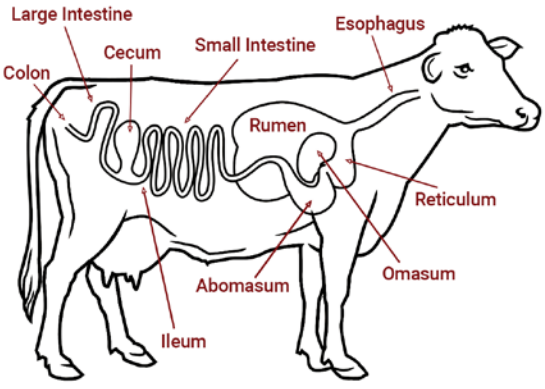
While the bacteria cannot multiply in the environment, an animal consuming water, pasture, or feed that has been contaminated with MAP could potentially become infected.



A cow ileum with thickened lining (top) is contrasted with a normal cow ileum (bottom). *Photo credit: Michael Collins, DVM, UW Johne's Information Center.*

MAP is resistant to many antibiotics and disinfectants and can survive in hot and cold conditions.[2] Disinfectants labeled tuberculocidal are effective, if organic materials are removed first.

MAP Infection of the Ileum



MAP primarily infects the ileum, or the end portion of the small intestine, by invading macrophages in areas of lymphoid tissue called Peyer's patches.

From there MAP migrates to and infects regional lymph nodes, primarily the mesenteric lymph nodes located near the small intestine.

In later stages of infection, the response to MAP causes thickening of the intestinal wall, which leads to poor absorption of nutrients. MAP may be found in many tissues and organs,[10] including reproductive organs.[2]

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Johne's Disease Facts

- MAP can evade immune system defenses.
- MAP can survive in the environment, but only multiplies within a host.
- MAP can survive a long time in the environment, at least 8 months in manure and over a year in water.
- MAP is resistant to many common disinfectants.
- The manure pit is usually sampled for herd screening.
- Environmental sampling or composite manure samples can assist in determining a herd's infection status.

Photo credit: USDA NRCS

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THE UNIVERSITY OF VERMONT EXTENSION

How Does Johne's Disease Spread?

by Whitney Hull and Julie Smith, DVM, PhD

While MAP (*Mycobacterium avium* subspecies *paratuberculosis*) can infect cattle of all ages, calves are considered most susceptible to infection. Environments in direct contact with adult cows are more likely to be contaminated, especially if any of those cows have high-positive test results.

The ingestion of MAP-laden manure via contaminated feed, milk, or water is the primary means of transmission. Teats of non-infected cows can carry infective MAP bacteria from the environment. Ingestion of MAP can occur when a calf suckles, via pooled colostrum from infected cows, when equipment is used to handle both manure and feed, or when manure contaminates a water source. Also, animals that come into contact with manure of other animals, for example at shows or fairs, could be at risk.[2]

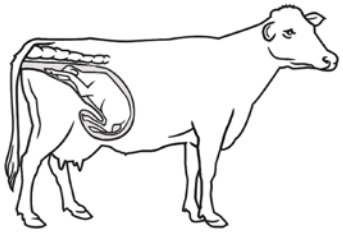
Milk and Colostrum

Animals in the later stages of infection can shed MAP in their milk and colostrum.

Feed and Water

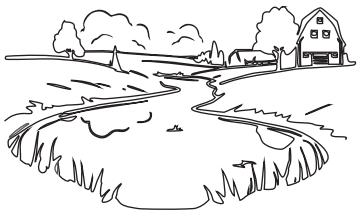
Contamination of feed and water is difficult to avoid with an infected herd.

Placental Transport



Fetal infection is more likely with dams in later stages of the disease.[20]

Contamination



Contaminated ponds & pastures are other transmission routes.[2] MAP can also survive ensiling.[5]

Other Routes

Semen from infected bulls could transmit infection to a herd.

MAP Incubation Period: Months to Years

Infected cattle begin shedding MAP after an incubation period that can last years. Animals infected with MAP before or immediately after birth may not show clinical signs for two to 10 years! Furthermore, animals often begin shedding the organism into the environment one to 2.5 years before exhibiting clinical signs. This means by the time an animal is diagnosed with Johne's disease, it may have transmitted the disease to other animals.

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Johne's Disease Facts

Johne's disease is usually "purchased." Even a closed herd of many years can harbor MAP.

Fecal-oral transmission is the primary route of MAP spread.

An amount as small as a thimbleful of manure can infect a calf.

Infected animals usually begin shedding MAP into the environment over a year before showing clinical signs.

Johne's disease is subclinical during its long incubation period. It is present but does not create noticeable signs.

Not all transmission routes can be controlled. Fetal infection is beyond a farmer's control. Focus on what can be controlled.

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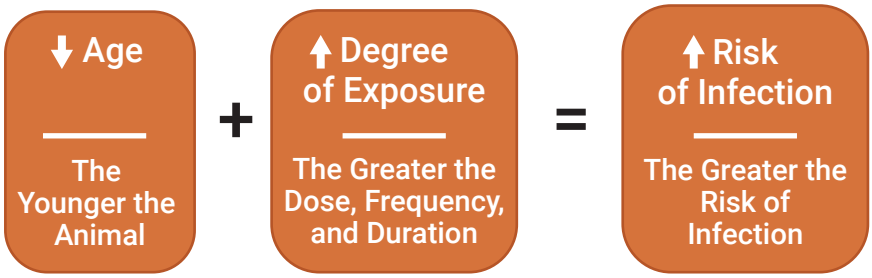
THE UNIVERSITY OF VERMONT EXTENSION

What Influences Risk of Infection?

by Whitney Hull and Julie Smith, DVM, PhD

An animal's age at exposure to MAP (*Mycobacterium avium* subspecies *paratuberculosis*), combined with the dose of infective material, are important factors in determining the risk of developing disease later in life. An animal that encounters MAP does not necessarily develop Johne's disease.

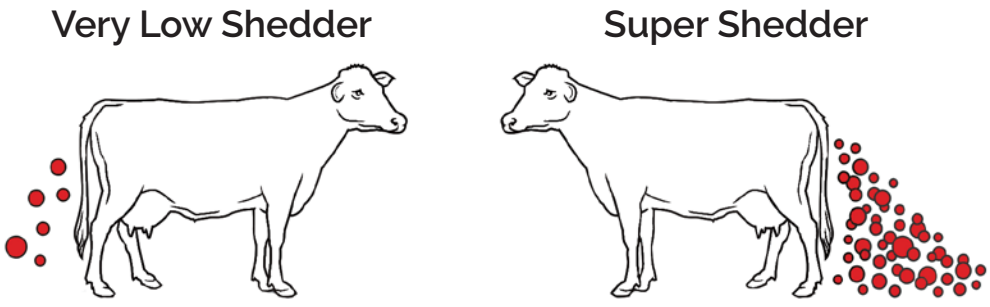
Calves are the most susceptible to infection and can go on to develop the most severe disease. As animals get older, the likelihood of becoming infected with MAP decreases. Larger doses of the organism ingested, increased frequency and duration of exposure, and greater density of animals all increase the risk that an animal will become infected.[16]



One Infected Animal, a Heavily Infected Herd?

The amount of MAP shed from one cow can range from only hundreds to over billions of bacteria per day. Cows shedding over 10,000 colony forming units (CFU) of MAP per gram of manure are considered "super shedders." Cows with clinical signs are typically shedding well over this amount.

While a herd may only have a few "super shedders" at one time, these animals can shed billions of bacteria into the environment and increase exposure risk of other animals in the herd.[6]



An infected herd usually has more low shedders than heavy shedders or super shedders. Infected animals should be culled before they become super shedders.

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Johne's Disease Facts

Young calves are at the highest risk of MAP infection, but adult cattle can be infected, too.

Why are newborn calves so susceptible?

During the first 24 hours of life when passive transfer of immunity occurs, MAP can also cross the gut lining. MAP initiates infection in specialized gut immune tissue called Peyer's patches.[19]

During passive transfer, antibodies as well as bacteria can enter a newborn's blood system.

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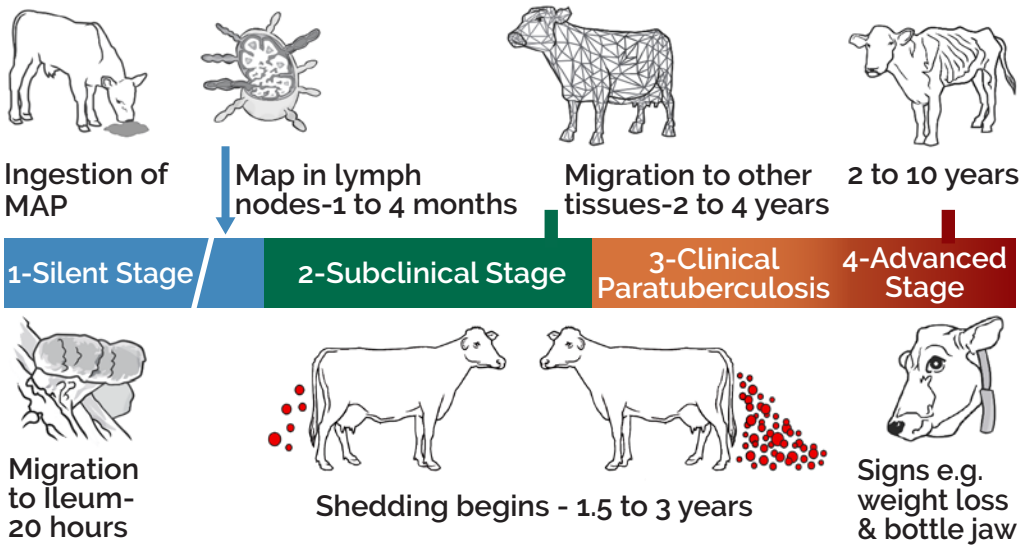
THE UNIVERSITY OF VERMONT EXTENSION

How Does the Infection Progress?

by Whitney Hull and Julie Smith, DVM, PhD

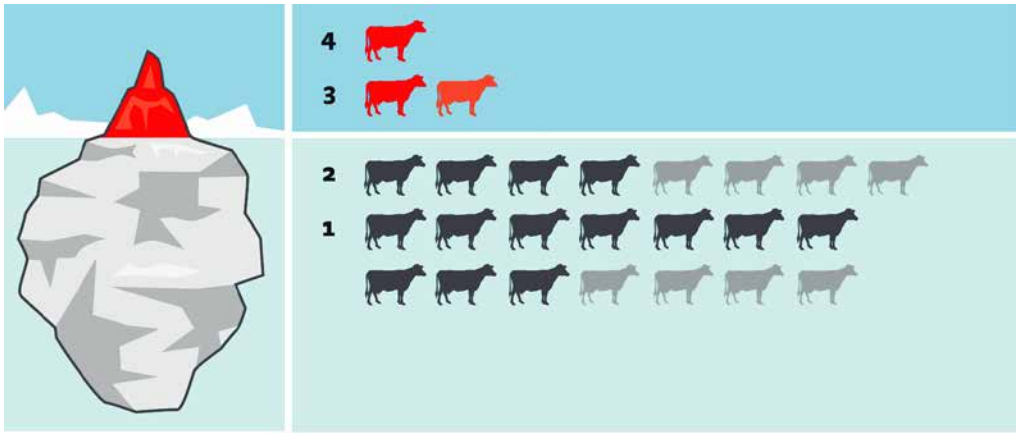
The Timeline of Johne's Disease Events



Signs of Johne's Disease: The Tip of the Iceberg

The distribution of MAP (*Mycobacterium avium* subspecies *paratuberculosis*) infected cattle among the four stages of the disease resembles an iceberg.

For every animal in stage 4, the advanced stage, there are approximately 1 to 2 in the clinical stage, 4 to 8 in the subclinical stage, and 10 to 14 with silent infections. Only 30 percent of these infections would be detectable by tests. That is why a clinical cow is just the tip of the iceberg as many other cows may be unknowingly infected.[19]



This figure represents the approximate number of cattle infected in a herd where one cow is identified in the advanced stage of Johne's disease.

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Stages of MAP Infection

1. The first stage of infection is "silent" and undetectable by tests, yet MAP is invading immune tissues. Animals in this stage are not shedding organisms.
2. Subclinical adults begin shedding small amounts of MAP. The infection begins to migrate to other tissues. Some cases may be detected by fecal culture. This stage can last many years.
3. Clinical cows shed large amounts of MAP and may show symptoms such as intermittent diarrhea and gradual weight loss, caused by reduced nutrient absorption. Fecal and serological tests can detect clinical animals.
4. Cows with advanced disease exhibit lethargy, emaciation, and persistent diarrhea. Bottle jaw, or edema under the jaw, can also be present.

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THE UNIVERSITY OF VERMONT EXTENSION

Should I Test for Johne's Disease?

by Whitney Hull and Julie Smith, DVM, PhD

Develop a Testing Strategy With Your Veterinarian

Your veterinarian can develop a testing strategy based on your goals, and they will interpret the results.

Testing is useful to:

- Screen a herd for the presence or prevalence of Johne's disease.
- Confirm a diagnosis in an animal exhibiting clinical signs.
- Monitor and inform a Johne's disease management plan.

Examples of Goal-Directed Testing Strategies

Is this herd infected?

Testing of environmental or pooled fecal samples is the simplest and most cost effective way to establish herd status. Screening tests of each animal can be used to estimate what proportion is infected (that is, the herd prevalence). For most purposes the herd prevalence estimate from a risk assessment is adequate to inform the interpretation of subsequent test results.[4]

Is this animal infected?

To confirm a suspect or clinical diagnosis, use an organism detection test such as fecal culture or polymerase chain reaction (PCR). This is done when a cow has a positive ELISA (enzyme-linked immunosorbent assay) result during herd screening, or a cow is exhibiting clinical signs of the disease.

How are we doing with reducing herd prevalence?

Routine testing can be used to make decisions and track progress towards reduction and eradication of Johne's disease. The goal is to remove infected cows before fecal shedding occurs and clinical signs develop.[14]

Sources of Frustration and How to Cope

- Recognize that test results are sometimes inaccurate. False positive and false negative test results are possible. Work with a veterinarian you trust to interpret the results for your herd.
- Animals in early stages of infection may not mount an immune response or shed MAP. These animals will appear negative on all tests. These are false negatives.
- Passive shedding or "pass through" shedding can occur when uninfected animals ingest and excrete MAP in highly contaminated herds. These animals can be false positives. Some will become truly infected.
- Be patient. Monitor test results over time to assess progress.

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Johne's Disease Facts

Can the level of environmental contamination tell me how many animals are infected?

Greater environmental contamination can indicate that more animals are shedding or that a super shedder is present.

Establishing good management practices is key to controlling the spread of Johne's disease.

Develop a plan for introducing new animals to ensure risk to the rest of the herd remains low.

Testing at the herd or individual level is a tool to inform better management and culling decisions.

The perfect test may not exist, but available tests are adequate to successfully control Johne's disease with supporting management.

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THE UNIVERSITY OF VERMONT EXTENSION

What Do the Test Results Mean?

by Whitney Hull and Julie Smith, DVM, PhD

The current tests for Johne's disease are not perfect, but if used appropriately, they can provide valuable information for understanding the disease in a herd and guiding management decisions. When interpreting test results, it is important to understand what positive and negative results can really mean.

Four Categories of Results

A. True negative -
Test negative and not infected.

B. False negative -
Test negative but infected.

C. True positive -
Test positive and infected.

D. False positive -
Test positive but not infected.

Imagine a farmer who tests 100 cows with an ELISA (enzyme-linked immunosorbent assay) that has a **sensitivity** of 40 percent and a **specificity** of 99 percent. If the actual prevalence of Johne's disease in the herd is 20 percent, the results might look like the following:

		TRUE ANIMAL STATUS +	TRUE ANIMAL STATUS —
TEST RESULT	+	8 C	1 D
TEST RESULT	—	12 B	79 A

More information on test interpretation can be found at:
www.uvm.edu/extension/johnes-disease

Key Points for Interpreting Test Results

- Animals less than 24–36 months of age are more likely to have false negative test results than older animals, so they are not usually sampled when screening a herd.
- Available tests do not have 100 percent sensitivity; that is, they do not detect all infected cattle.
- As more information is gained about the prevalence of Johne's disease in a herd, test interpretation improves.

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Johne's Disease Facts

Sensitivity

The proportion of infected animals a test correctly identifies as positive. Higher values of sensitivity mean a test will have fewer false negative results.

Specificity

The proportion of non-infected animals correctly identified as negative. Higher values of specificity mean a test will have fewer false positive results.

Herd prevalence determines the predictive values of tests. The higher the prevalence of disease in a herd, the more likely a positive test result will accurately reflect the true disease status of an animal.

Work with your veterinarian to help interpret Johne's disease test results.

No test is perfect. There may be false positive or false negative results based on the sensitivity and specificity of the test.

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THE UNIVERSITY OF VERMONT EXTENSION

Which Testing Strategy Should I Use?

by Whitney Hull and Julie Smith, DVM, PhD

Use an individual animal test to guide management decisions

IS THIS ANIMAL INFECTED?

1 2 3

1 Fecal Culture or PCR
Submit samples from individual animals. Some labs can pool up to five samples per test.

2 Postmortem Tissue Culture
Use to test cows that die on farm. Can confirm cases or find the first case in a herd with no history of Johne's disease.

3 Milk or Serum ELISA
These samples are generally easier to handle than fecal samples. Consult with a veterinarian to interpret results.

Use environmental samples to screen sources of replacements or to assess environmental contamination

IS THIS HERD INFECTED?

Pooled Fecal or Environmental Samples

Collect manure from areas where the herd or specific groups of animals commingle and also from manure storage.

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Johne's Test Strategies

Polymerase Chain Reaction

PCR tests use a specific DNA probe to detect a matching DNA sequence. It is faster and somewhat less expensive than culture with few false positives. A negative test means the animal is not shedding MAP; it does not mean the animal is uninfected.

ELISA (Enzyme Linked Immunosorbent Assay)

Most ELISAs are designed to detect antibodies generated by the immune system in response to a specific infectious disease agent. They are relatively inexpensive, but may produce false positive and false negative results.

Bacterial Culture

Used to grow MAP on special media under specific temperature and oxygen conditions. MAP is very slow growing, and it can take up to 16 weeks to get results. Overgrowth by other bacteria can be a problem. Fecal or tissue culture is the most expensive test, but has very few false positives.

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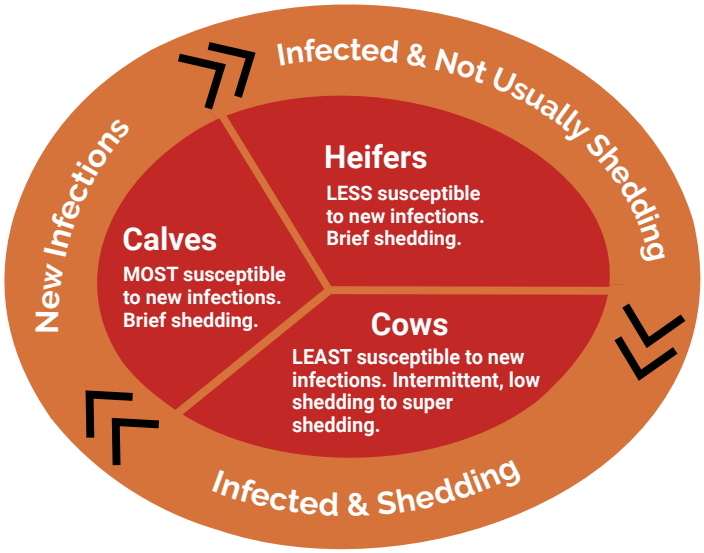
THE UNIVERSITY OF VERMONT EXTENSION

How Can Johnes Disease be Avoided?

by Whitney Hull and Julie Smith, DVM, PhD

Understand the Cycle of Infection to Avoid New Infections

Johne's disease is cyclical. Infected animals shed MAP (*Mycobacterium avium* subspecies *paratuberculosis)* bacteria into the environment. New animals then become infected through ingestion of MAP bacteria present in the environment.



Calf exposure pathways:
- During gestation
- Colostrum
- Other calves shedding
- Cows shedding

Heifer exposure pathways:
- Contaminated feed/water
- Other heifers shedding

Cow exposure pathways:
- Contaminated feed/water
- Other cows shedding

The diagram shows that in the cycle of Johne's disease, non-infected animals are exposed to MAP from infected shedding animals. As new animals are infected, they eventually begin shedding

Johne's Disease Can be Avoided

The best way to avoid bringing Johne's disease into a herd is to operate as a closed herd. However, if a herd purchases replacement heifers, cows, or bulls, caution must be taken when introducing new animals. When purchasing replacement animals, it is important to understand the limitations of available tests.

Herd screening tests can be helpful to understand herd prevalence of Johne's disease in the source herd. While an individual animal may test negative, it could be subclinically infected. A herd level positive test would indicate that the source herd has some level of infection, and purchasing replacements from this herd could put your farm at risk for introducing Johne's disease.

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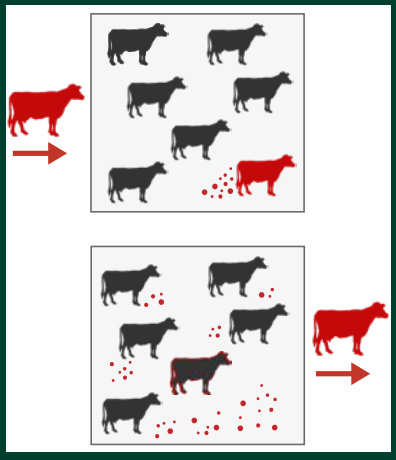
Johne's Disease Facts



Adding one cow can bring Johne's disease into a herd, but removing one positive cow may not remove Johne's disease from the herd.

A two-pronged approach is usually necessary to control Johne's disease: [3]

- **Use management practices to limit transmission of disease, especially to calves and other youngstock.**
- **Determine whether a testing strategy is right for your herd. Using an environmental screening test to determine herd prevalence can be a good first step.**

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THE UNIVERSITY OF VERMONT EXTENSION

How Can Johnes Disease be Minimized?

by Whitney Hull and Julie Smith, DVM, PhD

Prevent Exposure to Infected Manure, Milk & Colostrum

Calving Management

- One at a time in the calving pen.
- Clean calving pen after each use.
- Do not use calving pens as hospital pens.
- Keep calving pens clean, dry, and well-ventilated.
- Clean dam's udder and teats before calving.
- Remove newborn calf from dam ASAP.

Calving management is critical! Newborn calves are highly susceptible to infection by MAP and other pathogens.

Colostrum & Calf Feeding Management

Neonatal Calves

- Feed colostrum from individual cows. Do not pool colostrum.
- Collect colostrum after complete milking prep routine.

Pre-weaned Calves

- Feed milk replacer or pasteurized milk.

Keep feed clean and away from manure-contaminated tractors, skid steers, run-off, etc.

Contamination/Manure Management

- House calves and weaned heifers away from adult herd.
- Do not feed refusals from cows to younger animals.
- Use separate equipment for handling feed and manure.
- Avoid contaminating feed and water with manure.
- Minimize manure transfer from cow facilities to calves by cleaning boots and using separate equipment.
- Reduce exposure to manure from other farms and visitors.
- Use extra biosecurity precautions when working with sick cows.

Pastures should be designated for cows or heifers, not both.

Crop and Pasture Management

- Mature cattle and heifers should graze in separate pastures.
- Spreading of manure on fields used for forage is preferable to spreading on grazing pastures.
- Topdress manure as soon after harvesting forage as possible to allow ample time for environmental conditions to reduce MAP levels.

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Johne's Disease Facts

Johne's disease management points:

- Calving
- Colostrum
- Contamination
- Crops (or pasture)

Proper teat and udder cleaning is essential to prevent disease transmission.

- **Avoid exposure of animals to infected manure, milk, or colostrum.**
- **Avoid manure contamination of feed and water.**
- **Use separate equipment for manure and feed.**
- **Work from youngest to oldest animals to minimize disease spread to the most vulnerable animals.**

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THE UNIVERSITY OF VERMONT EXTENSION

Johne's Disease in Goats and Sheep

by Whitney Hull and Julie Smith, DVM, PhD

Both goats and sheep can become infected with MAP (*Mycobacterium avium* subspecies *paratuberculosis*). Johne's disease symptoms can look similar to those of internal parasites in goats and sheep.

The primary clinical sign is chronic weight loss despite normal eating behaviors.[8] Johne's disease may present with clinical signs in sheep and goats at a younger age than cattle, sometimes as early as 12 to 36 months of age.

Infection with Johne's disease weakens the immune system of small ruminants, which can also cause them to become infected with parasites.

Similar to transmission in cattle, Johne's disease is primarily spread via the fecal-oral route, in utero, or through milk and colostrum of infected ewes or does.[13]

Diagnostic tests used for cattle are not as accurate in small ruminants. ELISA (Enzyme Linked Immunosorbent Assay) tests are successful at identifying clinical cases in goats.

Management Recommendations

- Maintain a closed herd. Avoid buying new animals if possible.
- Purchase animals only from herds or flocks that test for Johne's disease and can provide herd status.
- Do not share rams or bucks without knowing the status of the animal or herd.
- Keep herds or flocks away from other species (cattle, wild ruminants) that could carry MAP.

Sources:

- Johne's disease in sheep and goats - https://www.canr.msu.edu/news/-johne-s-disease-in-sheep-and-goats [8]
- Robbe-Austerman, Suelee. (2011). Control of Paratuberculosis in Small Ruminants. Veterinary Clinics of North America: Food Animal Practice, 27(3), 609-620. https://doi.org/10.1016/j.cvfa.2011.07.007 [13]

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Johne's Disease Facts

Johne's disease is usually "purchased." Even a closed herd for many years may find that it harbors MAP.

Fecal-oral transmission is the primary route of MAP spread.

An amount as small as a thimbleful of manure can infect a lamb or kid.

Infected animals usually begin shedding MAP into the environment over a year before showing clinical signs.

Johne's disease is subclinical during its long incubation period. It is present but does not create noticeable signs.

Not all transmission routes can be controlled. Fetal infection is beyond a farmer's control. Focus on what can be controlled.

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THE UNIVERSITY OF VERMONT EXTENSION

Herd Health Goals and Action Plan

by Whitney Hull and Julie Smith, DVM, PhD

Goals for My Herd

Record 2-3 goals and action steps you and your management team identify.

Date:	
Goal 1	
Action Step 1	
Action Step 2	
Action Step 3	
Goal 2	
Action Step 1	
Action Step 2	
Action Step 3	
Goal 3	
Action Step 1	
Action Step 2	
Action Step 3	
Comments:	

Goal Setting

When formulating goals, consider:

Overall farm objectives:

- Does the farm want to maximize production, improve animal health, expand or reduce herd size?

Resources available:

- What labor, facilities, finances, replacements are available?

Health status of animals:

- Other health problems or management issues could be higher priority.

Timeline for achieving goals:

- Target dates will depend on current prevalence and aggressiveness of plan.

For more information, the following websites contain a wealth of information:

- Centers for Disease Control & Prevention, Food Safety - www.cdc.gov/food-safety/
- National Mastitis Council Information Central - www.nmconline.org/resources
- FARM (Farmers Assuring Responsible Management) www.nationaldairyfarm.com

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Herd Goals and Action Plan

Assess and Renew Your Herd Goals

Review your original goals. Have the goals for your herd changed?

Date:	
Goal 1	
Action Step 1	
Action Step 2	
Action Step 3	
Goal 2	
Action Step 1	
Action Step 2	
Action Step 3	
Goal 3	
Action Step 1	
Action Step 2	
Action Step 3	
Comments:	

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Action Plan Review

Have there been any changes to farm:

- Goals or objectives
- Resources
- Herd health
- Timeline

Every year, or as needed, you should schedule a time with your veterinarian to re-evaluate your goals and your herd status, and to adjust your action plan accordingly.

Additional plans can be printed at UVM Extension's Johne's disease website.

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