Johne's disease leaflet series

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Johne's disease

Frequently Asked Questions

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JOHNE'S DISEASE CONTROL PROGRAMME
Animal Health Ireland, 4-5 The Archways, Carrick-on-Shannon, Co. Leitrim, N41 WN27

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Frequently Asked Questions

Q1. What causes Johne's disease?

A bacterial disease of cattle

Johne's disease is caused by a bacterial infection. The name of the bacteria is *'Mycobacterium avium* sub-species *paratuberculosis'* which is commonly called '*MAP'*. Signs of Johne's disease are typically seen in animals that are between three and five years old but can occasionally be seen in animals that are younger than two years of age and in elderly animals.

Animals acquire *MAP* infection by mouth i.e. from colostrum, milk and feed, water or the general environment contaminated by dung/slurry from another infected animal shedding *MAP*. Calves born to infected cows may be born already infected. Initially the bacteria live mainly in the gut of infected cattle where they grow and cause damage very slowly. The bacteria can eventually spread from the gut to other parts of the body, being found in the muscle, milk, dung and the womb.

1. Which animals become infected when exposed to MAP?

Young animals (in the first months of life) are the most likely to become infected if exposed to MAP bacteria. The risk of becoming infected reduces as the animal gets older.

If an older animal is exposed to a large amount of *MAP* bacteria (e.g. in a herd where many animals are infected and shedding the bacteria) it may also become infected (Windsor and Whittington, 2010).

2. How long does it take for *MAP* infection to cause clinical disease?

An animal with a new infection will not show signs of disease and will appear to be healthy (Whitlock and Buergelt, 1996).

Disease can occur more quickly (after many months) when an animal is infected with a large amount of bacteria.

An infected animal can shed the bacteria to infect others before developing signs of disease.

See Q2: 'What are the signs of Johne's disease?' for more detail on these signs.

Johne's disease in calves and adults

Exposure to *MAP* bacteria usually leads to different outcomes in calves and adults.

Calves

- More susceptible to infection if they are exposed to *MAP*
- Rarely show signs even if they are infected.

Adults

- Are less likely to become infected when they are exposed to *MAP*
- Commonly develop signs once they have been infected for sufficient time.

See Q8: 'How does Johne's disease spread between animals on a farm?' for more details on how animals become infected.

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Q2. What are the signs of Johne's disease?

Typical signs include:

- Reduced production- lower milk yields and lower feed conversion efficiency
- Weight-loss despite a good appetite
- Scour (not bloody)
- Soft swelling of the jaw (bottle jaw) or brisket
- Death.

Signs develop with increasing time since infection, so that they become more obvious as an infected animal ages (Radostits et al., 2007).

A sub-clinical animal will also have reduced production, reduced fertility performance, reduced slaughter weight and slaughter value, reduced milk quality and increased susceptibility to other disease before the obvious signs occur, depending on the level of infection within the herd. The extent that these 'sub-clinical' affects occur is likely to vary between individual animals and herds (Merkal et al., 1975; Nordlund et al., 1996; Johnson et al., 2001; Gonda et al., 2007; Kudahl et al., 2009; P. Vázquez et al., 2012).

If animals are culled because of reduced performance, infertility or other disease, an infected herd may never have cows with the more obvious signs of Johne's disease.

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Q3. What are the stages of the disease?

MAP bacteria slowly damage the intestines of infected animals. The disease progresses as the gut becomes increasingly damaged. Progression can be described in 3 steps from the moment of infection.

Animals in the first months of life are most likely to become infected (stage 1) if exposed, although older animals may also become infected.

Animals may become **infectious** (stage 2) after a period of time (months to years) and shedding of *MAP* will increase as the disease progresses. As an animal may not become **affected** (stage 3) with clinical signs for many more years, undetected shedding from an infectious animal can continue for a long time (Weber et al., 2005).

Affected animals have been infected for a long time (many months to years) and are typically between three and five years old but can be younger or older. The clinical signs usually develop slowly (Radostits et al., 2007).

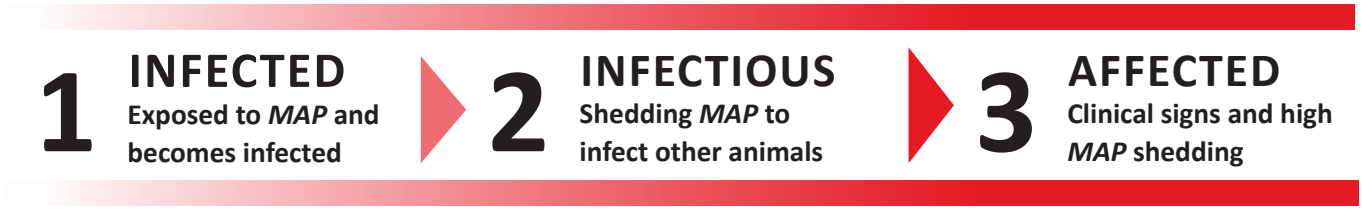

Figure 1. Johne's disease progression steps

The steps of an infection

1. An animal becomes infected

The newly infected animal appears healthy because there is little damage to the gut.

Animals acquire *MAP* infection by mouth i.e. from colostrum, milk and feed, water or the general environment contaminated by dung/slurry from another infected animal shedding *MAP*. Calves born to infected cows may be born already infected. Young animals are most susceptible to new infections. Bacteria are present in the small intestine and surrounding structures (called lymph nodes) where they cause very little damage. The animal fights the infection at these local sites but cannot get rid of the bacteria (Stabel, 2000).

In this early stage, almost no *MAP* bacteria will be shed although calves born infected or that become infected shortly after birth while in the calving pen or still with its dam can shed *MAP* and infect other new born calves. The animal does not produce any antibody and so antibody tests are not useful (Corbett et al 2017).

2. An animal becomes infectious

The animal still appears healthy but starts to shed *MAP* bacteria and can infect other animals.

Over a long period of time the bacteria slowly multiply damaging more of the intestines. The bacteria can now invade other areas of the body including the muscle, udder and womb.

Infectious animals will shed increasing amounts of bacteria in the dung and also start to shed in colostrum, milk and across the placenta to an unborn calf (Streeter et al., 1995; Whitlock and Buergelt, 1996; Whittington and Windsor, 2009).

Antibody may start to be produced, but only at low levels in a small proportion of infectious cows. Antibody tests will therefore fail to detect many infectious animals.

3. An animal becomes affected

The animals' performance starts to reduce. It loses weight despite continuing to eat well. Diarrhoea develops which gets worse and more persistent.

The bacteria continue to multiply and gut damage becomes severe. The local immunity is overcome allowing a rapid increase in bacterial growth. The animal now increases antibody production to try to fight the disease but this cannot stop the rapid increase in bacterial numbers (Stabel, 2000).

The increase in bacteria means that large numbers are shed in the dung. They continue to be shed in colostrum and milk and it is commonly spread to unborn calves in the womb (Whittington and Windsor, 2009).

The animal is now affected by the disease, typically starting with reduced performance. Eventually diarrhoea will develop which gets worse and more persistent. The animal will lose weight as feed conversion efficiency gets progressively worse and the gut is increasingly affected, may develop a soft swelling under the jaw, will become unable to rise and eventually will die from the disease (Radostits et al., 2007).

The increase in antibody production means that the antibody tests are better at detecting animals that are affected by Johne's disease.

Variable progression

There can be marked differences in the time it takes for the disease to move through these steps in different animals. Although the main signs (step 3) usually start between three and five years of age, they can start in animals that are younger or older than this (Windsor and Whittington, 2010).

The reasons for this difference are not fully understood, although the amount of bacteria that cause the initial infection and variability in the way individuals react to infection (genetic susceptibility) are probably involved (Sweeney, 1996; Whitlock and Buergelt, 1996; Koets et al., 2005; Kirkpatrick et al., 2011; Bermingham et al., 2010; Berry et al., 2010).

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Q4. What is the economic impact of Johne's disease on an infected farm?

Costs increase as prevalence increases

The economic impact of having Johne's disease in a herd depends on how many animals in a herd are **infected, infectious** and **affected** (Hutchinson, 1996; Ott et al., 1999; Lombard, 2011).

In herds with a very low prevalence it can be difficult to detect any economic loss (Hoogendam et al., 2009; Lombard, 2011).

However, where no attempt is made to prevent spread and more animals become infected over time, the economic impact will increase. An economic impact is consistently reported in herds with animals that have the obvious signs of Johne's disease (Hutchinson, 1996; Lombard, 2011).

See Q2 'What are the signs of Johne's disease?' for details of how Johne's disease progresses in an individual animal.

Johne's disease reduces production

The economic impact of Johne's disease occurs predominantly by:

- Reduced daily production. (This can begin when / before animals develop obvious signs).
- Reduced lifetime production due to early culling of animals with and without obvious signs and reduced salvage value when culled (Benedictus et al., 1987; Hutchinson, 1996; Lombard, 2011). A detailed review of previous international studies estimated the following to be associated with Johne's disease infected dairy cows (Chi et al., 2002):

Slaughter Value	**-25%**
Culling risk	**+25%**
Risk of death on farm	**+3%**
Days Open	**+28 days / year**
Milk Yield / Solids	**-16% to -25%**

In a large American study, the losses in infected herds compared to non-infected herds were:

€85 per cow per year	**For all infected herds**
> €170 per cow per year	**Once 10% of cull cows have obvious signs**

(Ott et al., 1999)

The economic impact in Ireland is less well known, though it will increase in individual herds with increasing prevalence of infection.

Some information is available about the impact of Johne's disease in Ireland, based on case study data collected from one infected herd over a ten year period (Barrett et al 2006).

Between five and ten years after introduction of Johne's disease the annual average gross margin was observed to decline from €155 per cow above the farmers' peer group to €130 per cow below i.e. a fall of €285 per cow per year relative to the peer group over the 10 years.

See Q8 'How does Johne's disease spread between animals on a farm?' for details of management practices that can increase the unseen spread of Johne's disease on a farm.

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Q5. How does Johne's disease spread between different farms?

The two main ways that Johne's disease is known to spread between farms are:

1. Introducing an infected animal
2. Colostrum, milk or dung from an infected animal or farm coming in contact with young animals (especially calves).
3. Where animals from a non-infected farm are reared elsewhere in contact with infected animals.

The purchase of an infected animal (male or female) is the most common way that Johne's disease spreads between farms (Sweeney, 1996; Radostits et al., 2007; Richardson et al., 2009).

Introduction by an infected animal

Purchased animals infected with *MAP* bacteria (the cause of Johne's disease) may be healthy for many years before they show signs. These healthy carriers can shed the bacteria in dung, colostrum, milk and to unborn calves in the womb (Whitlock and Buergelt, 1996).

Such animals have no signs of ill-health and these animals are frequently bought and moved between farms without any knowledge that they are infected with and may be shedding *MAP* bacteria.

When they arrive on a new farm 'unseen spread' can infect many replacement calves before the signs of Johne's disease are detected (Barrett et al., 2006).

See Q8 'How does Johne's disease spread between animals on a farm?' for more information on 'unseen spread' of Johne's disease on a farm.

Pre-movement / pre-purchase testing does not reduce risk

Testing a healthy animal before introducing it to a herd gives little information about its true status and the risk of it carrying *MAP* bacteria.

Infected animals will rarely test positive until they have been infected for many years. Young breeding animals that test negative must not be assumed to be free from infection.

See Q9 'What tests are available for individual animals and how reliable are they?' for more details on testing animals for Johne's disease.

Spread with colostrum, milk and dung

This is the second most common way that Johne's disease spreads between farms (Sweeney, 1996).

When the colostrum, milk or dung from an infected animal / farm contacts the cattle (especially calves) on another farm there is a risk that *MAP* will spread between the farms.

The risk of spreading Johne's disease between farms increases when you:

- Increase the amount of colostrum, milk and dung brought onto the farm
- Increase the contact young animals have with dung from test-positive animals in the herd, or dung from other herds
- Feed milk from test positive cows or waste milk from any cows.

Common management practices that facilitate spread between farms in this way can be ranked as highest, moderate and lower risk for introduction of Johne's disease.

HIGHEST RISK	▸ Bringing in infected animals from another farm. These animals may appear quite normal, with a negative test result, especially early in the disease process
HIGHER RISKS	▸ Spreading slurry from another farm onto land grazed by young animals ▸ Bringing in colostrum from another farm to feed to calves ▸ Bringing in milk from another farm to feed to calves ▸ Sending heifers to be reared on a unit that does any of the above, or any of the risky practices outlined below
MODERATE RISKS	▸ Using dirty equipment (trailers, crush etc) that is shared between several farms when working with young animals ▸ Farm visitors with dirty outer clothing working directly with young animals
LOWER RISKS	▸ Spreading slurry from an infected farm on land grazed by older animals ▸ Using dirty equipment (trailers, crush etc) that is shared between several farms when working with adult stock ▸ Farm visitors with dirty outer clothing working with older stock

Figure 2. Johne's disease spread risks between farms.

Other possible routes of spread between farms

There are other potential ways that Johne's disease might spread between farms but these are thought to be of lesser importance than the routes detailed above.

Spread from other farm animals

The *MAP* bacteria that infect cattle can also infect sheep and goats. It is possible that in some herds that graze sheep with cattle (or on land where cattle manure has been spread), the sheep may become infected and shed *MAP* bacteria in faeces (Muskens et al., 2001; Whittington et al., 2001; Radostits et al., 2007).

Spread from wildlife

MAP bacteria can be carried and shed by a wide range of wild animals including rabbits, deer, foxes, rats and some birds (e.g. crow, rook). The threat of spread to cattle from other species remains poorly understood but is likely to be low (Greig et al., 1999; Beard et al., 2001). The prevalence in wildlife in Ireland is currently not known.

Spread in semen

MAP bacteria are occasionally found in semen from infected bulls (Ayele et al., 2004). However, the probability of spread occurring from semen is considered low (EFSA, 2004). Bulls are not currently required to be tested for Johne's disease before entry into AI stations (EU directive 88/407/EEC) though Johne's testing is carried out voluntarily in Irish AI stations.

Spread in embryos

MAP bacteria can be found in the uterine flush fluids of infected cows and in artificially infected embryos after washing. In practice however the threat of spread via embryo transfer (when washed in accordance with international standards) appears to be very low (Rhode and Shulaw, 1990; Bielanski et al., 2006). Recipients brought into a herd may of course be a risk for introducing Johne's disease.

Spread in rivers

This is thought to be possible but has never been documented (Sweeney, 1996).

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Council Directive 88/407/EEC of 14 June 1988 laying down the animal health requirements applicable to intra-community trade in and imports of deep-frozen semen of domestic animals of the bovine species.

Q6. How do I stop Johne's disease coming into my farm?

To stop Johne's disease coming into your farm, reducing the risk from moved or purchased stock should be the first priority. Next, the risks from colostrum, milk and dung must be considered (Sweeney, 1996; Radostits et al., 2007).

It may be helpful to read Q5 'How does Johne's disease spread between different farms?' before reading this section.

Buying stock is the biggest risk

Buying new stock is the most common way of bringing Johne's disease onto a farm (Sweeney, 1996). The only way to prevent this risk is not to buy in any stock (including bulls). This may not be possible for herds where the purchasing of new stock is essential to the business. Importing stock from a country with more Johne's disease than Ireland is a higher risk than buying Irish cattle from tested herds with a risk management plan in place.

Minimising risk when purchasing stock requires careful planning

Minimising the risk of introducing Johne's disease with purchased stock in Ireland requires careful planning. This is because:

- Pre-introduction testing does not reliably identify carrier animals
- There are very few herds with a known low risk of having Johne's disease to buy stock from. Introduced stock should be kept away from calf rearing pens and young stock, or areas young stock graze.

Infected animals will rarely test positive until they have been infected for many years. Young breeding animals that test negative must not be assumed to be free from infection.

An animal that tests positive should be considered very high risk for carrying Johne's disease.

If a closed herd has repeatedly tested negative for Johne's disease then purchasing stock from such a herd would lower the risk.

See Q9 'What test are available for individual animals and how reliable are they?' for more details on test reliability.

Reducing risk from purchased stock

Purchasing stock will always pose the risk of bringing Johne's disease into a herd. If you buy from individual farms regularly, it could be helpful to ask them for the herd testing history for Johne's disease, the number of tests the herd has completed and whether there is a VRAMP in place for the herd. Your private veterinary practitioner can assist you in interpreting this information. If purchasing stock is absolutely necessary then the following steps will also help to reduce the risk:

- Minimise the number of animals purchased
- Buy from as few herds as possible (preferably only one)
- Buy from a herd that:
  - has not introduced stock (including bulls) for many years
  - has no history of animals with signs of Johne's disease
  - has no positive test results for Johne's disease and is actively managing farm biosecurity
  - has a VRAMP in place and actively manages farm biosecurity.

Reducing risk from colostrum, milk and dung

Contact with dung, colostrum and milk from an outside animal or farm can introduce Johne's disease (Sweeney, 1996). The following tables give examples of when this may happen and some options to reduce the risk.

To use the tables, identify whether you are currently doing any of the risk activities and choose the best control option that you can from the list. Higher risk activities should be addressed before moderate and lower risk activities.

The list below gives examples only and is not exhaustive. Control options should be created that are specific for your own farm and management practices. A good control option will:

- Reduce the amount of dung, colostrum and milk that is brought onto the farm
- Reduce the contact that young animals have with dung, colostrum and milk from test positive animals or herds with an unknown test history
- Avoid bringing onto the farm any dung, colostrum and milk from a Johne's infected herd.

Higher Risk Activities	Control Option	How effective will it be?
Spreading slurry* from an outside farm onto land grazed by calves	Do not spread slurry from outside farms	**Excellent**
	Spread slurry from Johne's test negative only or pig slurry	**Very Good**
	Do not spread slurry from outside farms onto land grazed by young animals	**Good**
	Spread slurry from one herd that has been closed for several years and has no history of Johne's disease or positive test results	**Moderate**
Purchasing colostrum / milk to feed to calves OR Sending heifers to be reared on a unit that feeds purchased milk	Do not purchase colostrum / waste milk / milk to feed to young animals	**Excellent**
	Purchase colostrum / milk from test negative herds with a VRAMP in place	**Very Good**
	Purchase only dried colostrum / milk products	**Good**
	Purchase colostrum / milk from one herd that has been closed for several years and has no history of Johne's disease**	**Moderate**

**Remember that a rented slurry tanker may be contaminated with MAP bacteria from the previous user even when you spread your own slurry*

***Heat treating liquid milk and colostrum at 60^{0}C for 60-120 minutes can reduce MAP and other infectious agents to undetectable levels without destroying important protein and antibodies (Godden et al., 2006; McMartin et al., 2006)*

Moderate Risk Activities	Control Option	How effective will it be?
Using dirty equipment (e.g. trailers, crush etc) that is shared between several farms when working with young animals	Do not use shared equipment when working with young animals	Excellent
	Thoroughly clean all shared equipment that is used when working with young animals before use	Very Good
Farm visitors with dirty outer clothing working directly with young animals	Do not use allow farm visitors to work with young animals, or	Excellent
	Ensure all farm visitors wear clean, disinfected (or disposable) outer clothing before working with young animals or overalls and boots supplied by you and kept exclusively for use on your farm	Very Good

Lower Risk Activities	Control Option	How effective will it be?
Using dirty equipment (trailers, crush etc) that is shared between several farms when working with older stock	Do not use shared equipment when working with older stock	Excellent
	Thoroughly clean all shared equipment that is used when working with older stock before use	Very Good
Spreading slurry* from an outside farm onto land never grazed by calves	Do not spread slurry from outside farms	Excellent
	Spread slurry from test negative herds only	Very Good
	Spread slurry from one herd that has been closed for several years and has a history of test-negative results for Johne's disease	Moderate

**Remember that a rented slurry tanker may be contaminated with MAP bacteria from the previous user even when you spread your own slurry*

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Q7. Can I treat an infected animal?

There is no recognised treatment

Johne's disease is currently considered an incurable condition. There is no recognised treatment for animals infected with *MAP* bacteria (Radostits et al., 2007).

Infected cows will get worse with time and shed bacteria in dung, colostrum, milk and across the placenta to unborn calves (Sweeney, 1996; Whitlock and Buergelt, 1996).

Treating known infected animals is not recommended

Infected cows can be stopped from spreading the bacteria to others in the herd only by culling or strict isolation from all other stock.

See Q8 'How does Johne's disease spread between animals on a farm?' for more details on how infected cows spread the disease.

Johne's disease is notifiable

Johne's disease is notifiable in Ireland since 1956. This means that DAFM must be informed of any suspected or confirmed case under SI 130 of 2016. If a faecal culture has been performed at a regional veterinary laboratory then notification will be done automatically and nothing further needs to be done. If the diagnostic test has been done in a private laboratory and the results are uploaded to the ICBF then notification is deemed to have occurred. If any person has a suspicion of the presence of disease on clinical signs alone, then the department must be notified by that person, or when diagnostic test results have not been uploaded to the ICBF.

DAFM do not currently place restrictions onto herds with confirmed Johne's disease positive animals.

Animals that have clinical signs consistent with Johne's disease must not contribute milk for human consumption (S.I No. 432 of 2009).

There is no compensation scheme for animals culled because of Johne's disease in Ireland (Pettit, 2004).

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Q8. How does Johne's disease spread between animals on a farm?

MAP bacteria spread from infectious to susceptible animals

MAP bacteria are shed by infectious animals in dung, colostrum and milk and may also pass to the fetus in the womb. Johne's disease typically spreads on a farm when *MAP* bacteria are passed from infectious animals to susceptible, non-infected animals. Older animals are likely to be the highest shedders and young animals (in the first months of life) are most susceptible to infection.

This spread can occur for years before any animal develops the signs of Johne's diseases. Some management practices can dramatically increase the rate of this 'unseen spread' on a farm (see below).

MAP bacteria come from animals that are already infected and infectious on a farm (typically older animals).

These animals shed the bacteria in:

- Dung
- Colostrum
- Milk
- In the womb: Calves can be infected in the womb if the dam is infected. This becomes increasingly common as the disease progresses in the dam (Whittington and Windsor, 2009).

Once *MAP* bacteria have been shed they can remain infective to susceptible animals (in the farm environment) for many months and sometimes for over a year (Whittington et al., 2004).

Shedding starts long before an animal shows signs of Johne's disease (unseen shedding). Animals that have progressed to show signs can shed billions of bacteria every day (Sweeney, 1996; Weber et al., 2005). The level of shedding increases as the disease progresses (Figure 3).

Spread to young and susceptible animals

Animals are most likely to become infected if they swallow *MAP* bacteria when they are very young. Even a very small amount of dung, e.g. on a dirty udder, can contain enough bacteria to infect a suckling calf.

Spread occurs to both new born animals and unborn calves on most farms.

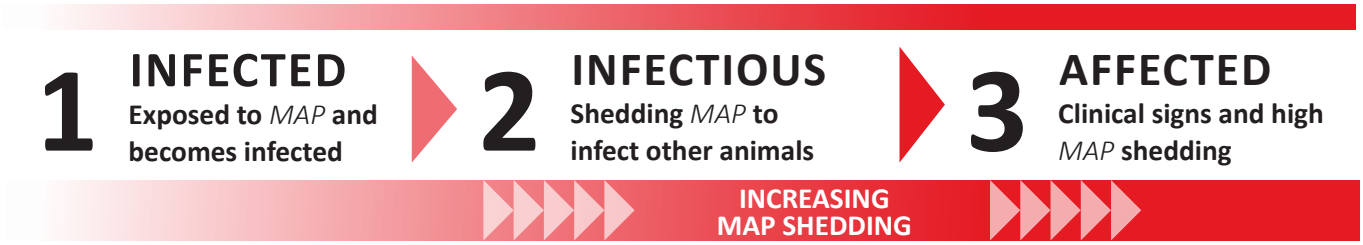

Figure 3. Johne's disease progression steps

See Q2 'What are the signs of Johne's disease?' for more detail on disease progression in infected animals.

Unseen spread

MAP bacteria can spread from infectious animals to susceptible animals for years before the first animal in the herd develops signs of Johne's disease.

Unseen spread means that by the time the first animal develops clinical signs in a farm:

- There may be many infected but apparently normal animals in the herd
- Young calves and susceptible older animals are at high risk of becoming infected (Whitlock and Buergelt, 1996).

If cattle are culled for low performance then unseen spread may continue for much longer without an animal being seen with clinical signs.

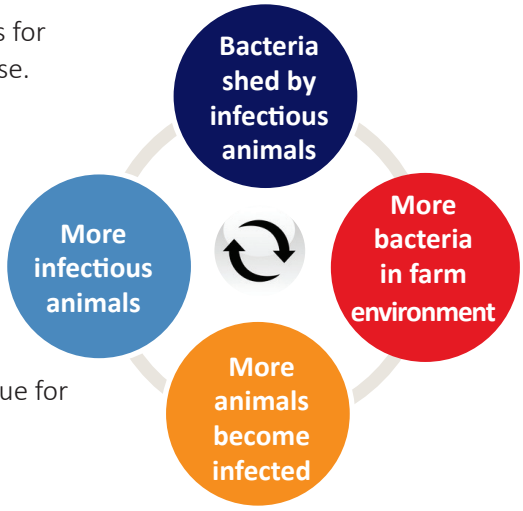

Figure 4. Johne's disease progression steps

Management factors can increase spread

Some common management practices can dramatically increase the rate of spread of Johne's disease on a farm.

This occurs whenever a single infectious cow feeds or is in direct or indirect contact with several calves / young animals that are not her own by:

- Inadequately cleaning pens between calvings
- Feeding pooled colostrum or milk
- Having group calving accommodation
- Having adult cows share accommodation with several calves / young animals
- Spreading slurry from infected cows onto land grazed by calves / young animals.

These activities present an increased risk of rapid spread of Johne's disease on a farm (Wells and Wagner, 2000; Radostits et al., 2007).

Other possible routes of spread on a farm

There are other potential ways that Johne's disease might spread on a farm but these are thought to be of lesser importance than the routes detailed above.

Spread from other farm animals

The *MAP* bacteria that infect cattle can also infect goats and sheep. However, sheep that develop Johne's disease are usually infected with a different strain that almost never infects cattle. It is possible that in some herds that graze sheep with cattle (or on land where cattle manure has been spread), the sheep may become infected and shed *MAP* bacteria in faeces (Muskens et al., 2001; Whittington et al., 2001; Radostits et al., 2007). Goats, deer and camelids can be readily infected with the cattle strain and any of these species of unknown status and co-grazing with cattle are a source of risk to the cattle herd. The cattle herd can also act as a source of risk to the goats, deer and camelids.

Spread from wildlife

MAP bacteria can be carried and shed by a wide range of wild animals including rabbits, deer, foxes, rats and some birds (e.g. crow, rook). The threat of spread to cattle from other species remains poorly understood but is likely to be low (Greig et al., 1999; Beard et al., 2001). The prevalence of *MAP* in wildlife in Ireland is currently not known.

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Q9. What tests are available for individual animals and how reliable are they?

Two types of test for Johne's disease

There are two main types of test that can be used to identify animals with Johne's disease. These are:

- Tests that find *MAP* bacteria directly
- Tests that find an antibody response against *MAP* bacteria.

Tests looking for bacteria are performed on dung or milk samples and tests looking for antibody are performed on individual animal blood or milk samples.

See Q2 'What are the signs of Johne's disease?' for more information on the signs of Johne's disease.

Two basic rules for all Johne's disease tests

Current JD test technology for all test types means that test result interpretation can be challenging. In an animal that is infected but has no signs of disease (Stage 1 and 2, Figure 5) bacteria may be shed in dung but not every day or in high numbers, making it hard to detect them.

At this time the animal will produce very little antibody, and so it is hard to find any in blood or milk. In the early stages of disease, using either type of test, the results will often be negative even though the animal is infected.

Once the disease has progressed so that an adult animal shows signs of disease (stage 3 below) there will be more bacteria in dung and more antibodies in the blood. It is much easier to find the bacteria (in dung) or antibody (in blood and milk) and the tests become more reliable. The next section contains information on Johne's test reliability. **To be confident that a herd has a low risk of having Johne's disease there should be no test positive animal over a number of years. In addition, the management of the farm should be such as to minimise all exposure of susceptible stock. Both are achievable where tests are interpreted in the light of results from on-going farm risk assessment.**

See Q2: 'What are the signs of Johne's disease?' for more information on the progression of Johne's disease in infected cattle.

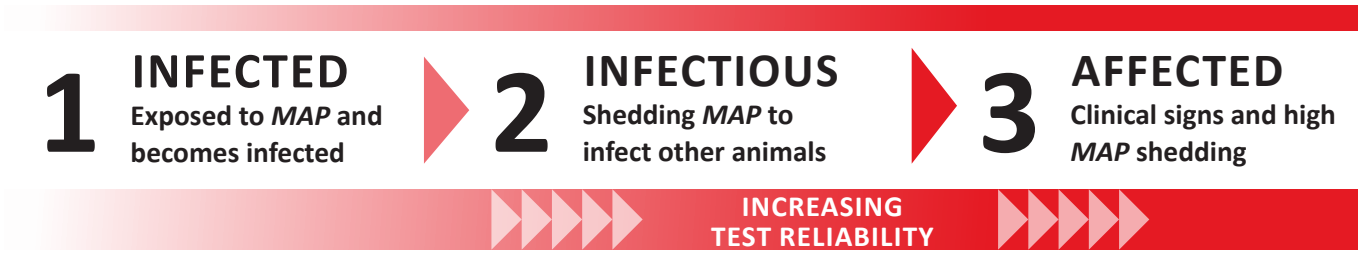

Figure 5. Johne's disease progression steps

More information on test reliability

Laboratory tests for all diseases are less than 100% reliable. This means that from time to time the test result may not reflect the true disease status of the animal. This is the case with Johne's disease too.

When a test does not reflect the true status of an animal it can give either:

- a positive result when testing a non-infected animal. This is called a 'False Positive'. A 'Specificity' score (0-100%) indicates how often the test will give a negative result when testing non-infected animals

OR

- a negative result when testing an infected animal. This is called a 'False Negative' result and happens very frequently with Johne's disease tests. A test's 'Sensitivity' score (0-100%) indicates how often the test gives a positive result when testing infected animals.

Sensitivity scores are low for individual animal Johne's disease tests, especially before clinical signs are seen. The sensitivity for Johne's disease tests in individual animals are commonly estimated to be less than 30% and is highly dependent on the stage of the disease.

The sensitivity of tests improve as Johne's disease progresses from Step 1 (infected) to Step 3 (affected).

The specificity of a test measures how many uninfected animals are correctly identified by the test, i.e. how many true negatives does the test reveal. A number of factors influence the specificity of antibody tests for Johne's disease. In some animals the TB skin test can lead to a transient antibody response that cross-reacts with the blood or milk antibody tests for Johne's disease leading to false positive test results. Therefore, herds using these tests should avoid using them for the three months following a TB skin test including the second day of the TB test. Also milk samples taken from cows during the first week of lactation may yield false positive test results for milk based Johne's disease tests due to the high level of antibody present in early lactation milk. Estimates for the specificity of Johne's antibody tests range from 98% to 99%. Therefore, on average, it might be expected that approximately 1-2 in every 100 tests on non-infected animals might yield a false positive test reaction in a truly negative animal.

When considered together, Specificity and Sensitivity values give an overall indication of the reliability of the test. They can both change with other factors (e.g. how samples are stored, the technical design of the test and how many similar bacteria are in the cow's environment). While there are limitations with the tests, i.e. that some infected animals will be missed and some unifected animals will test positive, they remain very valuable tools for herdowners wishing to reduce the risk of disease transmission within their herds and therefore an estimated range in likely score is often all that is known for a test (Osterstock et al., 2007).

It is a requirement that approved laboratories are used for the current AHI voluntary Johne's disease Control programme. Approved laboratories are accredited to carry out Johne's disease tests to the international quality standard ISO/IEC 17025 should be used for testing.

Tests to find *MAP* bacteria

There are currently two tests available to detect *MAP* bacteria for which sufficient data on sensitivity and specificity are available to allow them to be recommended for use in an Irish context. These tests are called a 'Faecal Culture' and Faecal PCR.

Faecal Culture

This test takes a dung sample and places it into optimal conditions for the *MAP* bacteria to grow so that it can be identified. It is the most definitive test for *MAP* (and has a specificity of 100% and a sensitivity in the order of 60%). However false negative results can occur because of the absence of viable bacteria in the sample being examined. Occasionally false positives may occur as a result of where viable *MAP* are present as a consequence of pass through. The situation known as 'pass through' can occur in environments where there is a high level of contamination and

bacterial shedding. The bacteria grown in the sample are not produced by the animal but are consumed from the pasture by the animal and 'pass through' in the dung. If MAP are passing through an animal from a heavily infected environment it is a reliable indicator of the presenceof MAP in the herd.

Faecal Polymerase chain reaction (PCR)

This test takes a dung sample and submits it to a laboratory process to release the bacterial DNA which is then amplified and measured using specialised techniques. Like the faecal culture this test has a high specificity and higher sensitivity than ELISA testing. However false negative results can occur because of the absence of bacteria from the sample being examined. An additional complication with PCR testing occurs because the test is measuring bacterial DNA and this may have been obtained from non-viable bacteria. The situation known as 'pass through' can occur in environments where there is a high level of contamination and bacterial shedding. However even in this situation, the PCR is a reliable indicator of the presence of *MAP* in the herd.

FAECAL CULTURE		
	NO CLINICAL SIGNS	WITH CLINICAL SIGNS
False Positive	**Very Rare** Specificity is almost 100%	**Very Rare** Specificity is almost 100%
False Negative	**Very Common** Sensitivity 16-30%	**Occasional** Sensitivity 60-70%

(Nielsen and Toft, 2008; Vidal-Diez et al., 2009; Wang et al., 2011)

Tests for antibody response to *MAP* bacteria

Modern 'ELISA' tests are more reliable than the other tests that look for an antibody response to *MAP*. The test reliability is known with confidence only when these are used on **individual animal blood or milk samples**.

ELISA tests are very useful as a herd screening test because they are inexpensive and can give a result within days of taking the sample (Collins, 1996).

When using an antibody test it is advised to wait at least 3 months since the last TB skin test, as this can lead to an increase in false positive results (Varges et al., 2009).

ELISA on Individual Blood Samples

INDIVIDUAL BLOOD ELISA		
	NO CLINICAL SIGNS	WITH CLINICAL SIGNS
False Positive	**Occasional** Specificity 95-100%	**Occasional** Specificity 95-100%
False Negative	**Very Common** Sensitivity 7-22%	**Common** Sensitivity greater than 22%

(Kohler et al., 2008; Nielsen and Toft, 2008; Vidal-Diez et al., 2009)

ELISA on Individual Milk Samples

INDIVIDUAL MILK ELISA		
	NO CLINICAL SIGNS	WITH CLINICAL SIGNS
False Positive	**Occasional** Specificity 95-100%	**Occasional** Specificity 95-100%
False Negative	**Very Common** Sensitivity 6-18%	**Common** Sensitivity greater than 18%

(Nielsen and Toft, 2008)

There are two Johne's disease tests currently recognized by the AHI voluntary Johne's disease Control Programme, as herd screening tests, each based on samples collected from all individual eligible animals in the herd. These are the serum ELISA and the milk ELISA tests. Faecal culture and Faecal PCR are usually reserved for ancillary testing of animals that are ELISA test positive.

Other tests

There are a number of other tests that can be used when investigating Johne's disease, including:

Tests for *MAP* bacteria:

- Bulk milk PCR or culture
- Individual animal milk PCR or culture
- Environmental PCR or culture
- Bulk and individual milk phage culture
- Direct microscopy of faeces stained to identify 'acid-fast' bacteria.

Bulk milk testing for antibodies to Johne's disease is popular in some countries because it is easy to perform and inexpensive. However, a bulk milk antibody test is not a reliable way to test a herd. A very high proportion of False Negative results is expected (van Weering et al., 2007). For this reason, bulk milk testing is not an approved test for the Irish Johne's disease programme.

Although a positive result indicates a high risk of infection, it is misleading to assume that your herd is not infected with Johne's disease based on negative bulk milk antibody results.

Repeated testing of the all eligible animals in the herd is the only way to accurately determine Johne's disease status.

Although a positive BMT result is likely to indicate an infected herd (that may have a very high prevalence of infection) it is not possible to accurately estimate from a single result how many cows in the herd are infected (Christensen and Gardner, 2000). This also requires repeated herd testing.

However, there is currently insufficient data about diagnostic sensitivity and specificity for these tests to be recognised by the voluntary Johne's Disease Control Programme. Further research is needed to characterise these tests in an Irish context before they can be usefully interpreted as part of a herd testing programme.

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Q10. Is there a vaccine for Johne's disease?

No effective vaccine against Johne's disease

Current vaccines do not stop animals from becoming infected or from shedding the bacteria. They can reduce signs and delay their onset but are not useful in controlling Johne's disease on farm (Kalis et al., 2001).

These vaccinations interfere with TB tests, and therefore are commonly not legal in countries undergoing active control of TB, including Ireland (Álvarez et al., 2009). Vaccination is available in Northern Ireland but vaccination is not licensed in the the Republic of Ireland.

Research is ongoing into better vaccines but these are not likely to be available for many years (OIE, 2008).

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Q11. Are any human diseases linked with Johne's disease?

MAP bacteria are traditionally classed as 'non-zoonotic' meaning that they do not cause disease in humans (Greenstein, 2003).

There are only a very small number of isolated case reports in the medical literature where *MAP* bacteria have been definitively associated with human disease (Greenstein, 2003).

MAP bacteria and Crohn's disease

In recent years, medical researchers have been investigating the possibility that *MAP* bacteria might be associated with a human disease called 'Crohn's Disease', (Golan et al.,2009)

Crohn's disease is an intestinal disease of humans where the wall of the bowel becomes thickened and inflamed. It's cause is currently unknown (Sartor, 2006).

The possibility that ingesting *MAP* bacteria might increase the likelihood of developing Crohn's disease is a matter of debate (Greenstein, 2003). Waddell et al (2015) conducted a meta-analysis of the zoonotic potential of *MAP* and confirmed a significant positive association for Crohn's disease (odds ratio range 4.3–8.4) but concluded that knowledge gaps exist. Viable *MAP* has been found in retail pasteurised milk (Carvalho et al., 2012) and *MAP* artificially inoculated into pasteurised milk has been detected in yoghurt and commercial fermented milk products (Van Brandt et al., 2011). Thus, if *MAP* is transmitted to humans, it may occur via ineffectively pasteurised milk or milk products (O'Reilly et al., 2004)

The Food Safety Authority of Ireland

The Food Safety Authority of Ireland conducted their first scientific review in January 2000 to consider whether *MAP* bacteria might contribute to Crohn's disease. They concluded that there was insufficient evidence to prove or disprove an association at that time and recommended that advances in medical research should be monitored regularly (Collins, 2000).

A second comprehensive review was completed in 2009 and concluded that the balance of available evidence at the time did not support a causal relationship between *MAP* bacteria and the incidence of Crohn's disease (FSAI, 2009).

Both of these reports can be viewed on the Food Safety Authority of Ireland (www.fsai.ie).

http://www.fsai.ie/uploadedFiles/Resources_and_Publications/Publications/*MAP*_Does_it_contribute_to_Chrons.pdf

www.fsai.ie/WorkArea/DownloadAsset.aspx?id=8552

(URL's correct as of January 2017)

MAP bacteria and milk

MAP bacteria are shed in milk by infected cows and live bacteria are only occasionally found in liquid milk sold after pasteurisation (Grant et al., 2001).

In a recent Irish investigation, no live *MAP* bacteria were found in any of 357 pasteurised milk samples, though dead *MAP* bacteria were found in 35 (9.8%) of the same group of samples (O'Reilly et al., 2004).

It has been recommended that reasonable measures should be taken to reduce the potential exposure of the public to *MAP* bacteria while a potential link to Crohn's disease remains uncertain (International Forum for Transmissible Animal Diseases and Food Safety (TAFS) 2009).

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Q12. What is the prevalence of Johne's disease in Irish Beef and Dairy herds?

Johne's disease is more prevalent in dairy herds

A simple random survey was conducted in Ireland during 2005 to investigate the prevalence of Johne's disease.

After accounting for test limitations, the estimated prevalence in Irish beef and dairy herds were:

Dairy Herds	**20%**	**1 in 5 herds infected**
Beef Herds	**6%**	**1 in 17 herds infected**

(Good et al., 2009)

This estimated prevalence in dairy herds is consistent with a previous report (Cashman et al., 2008).

The difference in prevalence between dairy and beef cattle is currently thought to be primarily due to differences in how much they have been exposed to *MAP* bacteria (in turn related to management factors and frequency of stock introductions) (Koets et al., 2000; Radostits et al., 2007).

Johne's disease is increasing in Ireland

The prevalence of Johne's disease is increasing in Ireland.

In the 60 years from 1932-1992 there were 92 cases of clinical disease reported. In the next 10 years until 2002 there were 232 cases reported (Good et al., 2009).

The recent increase is likely to have been facilitated by the importation of healthy, infected stock from Europe with the advent of the single market in 1992 (O'Doherty et al., 2002; Good et al., 2009; Richardson et al., 2009).

It is likely that the prevalence of Johne's disease continued to increase since the studies published in 2008 and 2009 and will continue to increase in the Irish cattle population unless farmers actively engage with the AHI voluntary Johne's disease Control Programme.

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Q13. How should I test a herd for Johne's disease?

Regular testing in conjunction with effective biosecurity, and a regularly reviewed VRAMP are the most effective means of Johne's disease control. Because of the imperfect results from the ELISA test, it is important to test all eligible animals in the herd and repeat rounds of herd testing to give a high level of confidence in the true status of a herd.

Testing in combination with assessment VRAMP improves the confidence in risk of infection or freedom from infection.

If using a Milk ELISA Test, two tests, three months apart should be carried.

See Q9 'What tests are available for individual animals and how reliable are they?' for more details on testing individual animals.

Q14. How do I control Johne's disease in an infected herd?

Breaking the cycle of unseen spread

Control of Johne's disease in a herd requires a long term commitment. The disease cannot be reduced or eradicated quickly.

The basic principles of control are to:

- Prevent new introductions into the herd using biosecurity measures
- Develop, implement and regularly review a risk assessment and management plan in consultation with your veterinary practitioner.
- Reduce new cases by protecting calves from exposure to potentially infected colostrum and milk, and the dung from all adult cows
- Reduce shedding into the farm environment by removing known carrier cows.

These four principles together will reduce the unseen spread of Johne's disease in a herd.

See Q8 'How does Johne's disease spread between animals on a farm?' for more information on disease spread.

See Q6 'How do I stop Johne's disease coming into my farm?' for more information on biosecurity.

Q15. If I need colostrum in an emergency what is my best option so as not to spread Johne's disease?

It is very important to give sufficient (3 litres for average size Holstein calves) colostrum within the first two hours of birth. It is very important to avoid feeding the mother's own colostrum if the cow is a Johne's disease test positive animal, since there are other options available. In order of preference, the options are:

- Use frozen colostrum from a young, Johne's disease tested negative animal from your own farm and keep a record of which calves were fed this colostrum. Only colostrum collected at the first milking, soon after calving, should be frozen and stored. This is the safest from a disease spread point of view, and colostrum from other 'dams' on your own farm will be more likely to have more antibodies specific against disease threats native to your own farm. If the colostrum donor becomes Johne's disease positive at any stage then all her colostrum should be discarded
- Colostrum replacement (CR) products are the next best choice. However, they vary widely in quality. These will not have the farm specific antibodies, and absorption of antibodies from CR may be more variable than from colostrum. Therefore CR should only be used in individual calves where no other safe source of colostrum from your own farm is available. Use only products that are tested for efficiency of absorption. The use of CR is a decision which should be made on the advice of an approved Veterinary practitioner who is well placed to advise the most suitable product. Using these products will avoid any risk of bringing onto a farm disease a number of diseases including possibly Johne's disease from a neighbouring farm
- Colostrum from another farm – unless this farm can positively prove that it has a low risk of Johne's disease (very few farms in Ireland can at this stage prove that) it is not recommended that you import colostrum from another farm.

For more information on colostrum feeding in general - **click here** to see the Colostrum Management Leaflet which is part of the CalfCare series available on **www.animalhealthireland.ie**.

Q16. Is there a coordinated national approach for Johne's disease in the Republic of Ireland?

Animal Health Ireland coordinates a national voluntary control programme on behalf of industry stakeholders. For more information about the programme **click here** to visit the Johne's disease pages.

Johne's disease has been notifiable in Ireland since 1956. This means the Department must be informed of any suspected or confirmed case. SI 130 of 2016 which states that all suspect clinical animals and laboratory tested positive results must be notified to the RVO by farmers, laboratories and veterinary practitioners.

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