

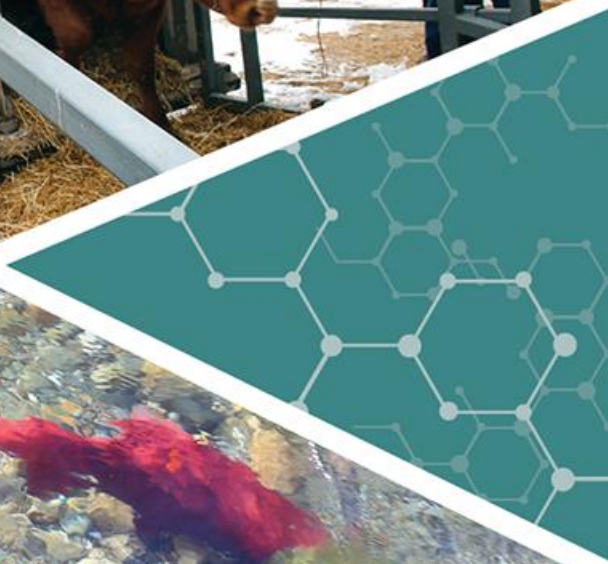


Canadian Food
Inspection Agency

Agence canadienne
d'inspection des aliments

Scrapie and Goat Genetics in Canada

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Canada

Scrapie and other Transmissible Spongiform Encephalopathies (TSEs)

TSEs are diseases that affect the central nervous system of several animal species characterized by;

- a long incubation period,
- a spongy brain degeneration,
- and a mortality rate of 100%.



Scrapie



CWD: Chronic wasting disease


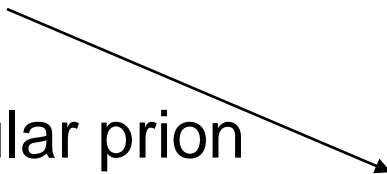


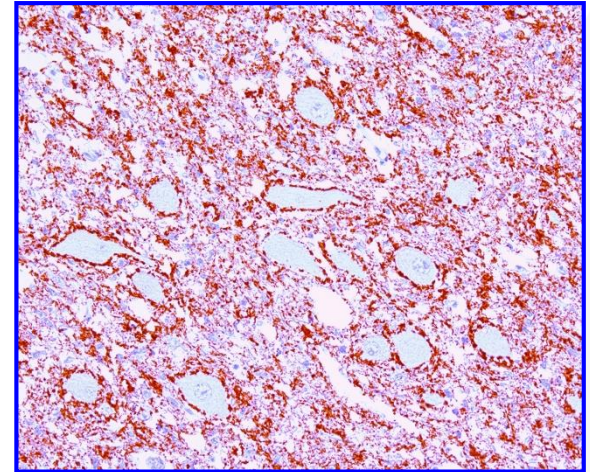
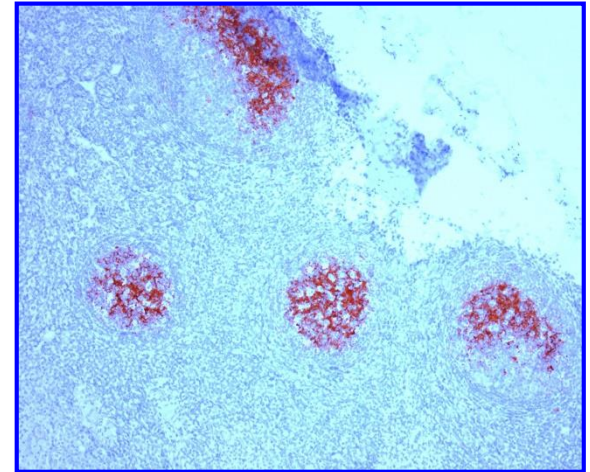
BSE: Bovine Spongiform Encephalopathy



CJD/vCJD: Creutzfeldt-Jacob disease

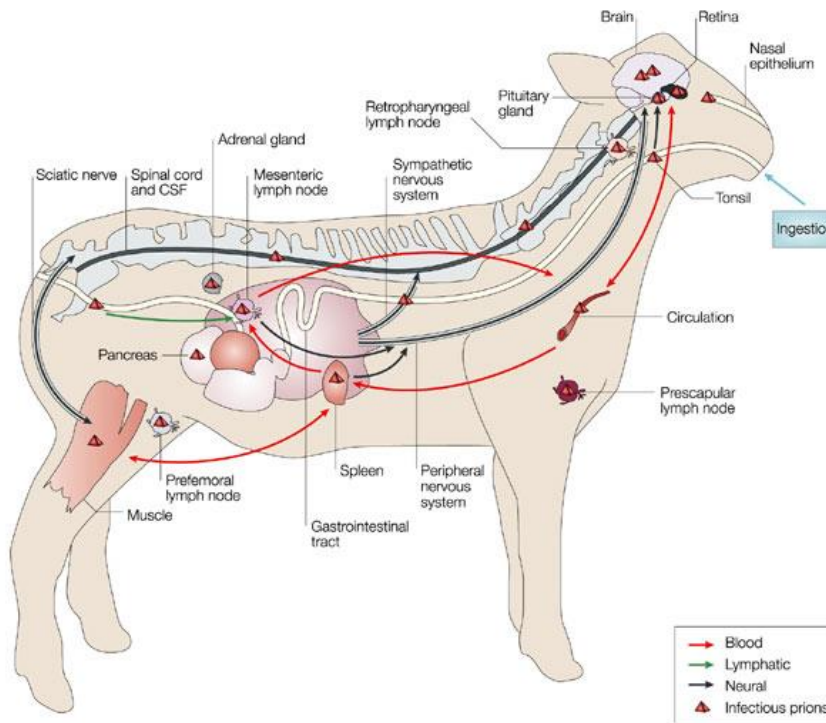
Scrapie – The Agent

- Causative agent considered to be an abnormal prion protein (PrP^{Sc}), which accumulates in many tissues including lymphoreticular system & central nervous system. 
- Conversion of normal cellular prion protein (PrP^{C}) to abnormal conformation 
- Major prion disease challenges include: Prolonged incubation period, environmental persistence, and lack of immune response (difficult to detect & can't treat)



Scrapie – Distribution of Infectivity and/or PrP^{Sc}

- Widespread tissue distribution in



Nature Reviews | Immunology

CNS	Milk
LRS	Muscle
PNS	Salivary Gland
Placenta	Kidney
Blood	Skin

Scrapie - Transmission

- Primary method of infection is through **ingestion**:
 - **Lambing/kidding**
 - Prions are excreted in placenta and vaginal discharges
 - Animals with access to lambing/kidding environment ingest prions and become infected, neonates are particular susceptible
 - **Milk/Feces/Urine/Environment**
 - Prions are excreted/secreted contaminating premises
 - Agent can persist for long periods in environment (report of up to 16 years)



Scrapie - Clinical Signs

- Weight loss
- Wool loss
- Incoordination, Tremors
- Nibbling reflex
- Teeth grinding, Licking
- Aggression, Apprehension

- Clinical course 1 to 6 months
- Incubation period 2 to 5 years
- 3 to 5% mortality up to 20%
- Cost US \$20 million per year
- Pruritus is not common in North America, often just poor doing / wasting
- Neurologic / encephalic signs common
- Scrapie should be considered as a possible diagnosis in any neurological or wasting condition in a sheep or goat



Courtesy of Dr. Michelle L. Crocheck, USDAAPHIS-VS-MSL

Scrapie

- First described in 1732 in the United Kingdom
- First reported in Canada 1938
- Reportable since 1945 – Destroy infected flocks
- National Scrapie Eradication Program, 2005
 - Active: detect pre-clinical cases and trace
- Goal to be scrapie free



Importance of Scrapie Control

- Trade/market access barrier to export
- Partners (EU/US) engaged in eradication
- Animal welfare
- Environmental accumulation
 - Prevent future problems
- Difficult to rule out human health risk
 - Strain mutation, host range, increased exposure, *in vitro* studies

Summary of Goat Scrapie in Canada

- One positive goat noted in literature in 1975, resided on an infected sheep farm in Quebec
- One positive goat found in 2007, associated with infected sheep flock in Ontario
- Very little surveillance in goats so difficult to know the prevalence of goat scrapie in the Canadian goat population
- 2013-2015 - First diagnosis of an infected goat herd in Canada. 7 infected premises in Ontario found as part of this investigation.
- 2016 – New infected herd in Ontario
- 2017-2018 – Diagnosis of scrapie in an index herd in Manitoba. Total of 8 infected farms in MB and 1 in AB found as part of this investigation.

Summary of Goat Scrapie in Canada (continued)

- 2018 two herds in MB (linked)
- 2019 two sheep flocks in AB
- No positive herds in 2020 or 2021 to date, but surveillance numbers have been down significantly since COVID-19, especially in Ontario, where the largest amount of small ruminants either live and/or are slaughtered in Canada.

Surveillance Plan Upcoming Years

- In our plan to eradicate scrapie from Canada, we must find any remaining pockets of disease and clean up the farms.
- The two main areas where we still need adequate samples are: 1) certain geographically underrepresented areas and 2) mature (12 months and older) goats.
- Working on analyzing past surveillance data, and mapping out all abattoir locations, we are also going to work on outreach with the goat industries in Canada and goat producers and abattoirs to collect more mature goat samples.
- We can expect cases to go up over next years as we want to find remaining cases in and stamp them out so that, over time, Canada can be declared scrapie free.

Disease Control Actions on Scrapie Infected Premises

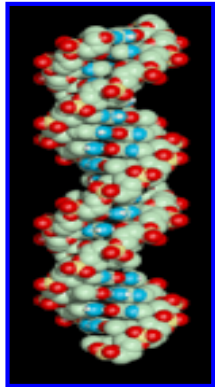
- **Destruction of infected and at-risk animals**
 - Sheep:
 - **Genotyping**: destruction of susceptible sheep
 - Goats:
 - Complete herd destruction
- Post-mortem scrapie testing
- Compensation



Disease Control Actions on Scrapie Infected Premises

– Genetics of Scrapie

- A blood test is used to determine a sheep's genotype
- Can be determined at any age
- Genotyping is DNA testing of the prion gene (PRNP)
 - 3 codons affect susceptibility
 - 136, 154, 171
 - Genotypes written with codon number followed by corresponding amino acids: 171QR, 171RR, etc.



Genetic Susceptibility Combinations in Sheep

Genotype (136, 171)	Susceptibility
136AA 171RR	negligible
136AA 171QR	very low
136AV 171QR	intermediate
136AA 171QQ 136AV 171QQ 136VV 171QQ	high

In North America have not had a 171RR sheep test positive for scrapie.
In Canada have not had 136AA 171QR sheep test positive for scrapie.



**Blue – Susceptible sheep
ordered destroyed**

**Orange – Resistant sheep
remain on premises**

What do we now know about scrapie genotypes and goats?

- There is convincing evidence from North America and European studies that there is genetic resistance for scrapie in goats.
- Based on data, goats having a single copy of either S146 (serine at prion protein position 146) or K22 (lysine at prion protein position 222) have shown a strong degree of resistance to natural infection with classical scrapie.
- Other alleles such as Q211 have been studied in Europe and other countries but at this time, not enough evidence to use this for regulatory purposes.

What Canadian goat breeds have shown resistant alleles?

- Allele S146 was most often found in meat breeds such as Boer and Savannah, as well as the Nubian dairy breed
- The K222 allele has been found less often in Canadian goats tested up to now and was mainly found in Toggenburg (dairy) herds.
- These alleles will most likely be found in other breeds in Canada as more goats are gentyoyped

Which goat breeds have shown resistant alleles internationally?

- Allele S146 has been found in meat and dairy breeds including Boer, Nubian Alpine, Saanen and LaMancha
- The K222 allele appeared most often in dairy breeds such as Toggenburg, LaMancha, Saanen and Alpine

How does this apply to the goat industry?

- At this time, in line with the US, the CFIA recommends focusing on alleles S146 and K222 when breeding for resistance in goats.
- In Canada genotyping services for DNA testing of goats at alleles S146 and K222 are available through GoatGEN Inc. and the Animal Health Laboratory
- Producers may use genotyping for selective breeding programs and individual herd management decisions. At this time, genotyping results for external laboratories are not considered official and would require testing by CFIA during a scrapie disease response.

Pilot Project: Special Procedures to triage scrapie positive goat herds during a disease response

Goal of Pilot Project

- The project will assess an alternative disease control pathway from the standard disease control procedures for scrapie infected goat herds in Canada involving genotyping for scrapie (along with other tools).
- The project will explore an alternative(s) to the current policy of whole-herd destruction in positive goat herds, and assess if they are adequate to eradicate scrapie on that farm.

Why a pilot project?

- New internationally accepted data, and enough Canadian data has been collected to look at using scrapie resistant genotypes in triaging goats in CFIA's scrapie-positive herd response, similar to what was previously explored in sheep.
- Other scrapie-affected countries have explored deviations from their standard stamping out programs in recognition of new information relating to scrapie resistant alleles S146 and K222 .

Any derogation from the standard program shall adhere to the following principles:

- The health of Canada's national flock/herd is not compromised
- The welfare of goats on scrapie-infected premises is not compromised
- The derogation is line with the goal of eradication and does not leave behind any scrapie positive goats on an infected farm.

How goat can producers help eradicate scrapie?

- Voluntary identification (pre-approved identifiers) until mandatory national identification is in place
- Test brains and lymph nodes of mature (>12 month old) goat that die or are slaughtered
- Reducing inbreeding and genotyping in selective breeding programs
- Join program or buy goats from producers enrolled on the Scrapie Flock Certification Program (SFCP)

Questions?



Canada