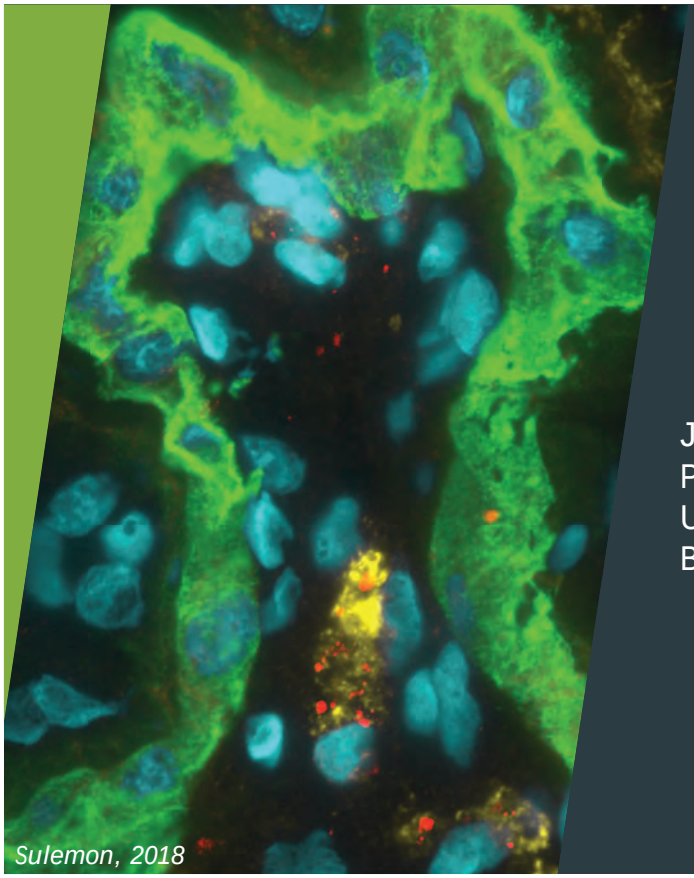


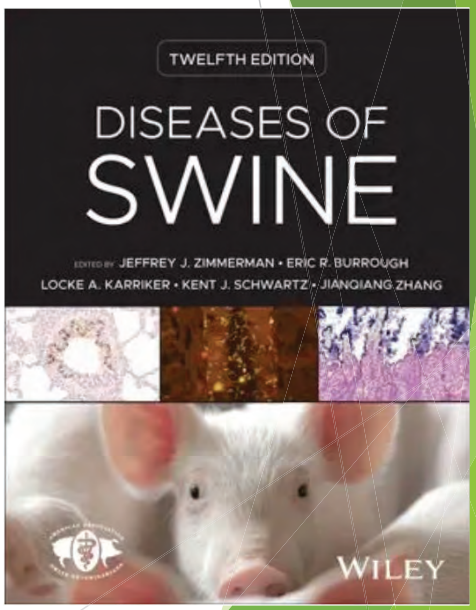
What's new with PRRS
~10-year journey

John Harding, DVM, MSc, DABVP (Swine Hlth Mgmt)
Professor, Western College of Veterinary Medicine
University of Saskatchewan
Banff Pork Seminar – January 2026

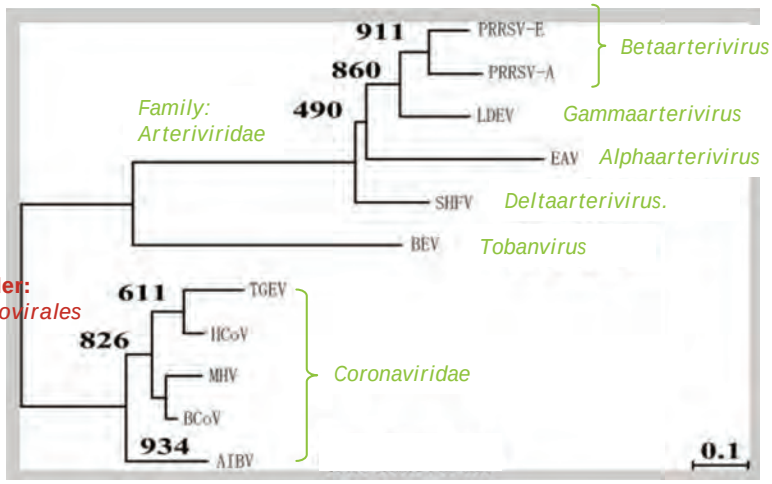
Porcine reproduction and respiratory syndrome (PRRS, PRRSV)

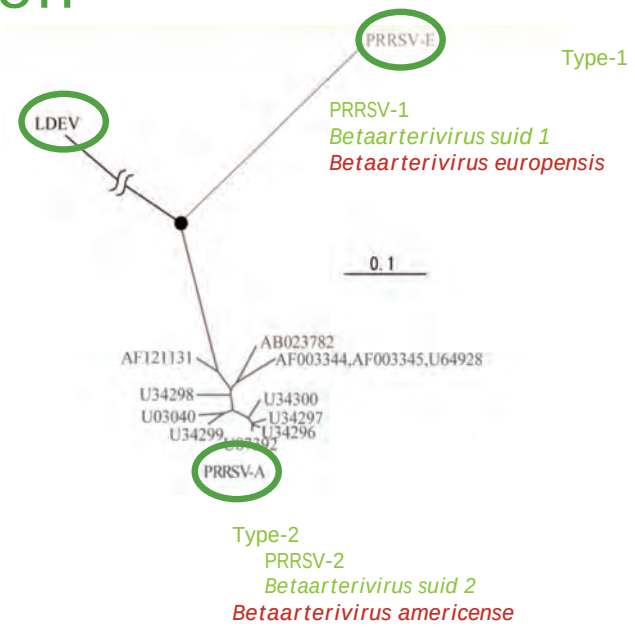
History & milestones

- 1987: Mystery disease (USA)
  - SIRS, PEARS, Pig Plague
- 1990: Blue ear disease (EU)
- 1991: Lelystad virus (EU)
- 1992: VR-2332 (USA)
- 1992: international adoption of "PRRS"
- 1994: first vaccines (MLV USA, killed EU)
- 2021: speciated PRRSV-1 and PRRSV-2



Proposed origin, taxonomy, evolution

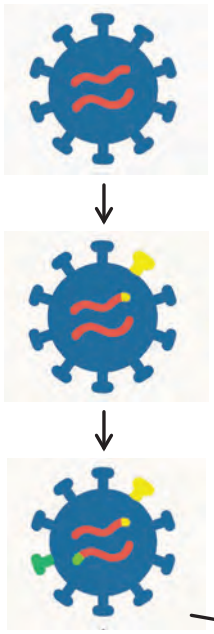




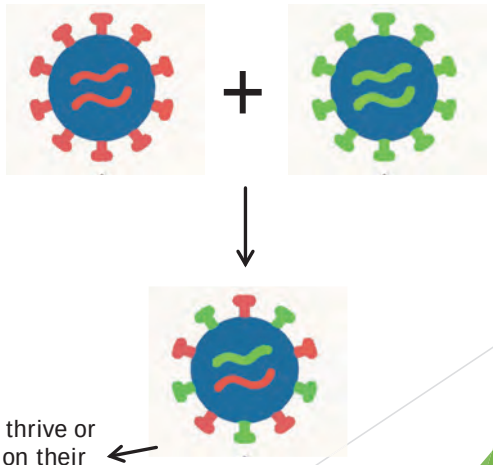
Hanada et al., 2005. doi:10.1093/molbev/msi089

Mutation & recombination

Viral mutation (drift)



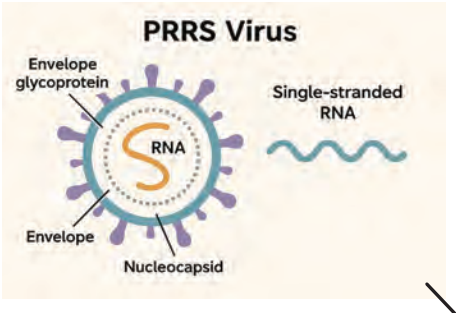
Viral recombination (shift)



Replication in the same cell at the same time

Progeny viruses thrive or fail depending on their level of fitness

Characterization of PRRSV isolates



Restriction enzymes

Mlu I  #__ (1)

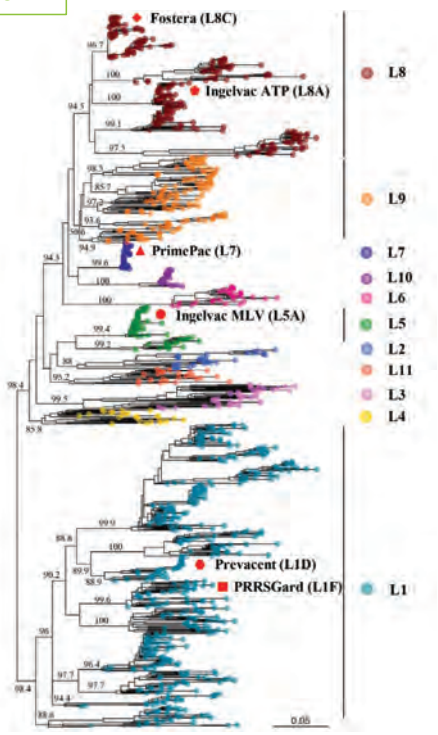
Hinc II  #__ (4)

Sac II  #__ (4)

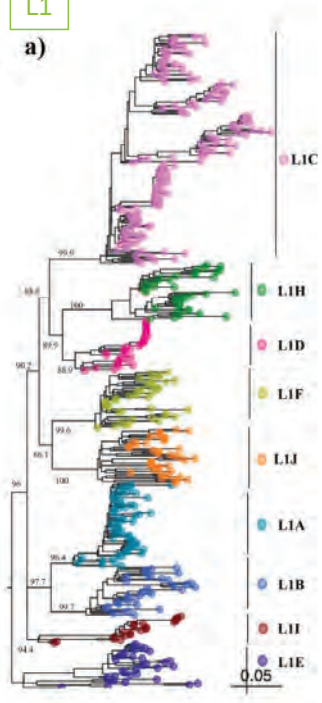
RFLP 1-4-4

PRRSV-2 Lineages: current terminology

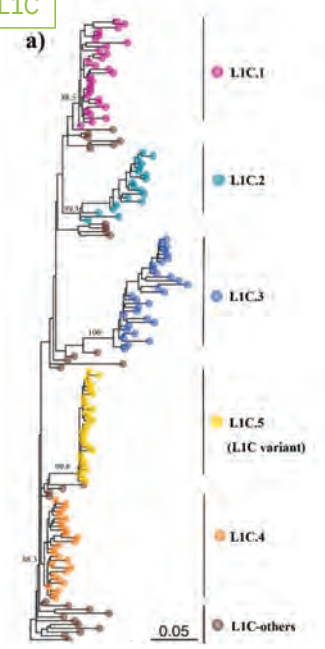
PRRSV-2



L1

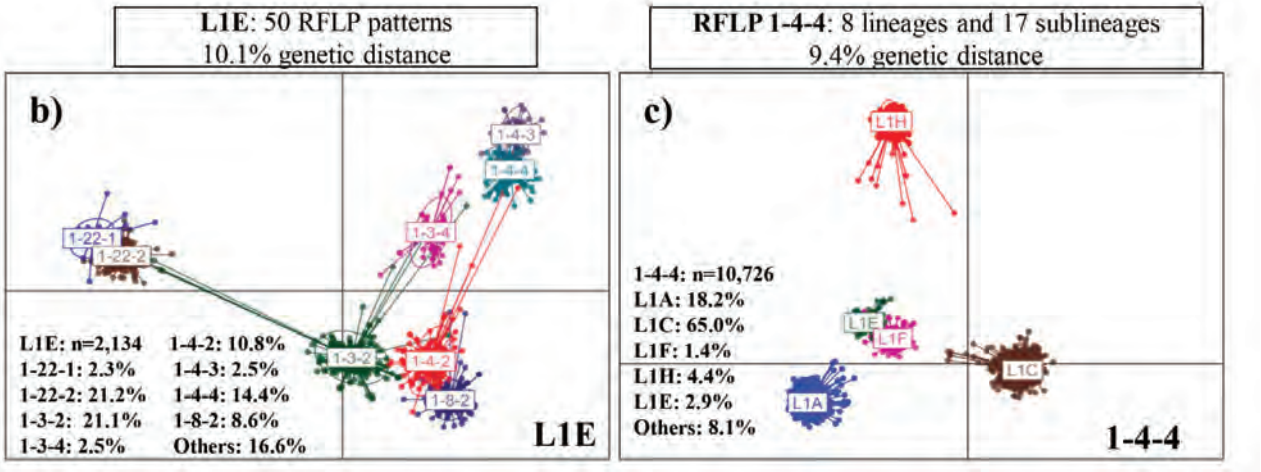


L1C



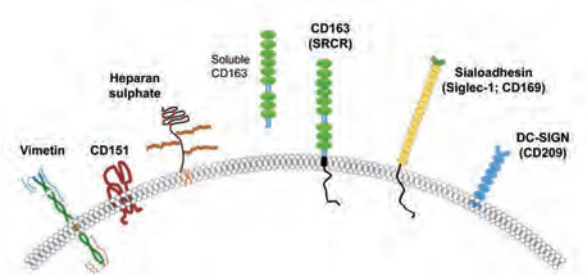
Yim im et al., 2023. 10.1128/spectrum.02916-23

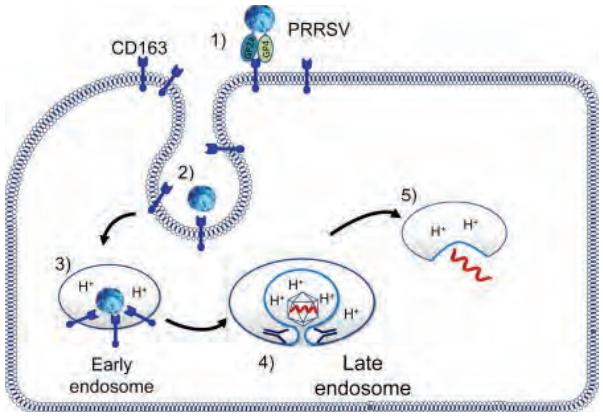
Lineages vs RFLP



Yim im et al., 2005. 10.1128/spectrum.02916-23

PRRSV receptors & CD163



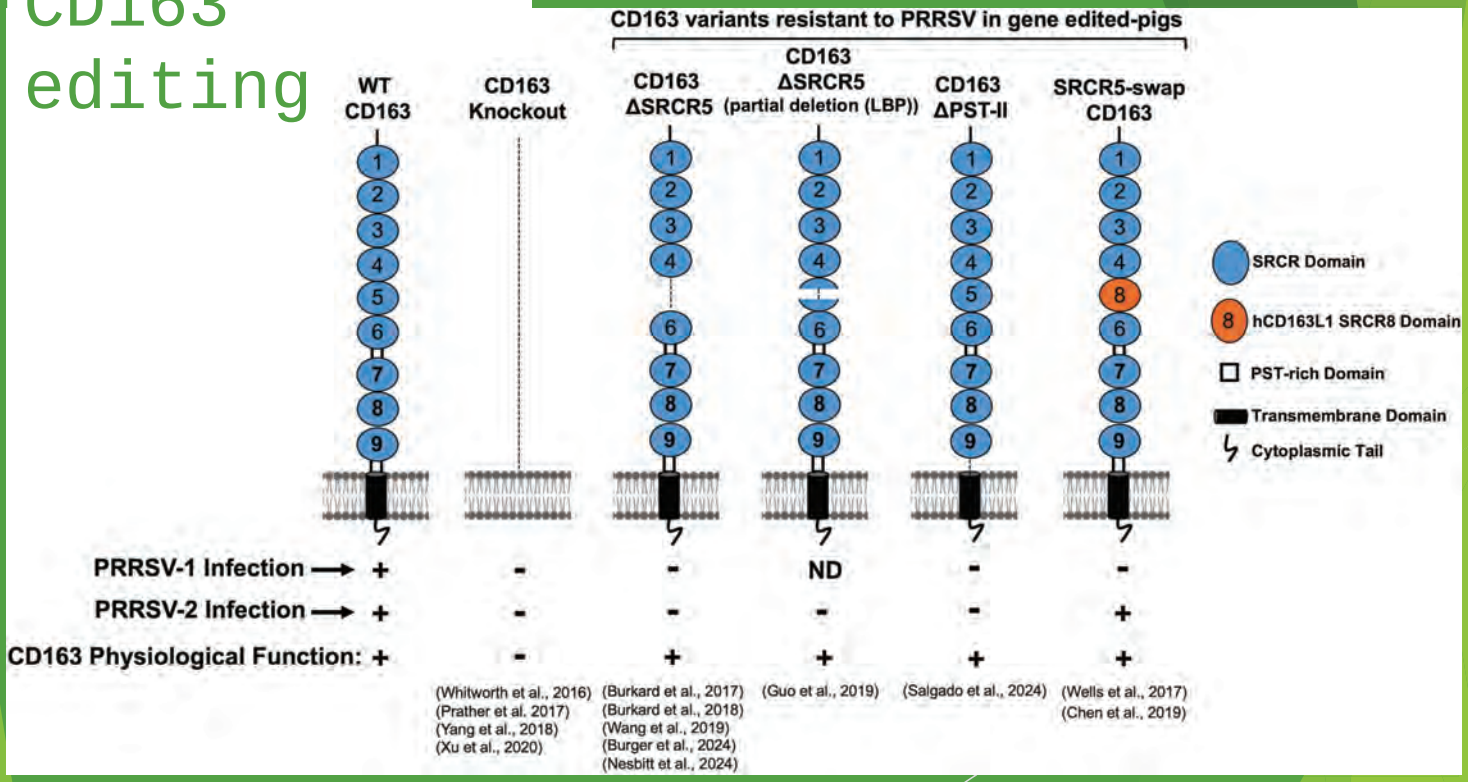


CD163

- One of 6 surface receptors
- Binds with PRRSV glycoproteins
- Internalized→ endosome
- Virus and endosome membranes fuse
- Viral RNA released into cytoplasm
- Translation → replication

Zhang & Yoo, 2015. doi/10.1016/j.vetmic.2015.04.002

CD163 editing



Rowland & Brandariz-Nuñez2024 https://doi.org/10.1016/j.virol.2024.110262

PRRS resistance

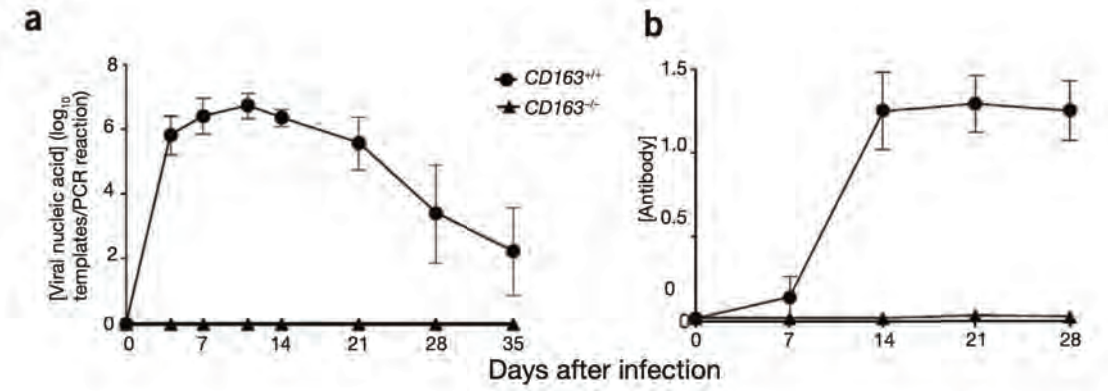
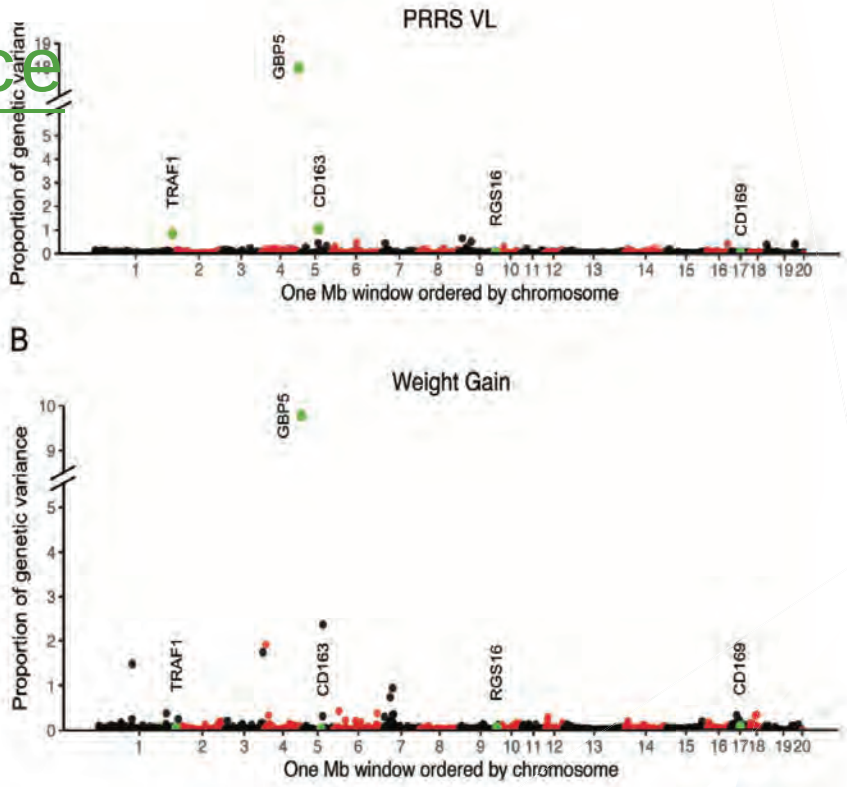


Figure 3 PRRSV-specific nucleic acid and antibody. (**a**,**b**) Mean and s.d. of PRRSV nucleic concentrations (**a**) and antibody (**b**) in serum from *CD163*$^{+/+}$ ($n = 7$) and *CD163*$^{-/-}$ ($n = 3$) pigs (one replication) are shown. Sample to positive ratio = the median fluorescent intensity (MFI) of the sample divided by the MFI of the positive control.

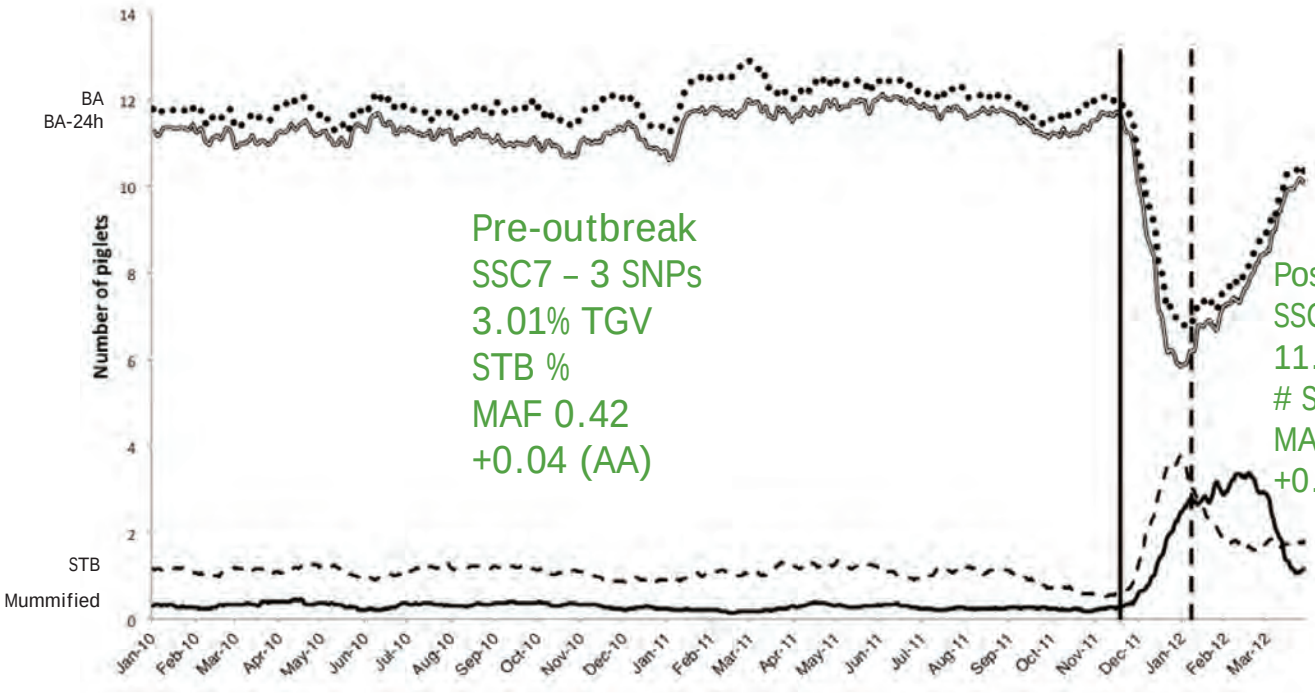
Whitworth, et al. 2016. doi: 10.1038/nbt.3434.

PRRS resilience



Dong et al. 2016. doi.org/10.1093/jas/skab274

GWAS for reproduction in PRRS

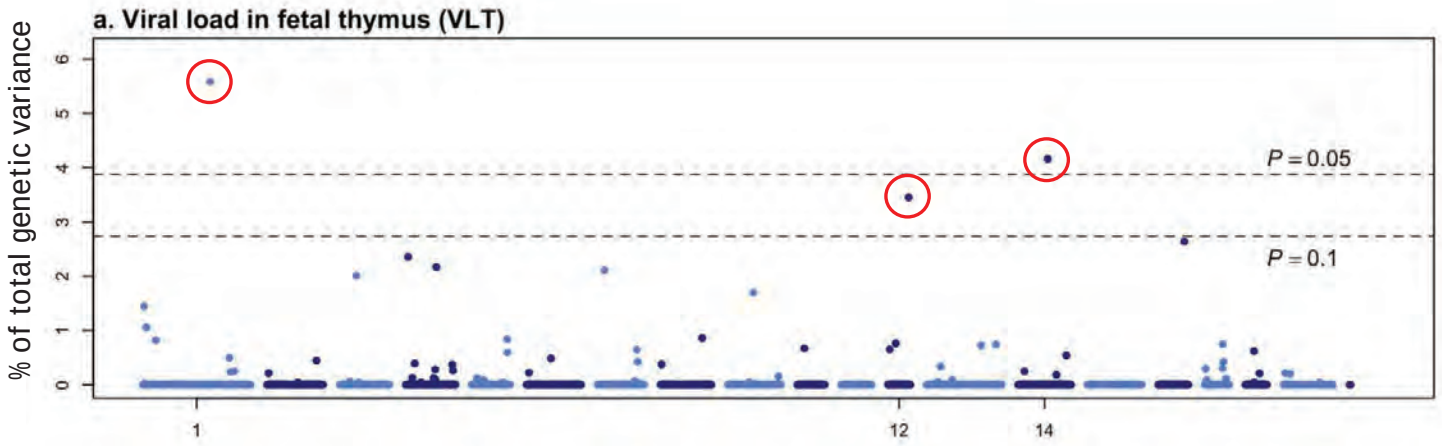


Pre-outbreak
SSC7 – 3 SNPs
3.01% TGV
STB %
MAF 0.42
+0.04 (AA)

Post-outbreak
SSC1 – 5 SNPs
11.04% TGV
STB
MAF 0.42
+0.48 (AA)

Serão et al. 21014. doi: 10.2527/jas.2014-7821

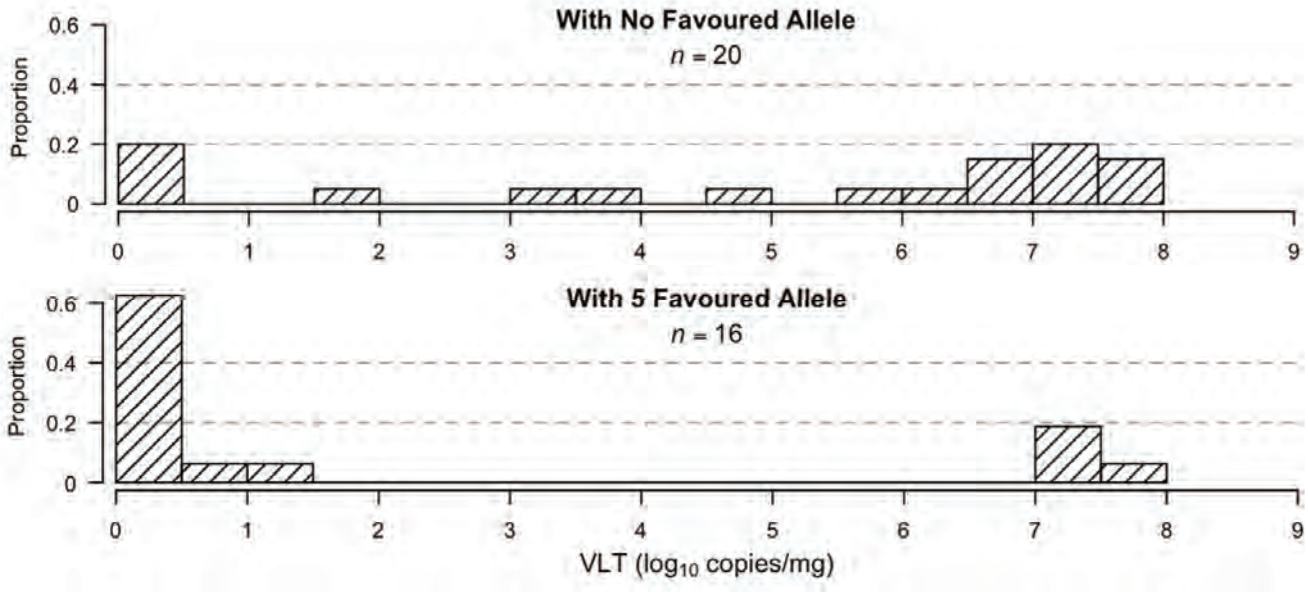
SNPs associated with viral load in fetal thymus



Three single nucleotide polymorphisms (SNPs) on SSC 1, 12 and 14 are associated with fetal viral load and collectively account for 13% of genetic variation

Yang et al. 2016. DOI: 10.1038/srep20305

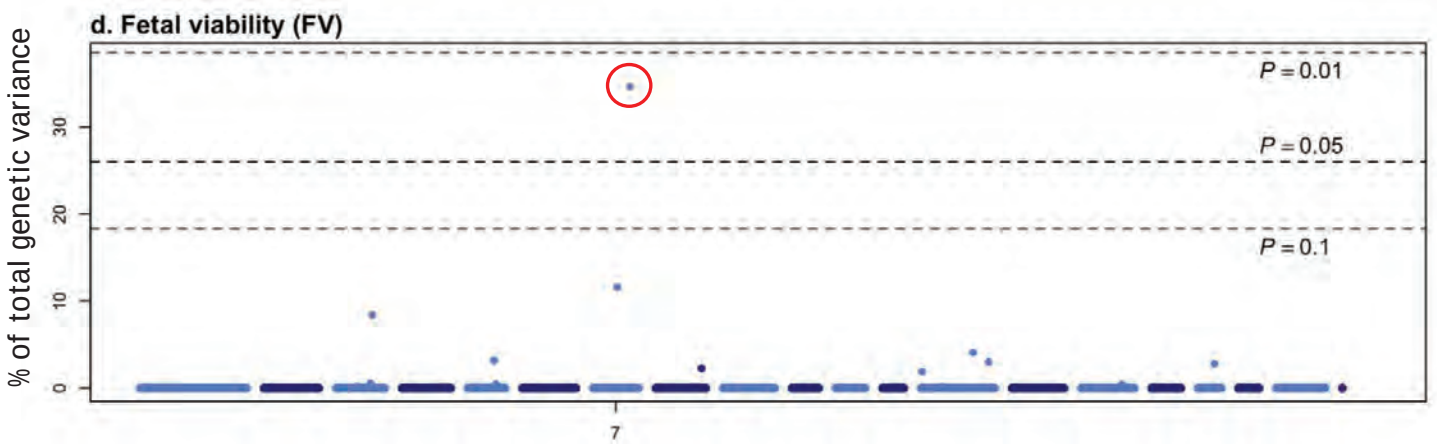
SNPs associated with viral load in fetal thymus



Favorable alleles are associated with decreased VL (~1 log per SNP) and accumulatively associate with greater proportion of negative fetuses

Yang et al. 2016. DOI: 10.1038/srep20305

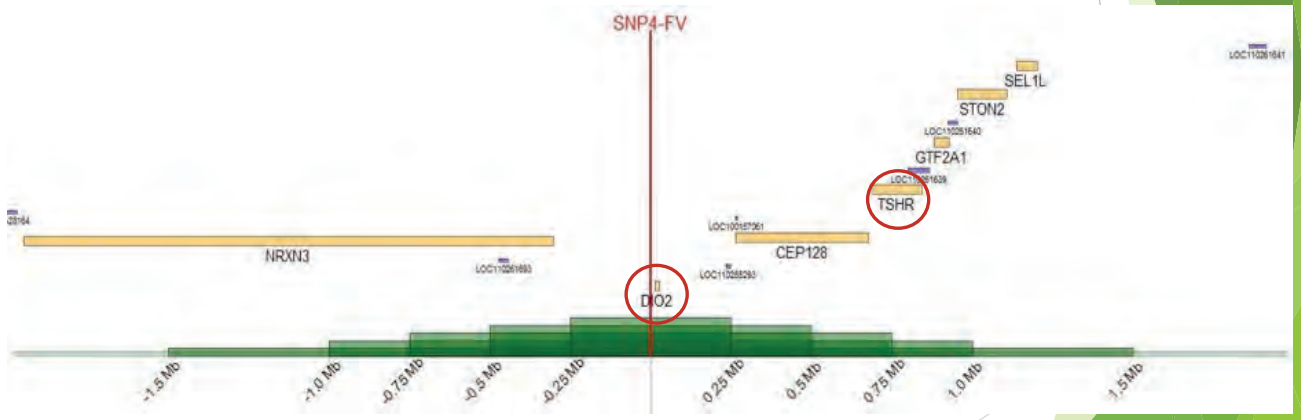
SNPs associated with fetal viability



	AA	AB	BB	No SNP
Total N	640	401	39	340
% viable	58.4	71.1	76.9	1.8
% dead	27.3	21.5	15.4	97.9

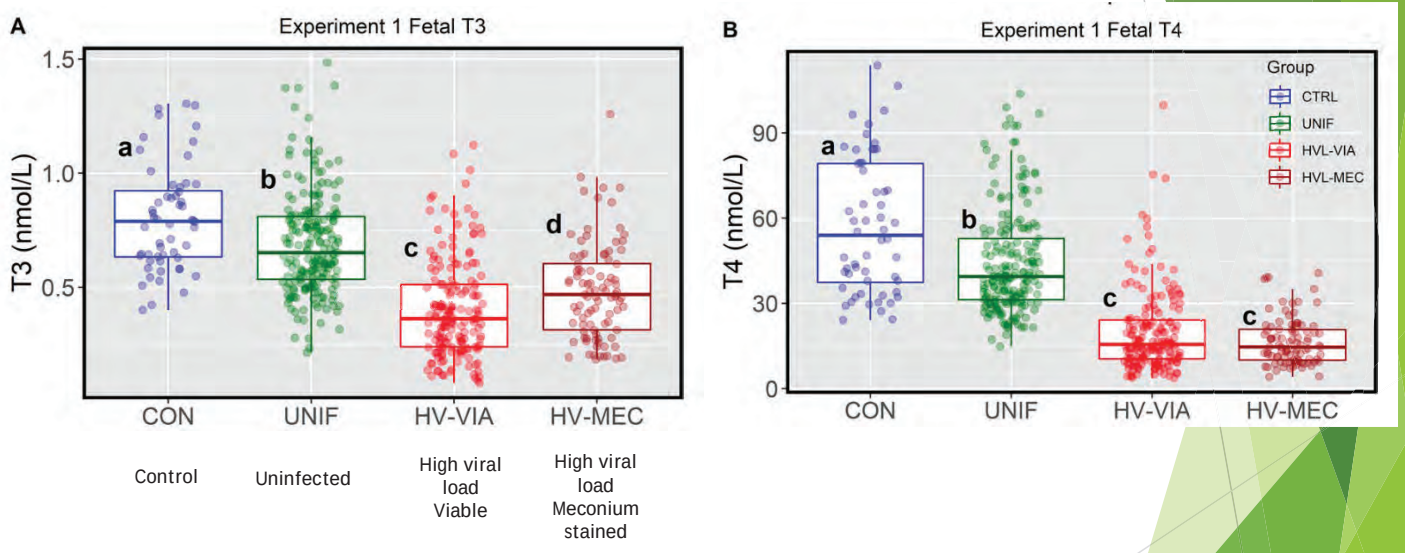
Yang et al. 2016. DOI: 10.1038/srep20305

Genes in proximity to SNP-4 associated with PRRS fetal viability



Pasternak, 2018

Thyroid hormone suppression in fetuses (21 dpmi)



Control

Uninfected

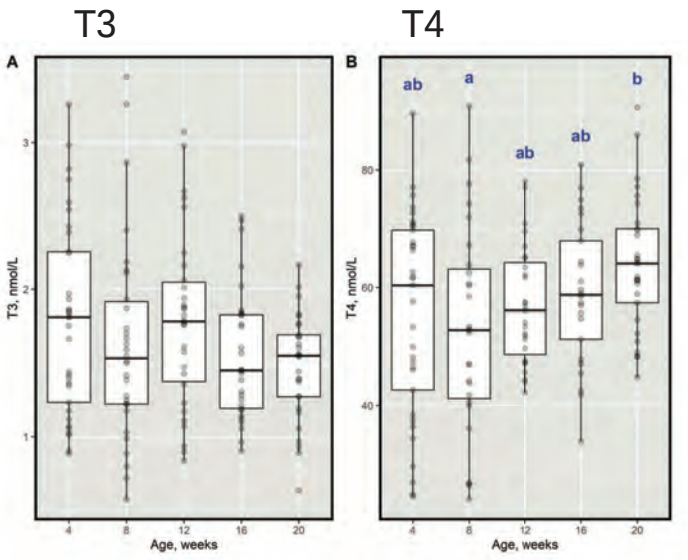
High viral load Viable

High viral load Meconium stained

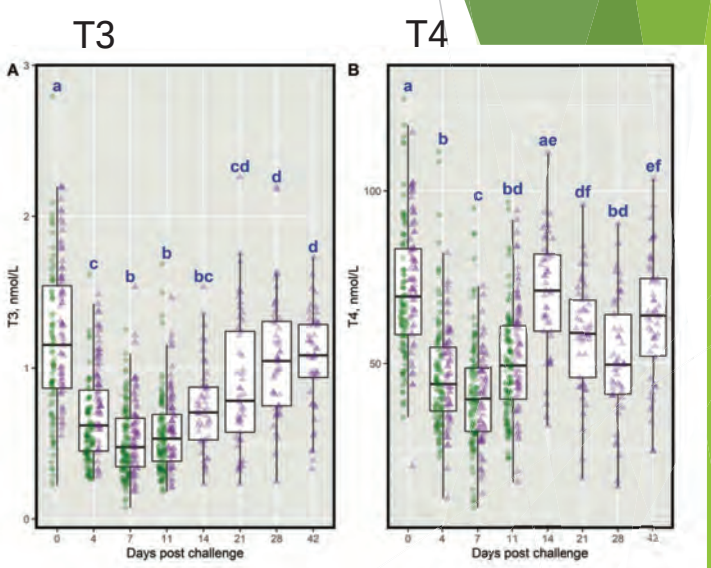
Normal fetal development impaired

Pasternak et al. 2020. doi.org/10.1186/s13567-020-00772-2

Thyroid hormone suppression in feeder pigs



Healthy



PRRSV inoculated

Pasternak et al. 2021. https://doi.org/10.1093/jas/skab325

Normal thymocyte development

- Lymphocyte progenitor cells (thymocytes) migrate from bone marrow to thymus (cortex).
- Various stages of maturity
- Acquire T-cell receptor (TCR) with the ability to respond to a unique antigen
- Develop surface markers (CD4/CD8)
- Undergo positive and negative selection to ensure self-recognition (MHC) but not excessive (auto-immunity)
- Mature CD4 (Th) and CD8 (CTL) lymphocytes respond to foreign antigens

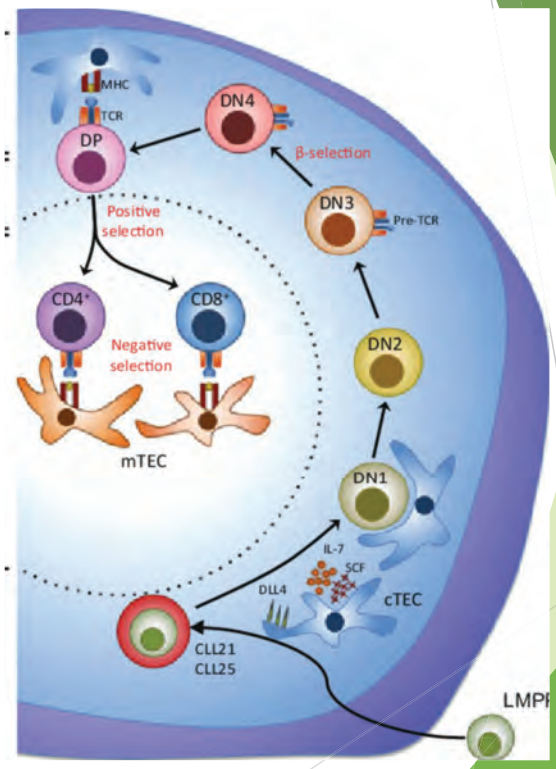
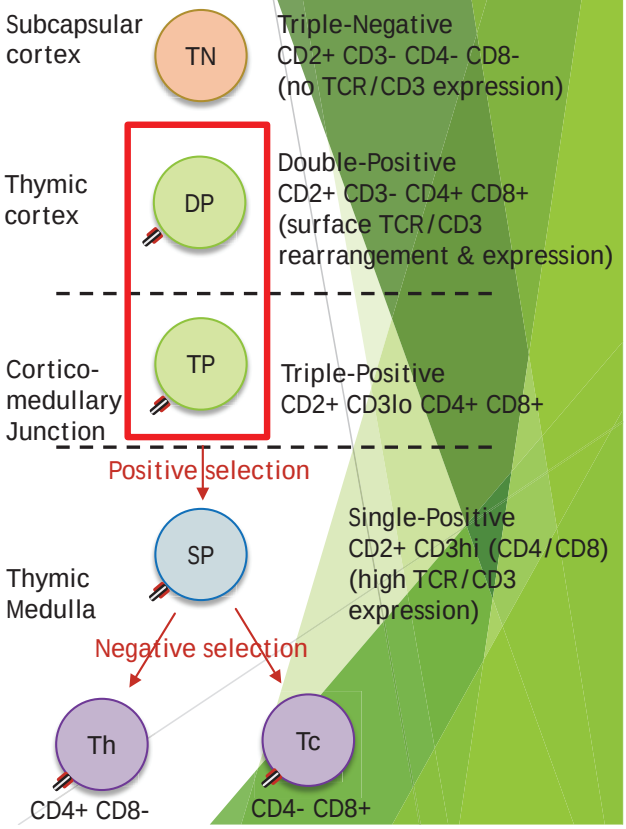


Figure: Bailis & Pear, 2014. DOI 10.1007/978-3-642-45198-0_11

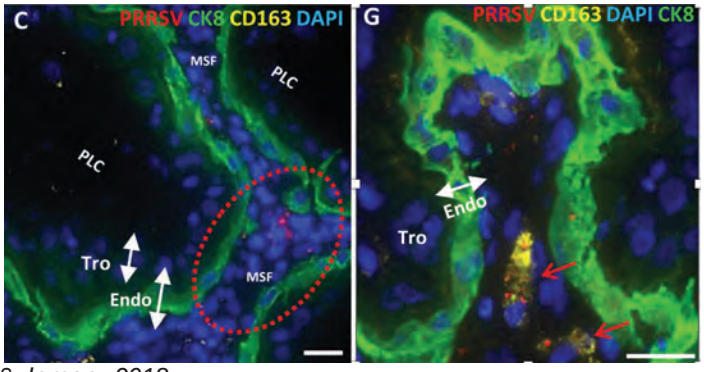
Affect of PRRS on thymocyte development

- Destruction of DP and TP progenitor cells (by 5 dpi)
- Selective destruction of Tc versus Th (by 10 days)
- Restriction in mature Th and Tc repertoire (decreased variability)
- Increase in “experienced” antibody forming B cells
- Over-production of IgM/G/A antibodies but none neutralize virus

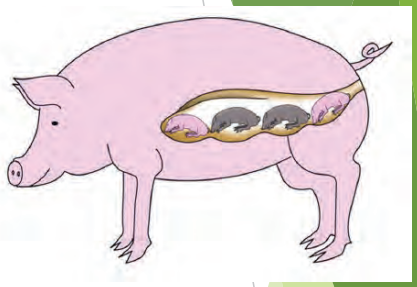


Sinkora et al. 2023. doi.org/10.1016/j.micinf.2023.105146

Reproductive pathogenesis



Sulemon, 2018



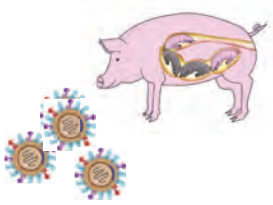
0 — 38 days — 76 days — 115 days

Breeding — Early — Mid — Late — Term

Unclear and infrequent signs
Early gestation the virus can cause embryonic death

Sporadic Late-term Abortions
Fetal mummification
Early farrowing
Stillborn fetuses
Weakborn live piglets

Factors involved in repro PRRS pathogenesis



Maternal Mφ infection

Viremia

Inflammation

Trafficking

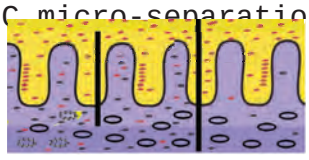
TH suppression

Endometritis
Vasculitis

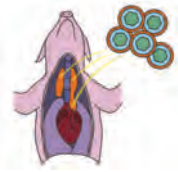
Viral replication in Mφ

Heterogeneous (patchy) viral load in MFI

Apoptosis
Cell cycle suppression
Decreased TJ expression (CLDN6, 10, OCDN)
PLC micro-separation?



Umb → Ser → Thy → organs

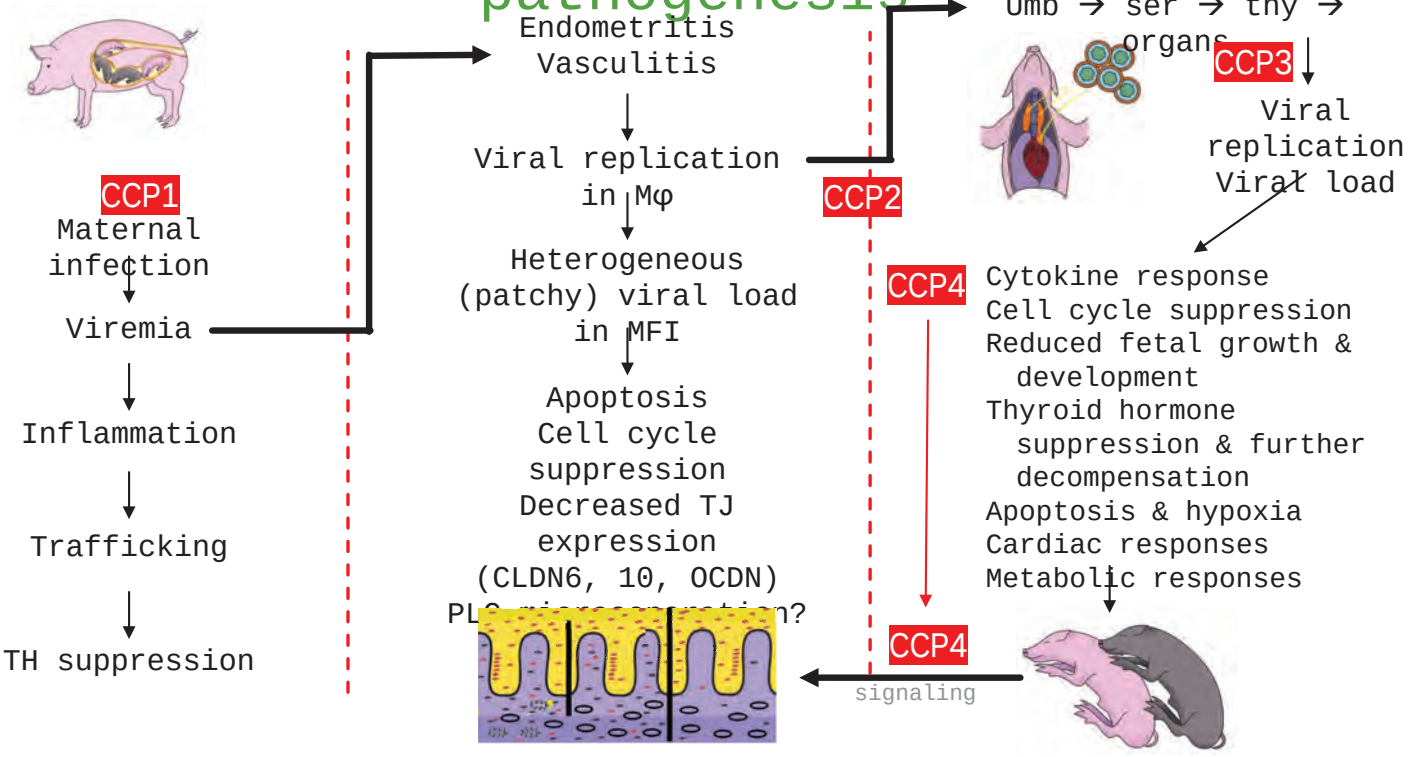


Viral replication in fetal Mφ

Cytokine response (IFNa, IFNg, TNFa, CCL2)
Cell cycle suppression
Reduced fetal growth & development
Thyroid hormone suppression & further decompensation
Apoptosis & hypoxia
Cardiac responses
Metabolic responses

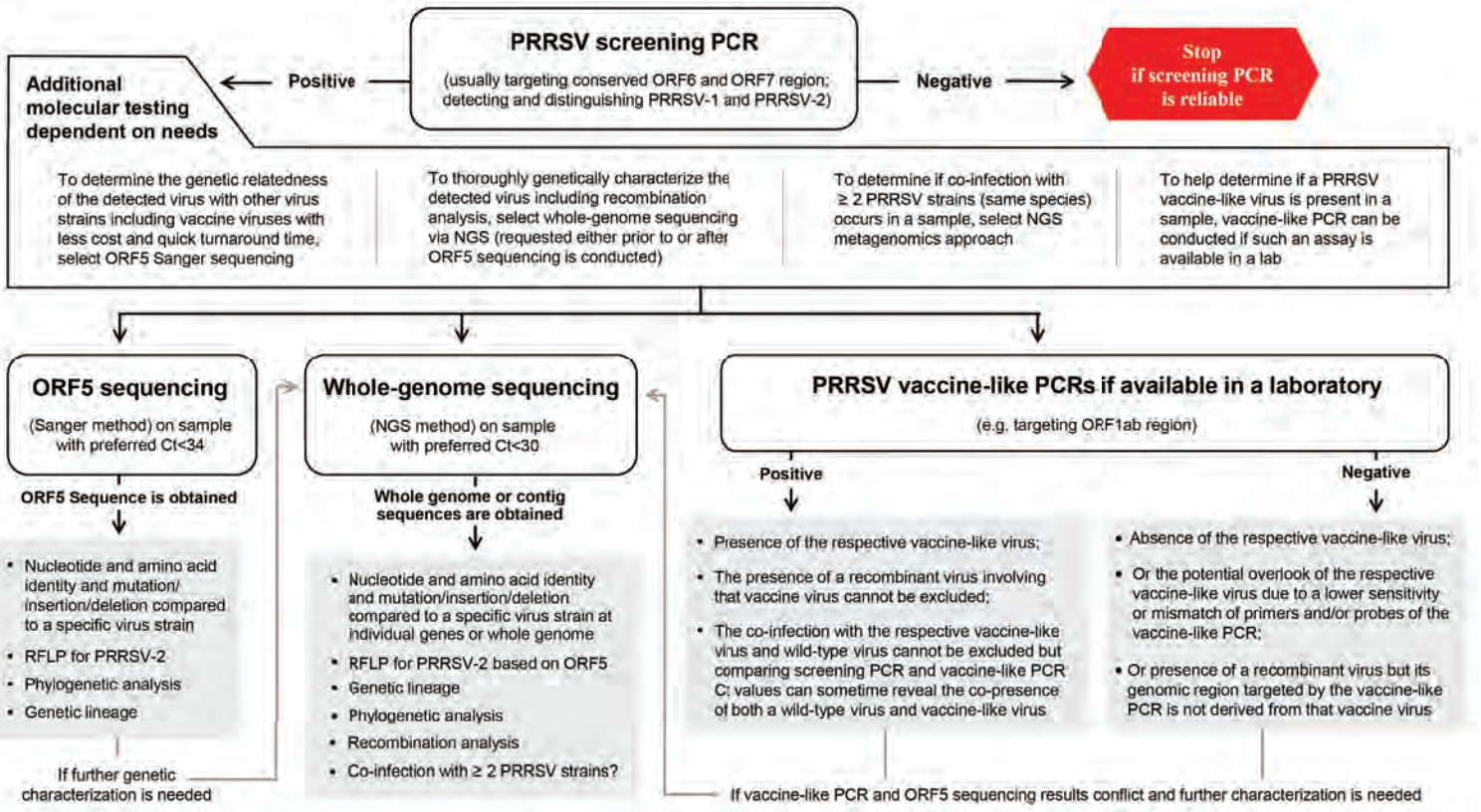
signaling

Factors involved in repro PRRS pathogenesis



Diagnostics

Harding, Diseases of Swine 12 ed. (Fig 37.2) 2025



Zhang, Diseases of Swine 12 ed. (Fig 37.3) 2025

Diagnostics: sow and litter (live/ante-mortem)

	Sample type	Assay/test	Features
	Sera	Antibodies VI/PCR/Seq	Excellent sample type, suitable for multiple assays, PCR only for acute cases since viremia is short lived (3-4 weeks), labour intensive to collect especially large numbers
	Tonsil scraping (TS)	VI/PCR/Seq	Technically demanding to collect, stressful for animals, better sample than sera for evaluating persistence (chronic infection), good for PCR/seq
	Tonsil-oral scrubbing (TOSc)	VI/PCR/Seq	Technically demanding to collect, less stressful for animals than TS especially if not restrained, good for testing persistence (chronic) infection, can be contaminated by feed/water, affecting VI and seq.
	Oral fluids	PCR, ± seq	Surveillance (regional, production stages), easy to collect, low success for VI & WGS
	Family oral fluids (~50% sow)	PCR antibody	Surveillance of due to wean pigs (late suckling), easy to collect, may need rope training, low success for VI & WGS, sow contributes to the sample – may cloud interpretation, older piglets only

Adapted from Table 37.2, Diseases of Swine 12 ed. 2025

Detection rates: TS, TOSc, Sera, OF

TABLE 1 PRRSV RT-rtPCR detection rate among sample types at 30, 60, and 90 days post live virus inoculation.

Sample types	PRRSV detection rate (95% CI)		
	30 days post-LVI	60 days post-LVI	90 days post-LVI
Tonsil scraping	85.3% (71.2–93.2%)[a]	74.2% (62.4–83.3%)[a]	29.5% (17.2–45.7%)[a]
TOSc	66.3% (50.9–78.7%)[b]	40.9% (29.8–53.1%)[b]	3.28% (0.5–16.9%)[b]
Serum	13.2% (5.9–27.1%)[c]	12.1% (6.2–22.4%)[c]	9.84% (3.6–24.1%)[b]
OF	8.8% (3.3–21.9%)[c]	8.0% (3.0–19.5%)[c]	17.86% (5.9–42.6%)[ab]

[a,b,c]Different letters indicate significant differences in the least-square means of PRRSV detection rate among different sample types at each sampling time point (Tukey test, $p < 0.05$). TOSc, tonsil-oral scrubbing, OF, oral fluid. LVI, live virus inoculation.

Li et al., 2024. doi.org/10.1186/s40813-024-00385-7
Li et al,, 2024. DOI 10.3389/fvets.2024.1506995

Factors associated with PRRS outbreaks

- 95 Midwestern sites
- Nurs, Fin, W-F
- Prospective: 2023/24
- OF (6 pens) collected E4W x 1 production cycle
- 115 question survey
- Outbreaks
  - Fin (14/17, 82%)
  - W-F (30/45, 67%)
  - Nurs (11/33, 33%)
- L1C.5 (19/32, 59%)

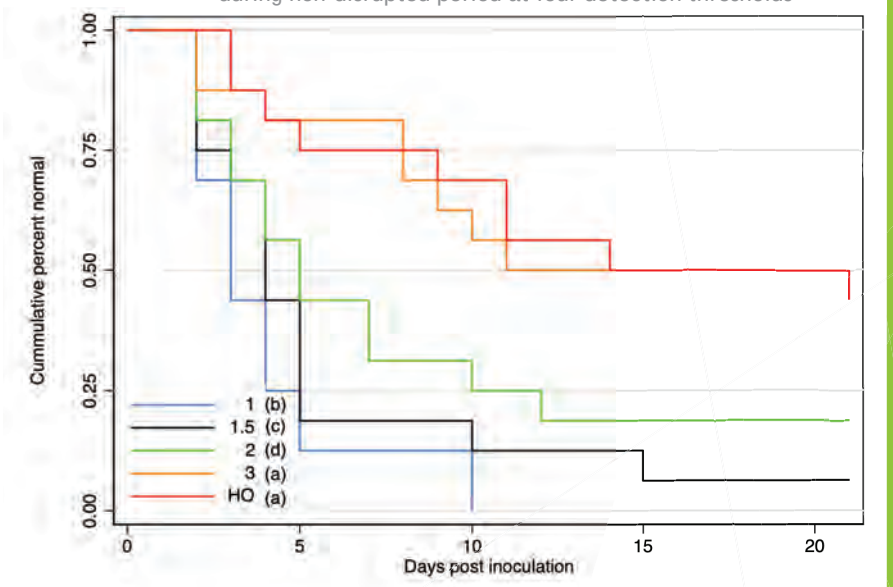
Biosecurity Practices	Levels	Odds Ratio	CI 95%	*p*-Value
Use of rendering as dead pig disposal method	No (Reference)	1		
	Yes	6.47	1.62–25.84	0.008
Natural vs. mechanical ventilation system	Mechanical (Reference)	1		
	Natural	10.88	1.35–87.60	0.025
Pigs hauled without confirmed PRRS status	No (Reference)	1		
	Yes	9.79	1.73–55.37	0.009
Allowing employees to cohabitate with others who work swine related jobs	No (Reference)	1		
	Yes	6.15	1.51–25.09	0.011
Production site type category	Nursery (Reference)	1		
	Finisher	17.47	2.44–125.19	0.004
	Wean-to-finish	8.47	0.85–84.24	0.068
Dedicated vehicle parking area for staff/visitors	No (Reference)	1		
	Yes	0.07	0.01–0.35	0.001
Dedicated manure pumping equipment per site	No (Reference)	1		
	Yes	0.07	0.01–0.43	0.003
Multi-farm employee mandatory overnight downtime	No (Reference)	1		
	Yes	0.15	0.04–0.56	0.004
Rodents never have access to feed bin	Reference			
	Never	0.08	0.02–0.47	0.004
Wild animals never have access to feed bin	Reference			
	Never	0.08	0.02–0.47	0.004
Presence of bench entry	No (Reference)			
	Yes	0.27	0.11–0.67	0.005
Exclusive 3rd party manure handling per site	No (Reference)			
	Yes	0.10	0.02–0.53	0.006
Site located within 1 mile of another swine site	Within 1 mile	1.59	1.12–2.27	0.010
Site located within 5 miles of another swine site	Within 5 miles	1.06	1.01–1.12	0.029

Musskopf et al., 2025,
doi.org/10.3390/vetsci12101000

Detection of behavioural changes using Precision Livestock Farming (NU*track*)

- PRRSV experimental challenge
- 5-week old nursery pigs
- 8 Ctrl / 16 PRRS (pens of 4)
- Monitoring:
  - Human observation (HO)
  - NUtrack (24/7) surveillance
    - Distance
    - Time at feeder/waterer
    - Lying: lateral, sternal
    - Rotations (angle radians)
- Changes versus control
- Sensitivity thresholds (Z=1, 1,5, 2, 3)
  - Non-disrupted period
  - Lateral-sternal ratio

Detection of changes in Lateral Sternal ratio in PRRSV inoculated pigs during non-disrupted period at four detection thresholds



Nosach et al., 2025

Herd classification system for PRRSV

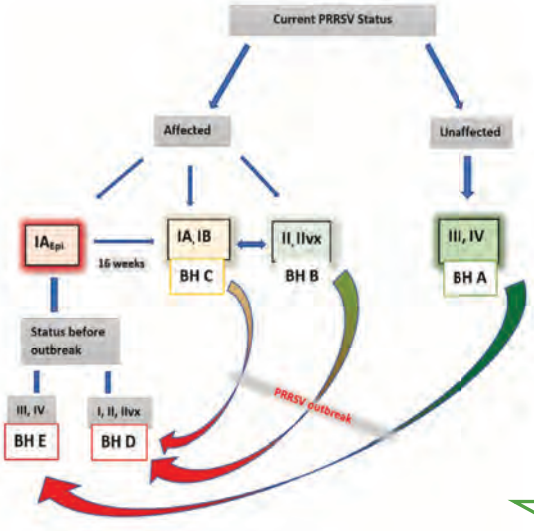
Herd category	Shedding status	Exposure status	Evidence to promote a herd to category
Positive Unstable High Prevalence (IA)	Positive, high prevalence	Positive	None required
Positive Unstable Low Prevalence (IB)	Positive, low prevalence	Positive	Serum or FOF from weaning-age pigs or PF tested by PCR
Positive Stable Without Vaccine (II) and With Vaccine (II-vx)	Uncertain	Positive	Serum from weaning-age pigs (may be used w/PF and FOF concurrently) tested by PCR
Provisional negative (III)	Negative	Positive	Serum from PRRSV naïve replacement breeding animals tested by ELISA
Negative (IV)	Negative	Negative	Serum from adult breeding animals tested by ELISA

▶Abbreviations: PF = processing fluids; FOF family oral fluids

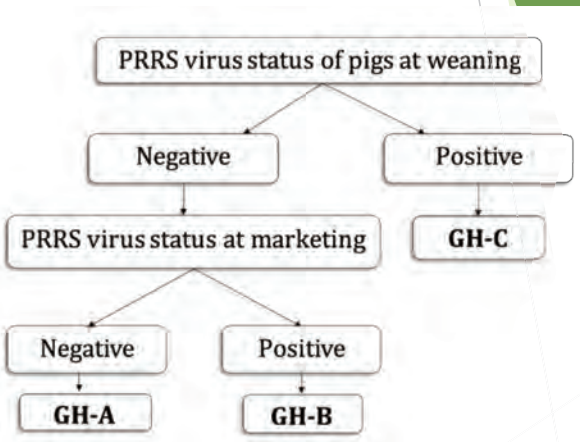
Holtkamp et al., 2021. doi.org/10.54846/jshap/1218
Adapted from Table 37.3 Diseases of Swine 12th ed

Economic impact of PRRS: USA 2016-2020

Breeding herds



GF herds



819.41 M USD/Yr

$1.2B

380.82 M USD/Yr

Osemeke *et al., 2025.* doi/10.1016/j.prevetmed.2025.106627

PRRS: Where are we heading?

- PRRSV is here to stay
- Widespread regional eradication does not work, never will
- Vaccines work, within limits, but will not eliminate the virus
- Biosecurity works, but has limitations in most farms
- PRRS resilience may be helpful, but will not by itself control disease
- Naturally existing PRRS resistance is exceptionally rare and not understood
- PRRS resistance through gene editing offers promise. Its long-term adoption will depend on the price, consumer attitudes, industry participation
- Antivirals are worth exploring, but may face regulatory challenges

At $1.2B/yr losses (USA alone), can we afford the status quo?