Prevalences and impact of selected new and/or neglected porcine respiratory RNA viruses in Denmark: Porcine respiratory coronavirus (PRCV), porcine respirovirus 1 (PRV1) and swine orthopneumovirus (SOV)

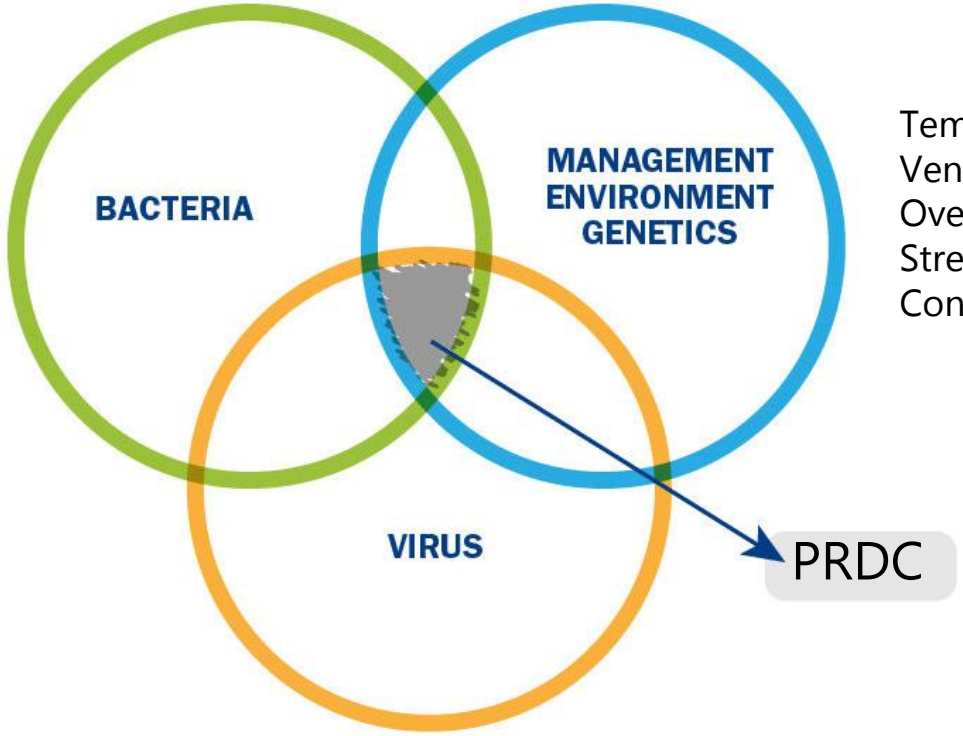
Amalie E. Bedsted, PhD student, IVH
Nicole B. Goecke, Postdoc, IVH

CPH pig 2024

UNIVERSITY OF COPENHAGEN

Porcine Respiratory Disease Complex (PRDC)

S. suis
H. parasuis
P. multocida
A. pleuropneumoniae
M. hyopneumonia
B. bronchiseptica



Temperature
Ventilation
Overcrowding
Stress
Continuous flow

Swine influenza A virus (swIAV)
Porcine reproductive and respiratory syndrome virus (PRRSV)
Porcine circovirus type 2 (PCV2)
Pseudorabies virus (PRV)
Porcine respiratory coronavirus (PRCV)

PRV1?
SOV?

PRV1 and SOV

Porcine respirovirus 1 (PRV1)
- porcine parainfluenza virus 1

- Family *Paramyxoviridae* and genus Respirovirus
  - Bovine and human parainfluenza virus (1,3)

- First detection in deceased pigs in China (Hong Kong, 2013)
  - Chile, Germany, Hungary, Poland, the Netherlands and USA

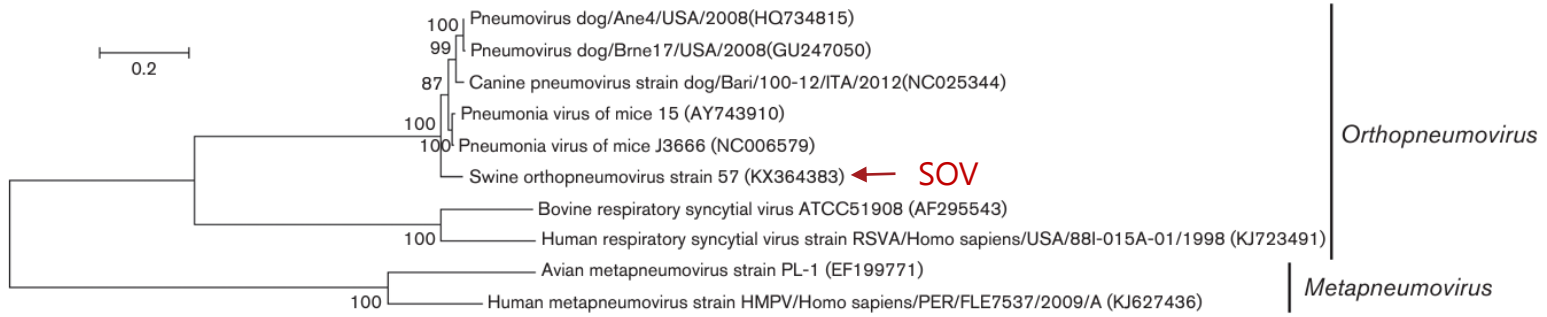
- Phylogeny
  - Clade 1 (EU + one Hong Kong): 94.6-99.9% (nt)
  - Clade 2 (USA + Asia): 93.2-99.9% (nt)

  } 88.7-91.9% (nt)

- Limited knowledge about the epidemiology and clinical impact in the frame of PRDC

Swine orthopneumovirus (SOV)

- Family *Pneumoviridae* and genus Meta- and Orthopneumovirus (SOV)

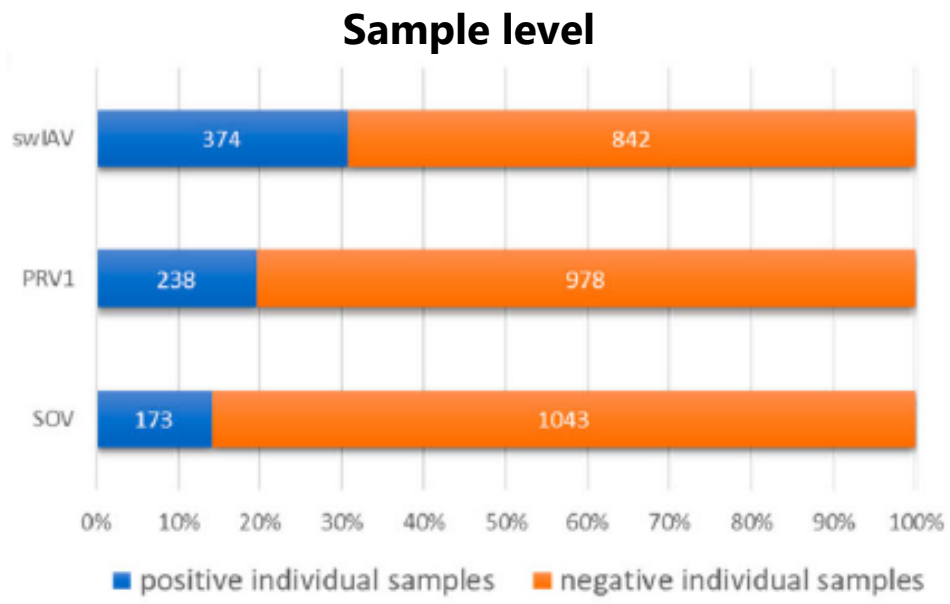


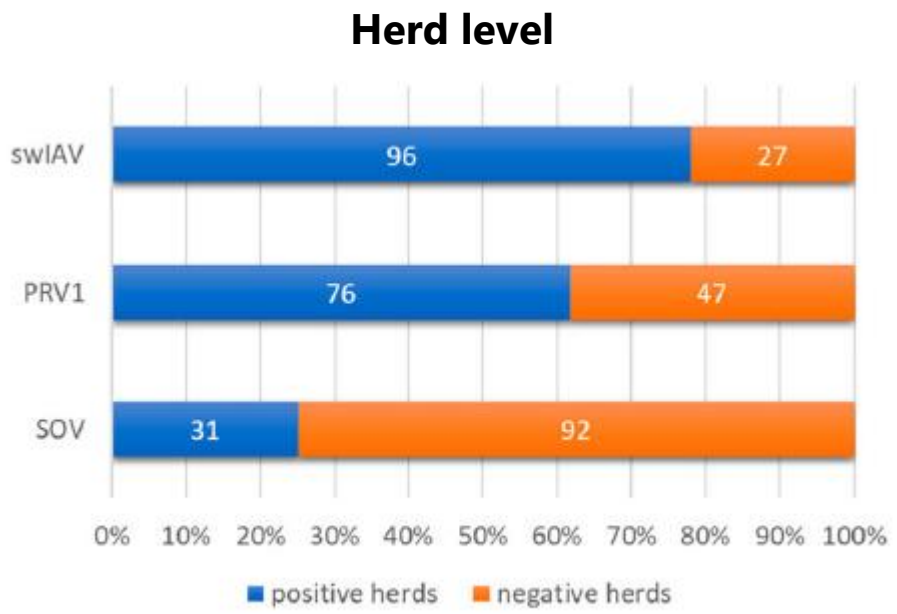
- First detection in feral pigs in USA (2016)
  - France, Germany, South Korea and Spain

- Limited knowledge about the epidemiology and clinical impact in the frame of PRDC

Detection of PRV1 and SOV in Europe

- **Germany** (Graff-Rau et al., 2023)
- Nasal swab samples derived from pigs with respiratory disease
- 1216 samples from 123 pig herds were analyzed (real-time RT-PCR)

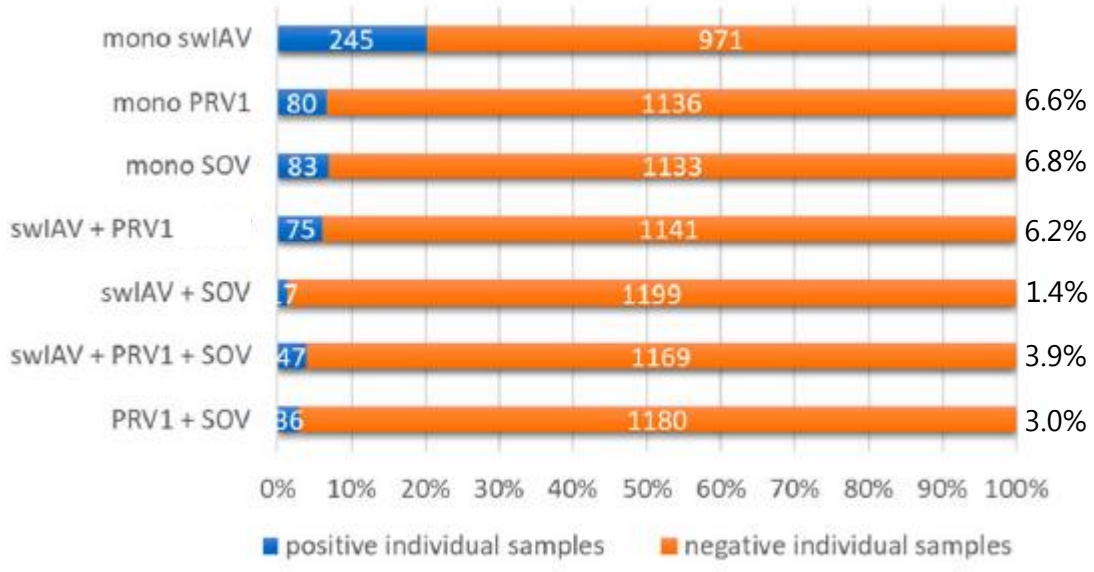




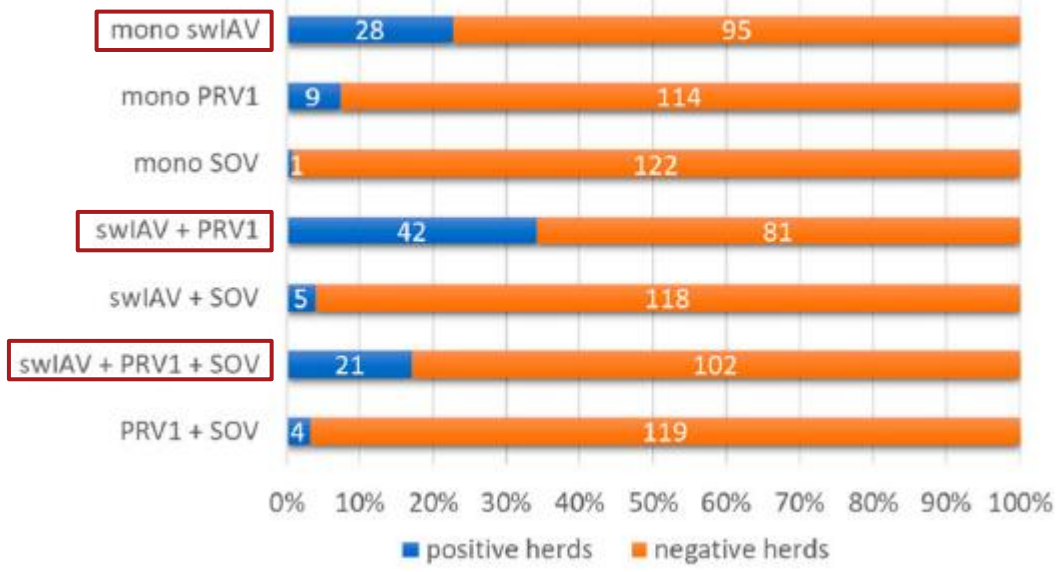
Detection of PRV1 and SOV in Europe

- **Germany** (Graff-Rau et al., 2023)
- Nasal swab samples derived from pigs with respiratory disease
- 1216 samples from 123 pig herds were analyzed (real-time RT-PCR)

Sample level

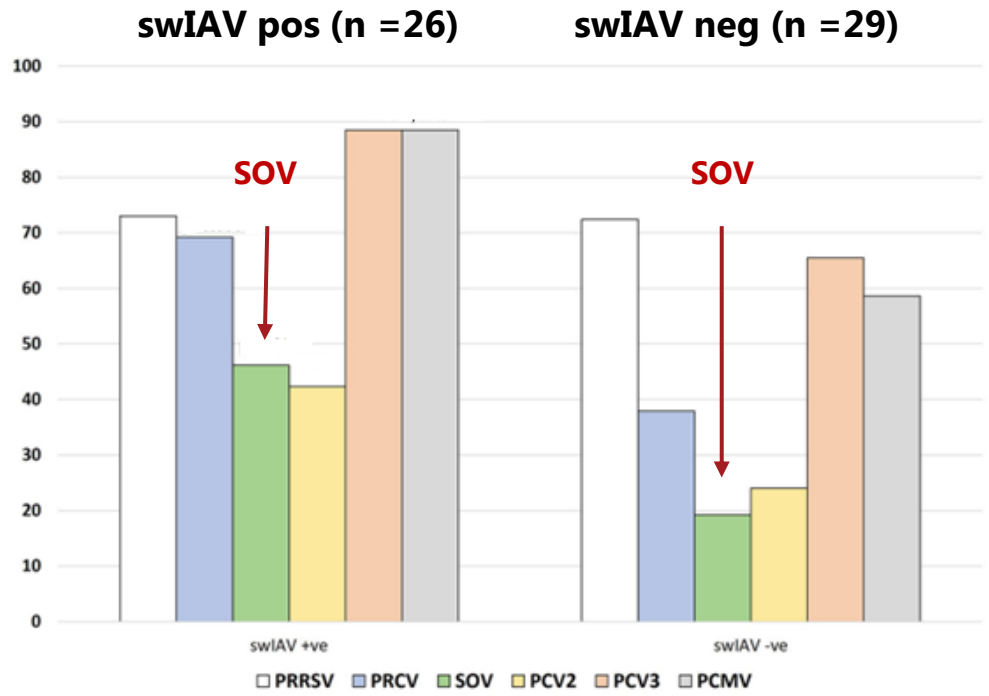


Herd level



Detection of PRV1 and SOV in Europe

- **Spain and Portugal** (Martin-Valls et al., 2022)
- Nasal swab samples derived from pigs with respiratory disease
- 873 samples (pools) from 55 pig herds were analyzed (real-time RT-PCR)

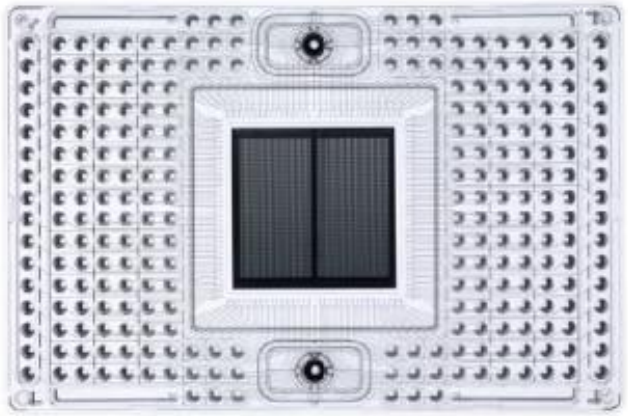


Overall findings – herd level:
SOV – 17/55 (30.9%)
PRV1 – 0/55 (0%)

Detection of PRV1 and SOV in Denmark

- High-throughput real-time PCR analysis (the "Fluidigm" chip)

192 samples x 24 assays



Respiratory pathogens:

- **Swine Orthopneumovirus (SOV)**
- **Porcine Respirovirus type 1 (PRV1)**
- **Porcine Respiratory Coronavirus (PRCV)**
- Influenza A virus (IAV)
- Porcine Circovirus type 2 (PCV2)
- Porcine Circovirus type 3 (PCV3)
- Porcine Cytomegalovirus (PCMV)
- *Streptococcus suis type 2*
- *Haemophilus parasuis*
- *Pastuerella multocida*
- *Actinobacillus pleuropneumoniae*
- *Mycoplasma hyopneumonia*
- *Mycoplasma hyorhinis*
- *Bordetella bronchiseptica*

CoVetLab project 2024
- Diagnosis, epidemiology and clinical impact of **PRV1** in Europe

- Partners: France, Germany, Spain, Sweden, the Netherlands, United Kingdom and Denmark (UCPH and SSI)
- Hypothesis: PRV1 could play a significant role in the PRDC
- Aims:
  1. Determine the presence and prevalence of PRV1 (real-time PCR)
  2. Define the age groups that are clinically affected by the virus
  3. Describe the genetic diversity of PRV1 strains circulating (NGS)
  4. Link the presence of PRV1 to specific clinical and pathological manifestations

CoVetLab project 2024
- Diagnosis, epidemiology and clinical impact of **PRV1** in Europe

- Aims:
  1. Determine the presence and prevalence of PRV1 (real-time PCR)
  2. Define the age groups that are clinically affected by the virus
  3. Describe the genetic diversity of PRV1 strains circulating (NGS)
  4. Link the presence of PRV1 to specific clinical and pathological manifestations

- Actions:
  - Establish and validate a diagnostic test (real-time PCR)
  - Analyse samples from other projects and national diagnostic submissions

CoVetLab project 2024
- Diagnosis, epidemiology and clinical impact of **PRV1** in Europe

- Aims:
  1. Determine the presence and prevalence of PRV1 (real-time PCR)
  2. Define the age groups that are clinically affected by the virus
  3. Describe the genetic diversity of PRV1 strains circulating (NGS)
  4. Link the presence of PRV1 to specific clinical and pathological manifestations

- Actions:
  - Full-genome sequencing of selected positive samples

CoVetLab project 2024
- Diagnosis, epidemiology and clinical impact of **PRV1** in Europe

- Aims:
  1. Determine the presence and prevalence of PRV1 (real-time PCR)
  2. Define the age groups that are clinically affected by the virus
  3. Describe the genetic diversity of PRV1 strains circulating (NGS)
  4. Link the presence of PRV1 to specific clinical and pathological manifestations

- Actions:
  - Establish and validate an *in situ* detection method
  - Experimental pig study
    - Pathological and *in situ* examination of respiratory organs from PRV1 positive pigs

PRCV

Coronaviruses

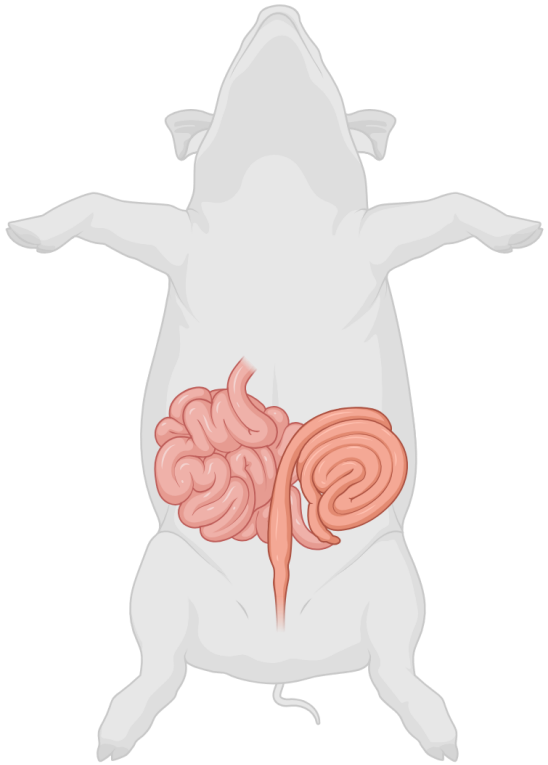
- Enveloped
- Positive sense ssRNA
- ~ 22-36 kb
- Symptoms: Respiratory, reproductive, enteric, hepatic, neurologic, renal
- Zoonotic viral species
- Four genera: α, β, γ, δ

https://www.quantamagazine.org/what-can-other-coronaviruses-tell-us-about-sars-cov-2-20200429/

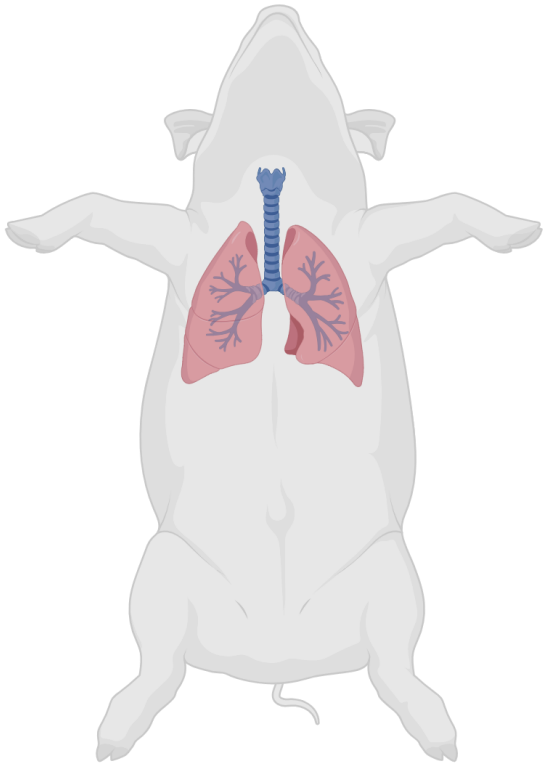
Coronavirus genera

	Host range	Examples
Alpha	Mammals	TGEV (pig), **PRCV** (pig), PEDV (pig), SADS (pig), FIP (cat), 229E (human), HKU1 (human)
Beta	Mammals	MERS (human), SARS (human), SARS-CoV-2 (human), MHV (mouse),
Gamma	Birds (and marine mammals)	IBV (bird)
Delta	Birds (and mammals)	PDCoV (pig)

PRCV and TGEV: Tissue tropism



TGEV



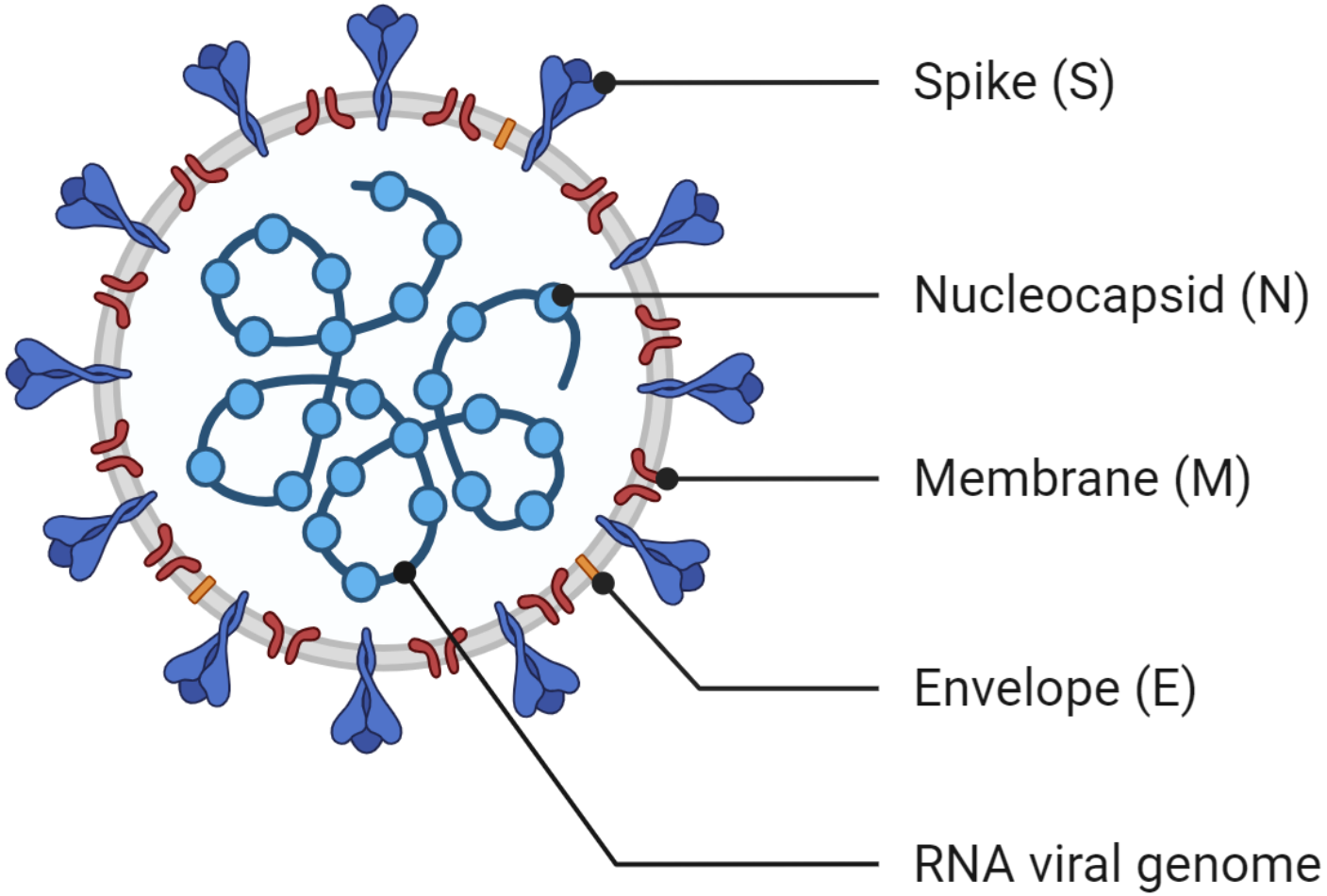
PRCV

PRCV infection of pigs

- Transmission: Respiratory fluids and aerosols
- Typically subclinical or mild
- Although may contribute to porcine respiratory disease complex

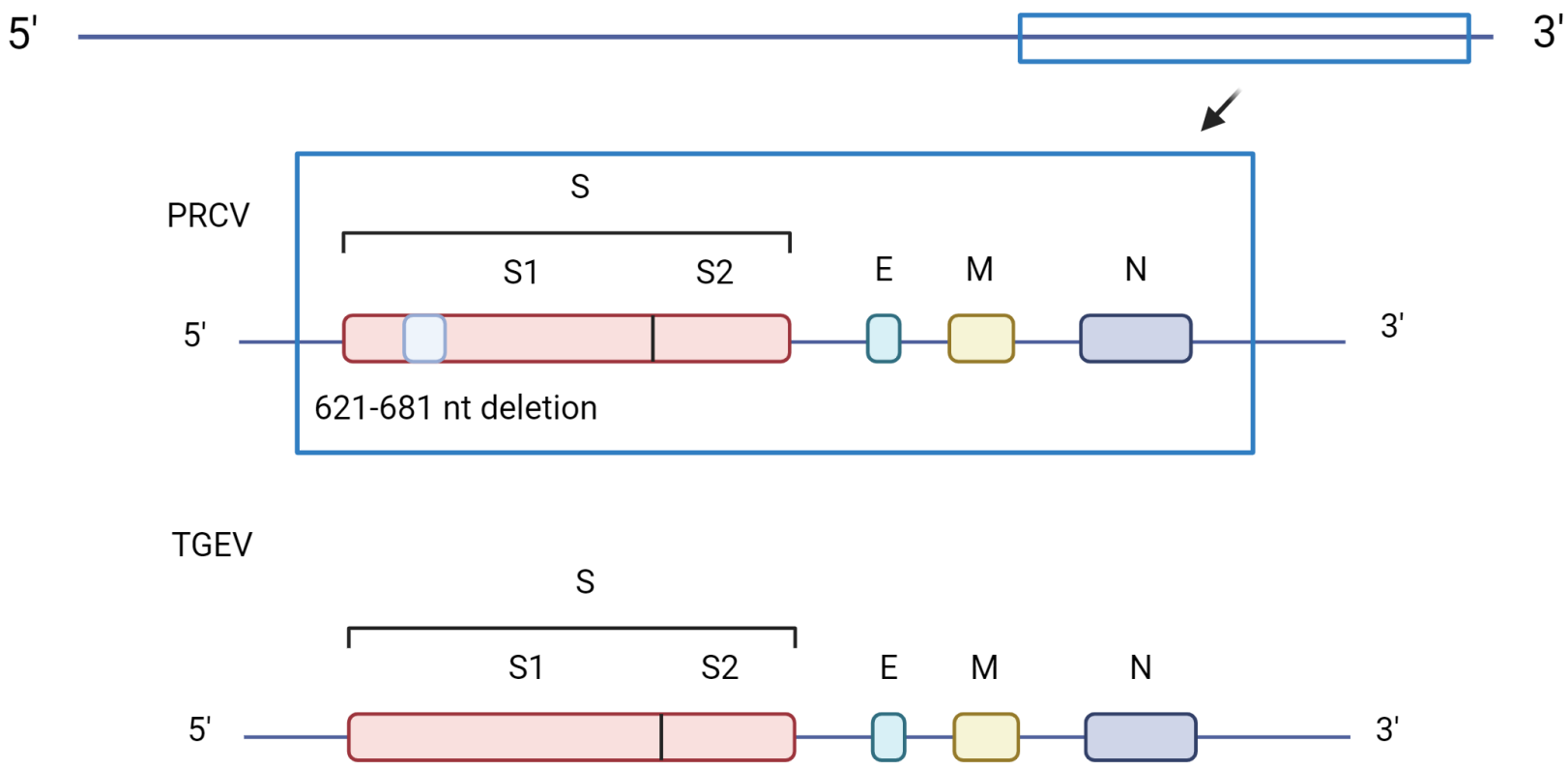
https://unsplash.com/s/photos/pig

TGEV and PRCV: Structural proteins



Adapted from "Human Coronavirus Structure" by BioRender.com (2024). Retrieved from https://app.biorender.com/biorender-templates.

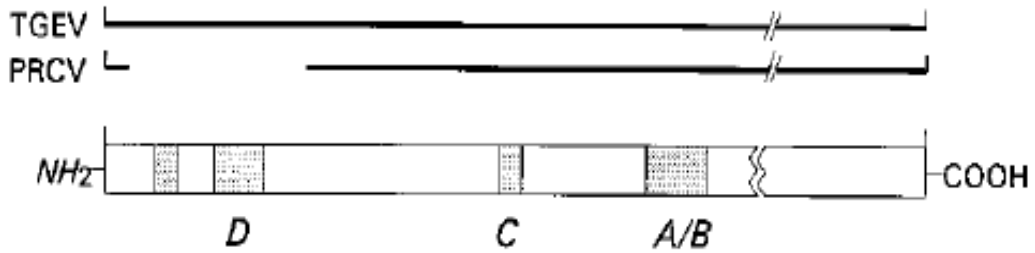
TGEV and PRCV: Genome



Modified from Turlewicz-Podbielska et al. (2021).
Designed in BioRender

PRCV and TGEV cross-reactivity

- Some degree of serological cross-reaction to TGEV
  - Serologically, TGEV can be differentiated from PRCV with a monoclonal antibody targeting antigenic site D (Paris nomenclature) (Krempl, 1997)
- Some degree of cross-neutralization and cross-protection (Magtoto, 2019; Laude, 1993)



Krempl et al (1997)

TGEV in farmed pigs in Europe

Country	Method	Prevalence (pig level)	Reference
Italy	Serology	5.5%	Ferrara et al. (2023)
Austria	Serology	0.6%-1%	Sipos et al. (2006)
Slovakia	PCR	0%	Salamunova et al. (2018)

TGEV has never been detected in Denmark – notifiable disease (list 2)

PRCV seroprevalence in farmed pigs in Europe

Country	Seroprevalence (pig level)	Reference
Italy	0.9%	Ferrara et al. (2023)
Finland	0%	Haimi-Hakala et al. (2017)
Austria	~ 70%	Sipos et al. (2006)
Norway	26.6%	Norwegian Veterinary Institute (2023) - for 2022

PRCV prevalence by PCR in Europe

- Portugal and Spain: **48% of samples tested** (from pigs with resp. symptoms) (Martín-Valls, 2022)

- Germany: **6.6% of samples tested** (IAV positive farms) (Vereecke, 2023)

PRCV seroprevalence in Denmark

- 1985-1986: 58.8% of 410 herds tested were seropositive (Henningsen, 1988)
  - PRCV first detected in DK in 1984 (Henningsen, 1988)

Acknowledgement and thanks for your attention

Lars Erik Larsen

Graham J. Belsham

Charlotte Hjulsager

Charlotte Kristensen

Marianne A. Schmidt

Rikke Søgaard

Jonathan R. Rogersen

Kasper Pedersen

Anette Bøtner

Thomas Bruun Rasmussen