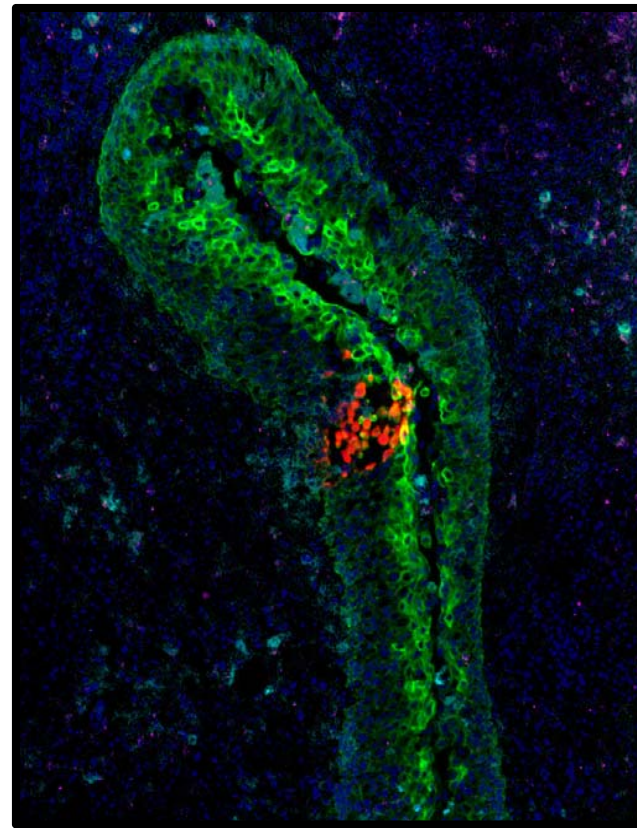
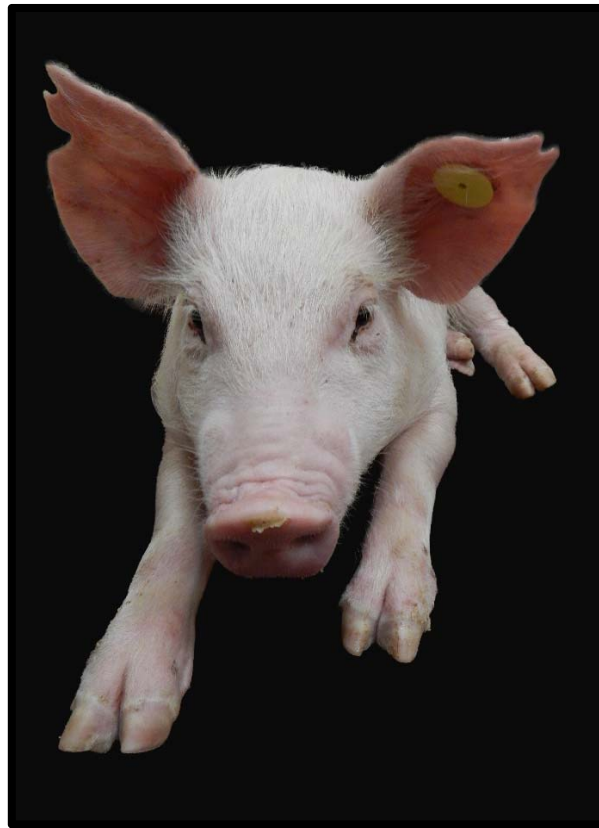


# PATHOGENESIS AND TRANSMISSION OF FMDV IN PIGS

**Carolina Stenfeldt, Luis Rodriguez, Jonathan Arzt**

Foreign Animal Disease Research Unit, USDA-ARS, Plum Island, USA



# FMDV pathogenesis in pigs

*Journal of General Virology* (2001), 82, 747–755. Printed in Great Britain

## The early pathogenesis of foot-and-mouth disease in pigs infected by contact: a quantitative time-course study using TaqMan RT-PCR

Soren Alexandersen, Martin B. Oleksiewicz† and Alex I. Donaldson

Institute for Animal Health, Pirbright Laboratory, Ash Road, Pirbright, Woking, Surrey GU24 0NF, UK

J. Comp. Path. 1995 Vol. 113, 51–58

## Pathogenesis of Foot-and-Mouth Disease in Swine, Studied by In-situ Hybridization

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Foreign Animal Disease Diagnostic Laboratory, NVSL-VS-APHIS-USDA, P.O. Box 848, Greenport, NY 11944 and \*Department of Veterinary Pathology, University of California, Davis, CA 95616, USA

Preventive Veterinary Medicine 88 (2009) 158–163

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journal homepage: [www.elsevier.com/locate/prevetmed](http://www.elsevier.com/locate/prevetmed)



## Foot-and-mouth disease viral loads in pigs in the early, acute stage of disease

C. Murphy, J. B. Bashiruddin, M. Quan, Z. Zhang, S. Alexandersen

## Foot and mouth disease virus transmission during the incubation period of the disease in piglets, lambs, calves, and dairy cows

K. Orsel<sup>a,\*</sup>, A. Bouma<sup>a</sup>, A. Dekker<sup>b</sup>, J.A. Stegeman<sup>a</sup>, M.C.M. de Jong<sup>c</sup>

<sup>a</sup> Faculty of Veterinary Medicine, Department of Farm Animal Health, Utrecht University, Utrecht, The Netherlands

<sup>b</sup> Central Institute for Animal Disease Control Lelystad (CIDC-Lelystad), Wageningen UR, The Netherlands

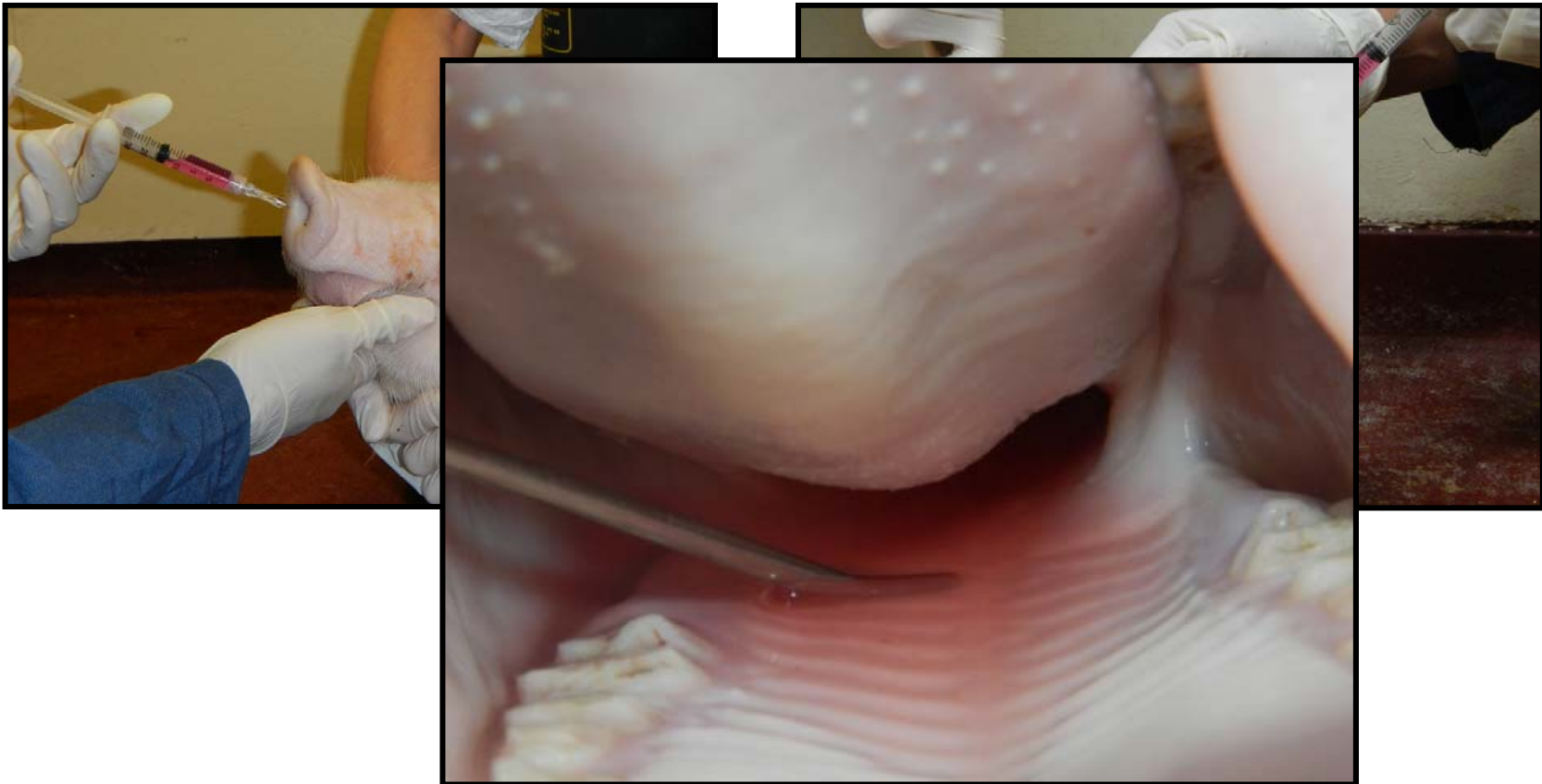
<sup>c</sup> Quantitative Veterinary Epidemiology, Wageningen University and Research Centre, Wageningen, The Netherlands

The progress and pathogenesis of foot-and-mouth disease virus (FMDV) was studied in infected pigs by observing the development of clinical signs in two separate experiments. Viral loads were determined by real-time quantitative RT-PCR in the liver, spleen, cervical lymph node, mandibular lymph node, retropharyngeal lymph node, soft palate, pharynx, tonsil, tongue and skin (coronary band area). Tissue samples were collected from both inoculated and contact-infected pigs at several time points during infection, and blood samples were collected to assess viraemia and its relationship to tissue viral load. Virus first appeared in the lymph nodes, followed by viraemia and then clinical signs. The results suggested that FMDV accumulated in lymphoid tissue up to six hours after infection, in the tissues drained by the mandibular lymph node and tonsil and then disseminated throughout the body where epithelial cells were the favoured sites of replication.

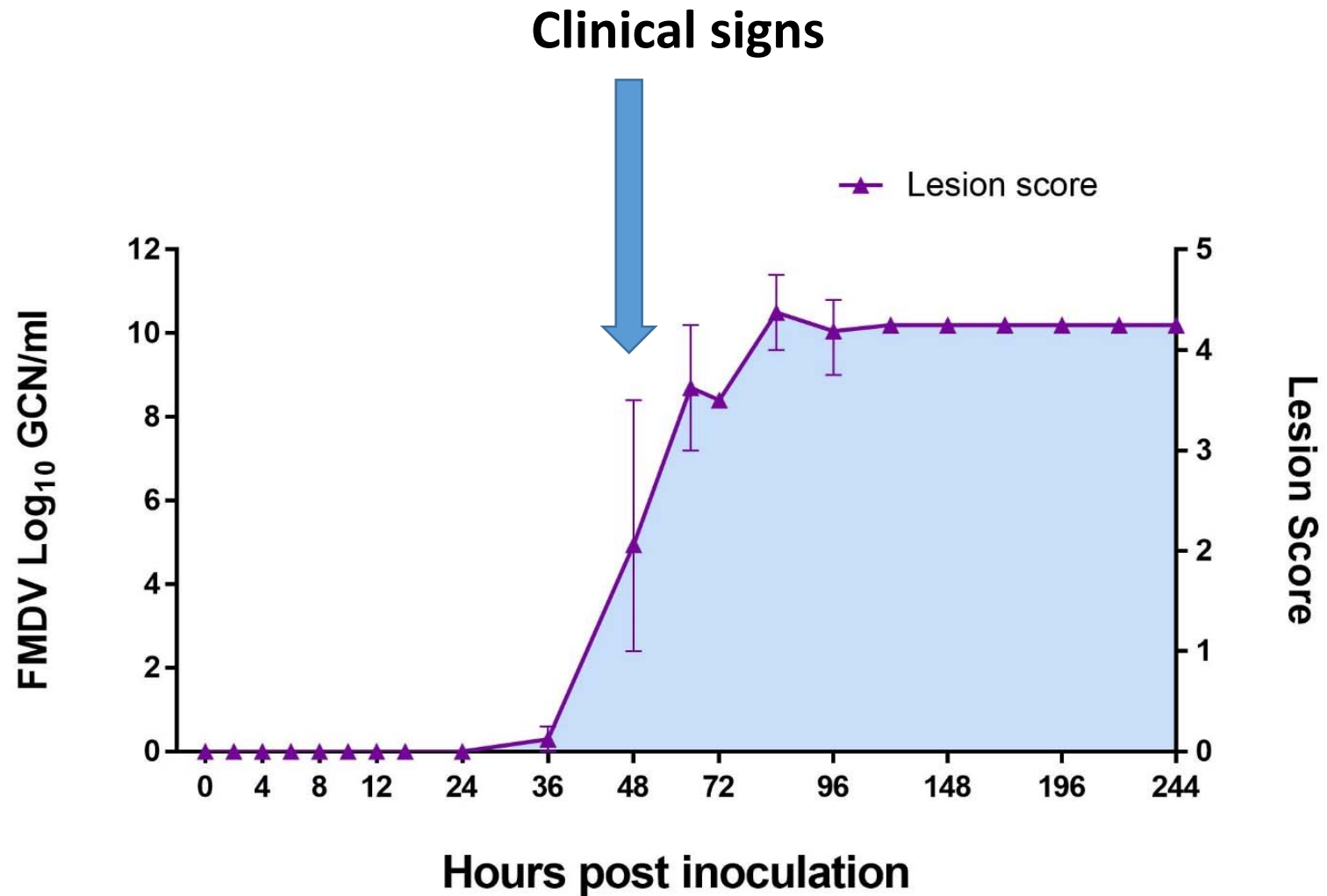
# Inoculation systems for FMDV studies in pigs

**Intra-nasopharyngeal inoculation  
(INP)**

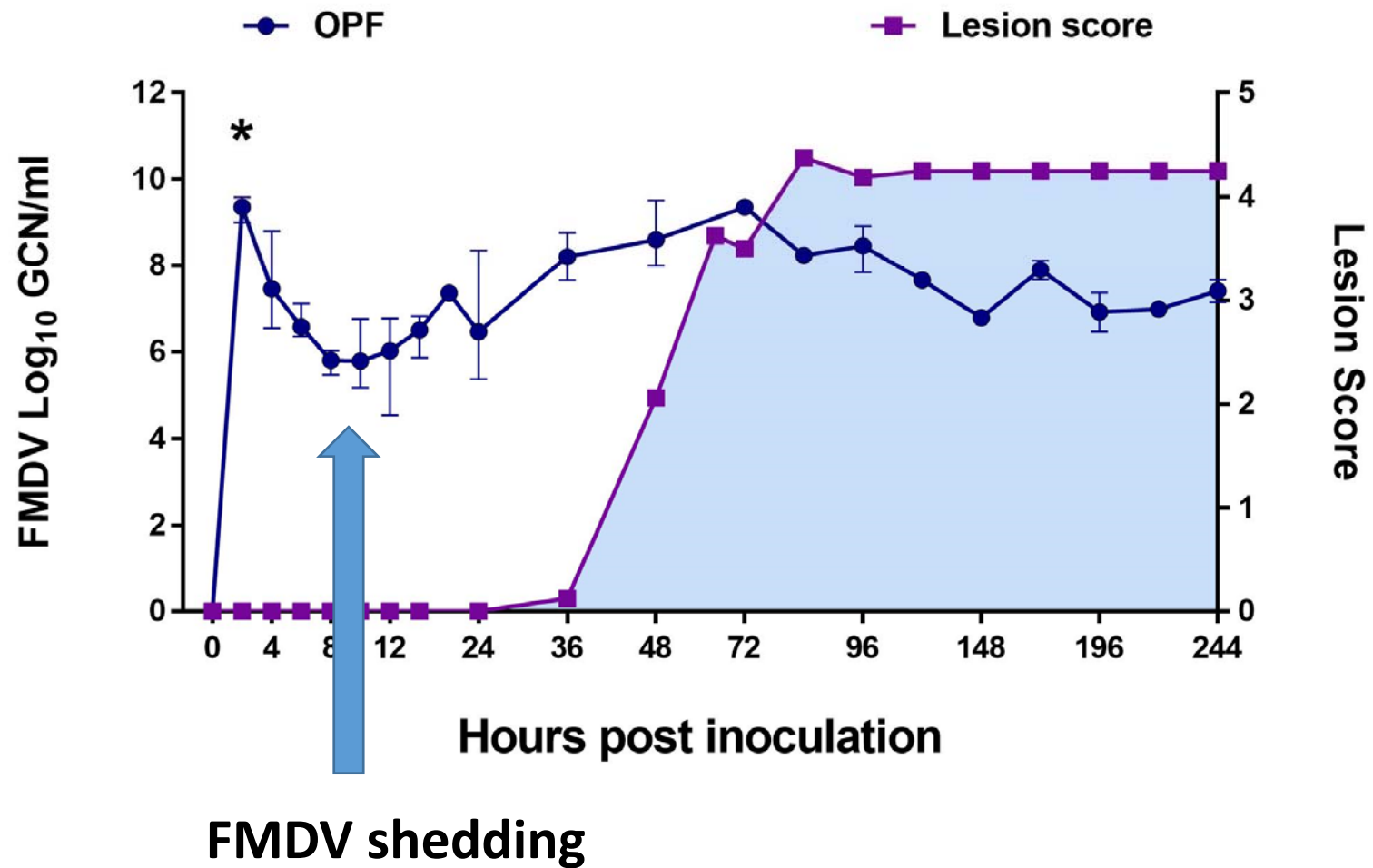
**Intra-oropharyngeal inoculation  
(IOP)**



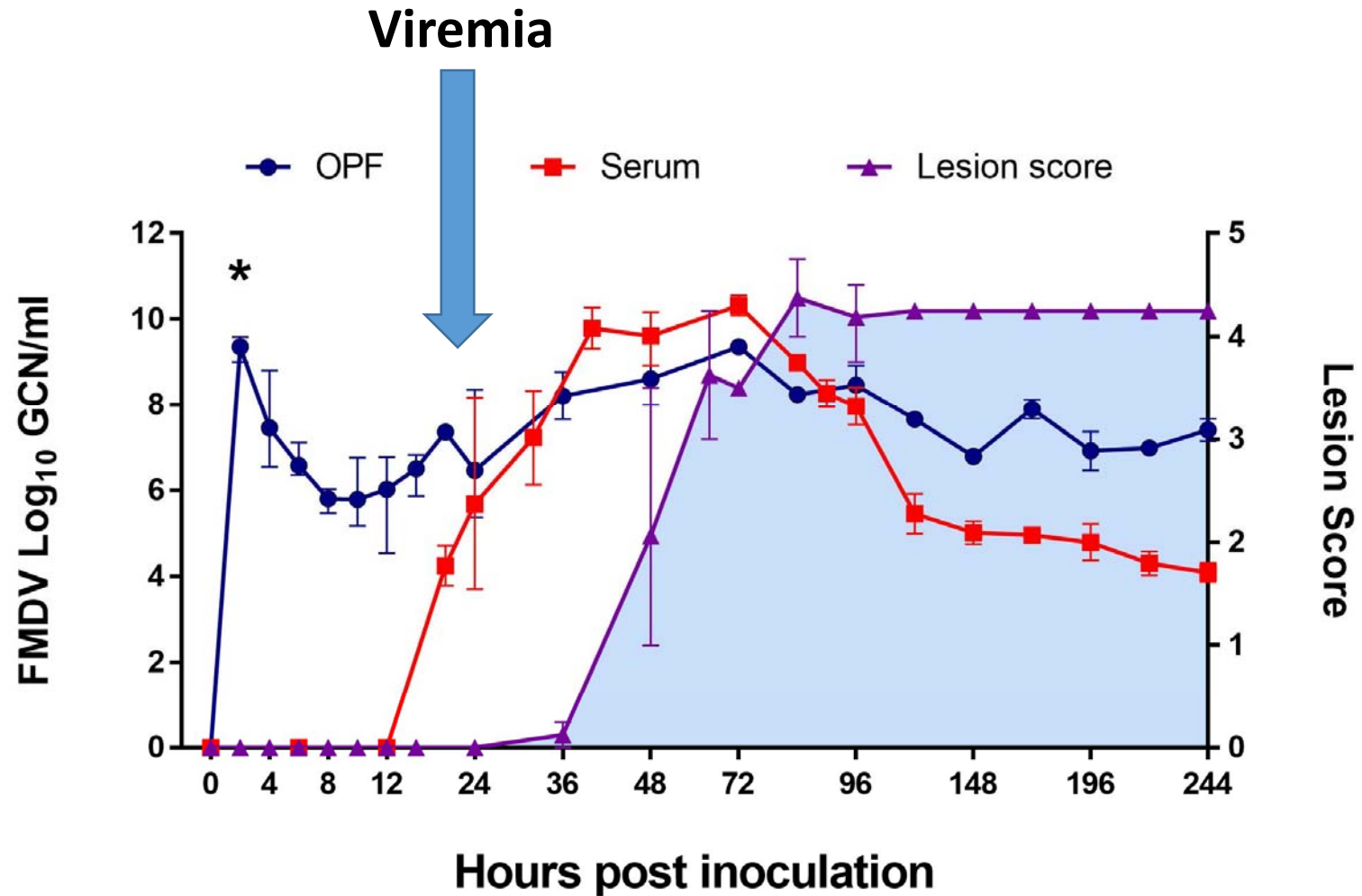
# FMDV Infection dynamics



# FMDV Infection dynamics



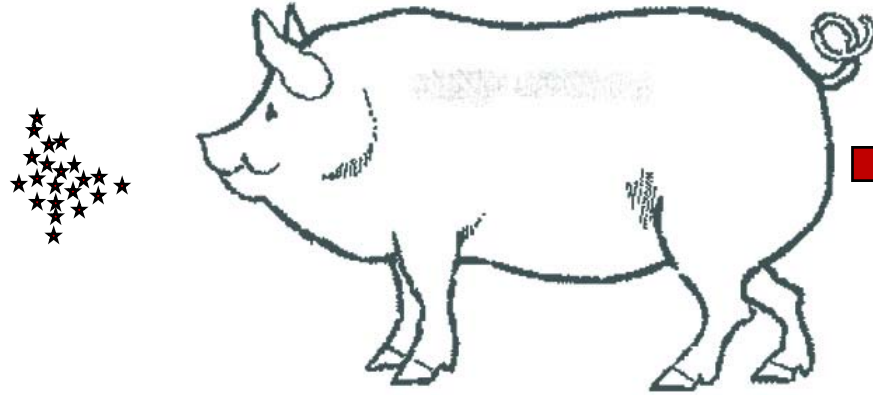
# FMDV Infection dynamics



# **FMDV Tissue distribution**

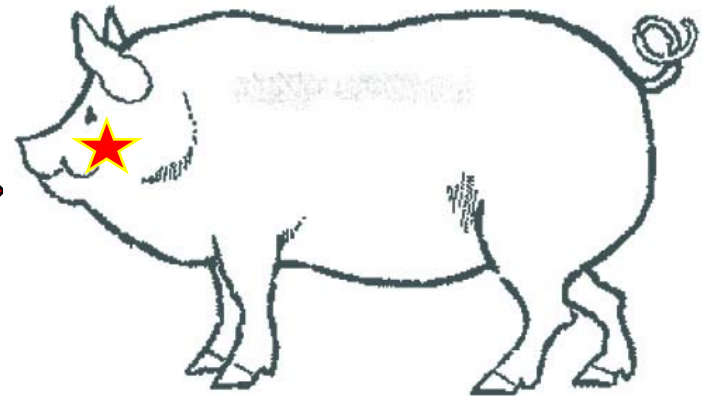
**Exposure**

**0 HPI**

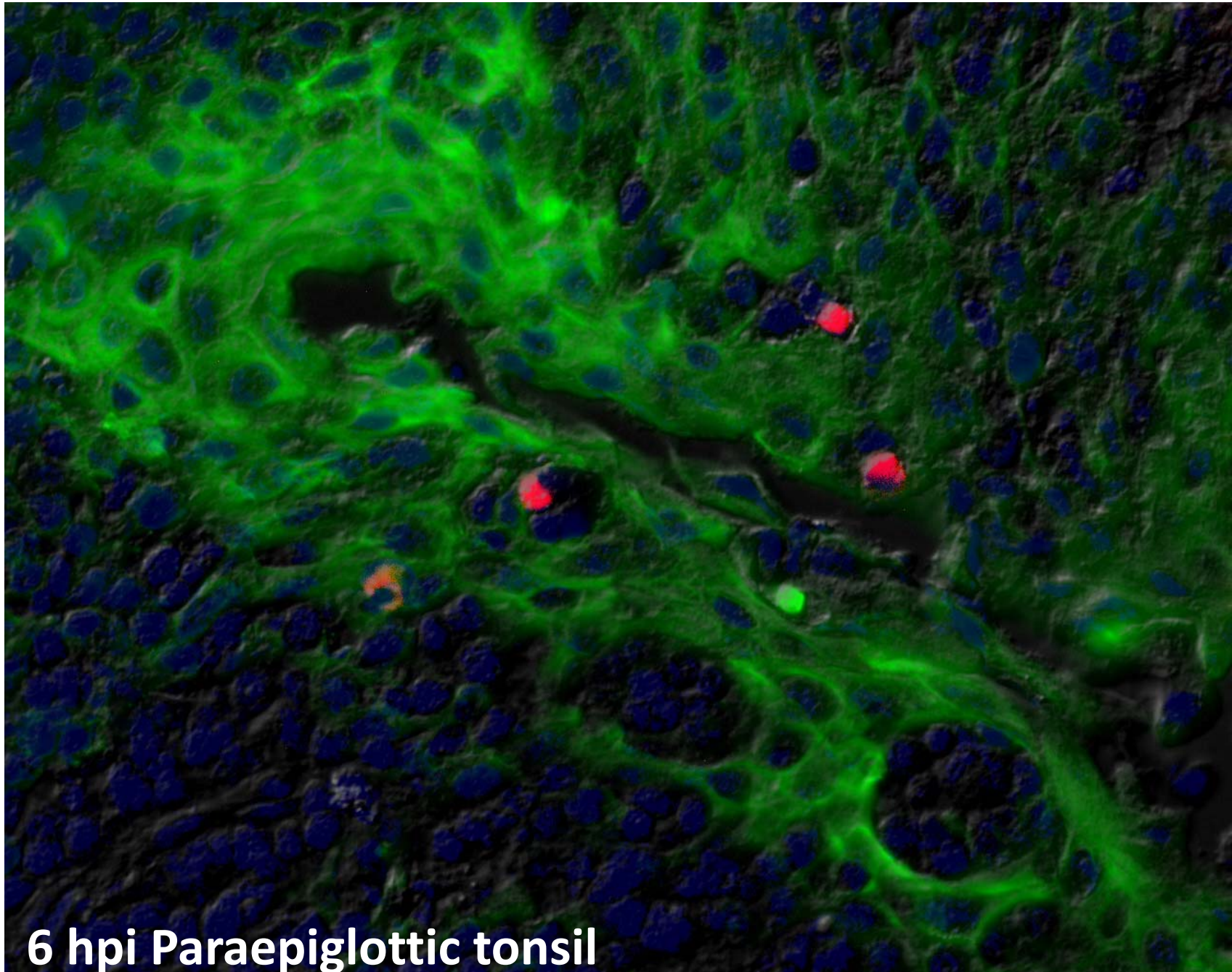


**Primary infection**

**6-12 HPI**





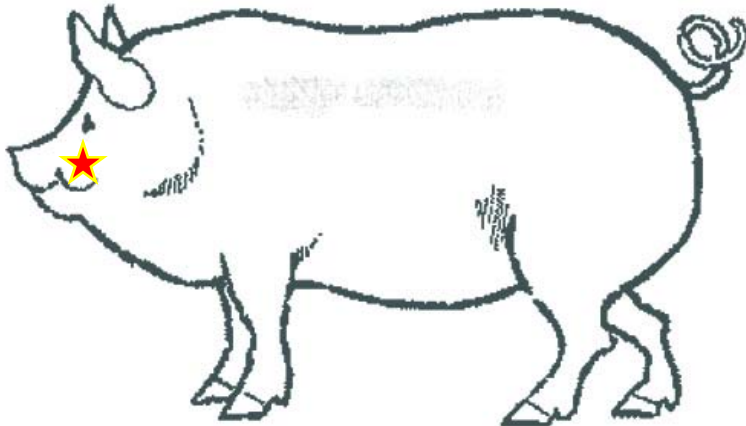


6 hpi Paraepiglottic tonsil

Cytokeratin (epithelium) FMDV VP1

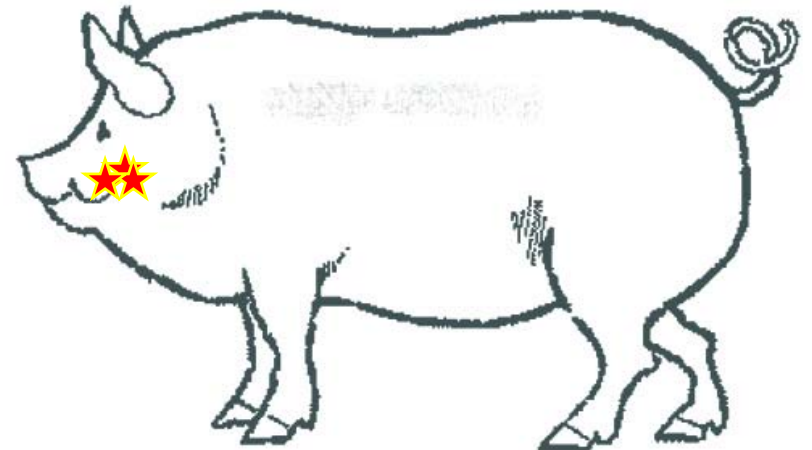
## Primary infection

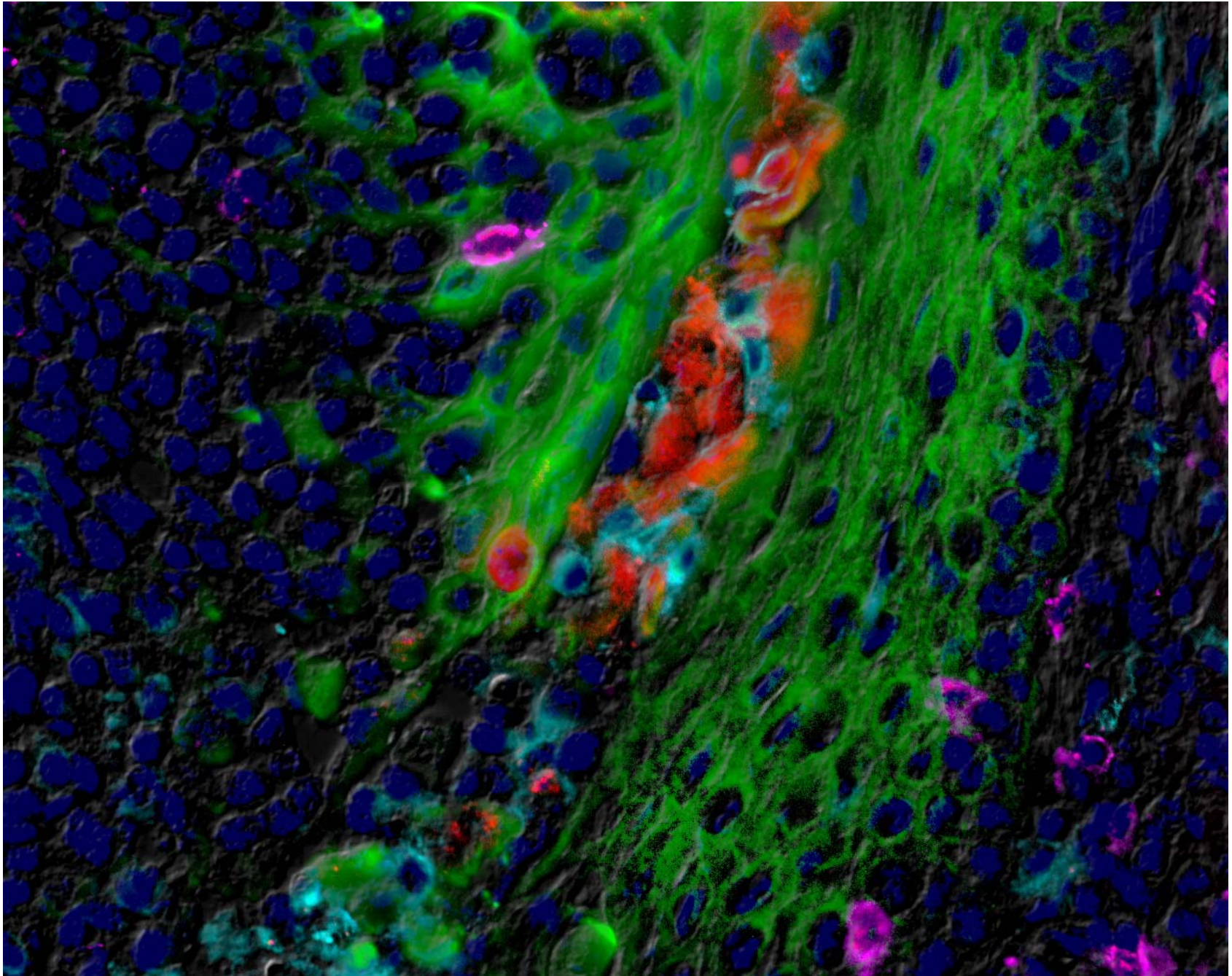
6-12 HPI



## Subclinical Infection

12-24 HPI

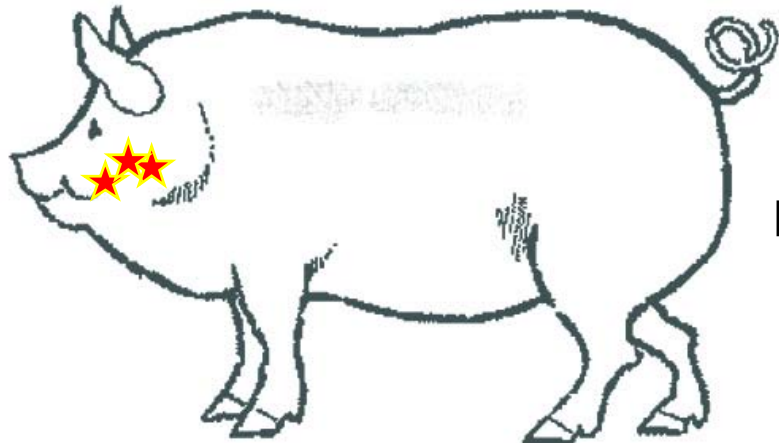




Cytokeratin FMDV VP1 CD172a CD8

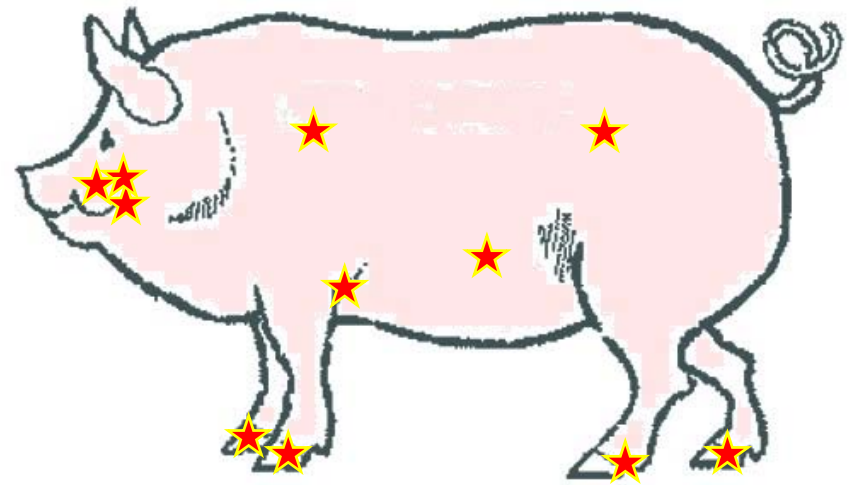
# Subclinical Infection

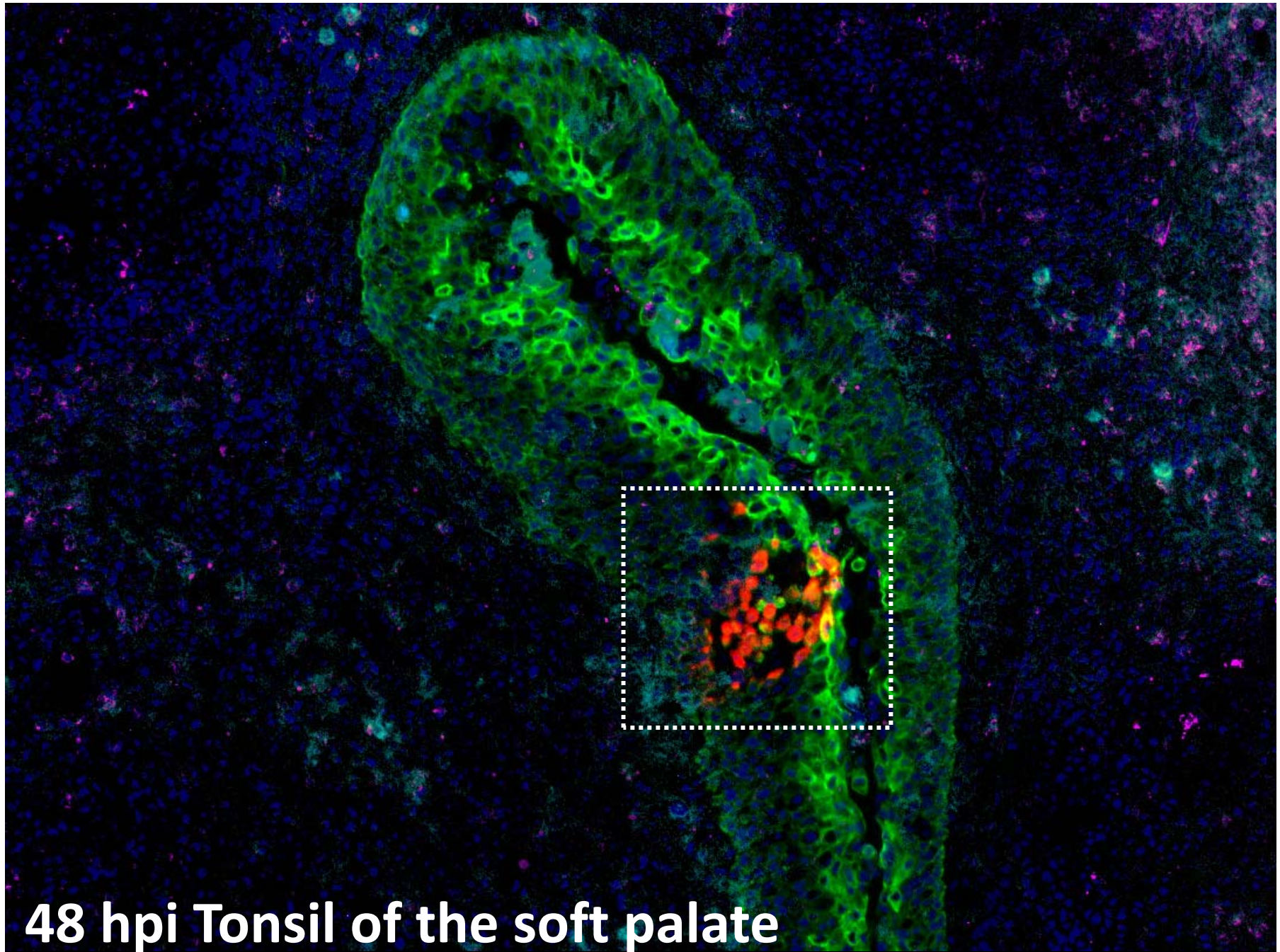
12-24 HPI



# Clinical infection

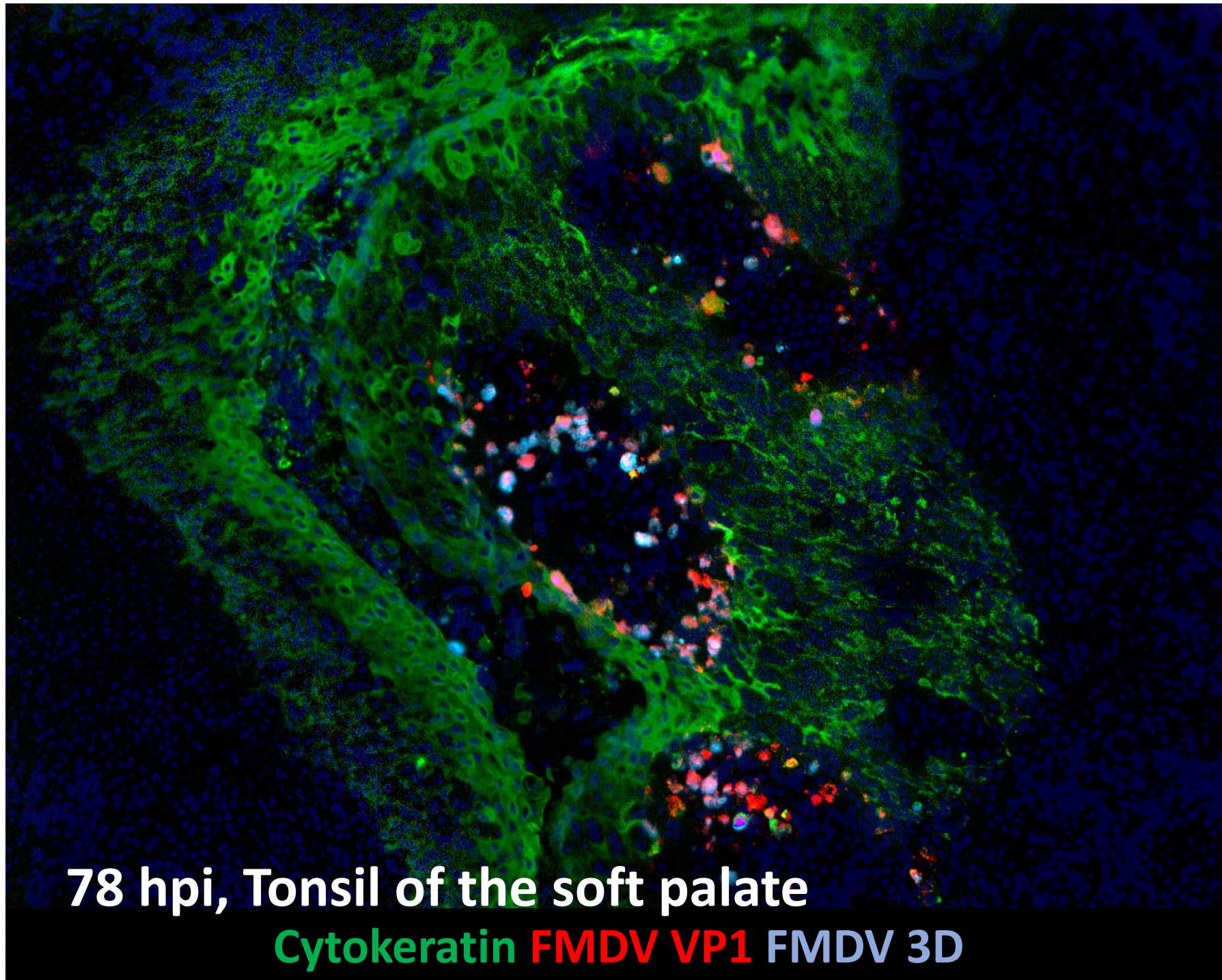
48 HPI





48 hpi Tonsil of the soft palate

Cytokeratin FMDV VP1 CD172a CD8



**Clinical infection**

**FMDV clearance**

**≥28 dpi: NO persistence  
of infectious FMDV in porcine tissues**





**Detection of FMDV structural antigen (and RNA) in lymphoid tissue at 28-60dpi, but NO persistence of infectious FMDV**

Transboundary and Emerging Diseases



Transboundary and Emerging Diseases

ORIGINAL ARTICLE

**Detection of Foot-and-mouth Disease Virus RNA and Capsid Protein in Lymphoid Tissues of Convalescent Pigs Does Not Indicate Existence of a Carrier State**

C. Stenfeldt<sup>1,2</sup>, J. M. Pacheco<sup>1</sup>, G. R. Smoliga<sup>1</sup>, E. Bishop<sup>1</sup>, S. J. Pauszek<sup>1</sup>, E. J. Hartwig<sup>1</sup>, L. L. Rodriguez<sup>1</sup> and J. Arzt<sup>1</sup>

<sup>1</sup> United States Department of Agriculture, Agricultural Research Service, Foreign Animal Disease Research Unit, Plum Island Animal Disease Center, Greenport, NY, USA

<sup>2</sup> Oak Ridge Institute for Science and Education, PIADC Research Participation Program, Oak Ridge, TN, USA

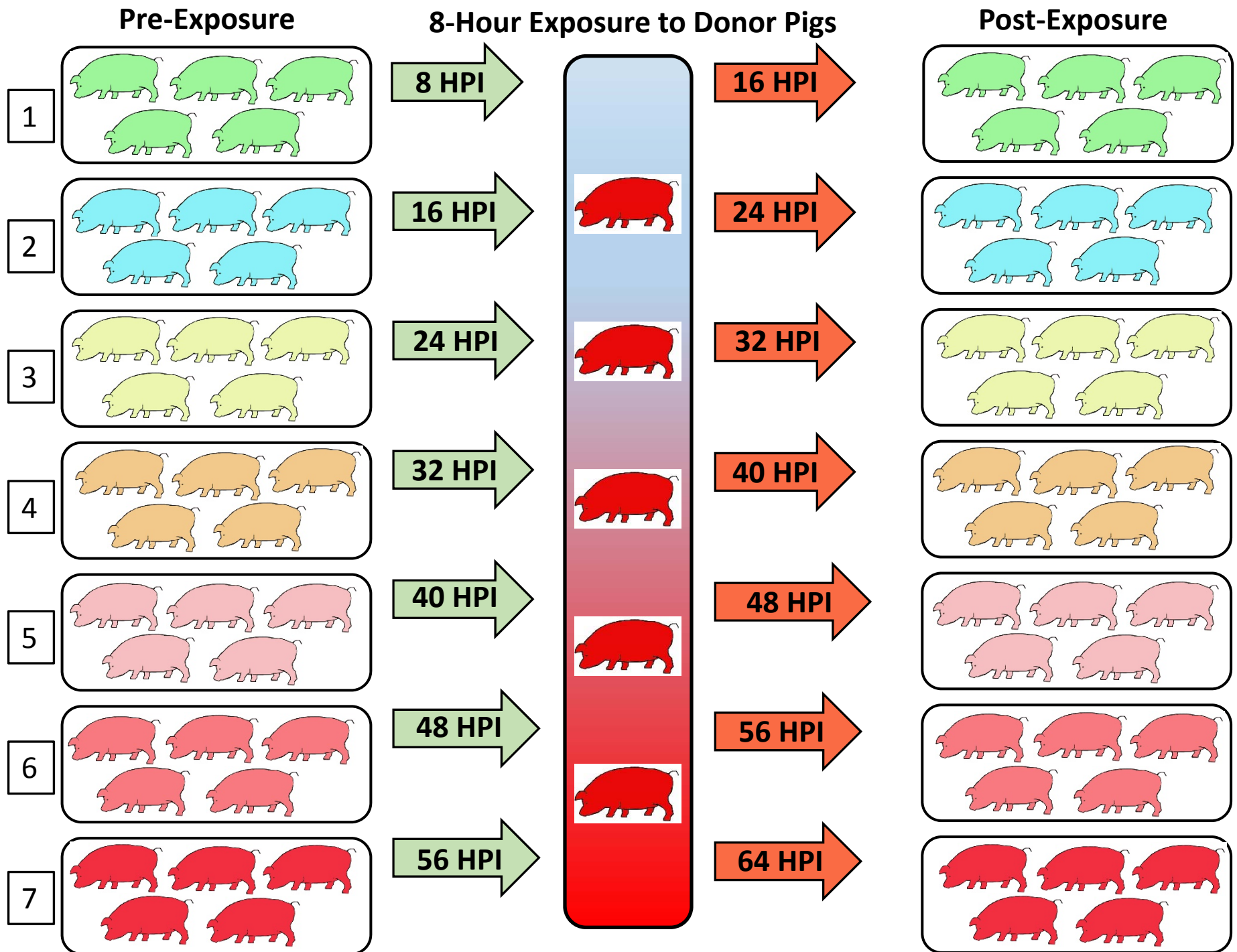
**FMDV VP1, CD21, CD3, CD172a**

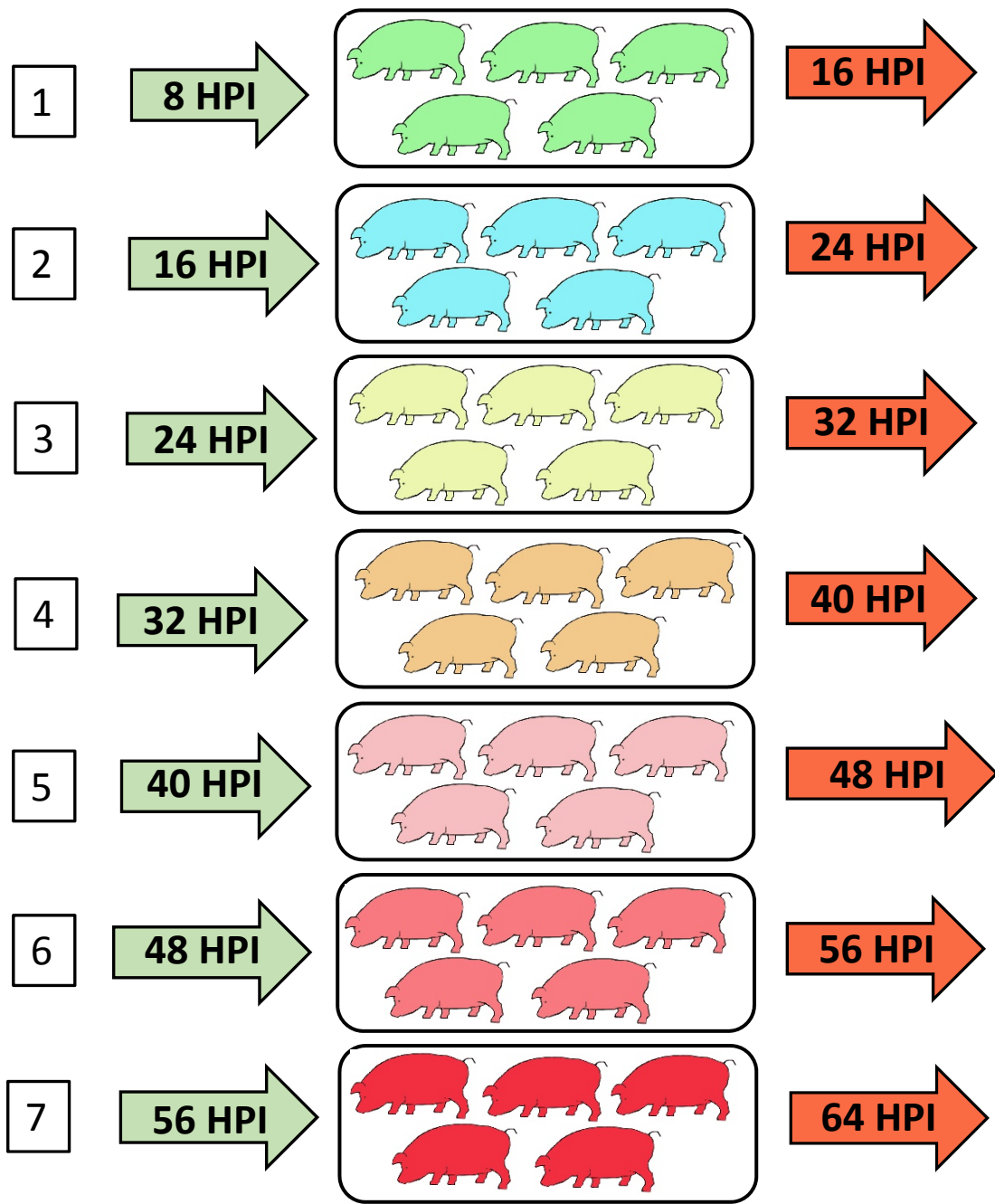


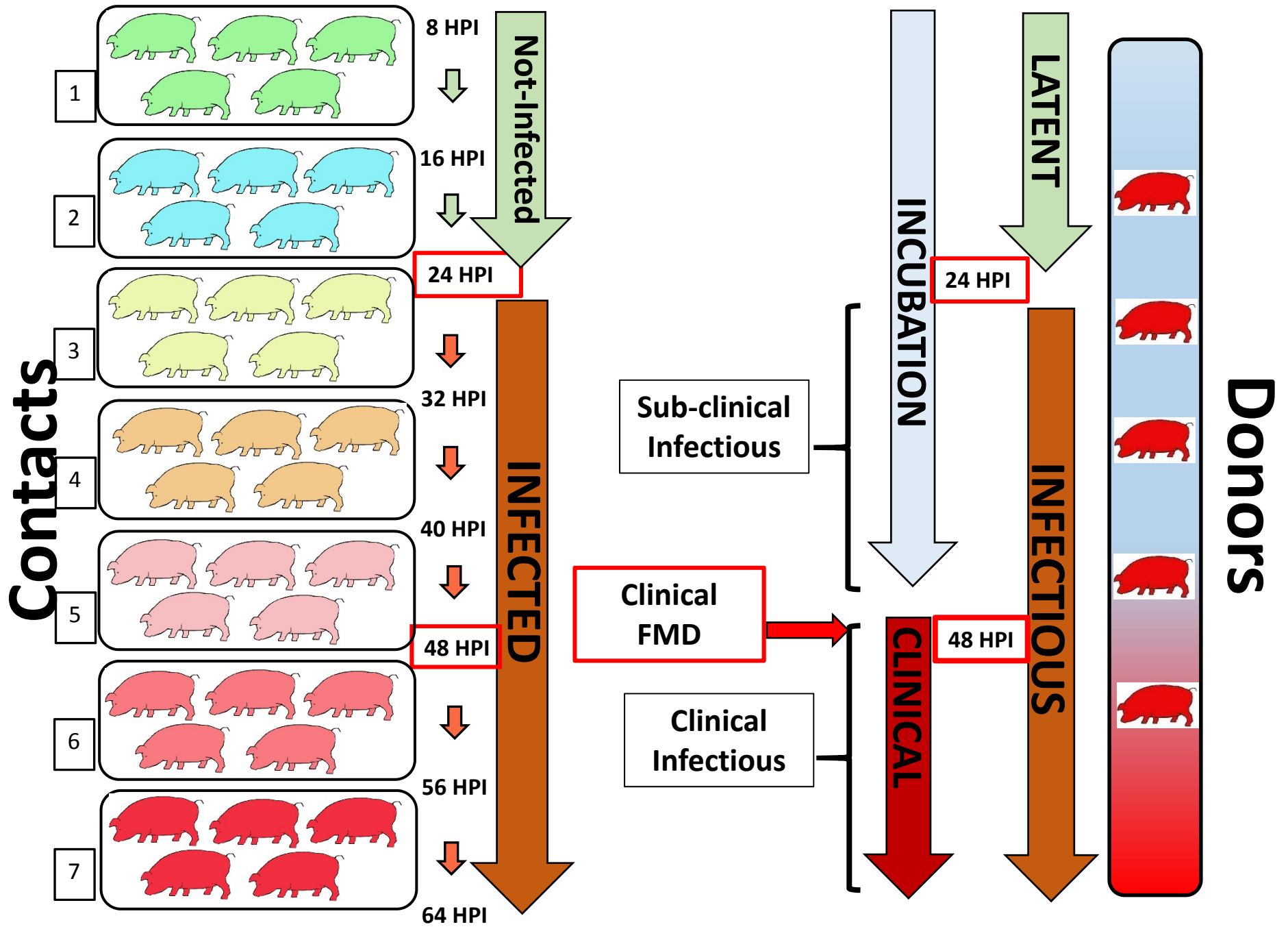
# **FMDV transmission in Pigs**

## **FMDV transmission in pigs**

- Experimental study designed to determine the onset of infectiousness in FMDV-infected pigs
- One group of “donor” pigs infected with FMDV A24 via intra-oropharyngeal inoculation
- Seven groups of contact pigs sequentially exposed to donors through 8 hours of co-habitation







## Conclusions

- Pigs are specifically sensitive to FMDV exposure via the upper gastro-intestinal tract (oropharynx)
- Primary infection localized to epithelium of oropharyngeal tonsils
- Substantial FMDV amplification in epithelium of the tonsil of the soft palate
- Complete clearance of infectious virus (no carrier state)
- FMDV transmission occurs ~24 hours prior to clinical signs of FMD

# Acknowledgements

**USDA-ARS, Plum Island Animal Disease Center**

Jonathan Arzt

Luis Rodriguez

Ethan Hartwig

George Smoliga

Steve Pauszek



**Funding sources:**

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“Improved Challenge Systems for FMD Vaccine  
and Biotherapeutics Testing In Cattle and Pigs”

US National Pork Board “Investigating potential  
existence of chronic, persistent foot-and-  
mouth disease virus infection in domestic pigs;  
implications for disease control strategies”

USDA/ARS-USDA/APHIS Interagency  
Agreement; “Enhancing National Models for  
FMD response with clinical data”

