

# Fit-for-purpose Animal models -Other Animal Models-

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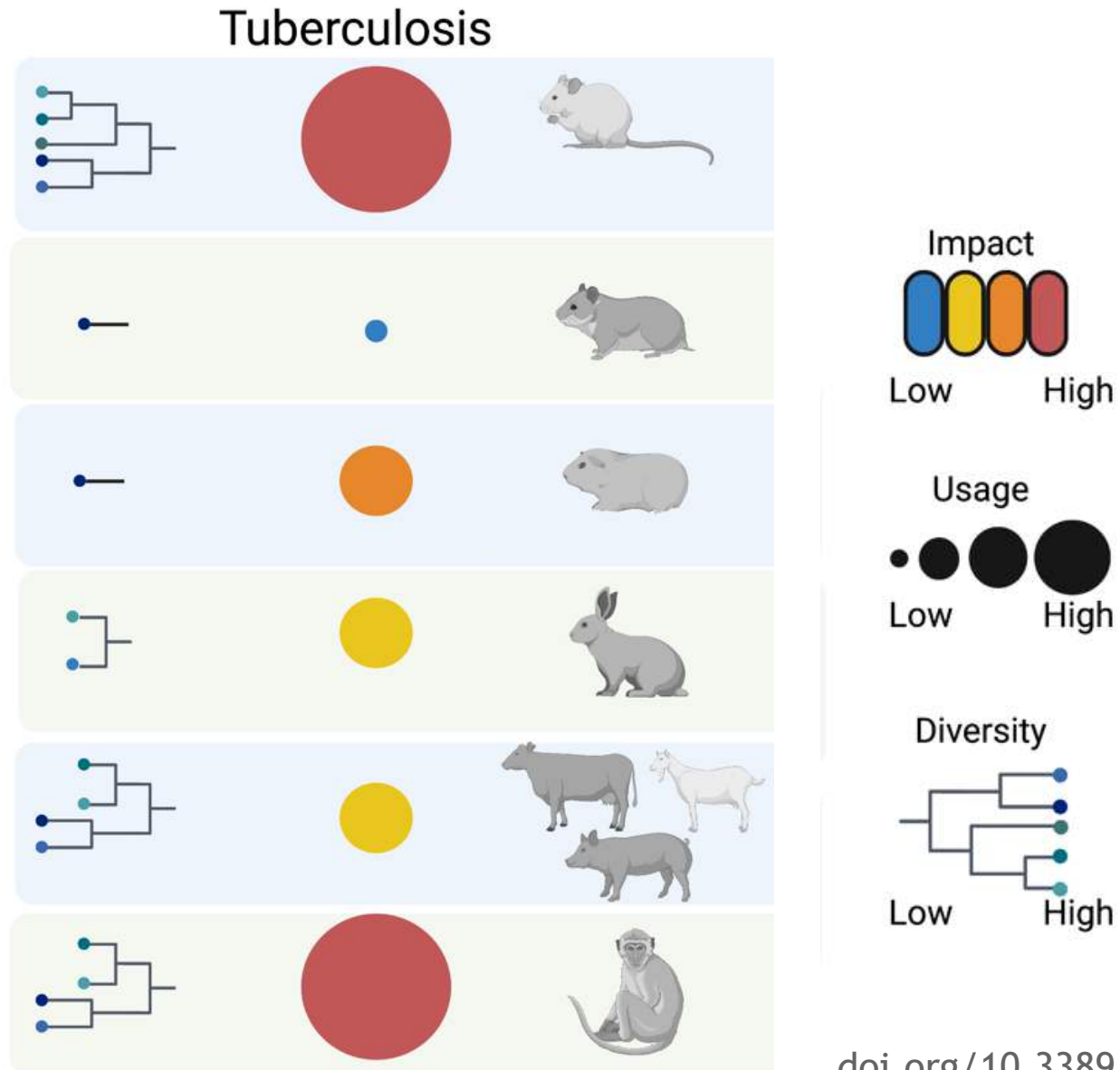
Greifswald, 2026-01-20

No Disclosures

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# Other animal models of human tuberculosis



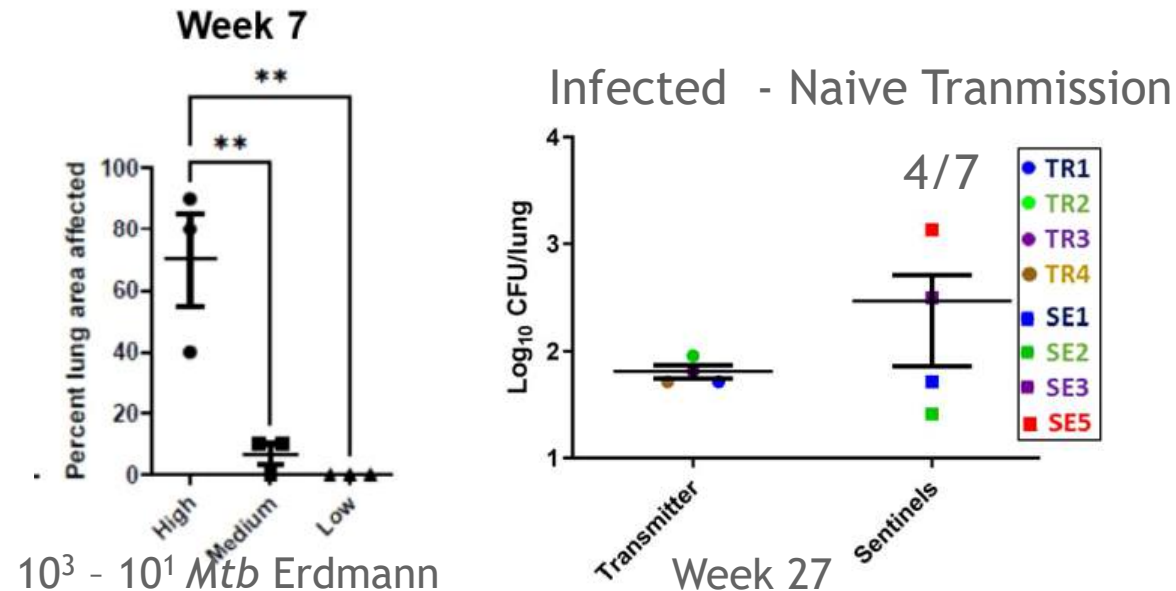
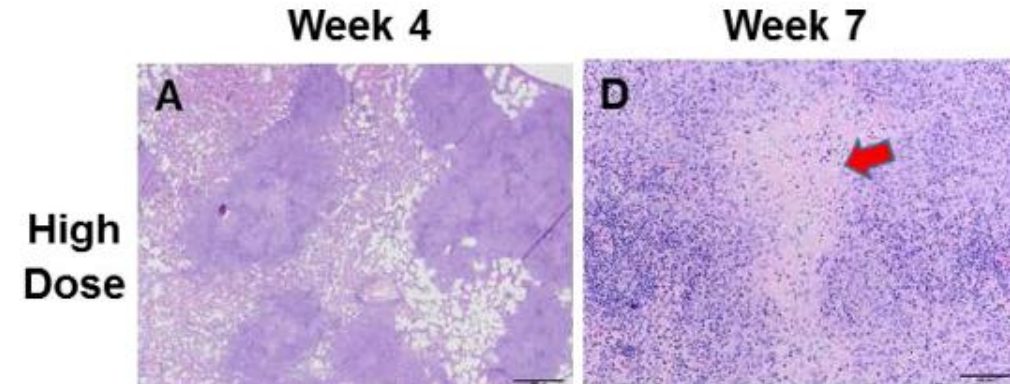
[doi.org/10.3389/fimmu.2023.1223260](https://doi.org/10.3389/fimmu.2023.1223260)

# Hamster and Ferrets: 2 potential models with limited data



## Take Home Summary

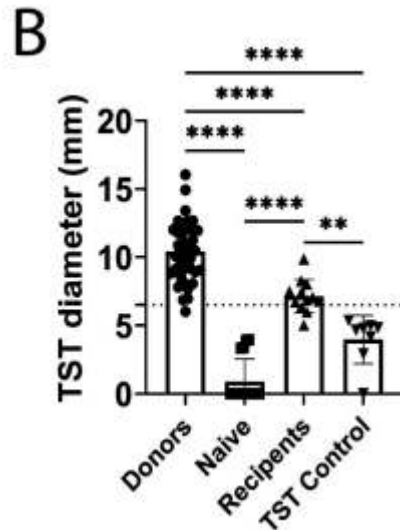
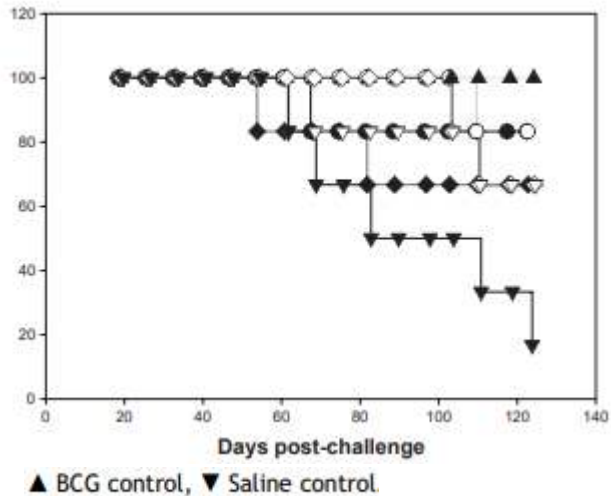
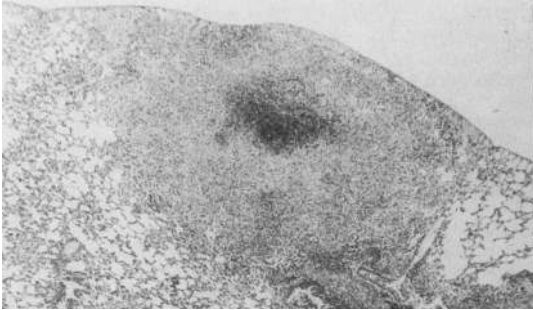
- Hamster and ferrets are not well studied
- Ferrets are reported as a potential natural host (*M. bovis*). Experimental infection with *M. tuberculosis* might require high doses
- Ferrets: Transmission can be studied in a high dose challenge model
- Limited tool box



## Literature selection

- DOI: 10.1111/j.1749-6632.1949.tb53954.x
- DOI 10.3389/fcimb.2022.873416

# Guinea pig: Highly used model for human tuberculosis; Highly susceptible to *M. tuberculosis*



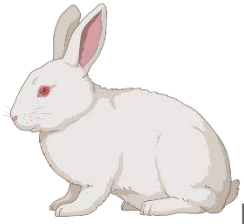
## Take Home Summary

- Historically used by Robert Koch (*M. tuberculosis* causes the disease; DTH)
- Airborne Transmission studies (e.g. Richard Riley) - low dose infection
- Highly susceptible to *M. tuberculosis* with caseous, necrotic primary lesions
- Extensively used as a preclinical model for new vaccine candidates (incl. CD1 restricted vaccines) - BCG protects very well.
- Limited tool box

## Literature selection

- DOI: 10.1101/2025.10.27.684829
- DOI 10.1086/515397
- DOI:10.1101/2025.10.27.684829
- PMID: PMC2032192
- DOI: 10.1016/j.tube.2004.09.009

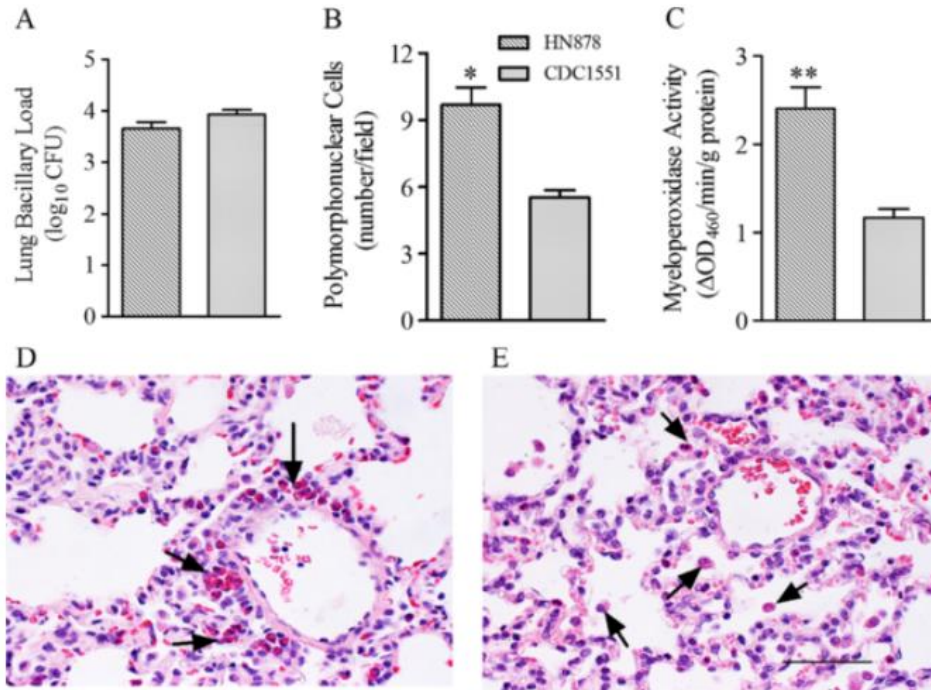
# Rabbit: Resistance to TB disease depends on genetics, bacilli, dose



New Zealand White rabbits

## Take Home Summary

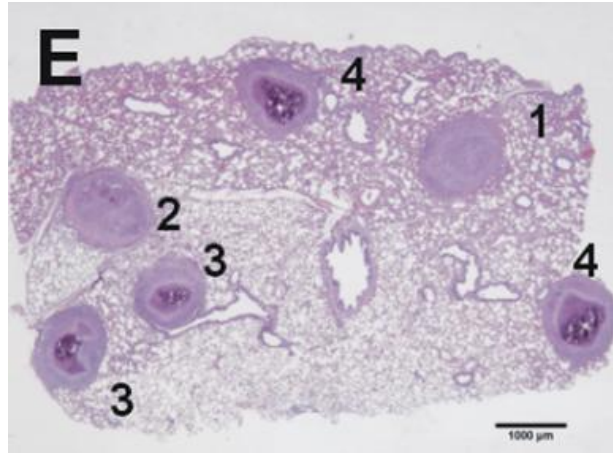
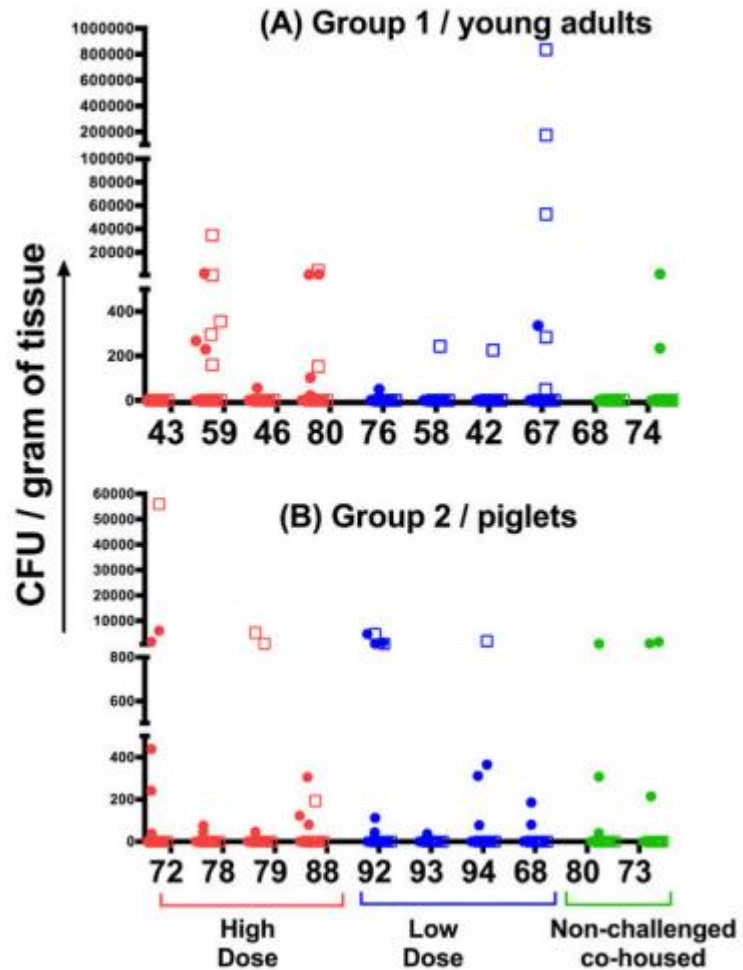
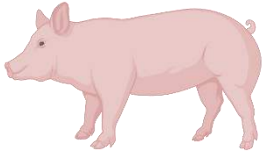
- Well characterized caseous necrosis, liquefaction cavitory post-primary lesions.
- Outcome of disease varies by *M. tuberculosis* strain and rabbit genetics (e.g. outbred versus inbred rabbits).
- *M. bovis* causes increased pathology compared to *M. tuberculosis*
- Limited tool box



## Literature selection

- DOI:10.1186/1478-811X-11-60
- DOI:10.1128/iai.64.11.4776-4787.1996
- DOI:10.1128/IAI.01132-08
- DOI:10.1128/IAI.72.3.1700-1705.2004
- DOI:10.1128/IAI.71.10.6004-6011.2003

# Pigs: Natural hosts of *M. tuberculosis* complex and model for human LTBI



## Take Home Summary

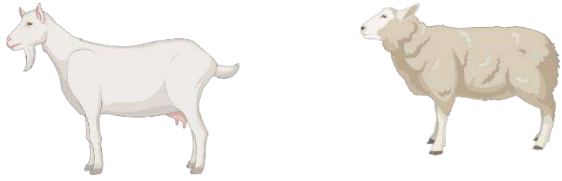
- Natural host of *M. tuberculosis* complex
- Human-like granuloma stages incl. encapsulation of the granulomas
- Primarily LTBI with some evidence of better protection against *M. tuberculosis* compared to *M. bovis*.
- Transmission to naive pigs has been demonstrated.
- Relative advanced tool box

## Literature selection

- DOI: 10.1371/journal.pone.0010030
- DOI: 10.1016/j.vetimm.2019.109884
- DOI: 10.1016/j.tube.2017.07.003
- DOI: 10.1016/j.tube.2022.102167

$1 \times 10^4 - 1 \times 10^2$  *Mtb* strain HN878

# Sheep and goat: Natural hosts of *M. tuberculosis* complex



## Take Home Summary

- Natural host *M. tuberculosis* complex and reservoir species
- Goats resemble human tuberculosis pathology (*M. caprae*)
- Human-like granuloma stages incl. encapsulation of the granulomas
- Some evidence of better protection against *M. tuberculosis* compared to *M. bovis*
- Almost no tool box; large animal model

Group—MTC species	n	Mean total lesion score ± S.E. (range)
(1) <i>M. bovis</i>	5	15.2 ± 3.1 (9–19)
(2) <i>M. caprae</i>	5	10.8 ± 3.1 (2–23)
(3) <i>M. tuberculosis</i>	4	3 ± 3.5 (1–6)

Article

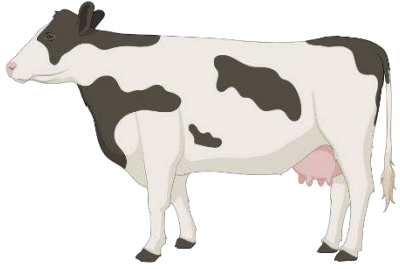
## Safety and Immunogenicity of Recombinant *Bacille Calmette-Guérin* Strain VPM1002 and Its Derivatives in a Goat Model

Julia Figl<sup>1,\*†</sup>, Heike Köhler<sup>1</sup>, Nadine Wedlich<sup>1</sup>, Elisabeth M. Liebler-Tenorio<sup>1</sup>, Leander Grode<sup>2</sup>, Gerald Parzmair<sup>2</sup>, Gopinath Krishnamoorthy<sup>3,‡</sup>, Natalie E. Nieuwenhuizen<sup>3,§</sup>, Stefan H. E. Kaufmann<sup>3,4,5</sup> and Christian Menge<sup>1</sup>

## Literature selection

- DOI: 10.1016/j.vetimm.2015.07.009
- DOI: 10.1128/CVI.05323-11
- DOI: 10.3389/fmicb.2023.1236834

# Cattle: Resistant to human disease causing bacteria (*M. tuberculosis*)

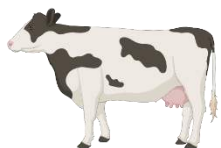


“tubercle bacilli or the sputum were injected under the skin, in others into the peritoneal cavity, in others into the jugular vein. Six animals were fed **with tuberculous sputum almost daily for seven or eight months**; four repeatedly inhaled great quantities of bacilli.”

“**none** of these cattle (there were nineteen of them) showed any symptoms of disease and they gained considerably in weight. From six to eight months after the beginning of the experiments they were killed. In their internal organs **not a trace of tuberculosis** was found”

Koch R (1901) An address on the fight against Tuberculosis. BMJ 2: 189–193.

# Cattle: Controlled experimental evidence of cattle resistance against *M. tuberculosis*



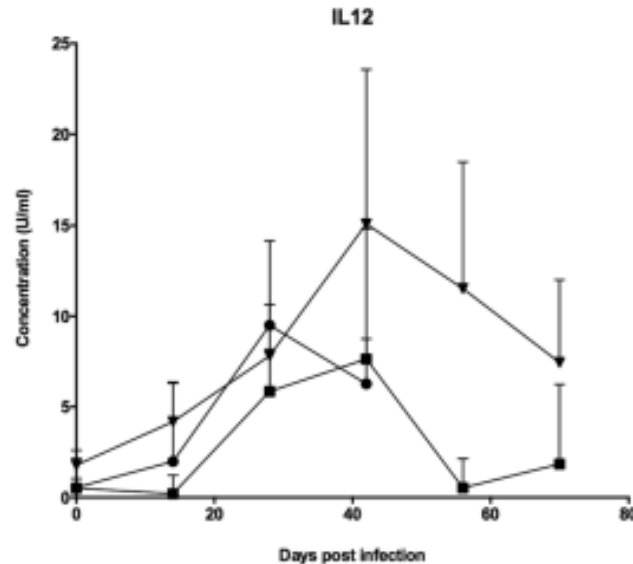
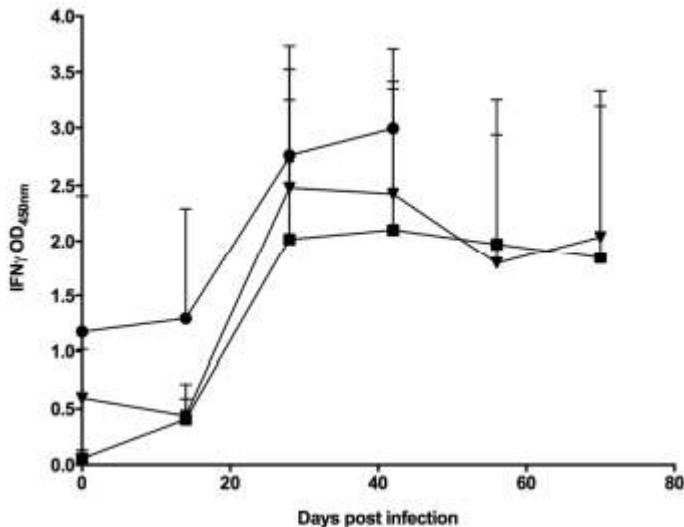
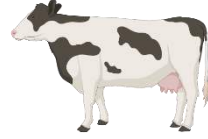
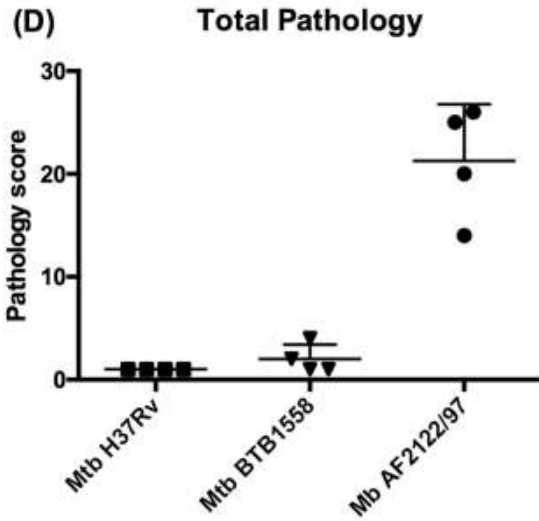
**Table 1.** With the exception of animals 2757, post mortems were performed 16 weeks post infection.

Animal <sup>a</sup>	Pathology <sup>b</sup>					Bacteriology <sup>c</sup>	
	Lung		Lymph Nodes		Total Pathology		
	Lobes affected <sup>***</sup>	Score <sup>**</sup>	Head LNs	Lung LNs <sup>**</sup>	LN Score <sup>**</sup>	Score <sup>**</sup>	Score <sup>**</sup>
<i>M. tuberculosis</i>							
2730	0	0	0	0	0	0	1
2731	0	0	0	0	0	0	5
2732	0	0	0	0	0	0	0
2733	0	0	0	0	0	0	6
2734	0	0	0	0	0	0	0
<i>M. bovis</i>							
2723	3	11	2	3	14	25	27
2735	4	15	1	5	16	31	16
2736	2	9	0	2	3	12	15
2756	5	20	0	5	15	35	23
2757	7	30	4	5	24	34	55

*M. bovis* (AF 2122/97) or *M. tuberculosis* (H37Rv) by endobronchial instillation of  $1.06 \times 10^6$  and  $2.86 \times 10^6$  CFU

DOI:10.1371/journal.pone.0008527

# Cattle: *M. bovis* and *M. tuberculosis* both induce a strong Th1 / IFN $\gamma$ response in cattle



## Take Home Summary

- Natural host of *M. tuberculosis* complex and reservoir species
- Cattle resemble human tuberculosis pathology (e.g. *M. bovis*). Including all stages of human granuloma incl. fibrotic encapsulated granulomas
- (Experimental) resistance against *M. tuberculosis* compared to *M. bovis*
- Natural infection with *M. tuberculosis* occurs
- Minimal tool box; large animal model

## Literature selection

- DOI: 10.1371/journal.pone.0008527
- DOI: 10.1128/CVI.00442-09
- DOI: 10.1038/s41598-017-18575-5

# Summary

- „Other animal“ models reflect the whole spectrum of human tuberculosis
- For most other animal models the tool box is limited (exception might be pigs)
- Some models can be used for transmission e.g. (guinea pig, ferret, pig)
- Different strains or genetics allow to investigate active versus latent tuberculosis (e.g. rabbit)
- Natural hosts of *M. bovis* reflect human tuberculosis (and obviously animal TB)
- Cattle are resistant to experimental infection with *M. tuberculosis* (Mechanism not understood)
- Interspecies comparisons are a powerful tool to investigate universal protective mechanisms