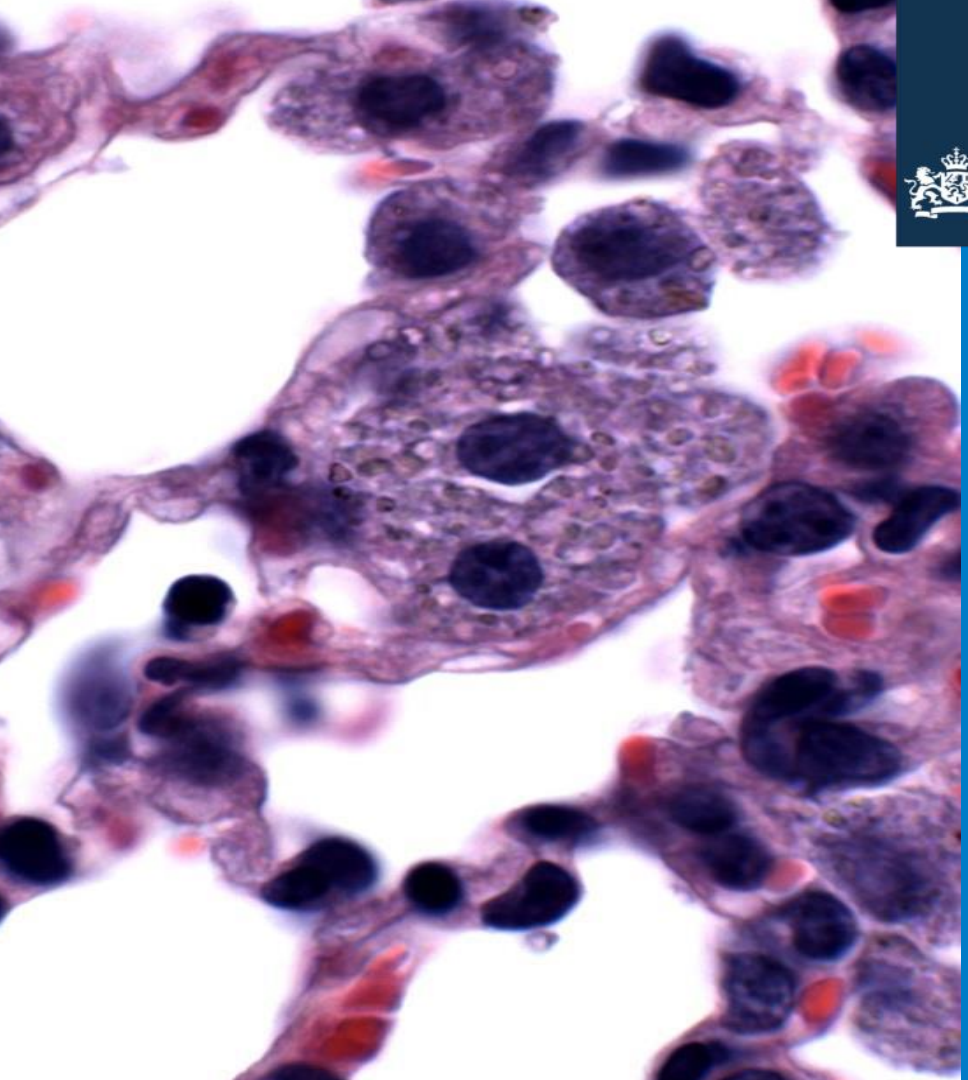


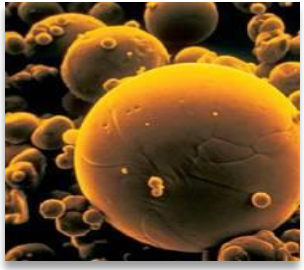
National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

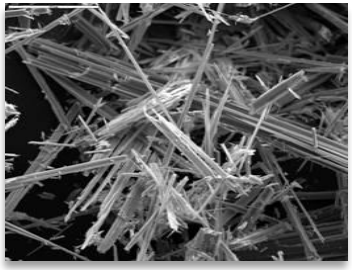
Biological particulate matter and health effects

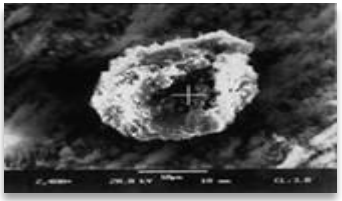
Flemming R. Cassee

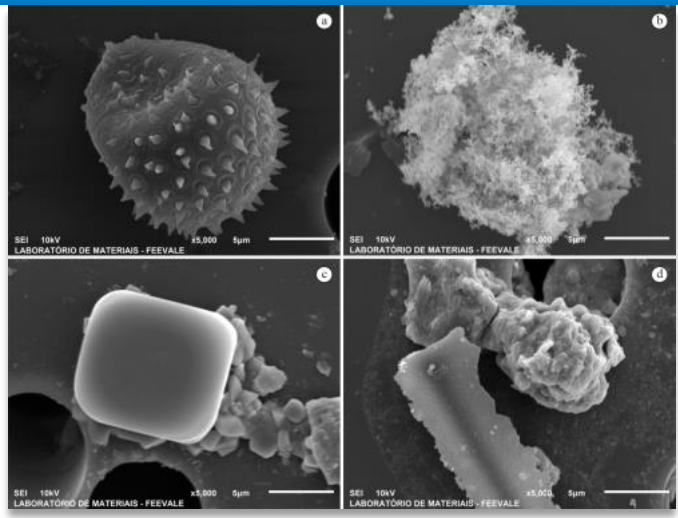
Utrecht University

What can be detected in air?

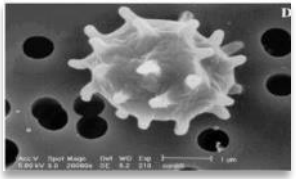


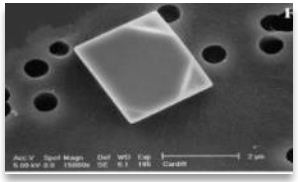


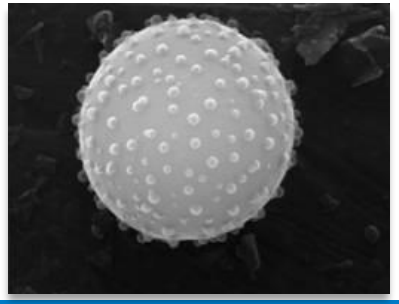


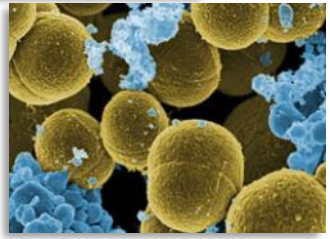


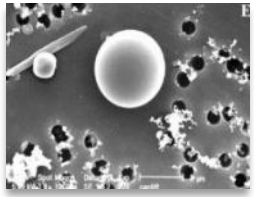
Alves et al., 2015
http://dx.doi.org/10.1590/1519-6984.00113suppl

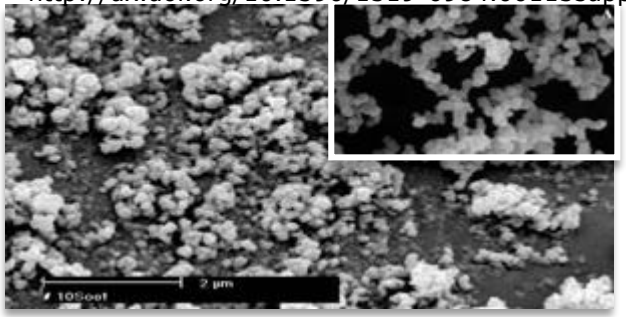








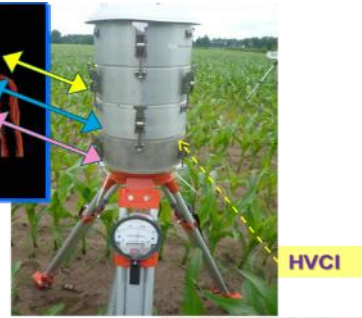




RAPTES: sampling particles

Road traffic
- Motorway
- City

Pig farms
Railway
Harbour



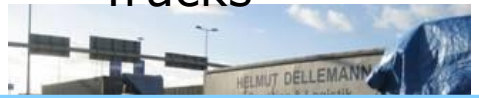
Water

Filters

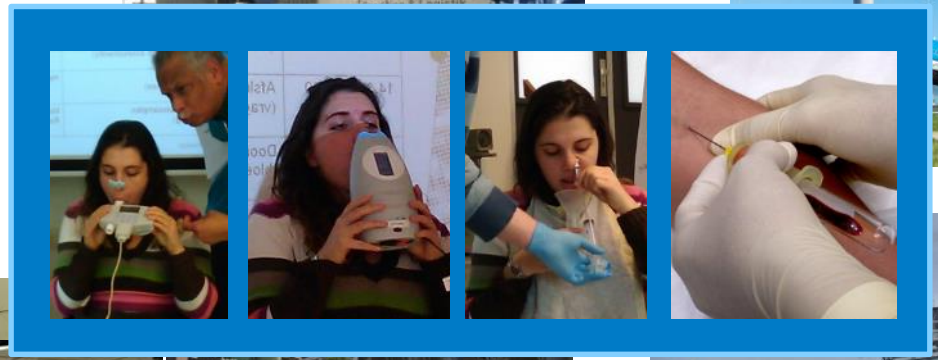
On site exposure: sources

Freeway

Trucks

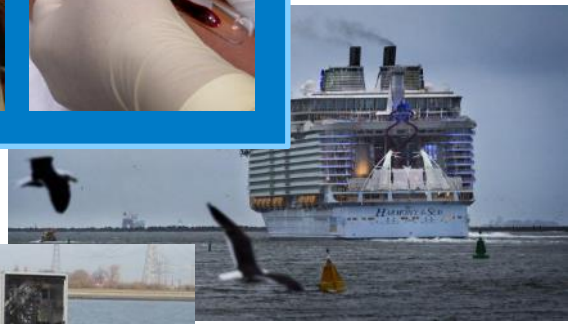


Airport



Underground railway

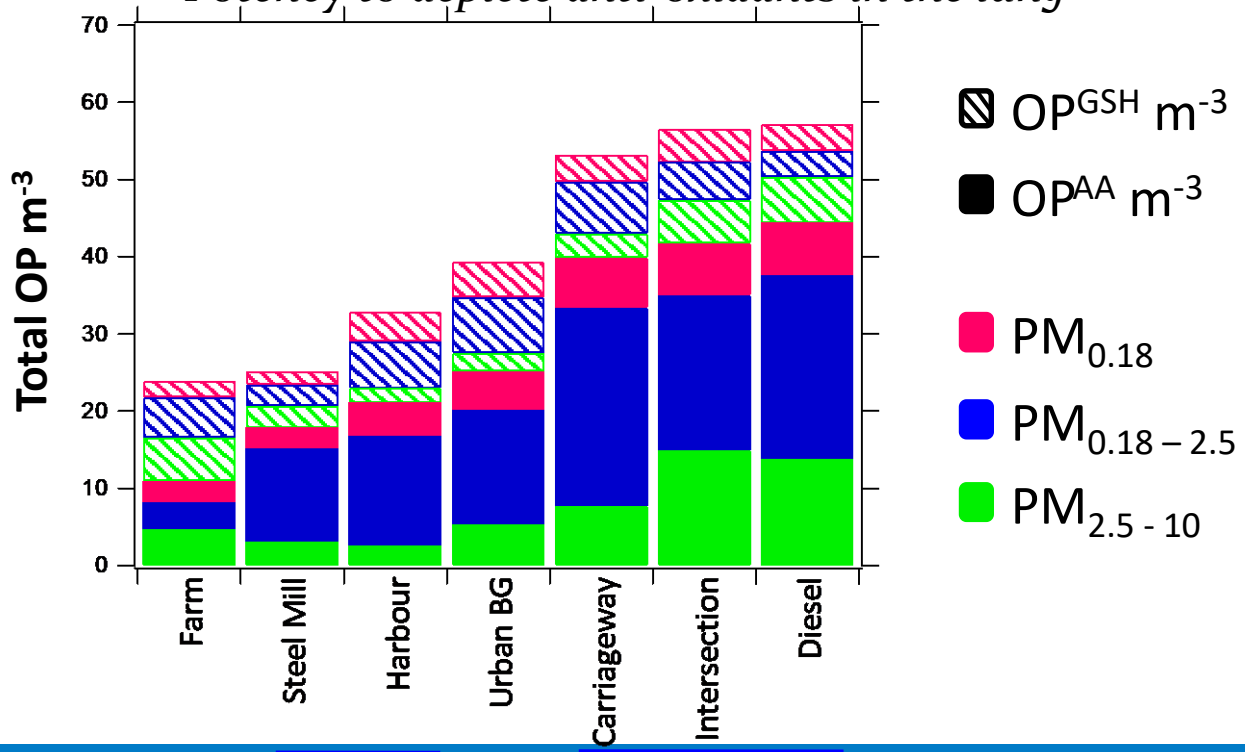
Pig farm



Shipping

PM Oxidative Potential – Site Contrasts

Potency to deplete anti-oxidants in the lung



Industrial Traffic

Conclusions from RAPTES on source specific effects

- Changes in particle numbers, NO_2 and NO_X were associated with evidence of acute airway inflammation (FE_{NO}) and impaired lung function.
- NAL-IL6 and IL-8 were associated with endotoxin, Organic Carbon-coarse, nitrate and NO_2, whereas NAL-protein was only consistently associated with NO_2 and serum IL-6 was negatively associated with endotoxin and OC-coarse
- OC and nitrate were most consistently associated with different biomarkers of acute cardiovascular risk. Suggestion role livestock farming
-

Sampling BioPM

Sampling

Device

Pig

Chicken

Goat

Composition of BioPM bacterial profile in different locations

Figure 1A

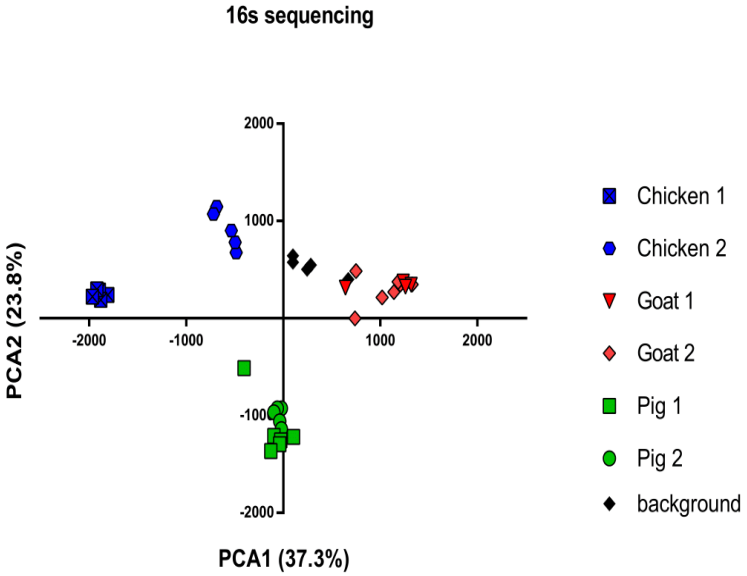
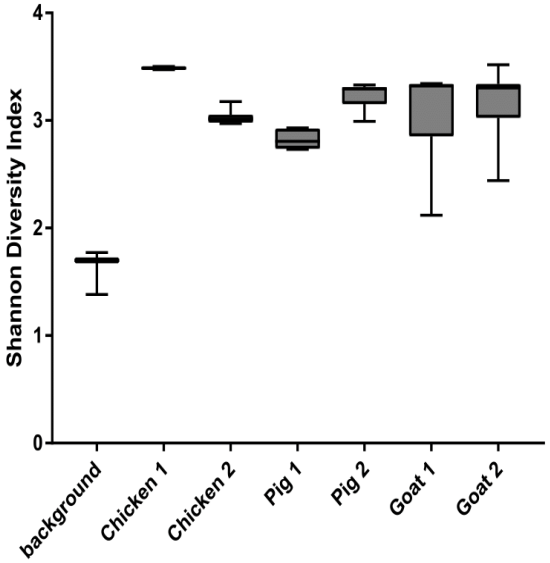


Figure 1B



Composition of the airborne bacterial profile in two pig, two pig, goat farms

Liu et al., Sci Total Environ. 2019 Oct 20;688:1298-1307

Composition of BioPM bacterial profile in different locations

Fungal profiles contained by ITS sequencing.

Figure 1C

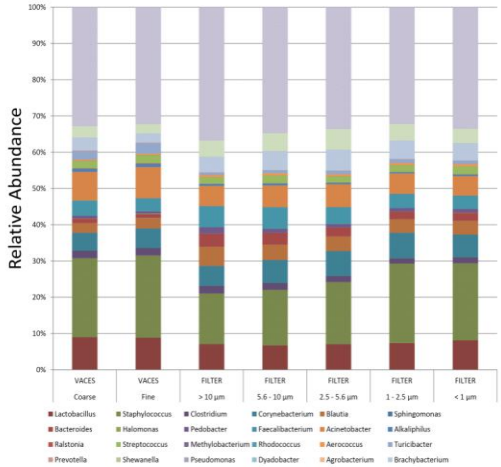
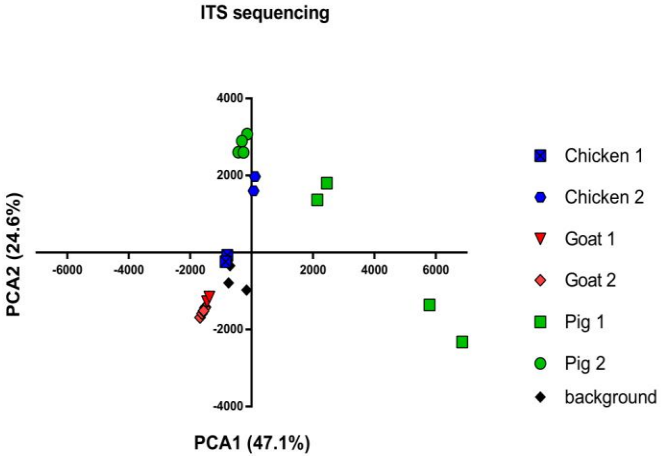


Figure 1D



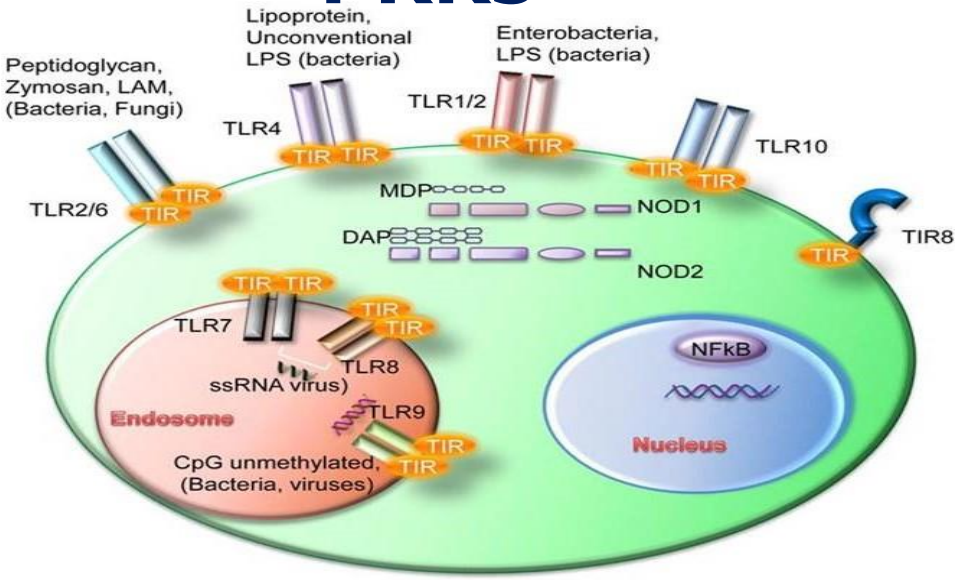
Relative abundance of bacteria at the genus-level for BioPM

Liu et al., Sci Total Environ. 2019 Oct 20;688:1298-1307

Activated innate immune receptors and cells

PRRs

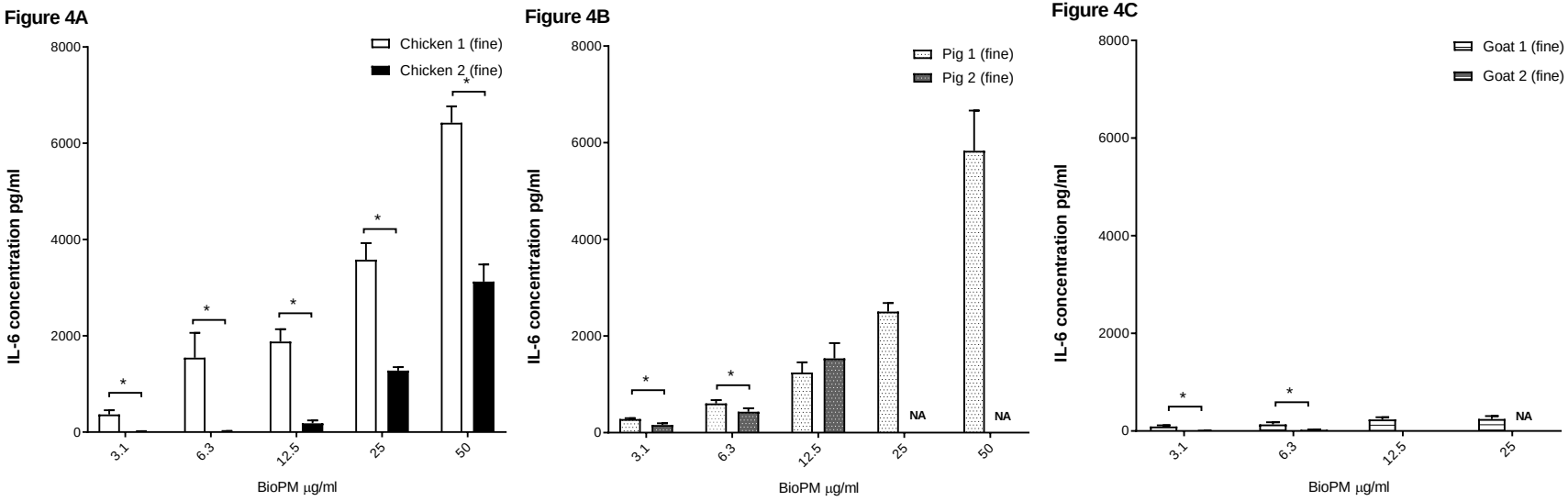
BioPM



cytokines → **Inflammatory response**

Muzio *et al*., 2012. MJHID, Vol 4, No 1

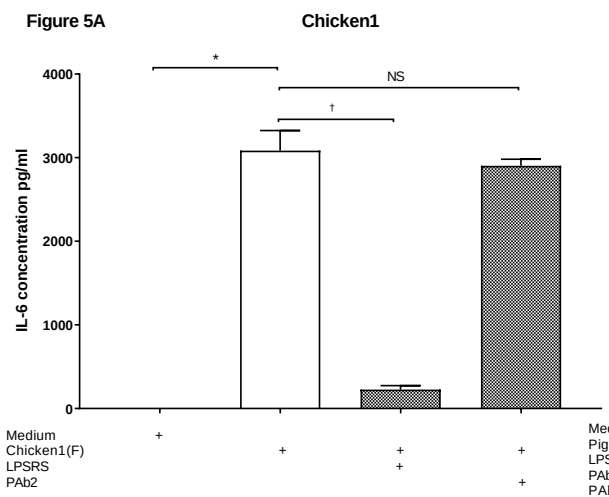
Effect of BioPM collected from different farms

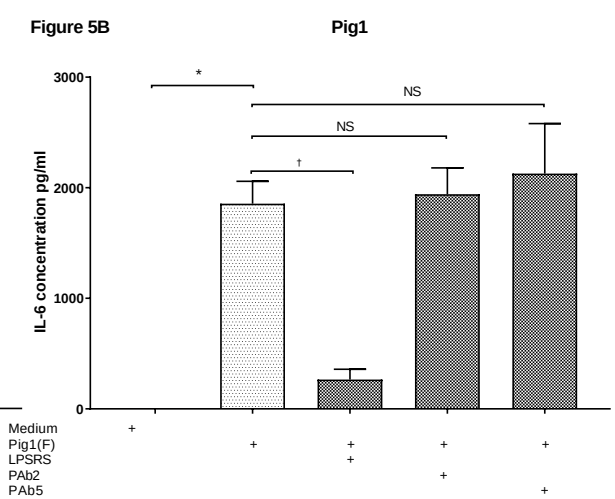


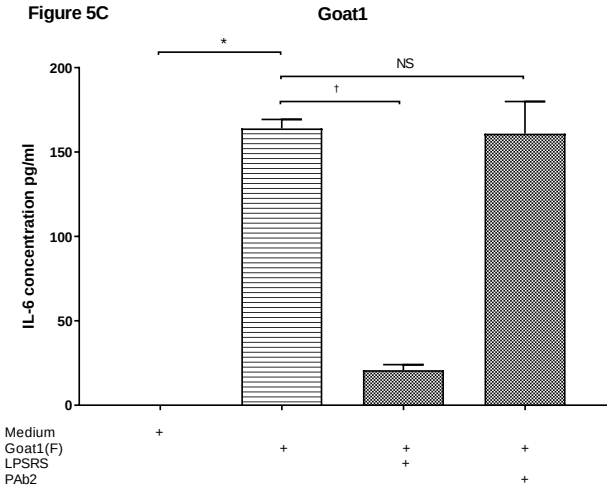
Secretion of pro-inflammatory marker IL-6 by cells

Liu et al., Sci Total Environ. 2019 Oct 20;688:1298-1307

Specific blocking of TLR2, TLR4 or TLR5 receptors







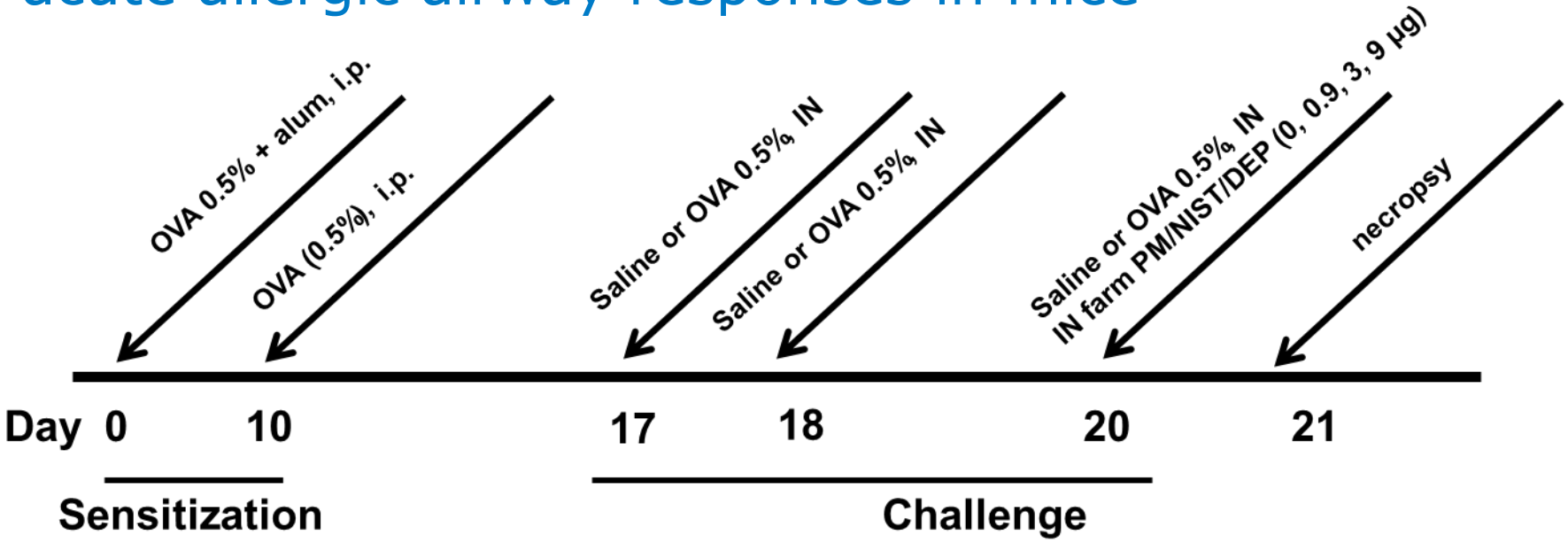
Liu et al., Sci Total Environ. 2019 Oct 20;688:1298-1307

Summary of receptor activation:

BioPM	TLRs								NODs	
	TLR2	TLR3	TLR4	TLR5	TLR7	TLR8	TLR9	null	NOD1	NOD2
Chicken	+	-	+	-	-	-	-	-	-	-
Pig	+	-	+	+	-	-	-	-	-	-
Goat	+	-	+	-	-	-	-	-	-	-
RIVM	-	-	-	-	-	-	-	-	-	-
Ligands	**Lipo-protein**	**Double stranded RNAs**	**LPS**	**Flagellin**	**Single stranded RNAs**	**Single stranded RNAs**	**CpG Micro-bial DNA**		**peptidoglycan**	**peptidoglycan**

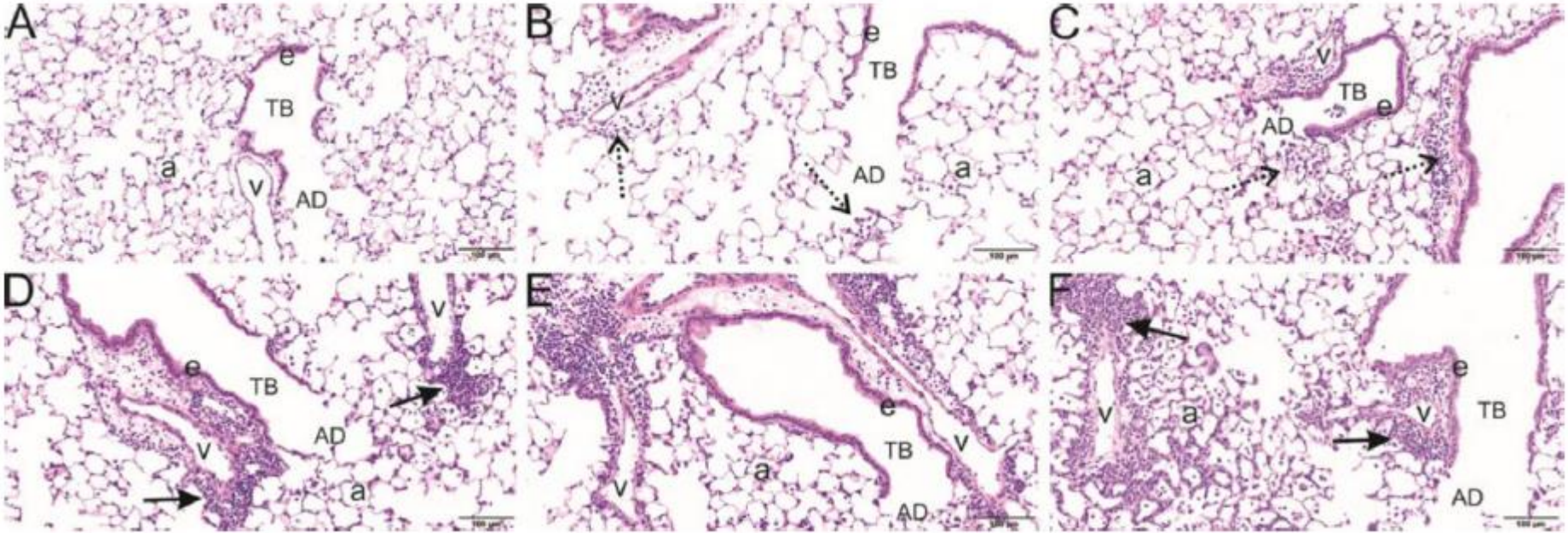
“ – ” minor or no activation

Airborne particulate matter & acute allergic airway responses in mice



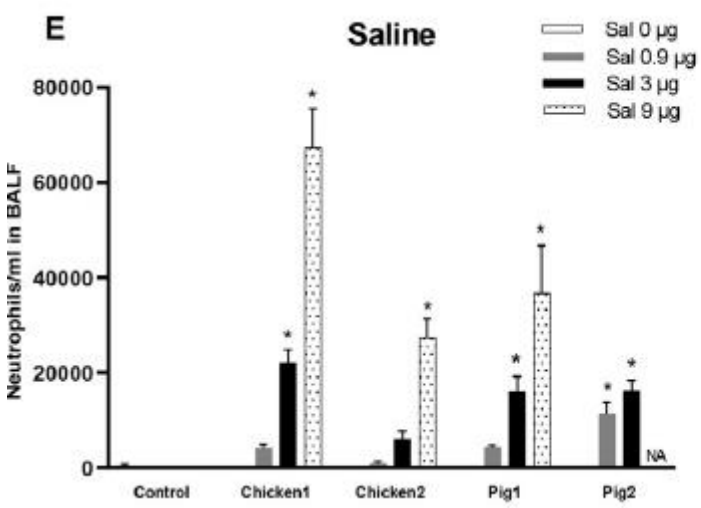
Liu et al., Inhal Toxicol. 2020 May;32(6):265-277
Liu et al., World Allergy Organ J. 2020 Apr 3;13(4):100114.

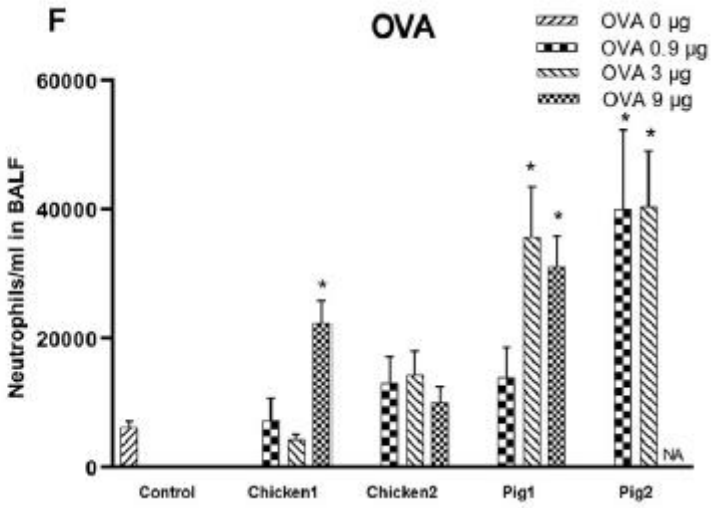
Pathology of the lungs



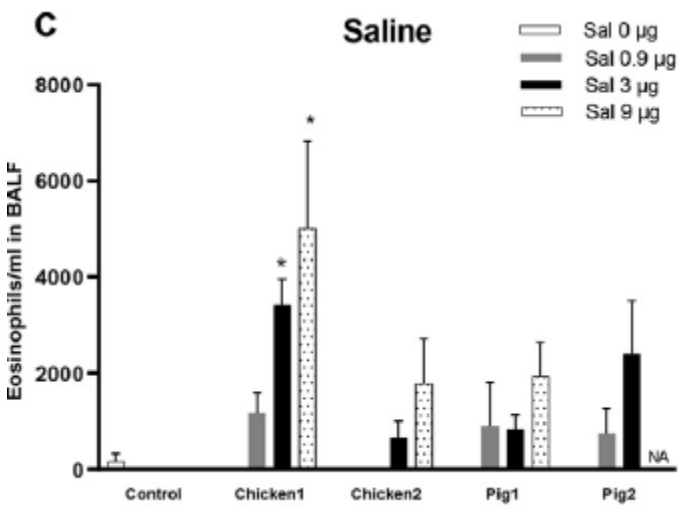
Light photomicrographs of lung tissue sections from mice intranasally challenged with
(A)Controle, (B) Chicken BioPM, (C) Pig 1 BioPM,
(B)(D) OVA, (E) OVA and Chicken BioPM, (F) OVA Pig 1 BioPM

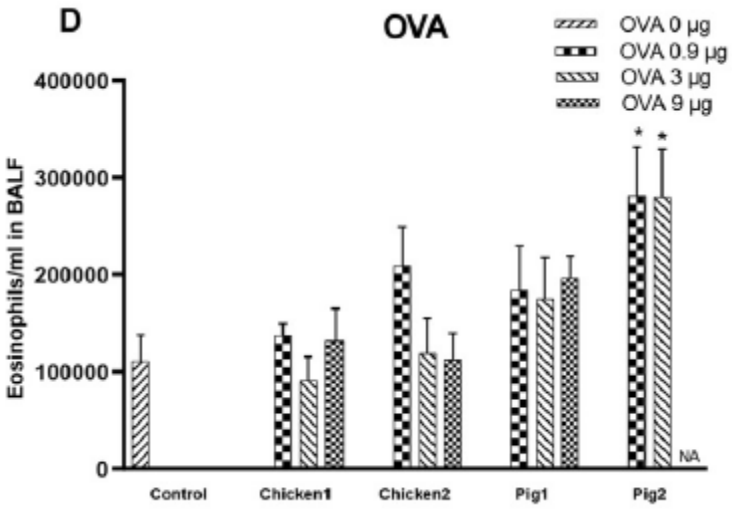
Inflammatory cells in lung: Neutrophils



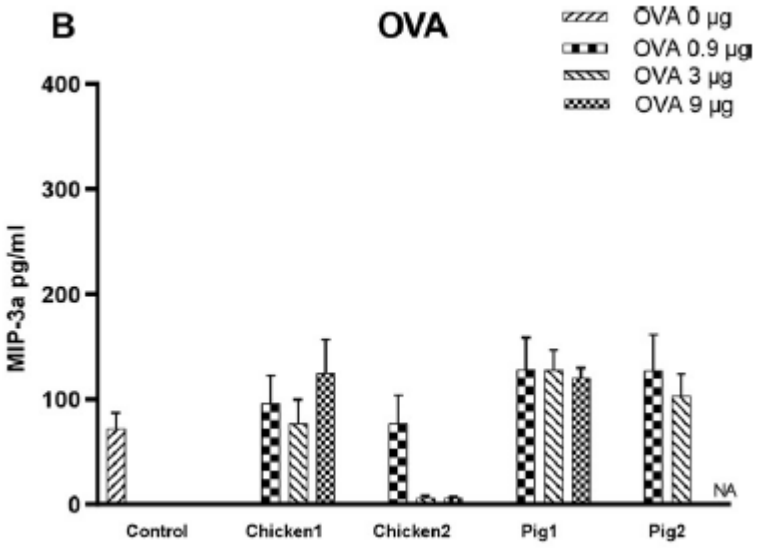


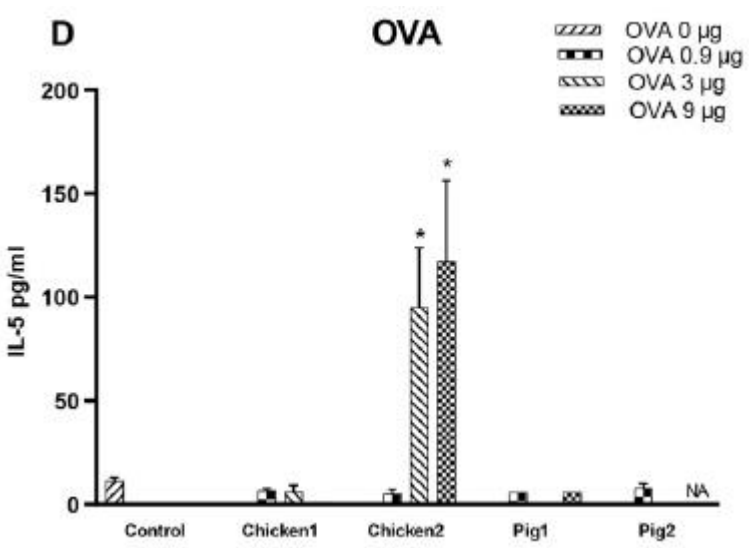
Inflammatory cells in lung: Eosinophils



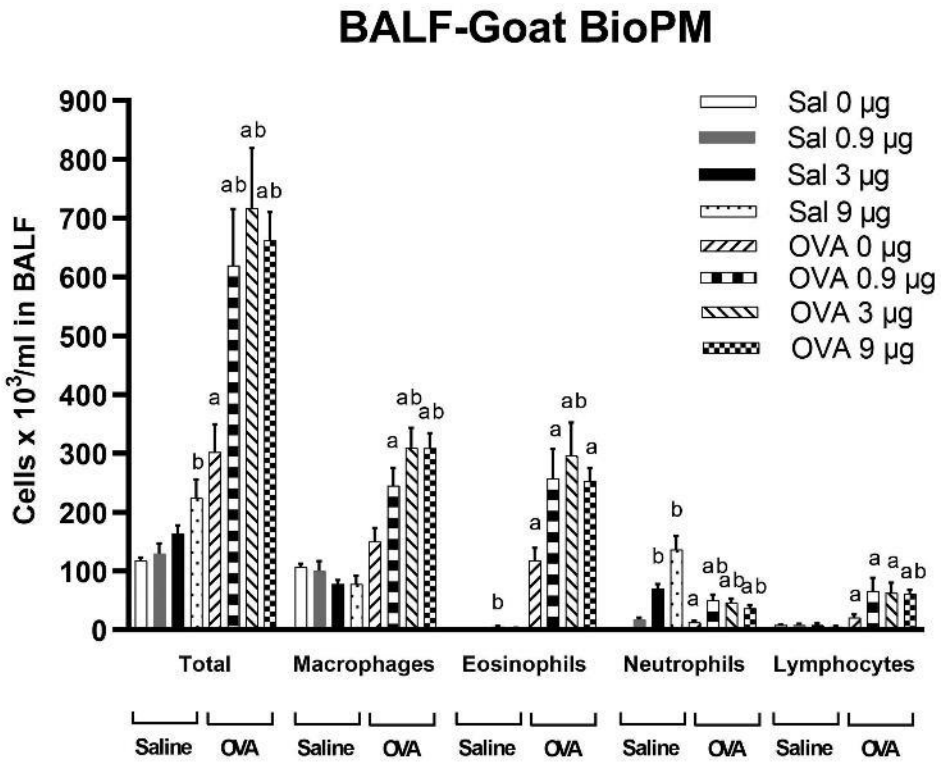


Different profiles for pro-inflammatory mediators





Cells in the lung after exposure to goat BioPM



Conclusions

- Livestock farm-derived BioPM contain substances → allergic response

- Variations are possibly based on the microbial or fungal diversity
  - The exact 'cause' remains unclear but evidence it presented that this type of PM can be just as or even more potent in affected respiratory symptoms
  - In the end, to what extend the effects occur highly depends on the level and duration of the exposure as well as existing disease status

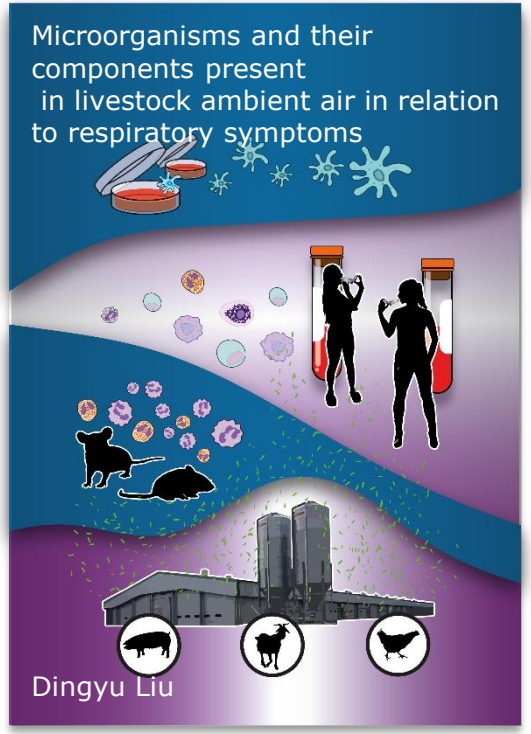
Acknowledgement

Dingyu Liu, PhD student, now Dr. Liu

Elena Pineli-Ortiz, Rob Mariman and Miriam Gerlofs-Nijland – RIVM

Gert Folkerts – Utrecht University

James Wagner & Jack Harkema – Michigan state University



RIVM internal R&D project MARS