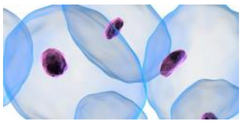

# Structural equation modelling of volatile fatty acid production in the rumen of dairy cows

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**Type of thesis:** Computational

**Required competences:** Advanced statistical skills, metabolic pathway analysis, basic R skills.

**Acquired competences:** Rumen microbial fermentation metabolism, Structural equation modelling, probabilistic modelling, mixed-effects modelling, data fitting.

**Date:** by mutual agreement

## Description

Rumen fermentation is a complex process by which microbes utilize dietary components fed to cattle. These dietary components may involve nutrients such as fibre, starch and sugars. After degrading these nutrients, microbial fermentation of degraded substrate along certain metabolic pathways yields volatile fatty acids (VFA) such as acetate, propionate and butyrate (e.g. Hegarty and Gerdes, 1999). The proportions in which these VFA are formed have implications for the yield of hydrogen that is utilized for methane production by the methanogenic archaea that also reside in the rumen. Furthermore, VFA serve as an energy source for the animal, of which propionate has a glucogenic potential and acetate and butyrate have a lipogenic potential. Currently, univariate predictions of VFA formation are used for evaluating the proportions of these three major VFA based on dietary components, but the predictions are only moderately accurate (Alemu et al., 2011). Structural equation modelling (e.g. Reed et al., 2014) may be the ultimate tool to predict correlated dependent variables such as fermentation products from metabolic pathways of the rumen microbial metabolism. Causal inference is evaluated by applying this technique, which goes beyond the development of merely empirical correlations (Shipley, 2000). The student will start with collating data available from the literature and predict proportions of VFA production in the rumen of dairy cattle by structural equation modelling. Depending on the statistical skills of the student, a Bayesian approach may be considered for model fitting.

# References

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Reed, K. F., et al. Prediction of nitrogen use in dairy cattle: a multivariate Bayesian approach. 2014. Animal Production Science 54:1918-1926.

B. Shipley. Cause and Correlation in Biology: A user's guide to path analysis, structural equations, and causal inference. Cambridge University Press, 2000.