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Institute of Animal Science

Metabolic adaptation of periparturient dairy cows characterised by changes of the blood metabolome

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Background

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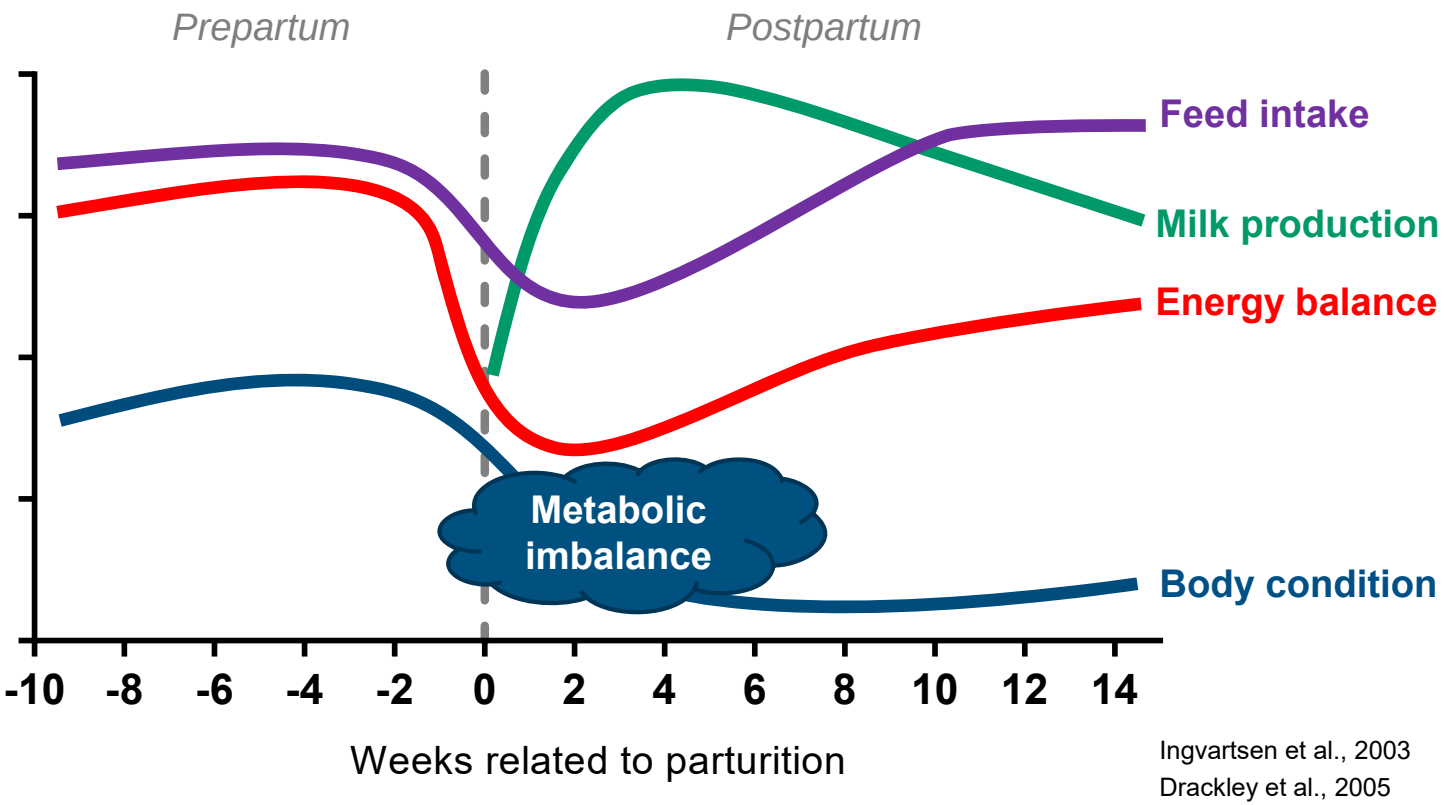
Physiological changes in peripartureint dairy cows



- Negative energy balance
- Higher risk for pathophysiological dysregulation of metabolism
- Critical period of time

Ingvartsen et al., 2003
Drackley et al., 2005
Roche et al., 2009

Background

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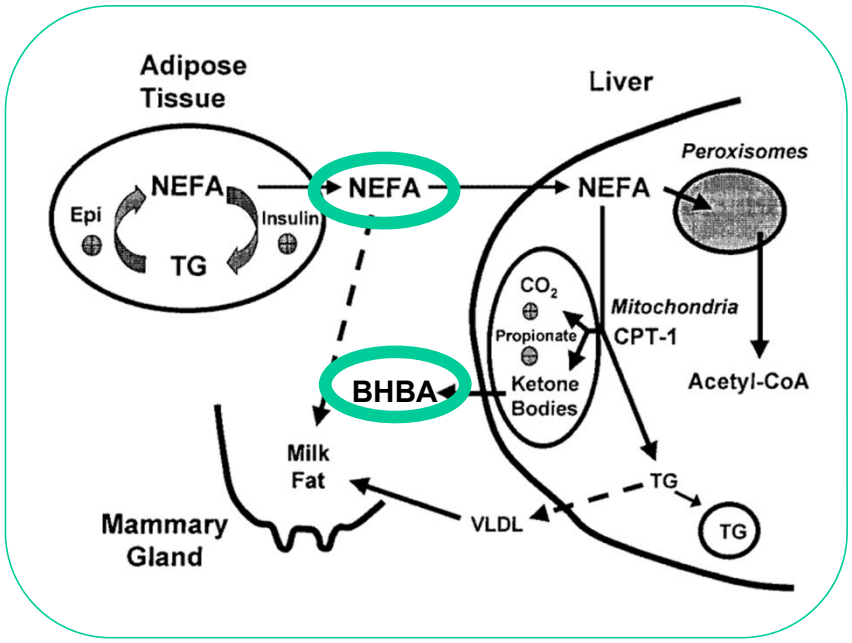
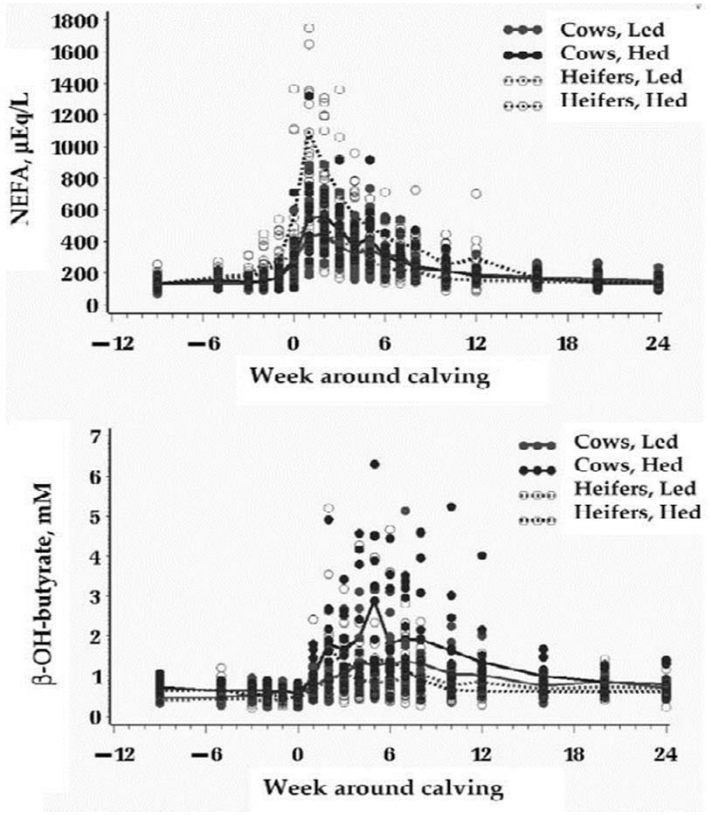
Conventionally used markers for the severity of negative energy balance:

- Non-esterified fatty acids (NEFA)
- Beta-hydroxybutyrate (BHBA)



Drackley 1999



Ingvartsen et al., 2003

Aims

To get a better understanding of periparturient metabolic changes:

- Study a whole **variety of metabolites** at a time
- **Repeatedly** during the periparturient period

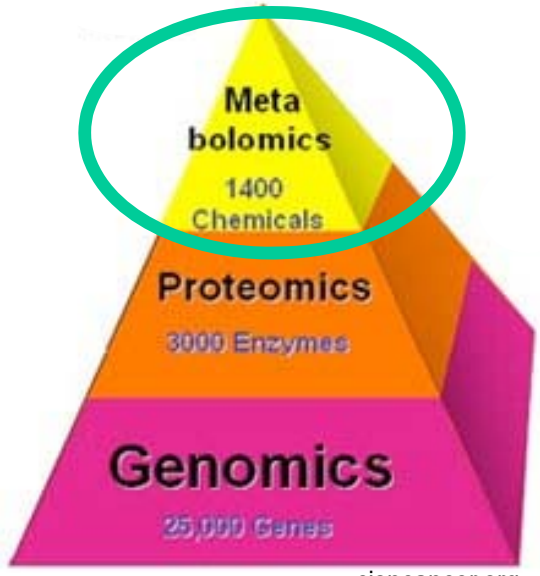
Explorative approach, focusing on:

- **Longitudinal** trends
- Variation **between individuals**

Metabolomics

„A systematic study of the unique chemical fingerprints that specific cellular processes leave behind“

Bennet, 2005



cisncancer.org

Materials & Methods

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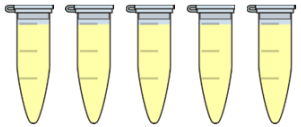
BLOOD SAMPLING:

d-42 **d-10** **d+3** **d+21** **d+100**



serum

German **Holstein** cows (**n=26**)

Selection criteria:

- multiparous
- clinically healthy
- similar BCS, body weight, milk yield

⇒ Goal: to establish a **homogenous group of cows**

Diet: a grass-silage and corn-silage based TMR according to the guidelines of the Society of Nutrition Physiology (Frankfurt am Main, Germany) for transition cows

Materials & Methods

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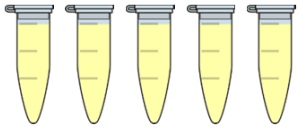
BLOOD SAMPLING:

d-42 **d-10** **d+3** **d+21** **d+100**



serum

Sample analysis by liquid chromatography-mass spectrometry **(LC-MS)** based **targeted** metabolomics:

AbsoluteIDQ p180 Kit of **Biocrates** Life Science AG (Innsbruck, Austria)

- **Acylcarnitines**
- **Amino acids**
- **Biogenic amines**
- **Glycerophospholipids**
- **Sphingolipids**

Relevance for:
energy, fat and carbohydrate metabolism,
mitochondrial and membrane function

Data analyzed in MetaboAnalyst[1] and R

[1]Xia et al.; Nucl Acids Res 2015 (DOI:10.1093/nar/gkv380)

Data analysis and visualization

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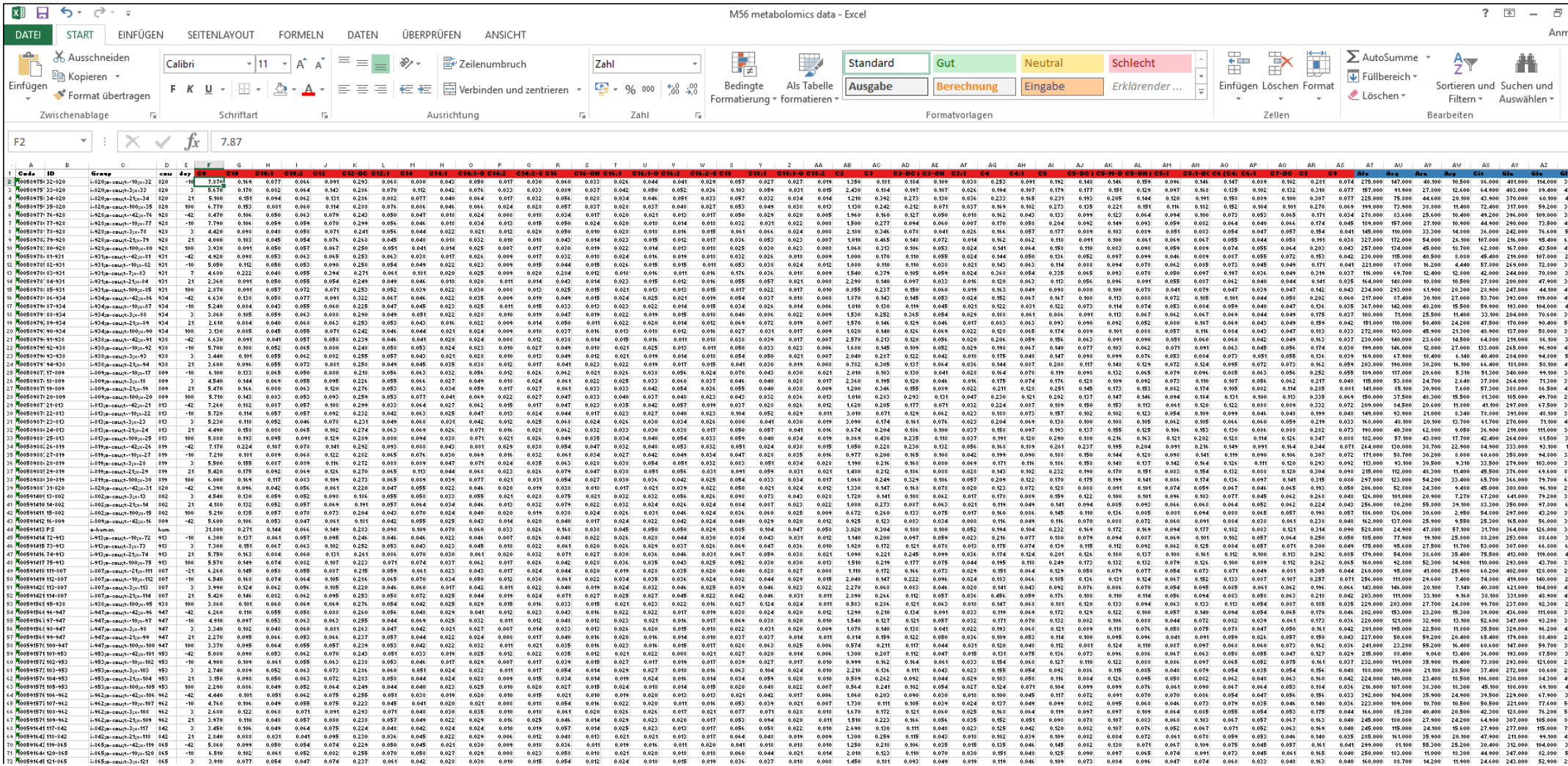
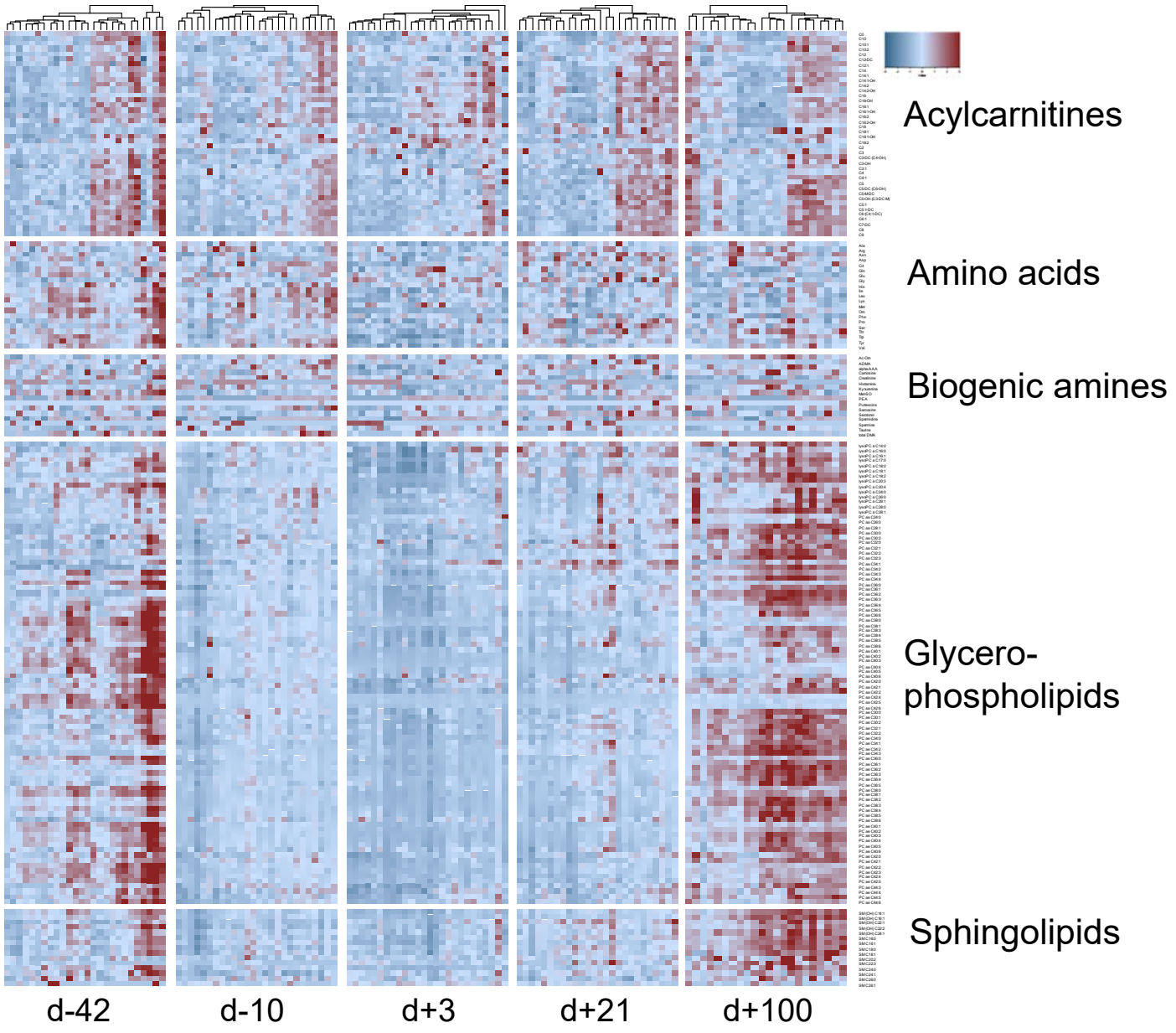


Results

Heatmap

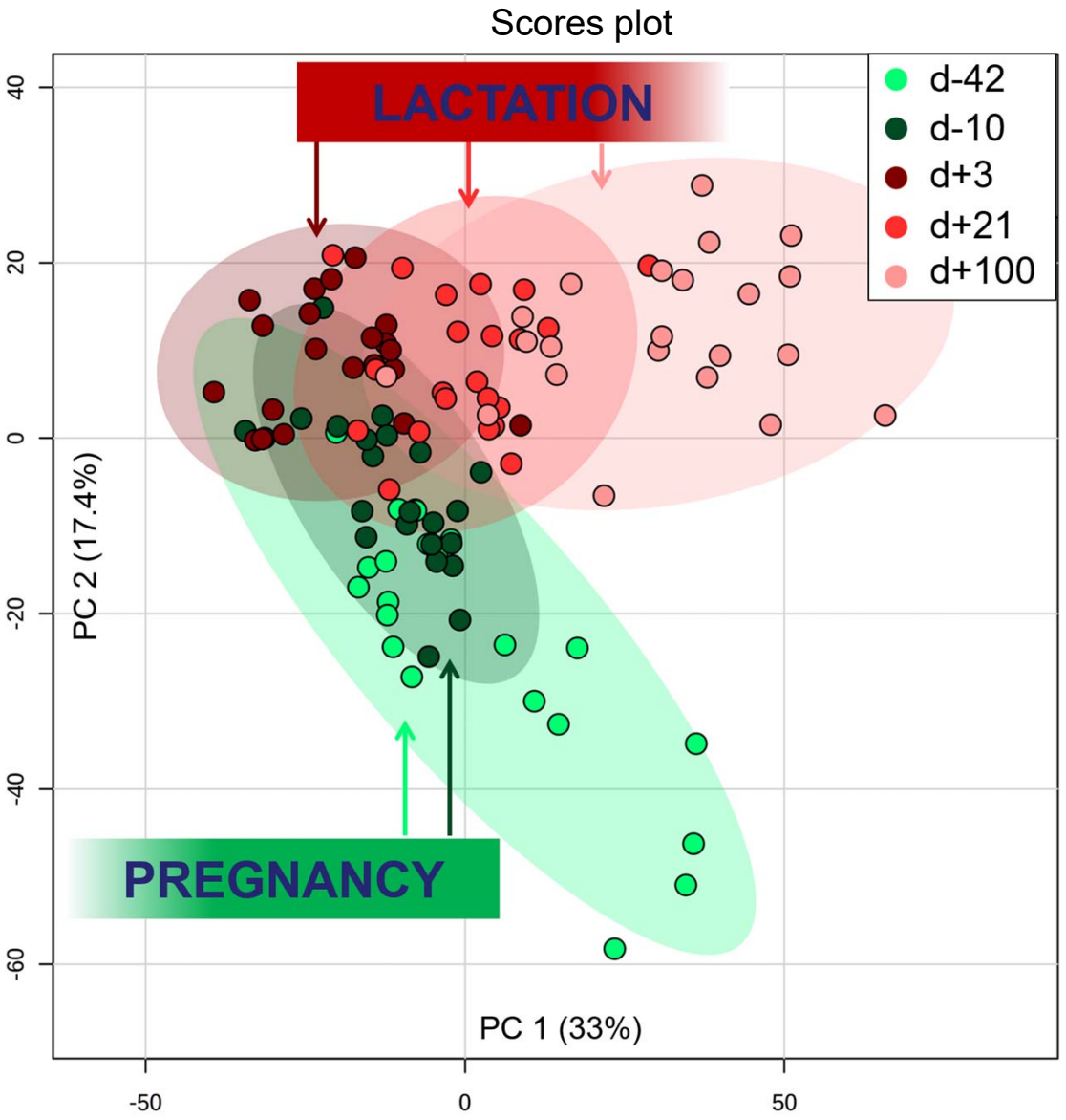
- **Time-related** changes of glycerophospholipids and sphingolipids
- **Clustering** by acylcarnitines
- **Heterogenous** pattern of amino acids and biogenic amines



Results

Principal component analysis (PCA)

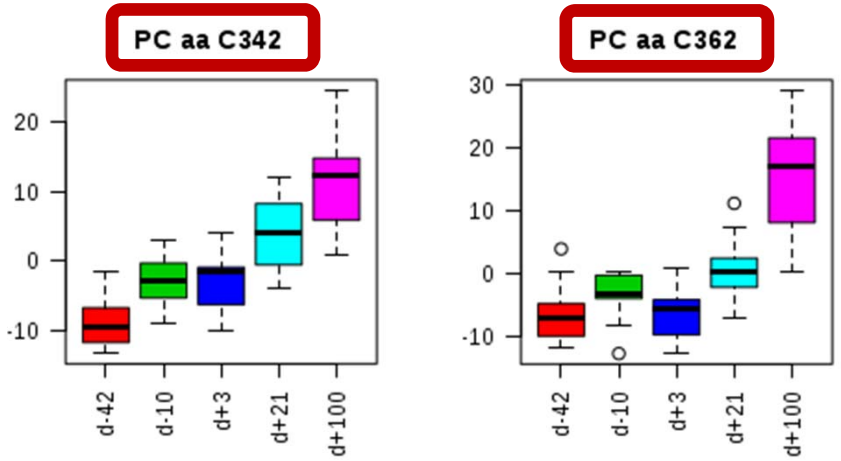
- Unsupervised method aiming to find the directions that best **explain the variance** in a data set
  - **Scores** are weighted averages of the original variables
- Continuous pattern **shift** from d-42 to d+100
- More **variation** at d-42 and d+100 (scores scattered over a larger area)



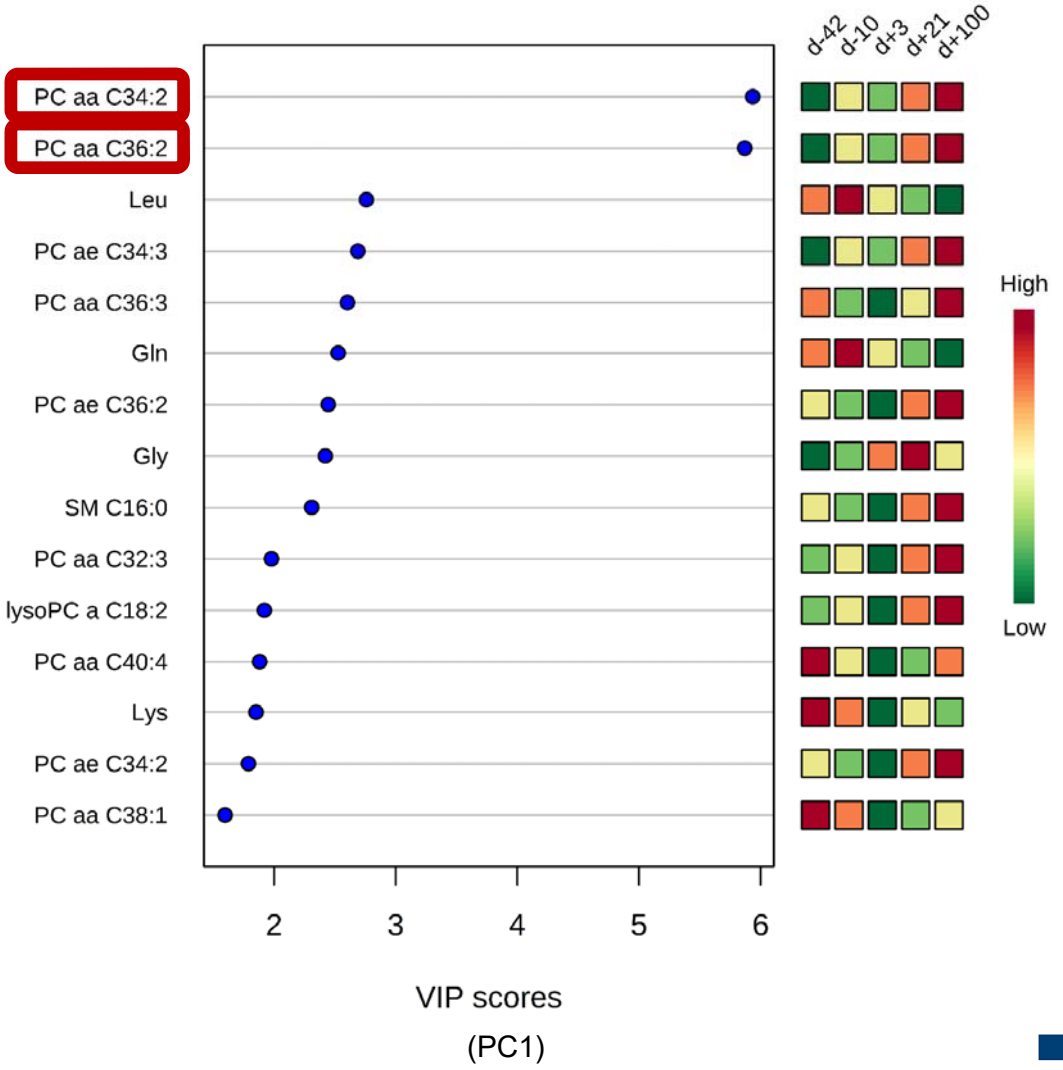
Results

Variable importance in projection (VIP) scores

- **Which metabolites** contribute the most to the separation between days?
  - Mainly phospholipids



Top 15 metabolites



Conclusions

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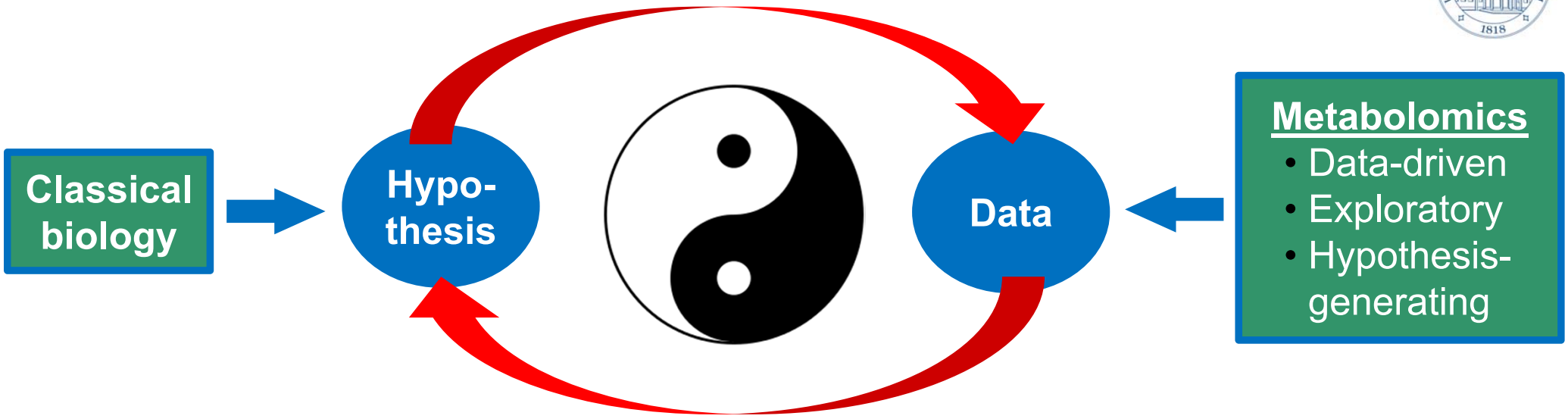


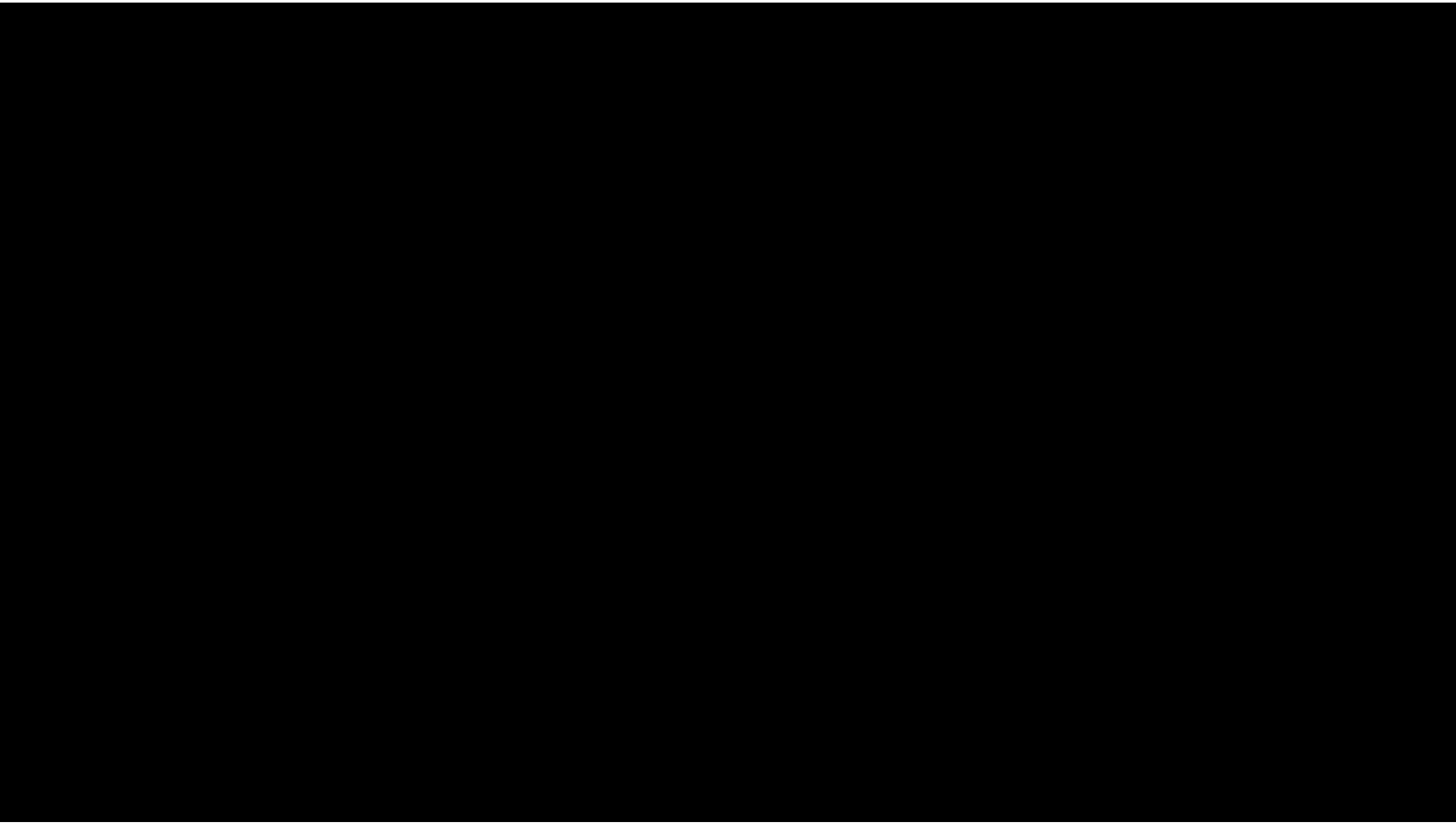
Glycerophospholipids:

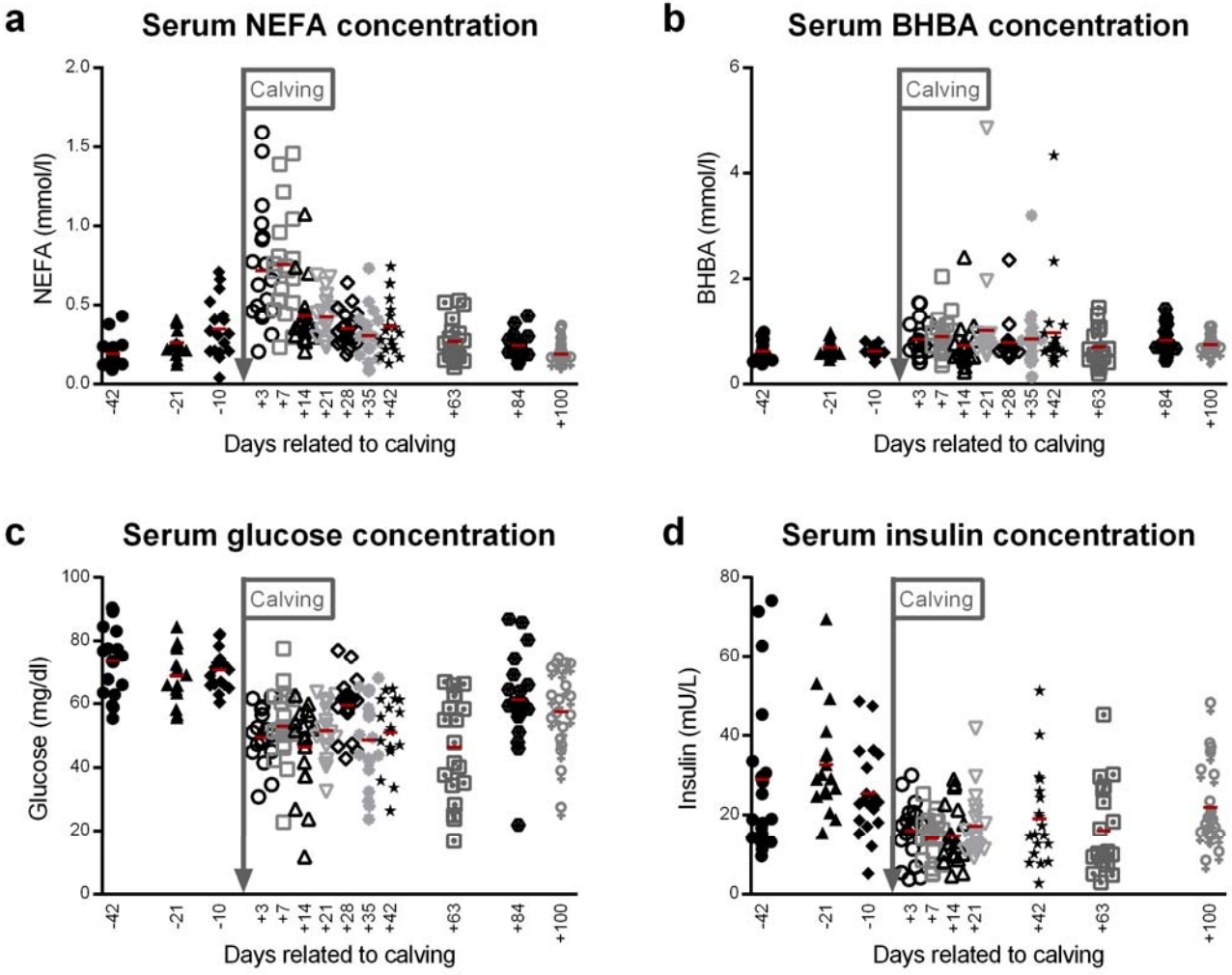
- Decrease around calving associated with plasma lipoprotein trafficking? …membrane function? …inflammation? …insulin resistance? …oxidative metabolism?
  (Gault et al. 2010, Yea et al. 2009, Ha et al. 2012, Imhasly et al. 2015)

Acylcarnitines:

- Inter-individual variation associated with mitochondrial transport? …fatty acid oxidation? *(Adams et al. 2009, Huber et al. 2016)*


Thank you for your attention!




a
Serum NEFA concentration
NEFA (mmol/l)
Calving
Days related to calving
b
Serum BHBA concentration
BHBA (mmol/l)
Calving
Days related to calving
c
Serum glucose concentration
Glucose (mg/dl)
Calving
Days related to calving
d
Serum insulin concentration
Insulin (mU/L)
Calving
Days related to calving