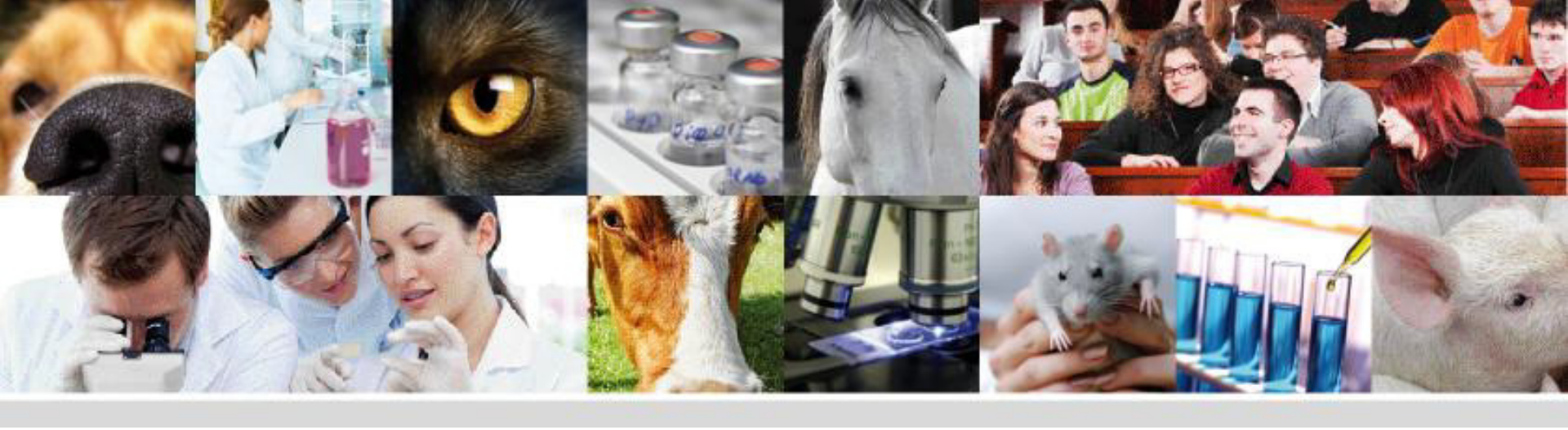


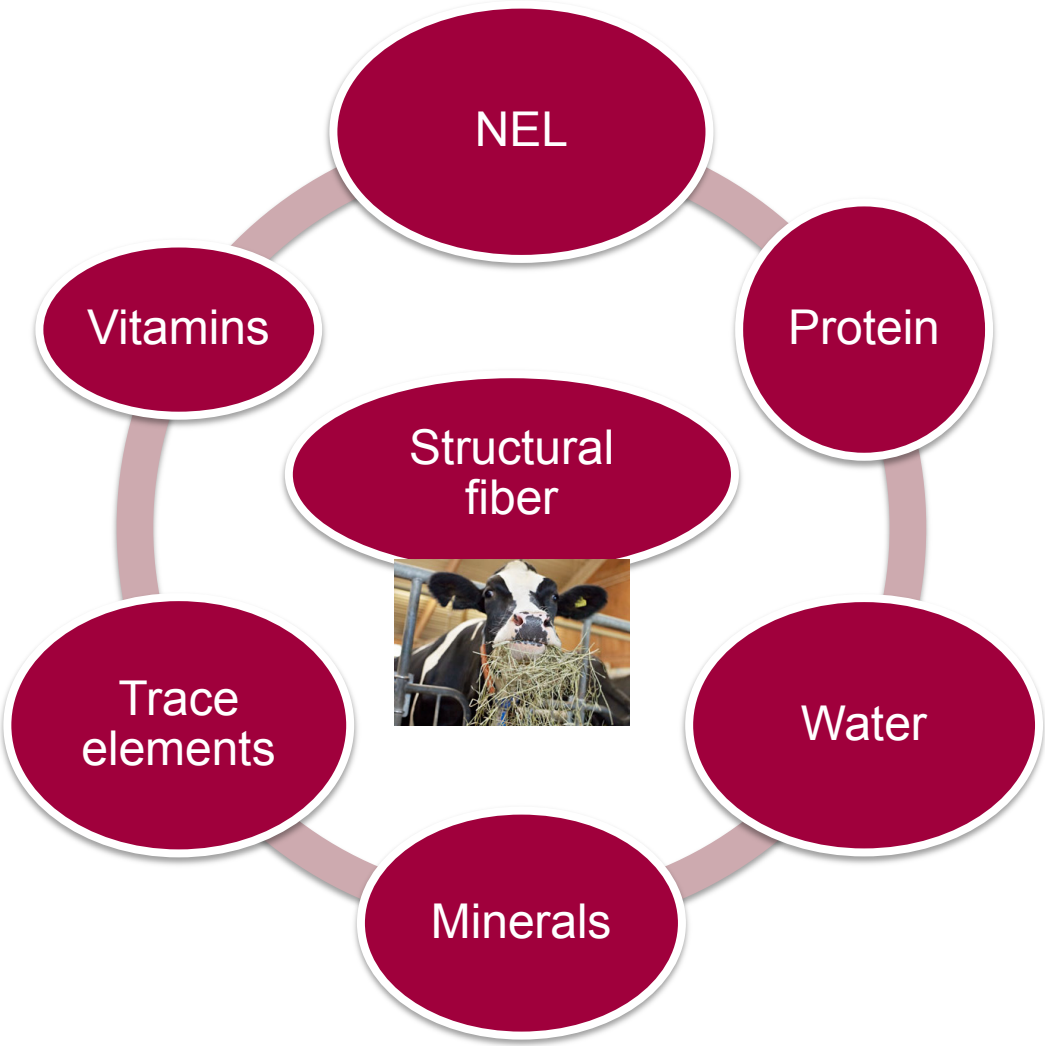
Role of physically effective fiber in rumen health of cattle

Prof. Qendrim Zebeli

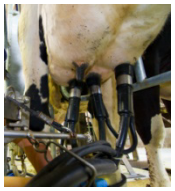
Veterinärmedizinische Universität Wien

vetmeduni vienna

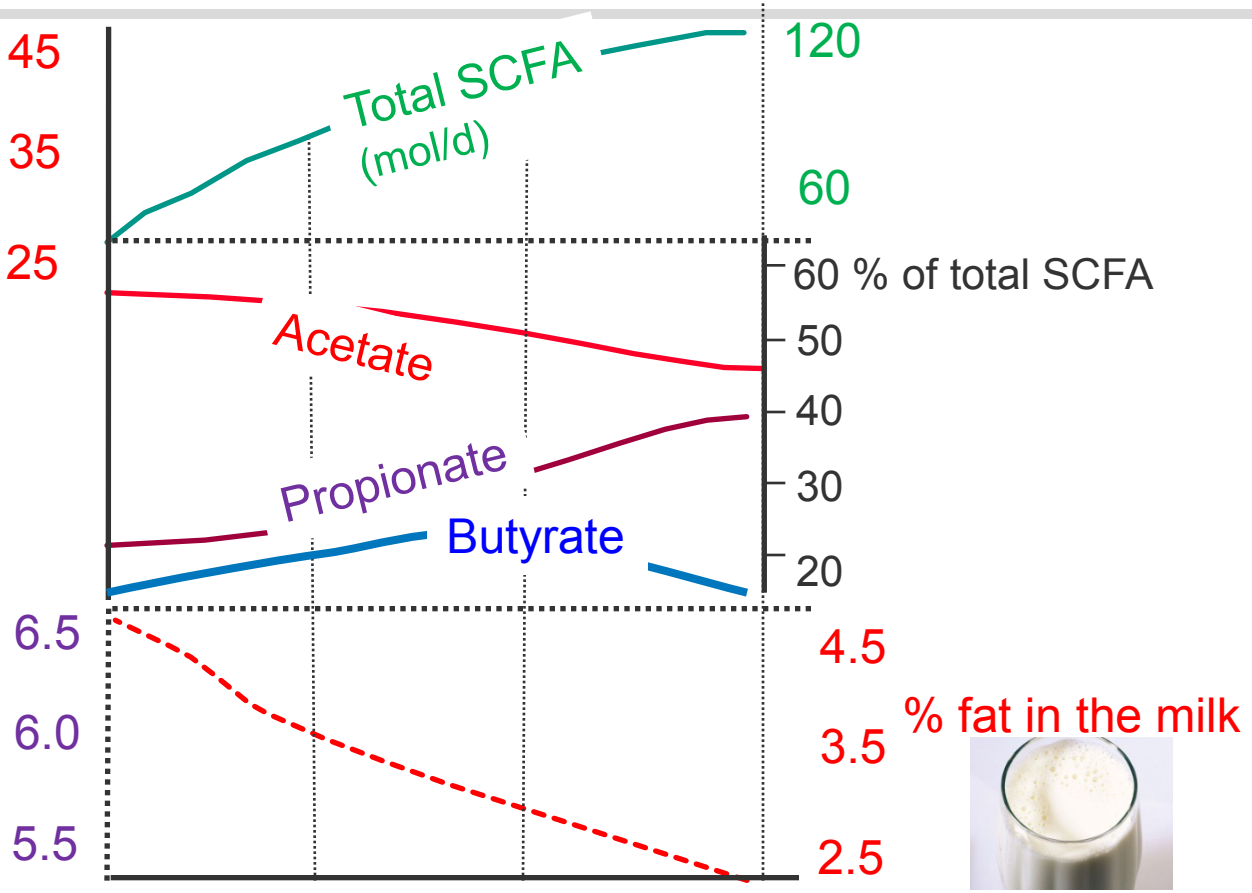
Nutrient requirements (rumen and host)



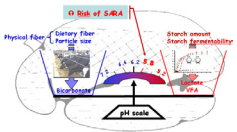
Requirements in structural fiber



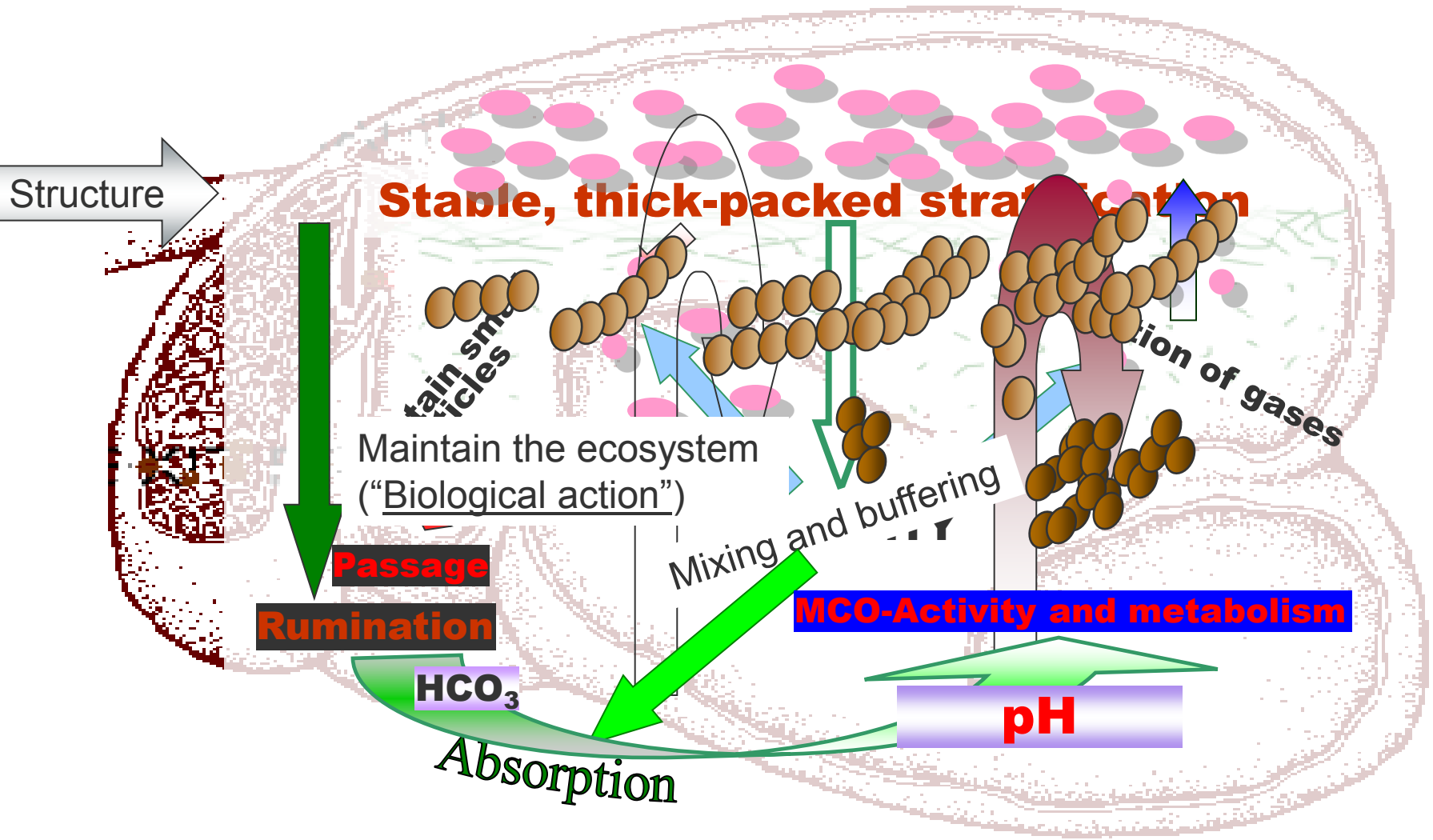
Milk yield



Concentrate	20%	50%	70%
Forage	80%	50%	30%



Importance of structural feed for the rumen

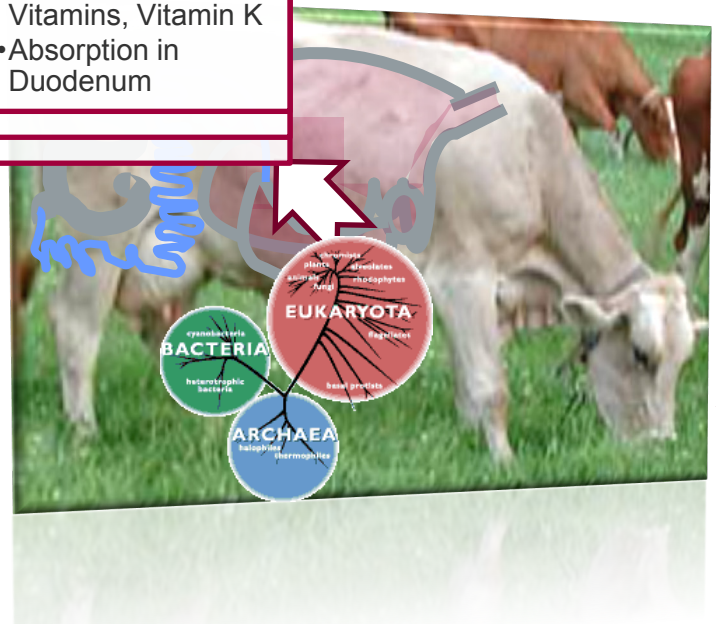


Rumen functioning & yields

vetmeduni vienna

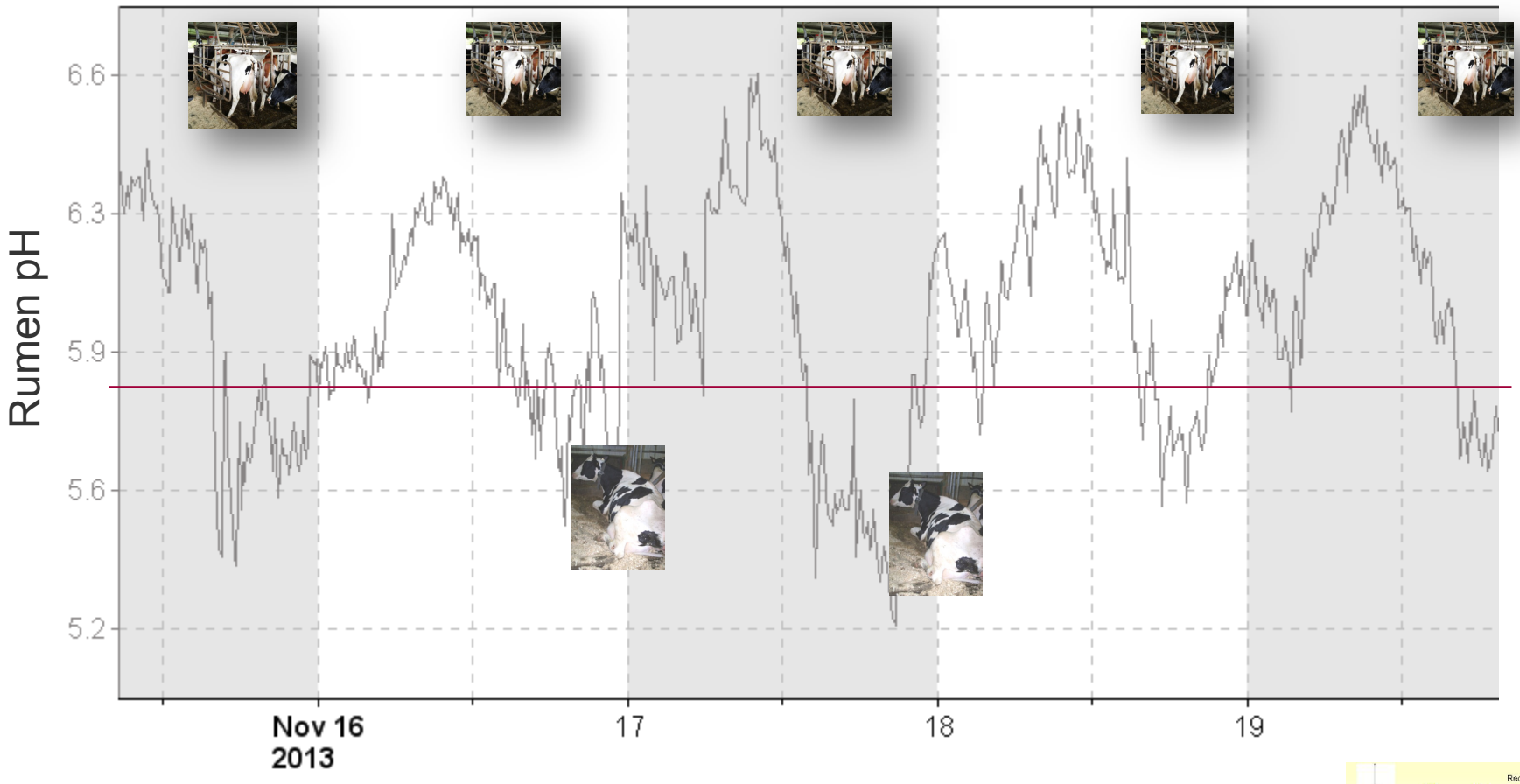
Nutrient degradation	•125 Mol SCFA/ day •Absorption und metabolism
Microbial protein synthesis	•~ 185 g/kg DOM • ~10 g/MJ ME •Absorption in Duodenum
Vitamin synthesis	•Different B-Vitamins, Vitamin K •Absorption in Duodenum

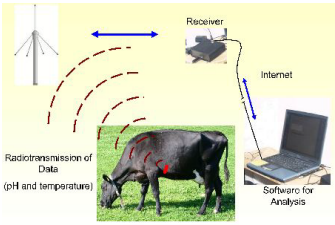
Eating time = 3-6 h/d
Meals per day = 5-6
Ruminating time = 6-10h/d
Saliva production = 120-190 l/d
Rumen volume = 150-200 l
DMI = 2-4% of body weight



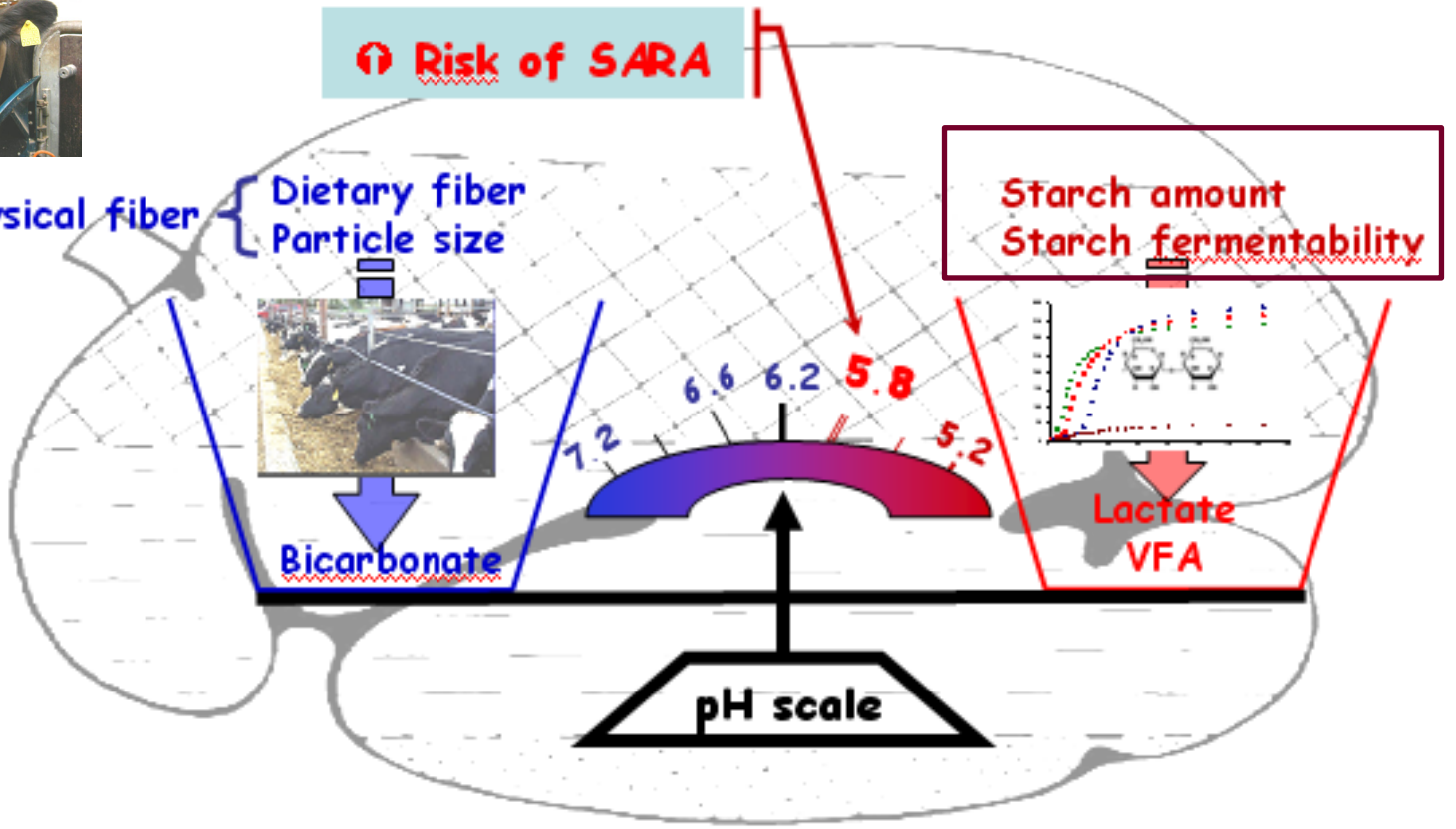
Feed intake

Rumen pH during the day

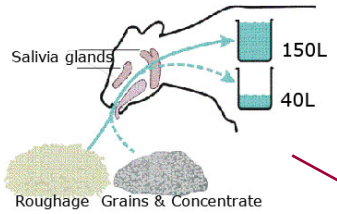




Maintaining optimal rumen pH



Regulation of intraruminal pH

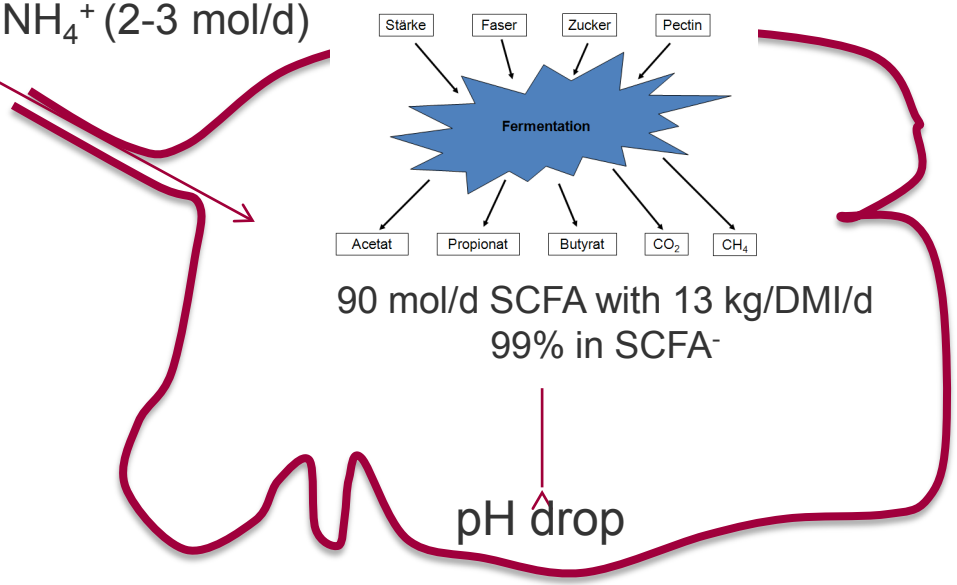


If 120 L saliva/d:

HPO_4^{2-} (5-6 mol/d)

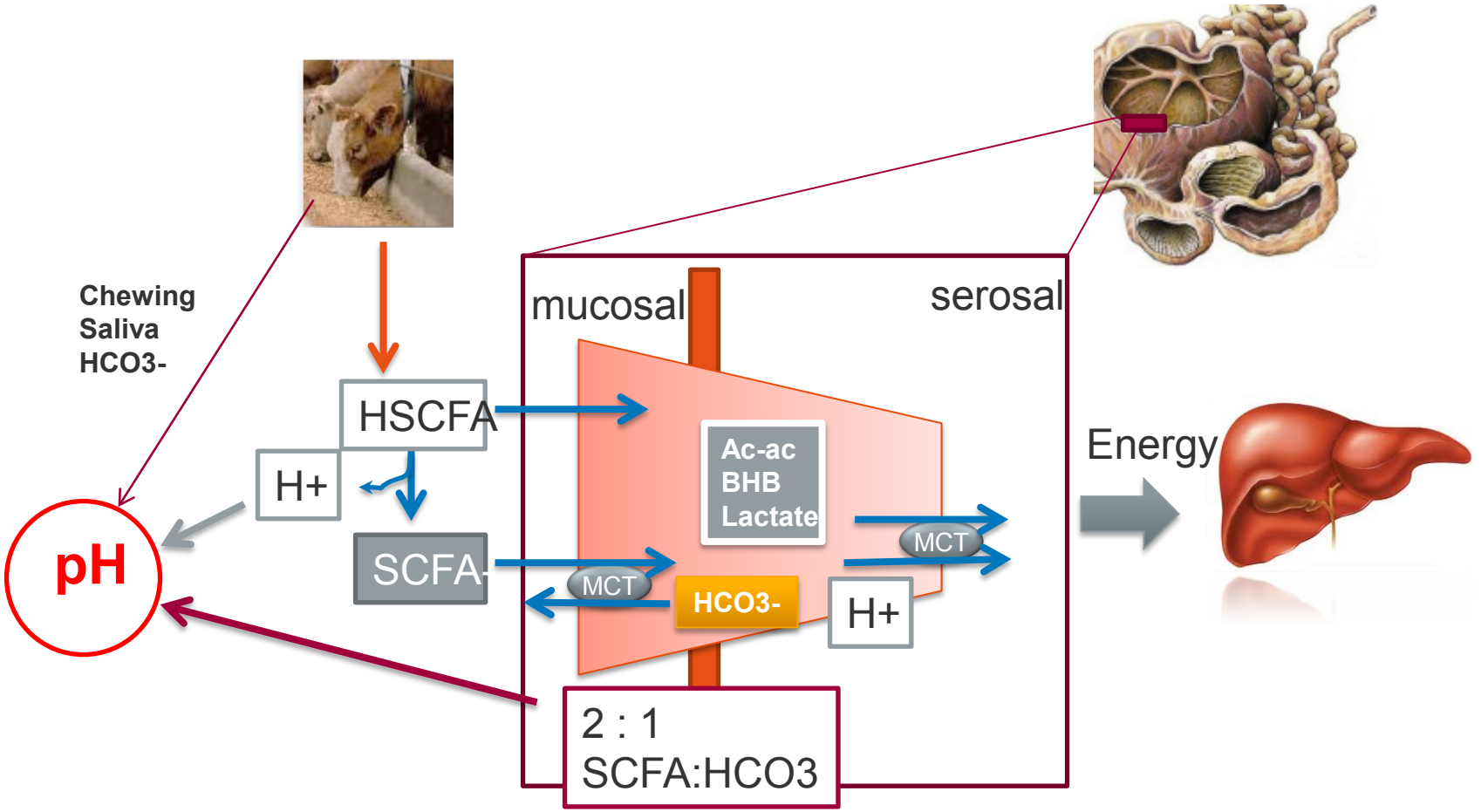
HCO_3^{2-} (30 mol/d)

NH_4^+ (2-3 mol/d)

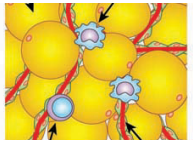


Saliva secretions can neutralize almost 40-45% of the fermentation acids

Rumen mucosa itself
Prepare the rumen!



Balancing efforts in cow feeding



Mobilisation
≈1 kg = 25 MJ NEL

Structural feed

Energy-density

≈135 MJ NEL

≈35 MJ NEL

≈100 MJ NEL

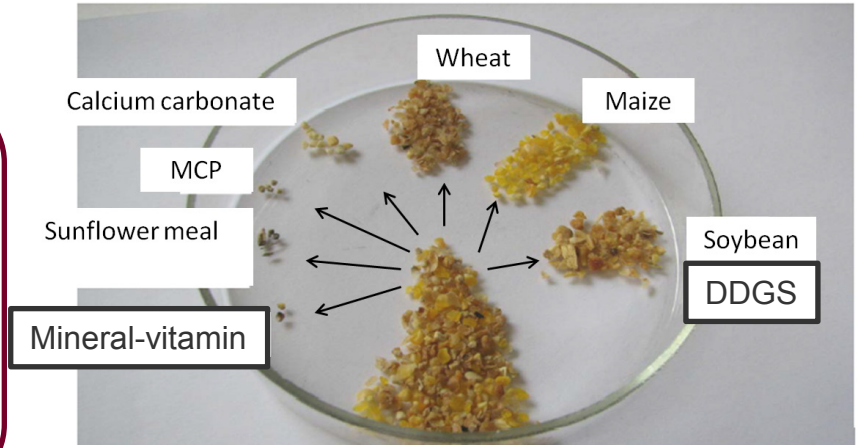
30 kg/d

21.4 kg DMI/d
7 MJ NEL/kg DM

Feeds for ruminants

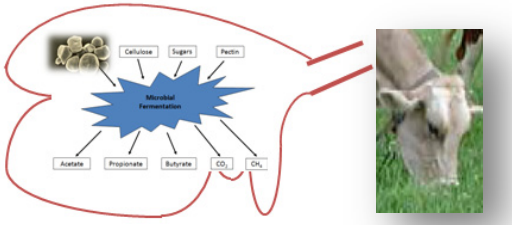
Forages
- Grass, pasture
- Hay, Haylage
- Silages (grass, corn)
- Straw (barley, wheat)

Concentrates
- Grains (barley, corn)
- By-products
- Oil seed products
- Mineral-vitamin mix
- Feed additives



Forages – vital to herbivores!

- Excellent source
  - Potentially fermentable fiber
    - Cellulose, Hemicellulose
  - Protein for microbial protein synthesis
  - Minerals and Vitamins
  - Physically effective fiber (peNDF)



„healthy energy“

To fullfil their vital role, forages must have „enough“ particle size (peNDF) !

Forages, more than nutrients

Grass silage

25% Fiber
0% Starch

Chemical composition

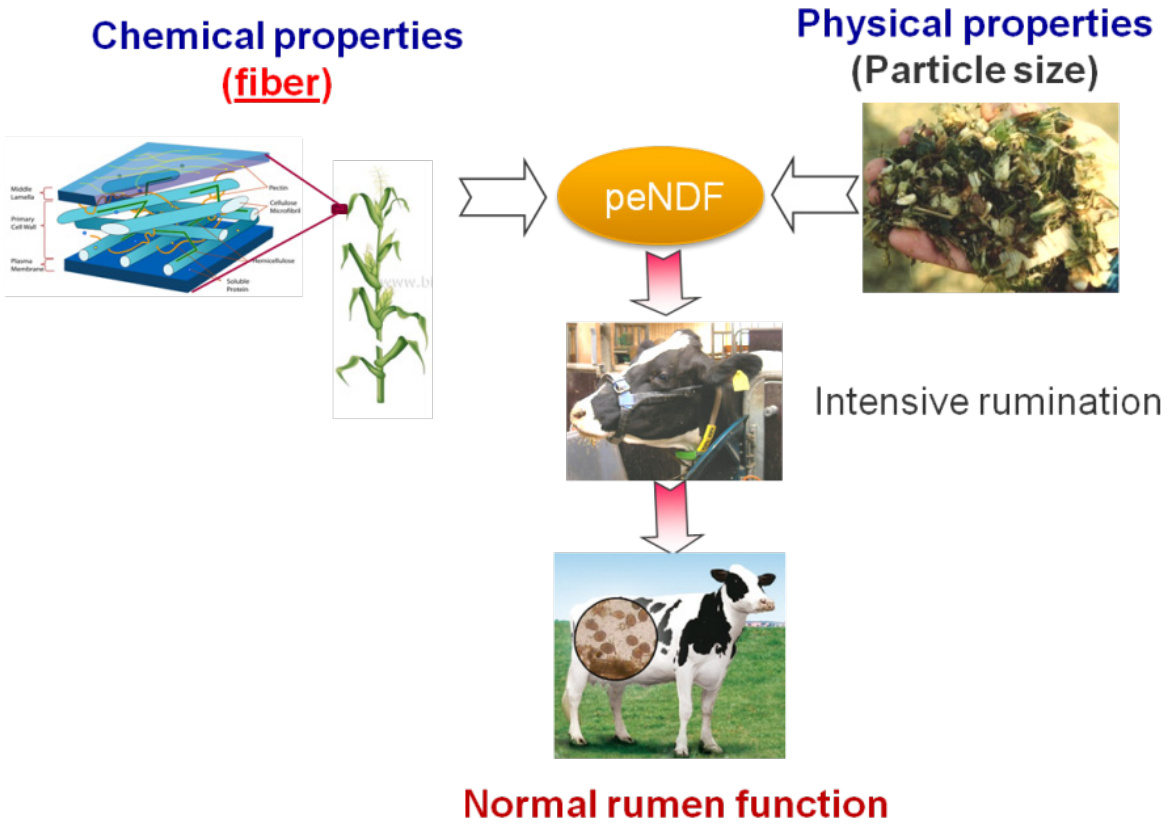
Particle size

Corn silage

20% Fiber
30% Starch

Structural value of forages

- Content of fibers (NDF) – chemically
- Particle size - physically



Structure in the diet, how?

Particle size of the silage?

Only this PS counts!

Large particles, more structure?

Optimierung der Futterpartikel ⇨ ⬇ Futterselektion ⇨ verbessert die Homogenität der Ration und die zirkadiane Fressmuster

Structure evaluation

Probe: < 400g TMR
Zyklen: [5 Hübe in jede Richtung] 2 Mal (5*4*2=40)
Hublänge: 17cm (≥ 0,5 ft)
Frequenz: ≥ 1,1Hz

Empfehlungen der Partikelverteilung für die Praxis

Partikelfraktion	TMR %	Grassilage %	Maissilage %
> 19 mm	3 – 8	10 – 20	3 – 8
8 – 19 mm	30 – 40	45 – 75	45 – 65
1.18 - 8 mm	30 – 40	20 – 30	30 – 40
< 1.18 mm	< 20	< 5	< 5

(Kononoff, 2003; Heinrich et al., 1996)

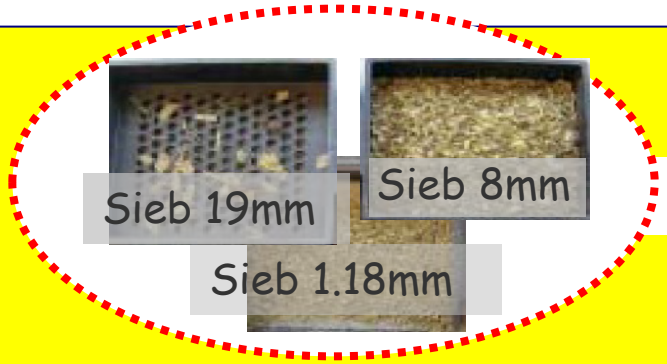
Physically effective fiber ($peNDF_{>1,18}$ and $peNDF_{>8}$)

Schüttelbox

+

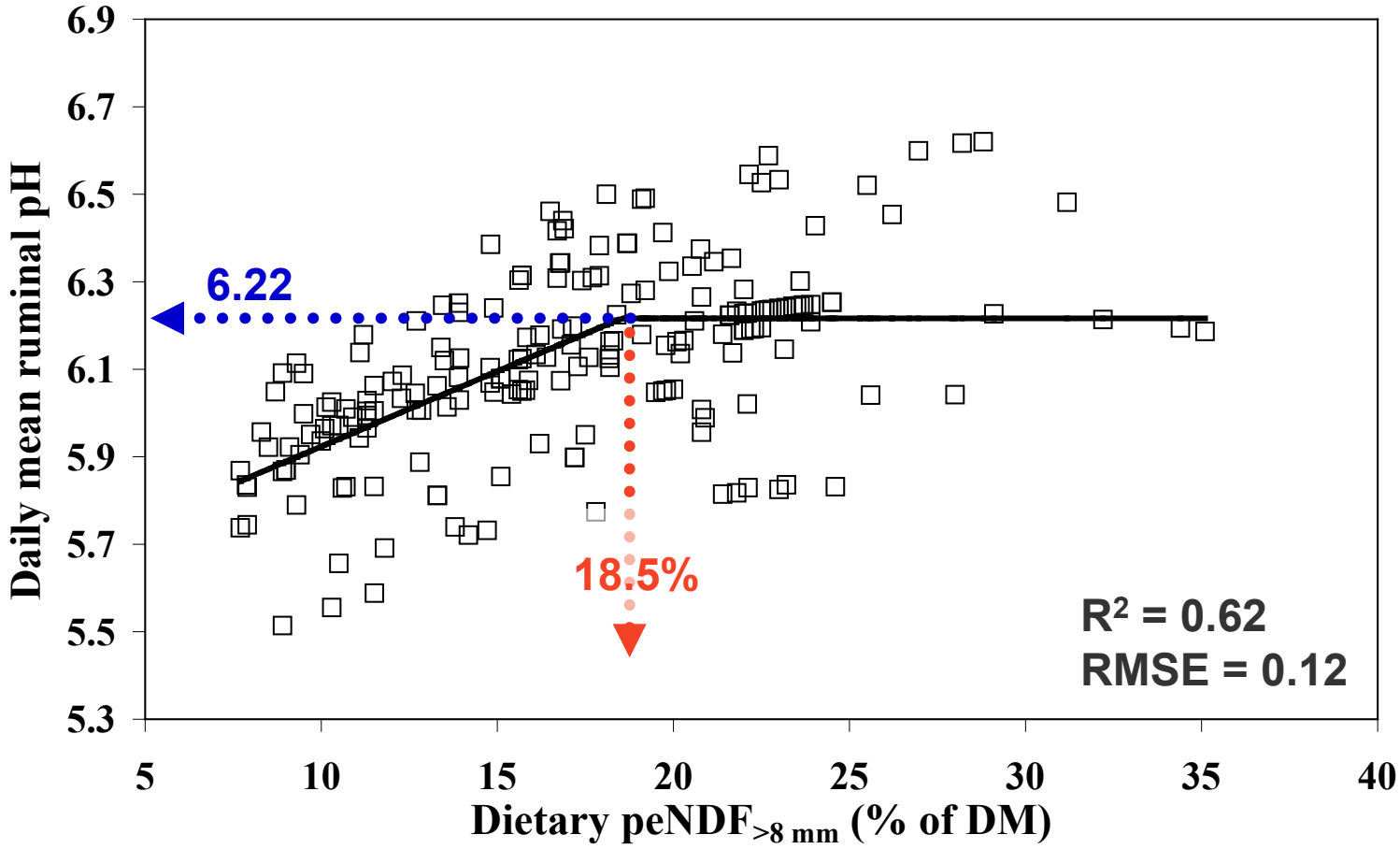
$peNDF_{>1.18}$ = peFaktor x NDF i. d. TMR

$peNDF_{>8}$ = peFaktor x NDF i. d. TMR



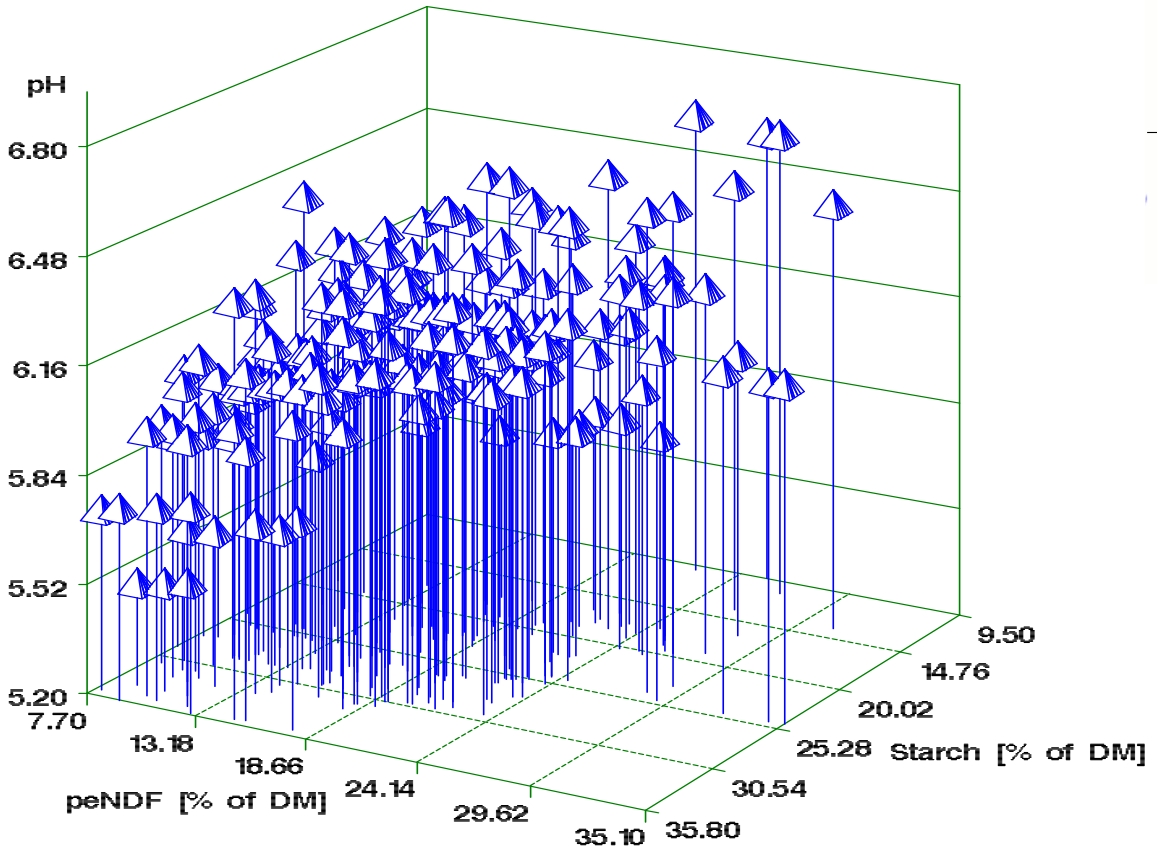
peFaktor = Anteil retiniert auf Sieb 1.18 mm

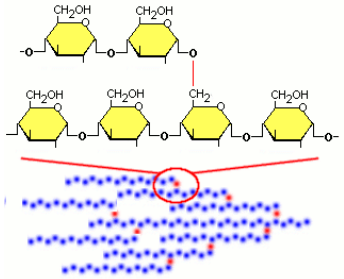
peNDF$_{>8}$ and ruminal pH



Zebeli et al. 2010

peNDF and starch content



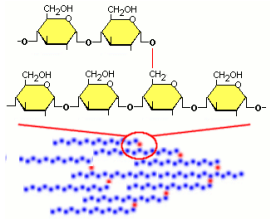


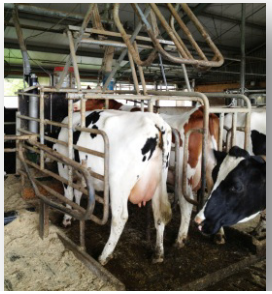
$$pH = 6.2 + 0.044 \times peNDF - 0.00085 \times peNDF^2 - 0.0093 \times starch$$

$$RMSE = 0.11;\ R^2 = 0.65,\ p < 0.001$$

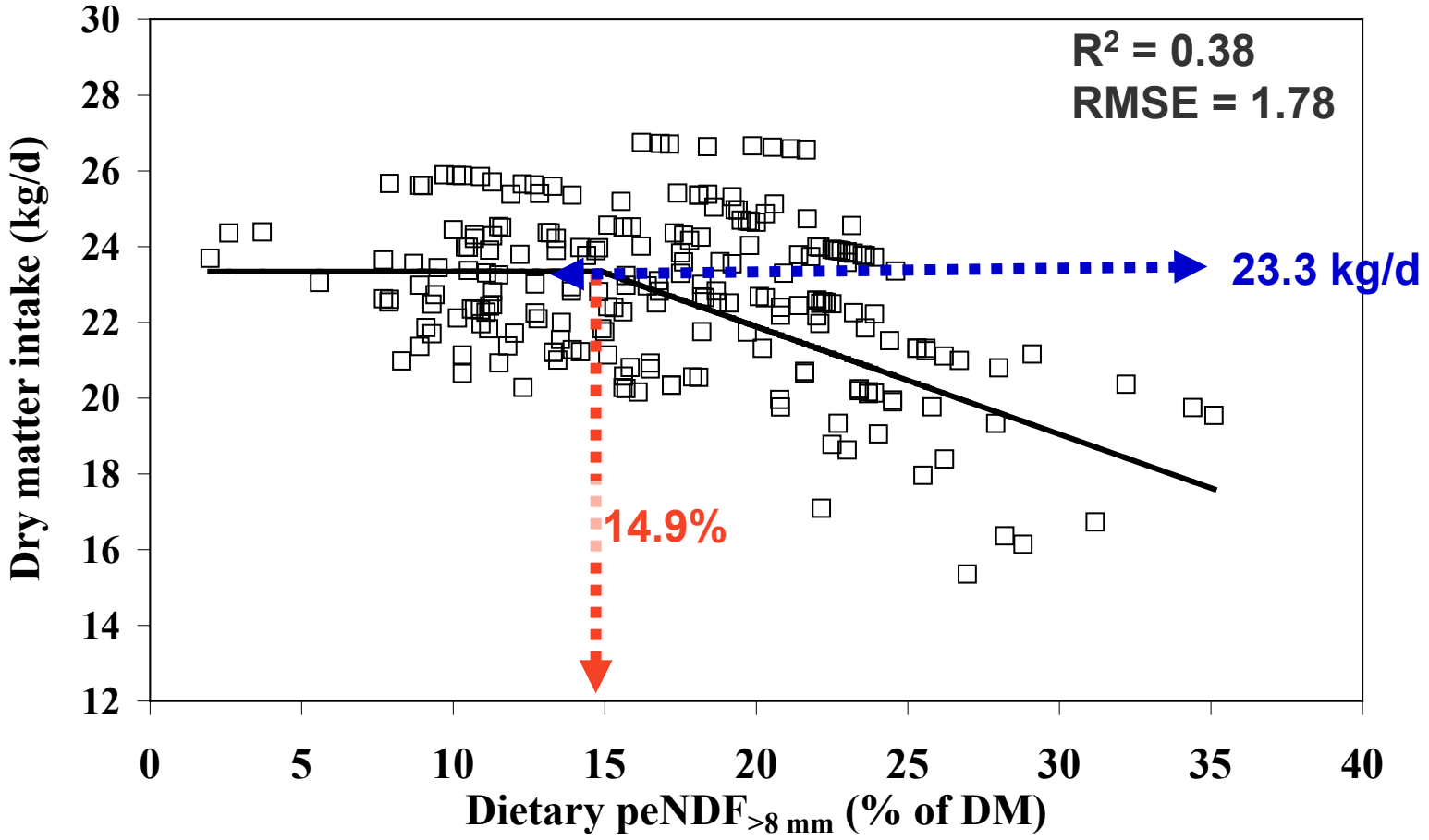
Concentrates

- Good source
  - Starch/“safe„ energy (grains)
  - Valuable protein (rumen undegradable protein, RUP)
    - Protein concentrates (e.g. soybean meal)
  - Digestible fiber (by-products)
  - Native minerals (P, various trace elements)
  - Mineral-vitamins (Premix feed)
- Disadvantages
  - Low in physically effective fiber
  - Rapidly fermentable
    - (unhealthy for ruminants/herbivores!!)

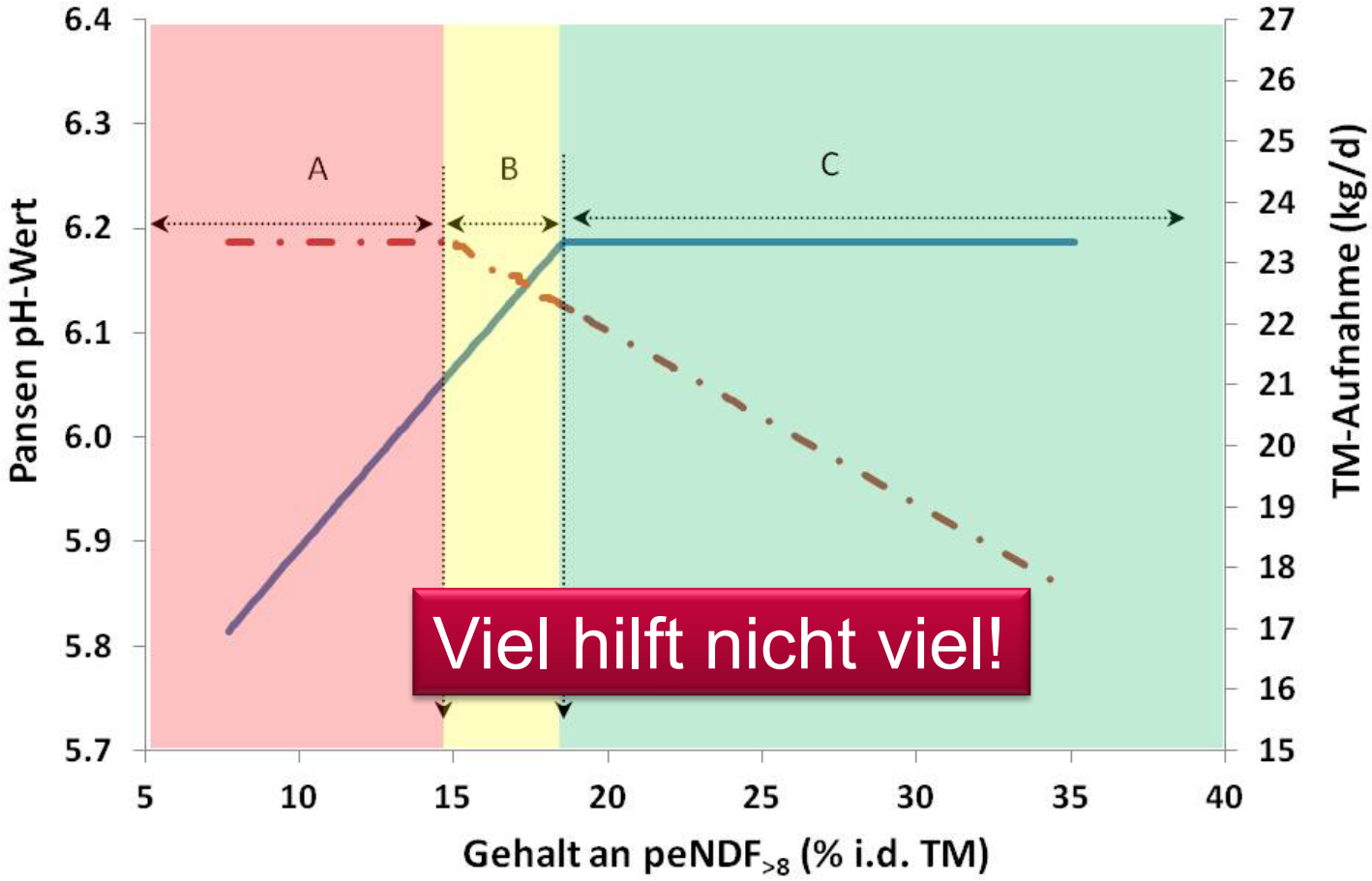




Zu viel peNDF senkt die Futteraufnahme!



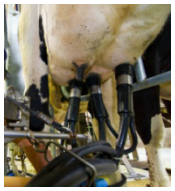
Wie viel peNDF in der Ration letztendlich?



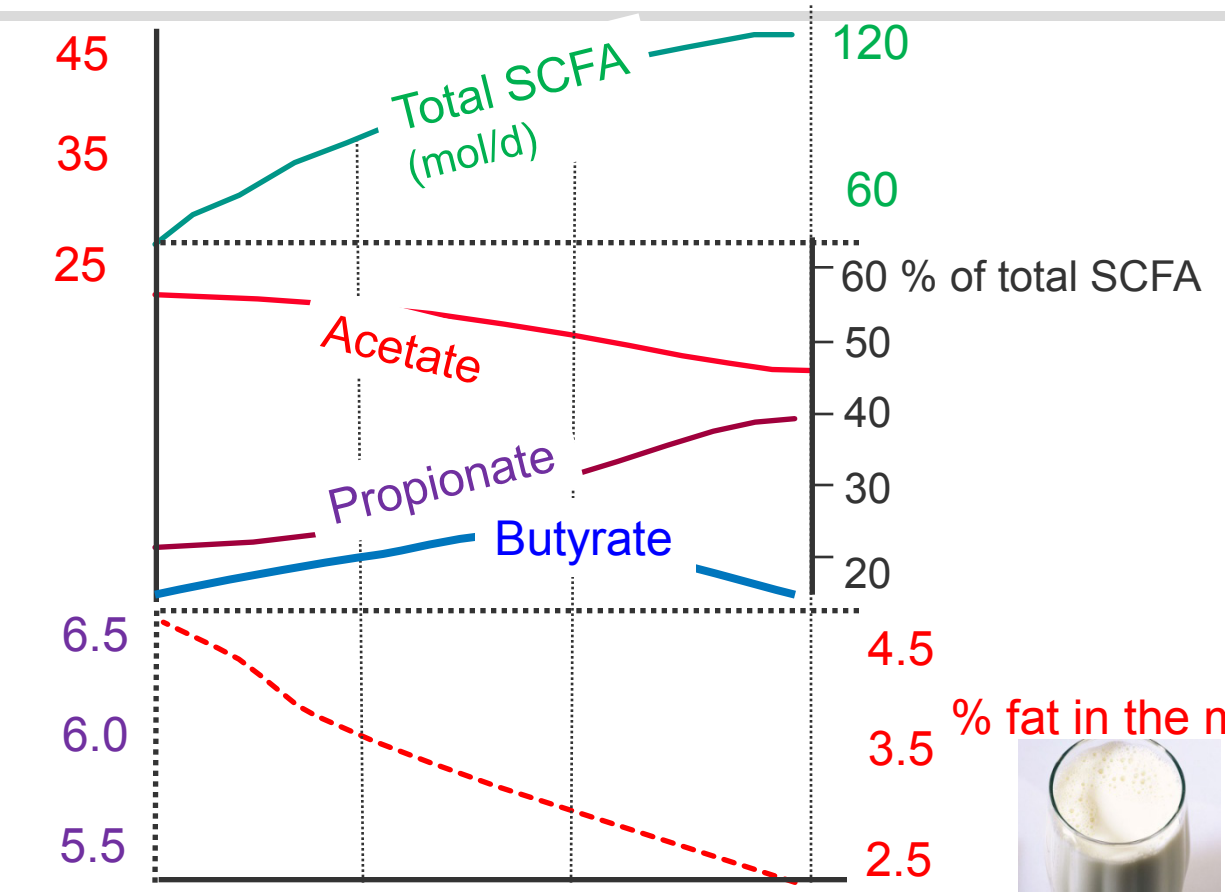
pH-Wert (—) TM-Aufnahme (--)

Main digestive disorders

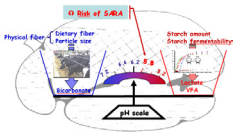
Feeding, fermentation profile in the rumen & milk



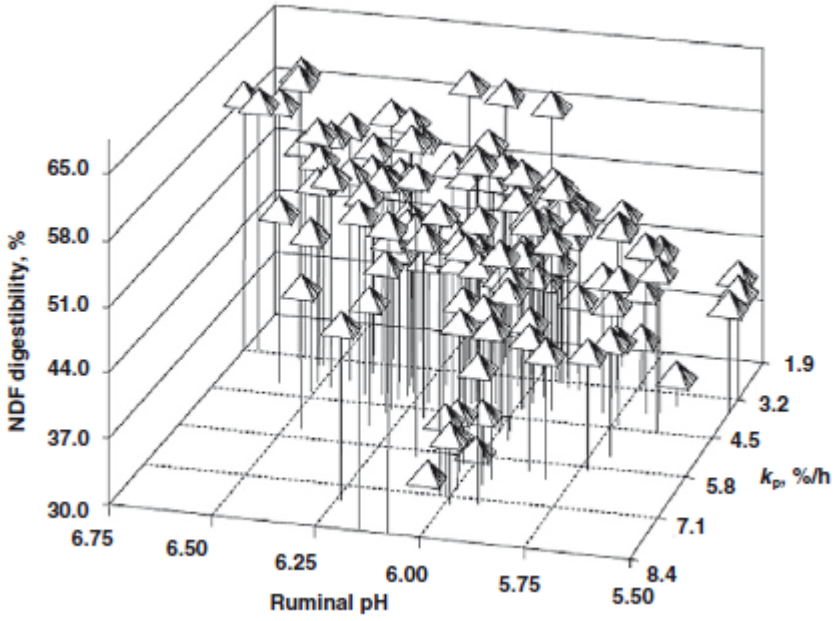
Milk yield

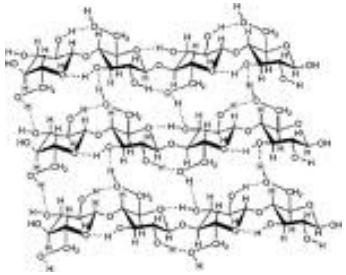


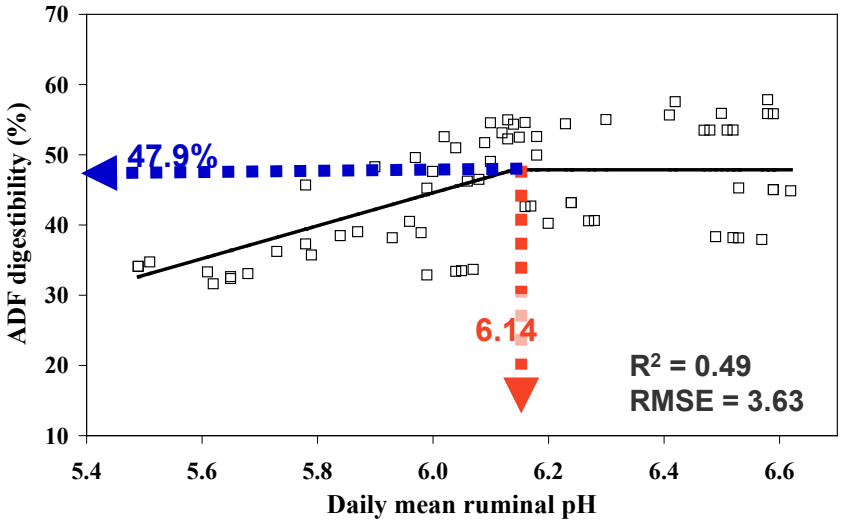
Concentrate	20%	50%	70%
Forage	80%	50%	30%



Optimal ruminal pH = high fiber degradation

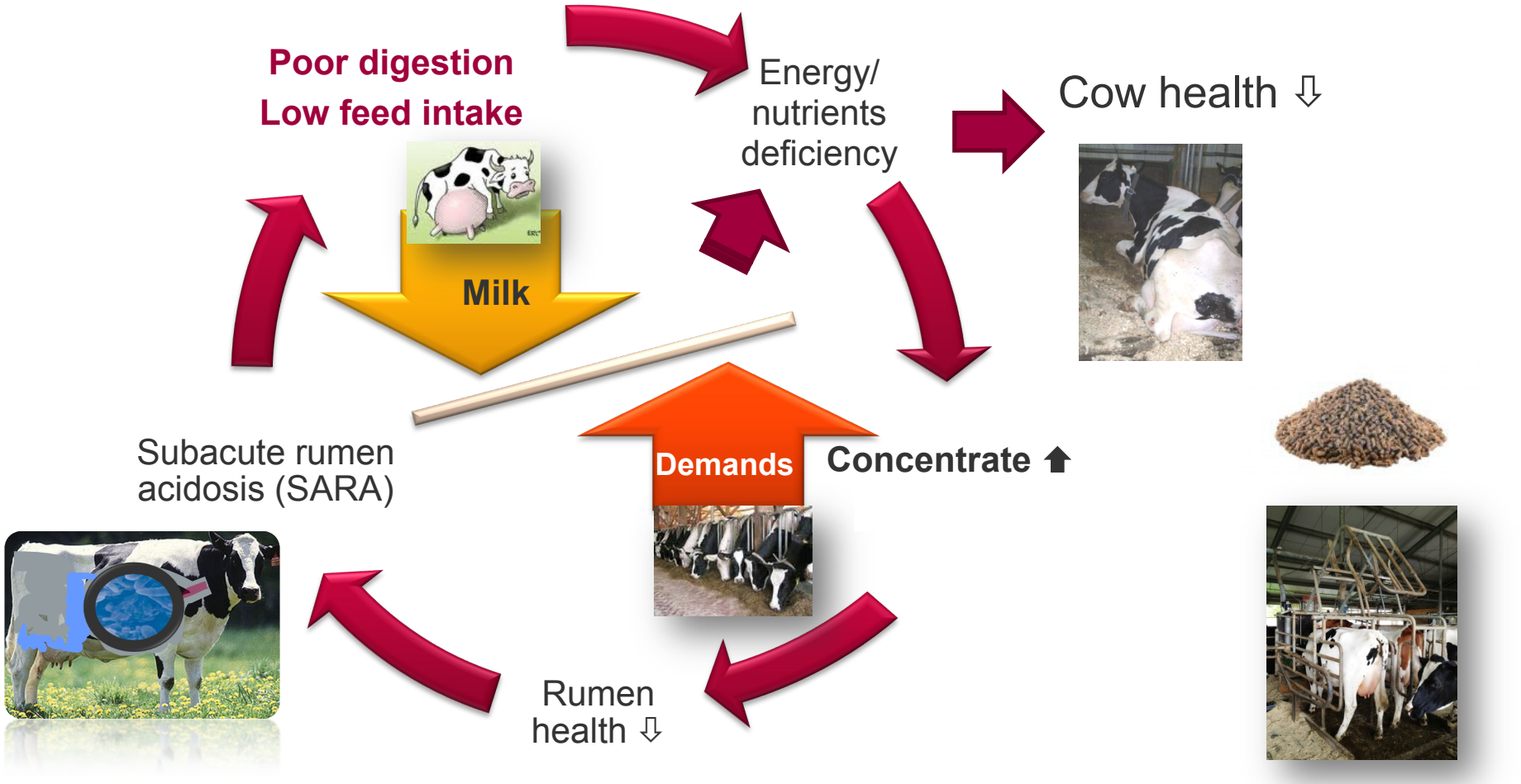




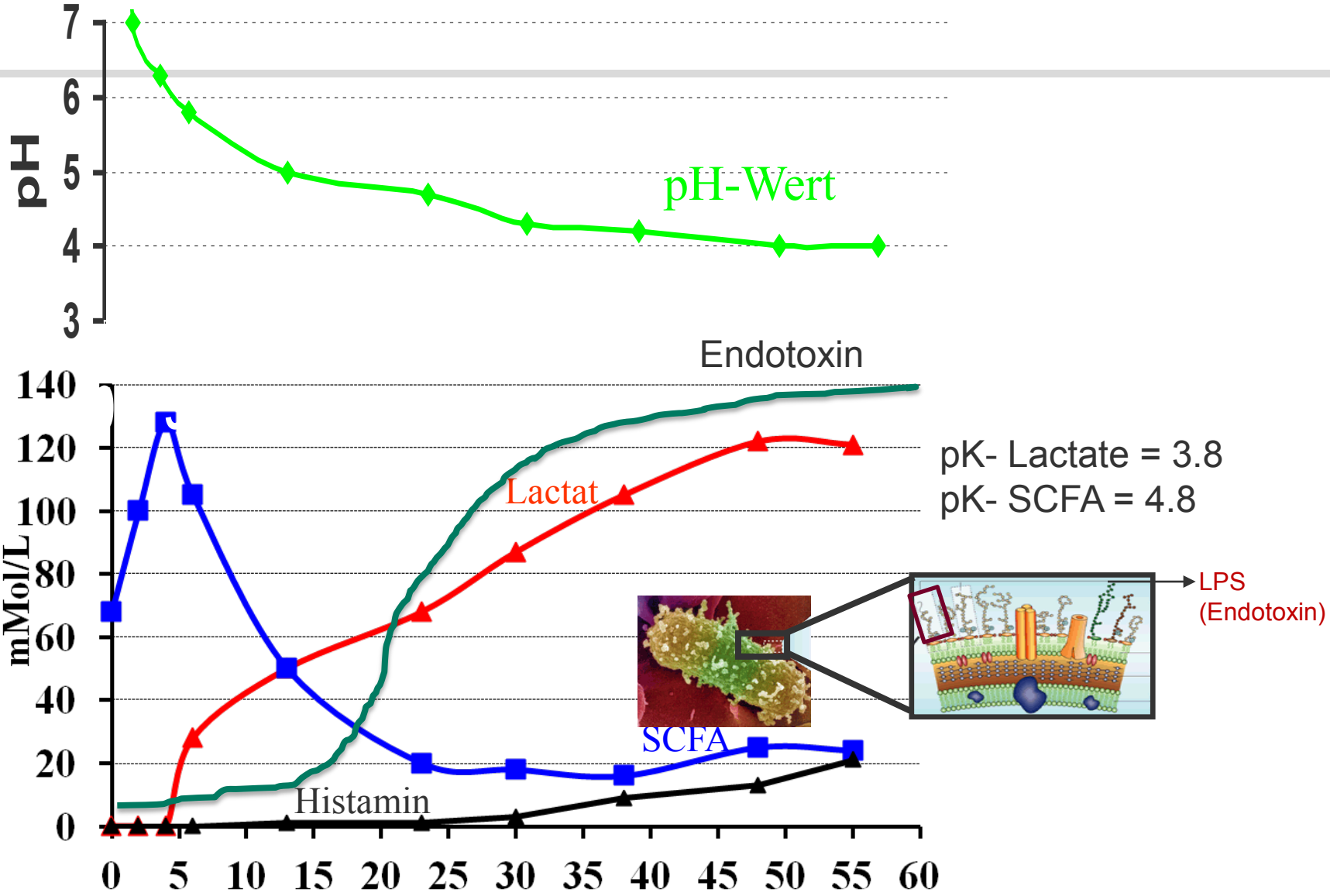


Zebeli et al. 2010

Nutrient deficiency and the „vicious circle“

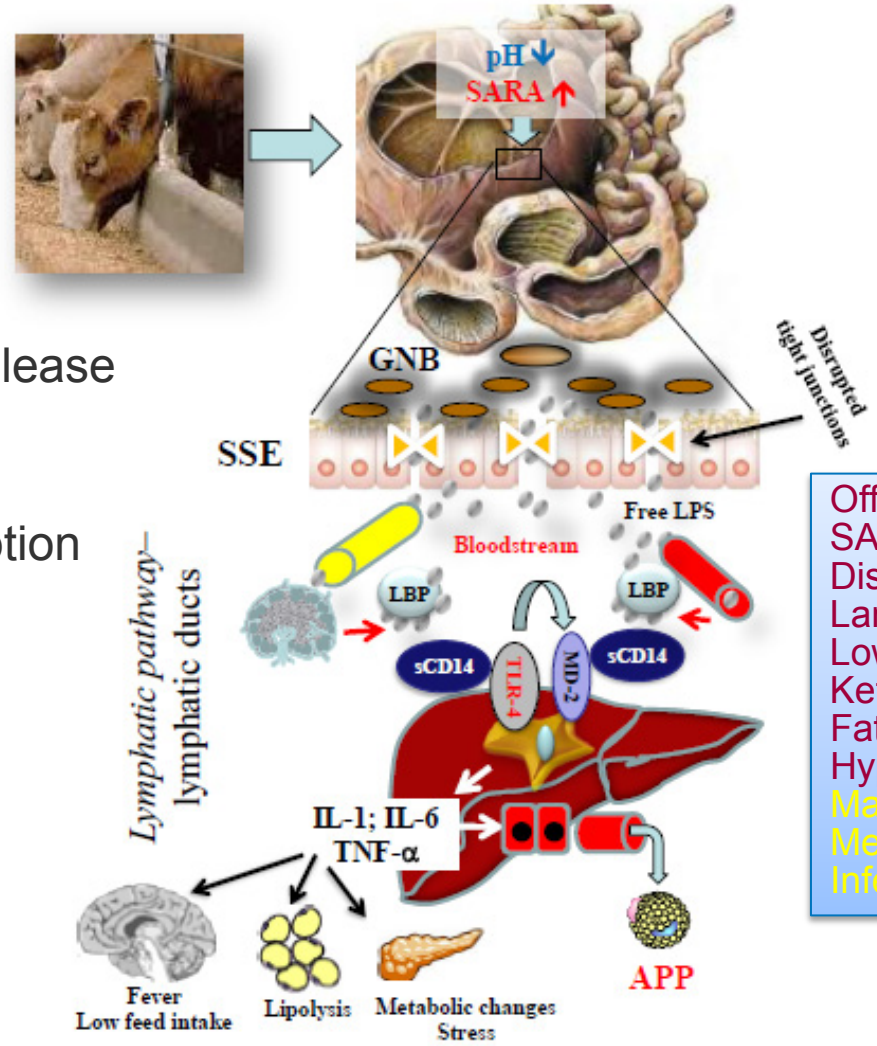


Low rumen health syndrome



Low rumen health – not only a local problem of the rumen

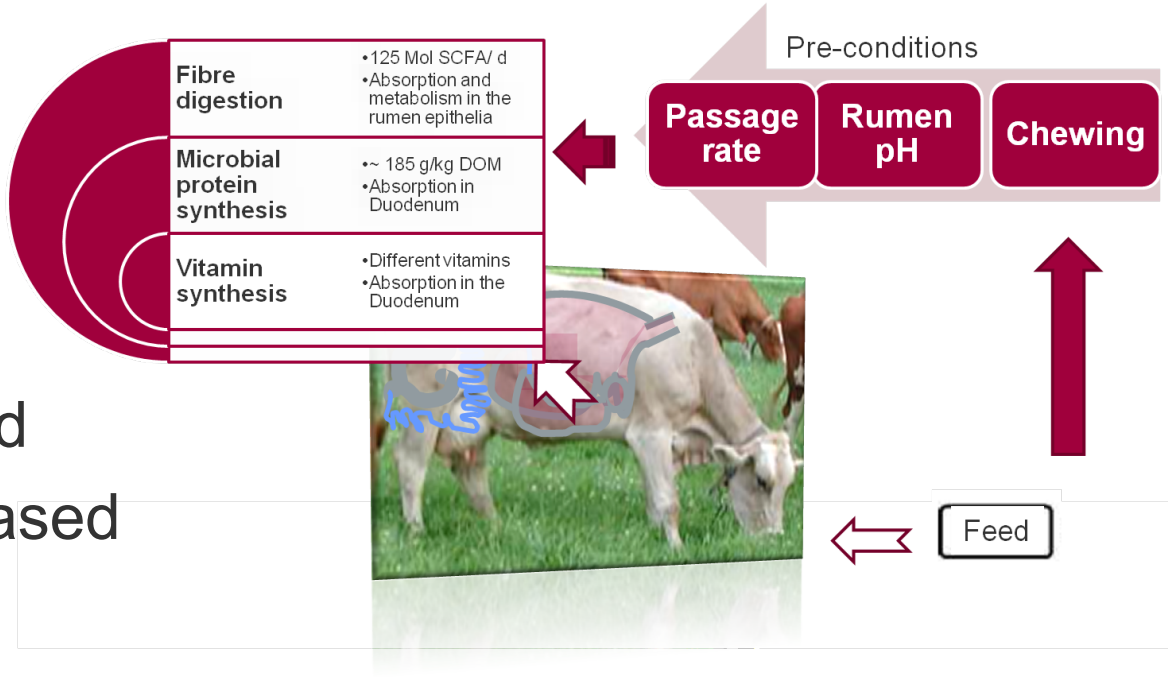
1. Dysbiosis/ endotoxin release
2. Epithelial barrier disruption
3. Inflammation (immune activation)
4. Metabolic disturbances



Off-feed
SARA
Displaced abomasum
Laminitis
Low milk fat syndrome
Ketosis
Fatty liver syndrome
Hypocalcemia
Mastitis
Metritis
Infertility

Zebeli & Metzler-Zebeli 2012. Res. Vet. Sci.

Low rumen health: consequences for health



- If rumen is disturbed
- Passage rate increased

- Lowered nutrient degradation (Lowered feeding value)
- Undesirable substances (mycotoxins) may not be fully degraded
- Antinutritive factors (Phytate, glucosinolate) may also not be optimally degraded

Forage quality/hygiene becomes highly important

Molded silage/feed should not be fed!

Conclusion

- Feeding enough structure means:
  - peNDF of the diet
  - Starch amount
  - Feeding management (selection and adaptation)
- It is worthy to take care about the structure!