Nutritional aspects of the fatty liver syndrome in dairy cows

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Residency class 2015

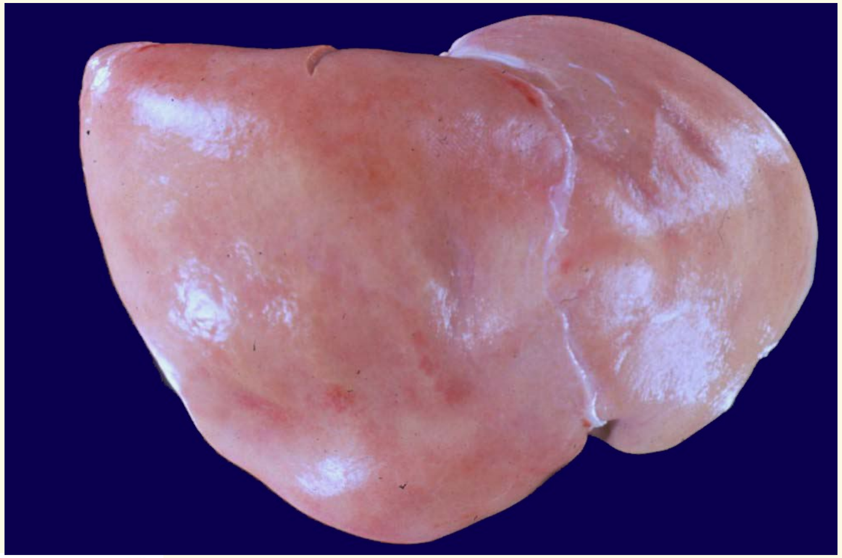
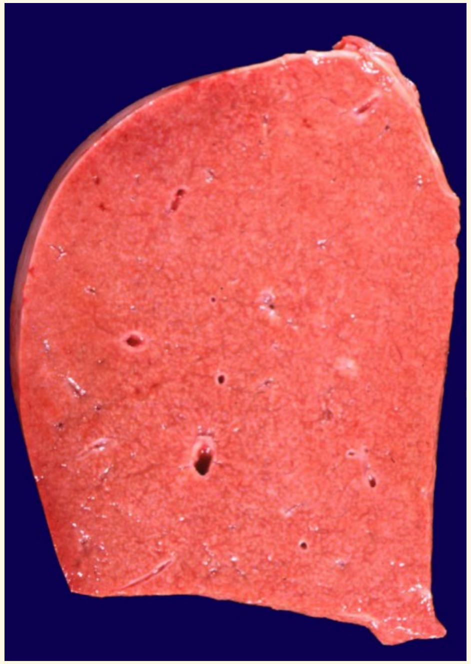
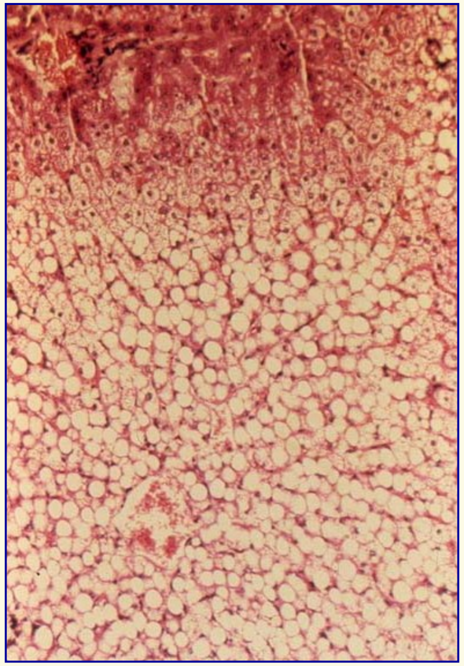
September 15th- 16th

Toulouse

Fatty liver syndrome (1)

- Fatty liver syndrome is metabolic disorder that result from intense fat mobilization during hormonal changes and negative energy balance associated with the transition period.

- The liver is an important metabolic organ. It plays a central role in controlling energy metabolism, hormonal status, detoxification of harmful compounds, immune responsiveness and reproductive function. Livers can become engorged with fat when there is an increase in the uptake of fatty acids from blood.

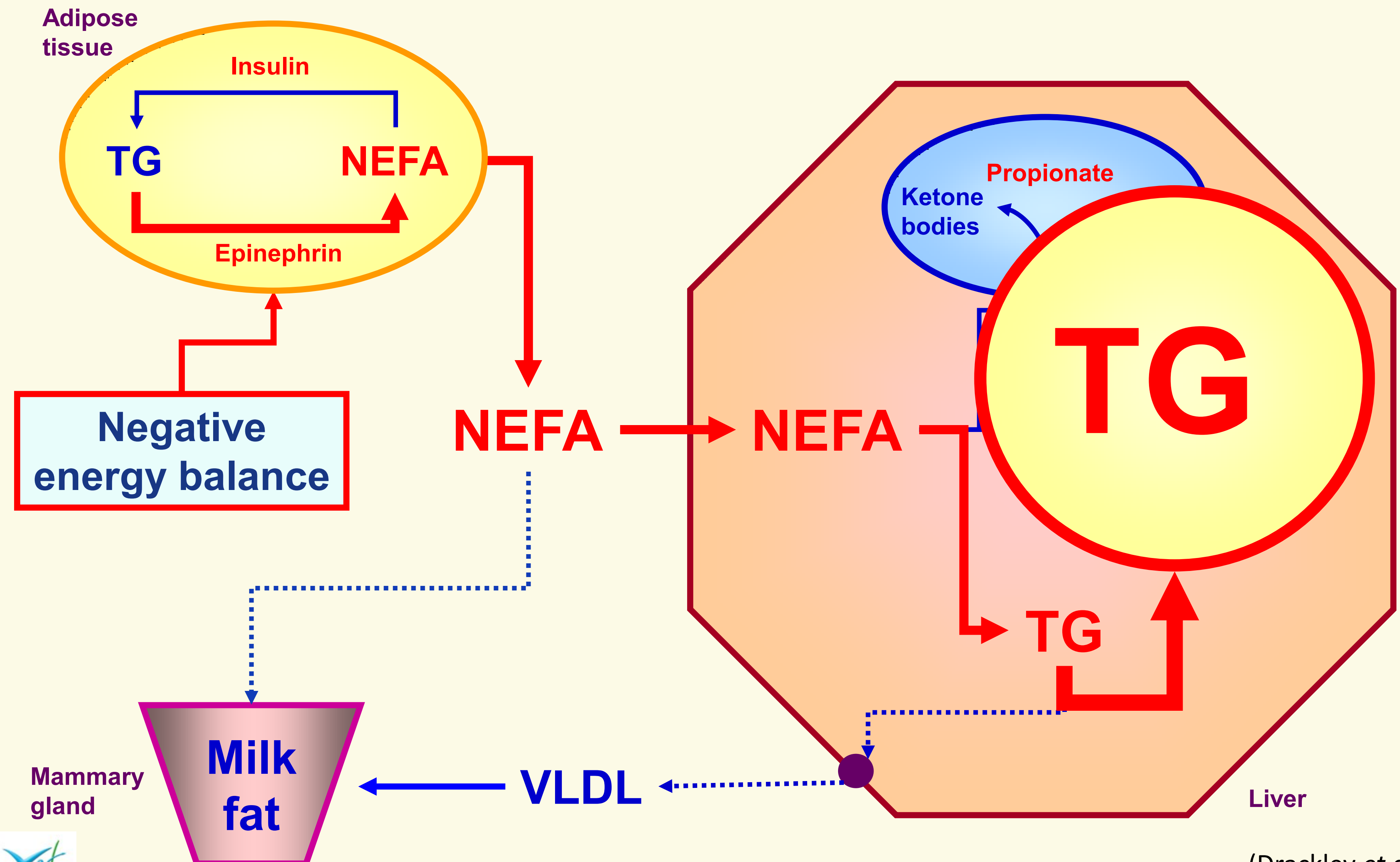




Fatty liver syndrome (2)

- Meeting the nutritional and metabolic needs of the dairy cow during the transition to lactation is a great challenge for optimal health and lactation performance.
- Fatty liver arises in response to various nutritional, hormonal, or toxic effects, but has mainly been reported as a physiological or pathological situation resulting from an excessive mobilization of fat.
- Fat infiltration occurs prior to and mainly during calving.
- More than 50% of multiparous dairy cows would experience fatty liver at calving.
- An excessive infiltration has been associated with increased incidence of mastitis, displaced abomasum, retained placenta, metritis, poor reproductive performance, and immune suppression.
- Cows with fatty liver are also more prone to develop ketosis and suffer production losses.

(Veenhuizen *et al*., 1991; Bobe *et al.*, 2004; Gonzalez *et al*., 2011; Zom, *et al*. 2011; Goselink *et al.* 2012; Grummer, 2013)

Relationships among lipid metabolism in adipose tissue, liver, and mammary gland



(Drackley *et al.* 1999)

Main physiological hormone changes occuring in early lactation

↓ **insulin**

↑ **somatotropin**

↓ **IGF-I**

↑ **prolactin**

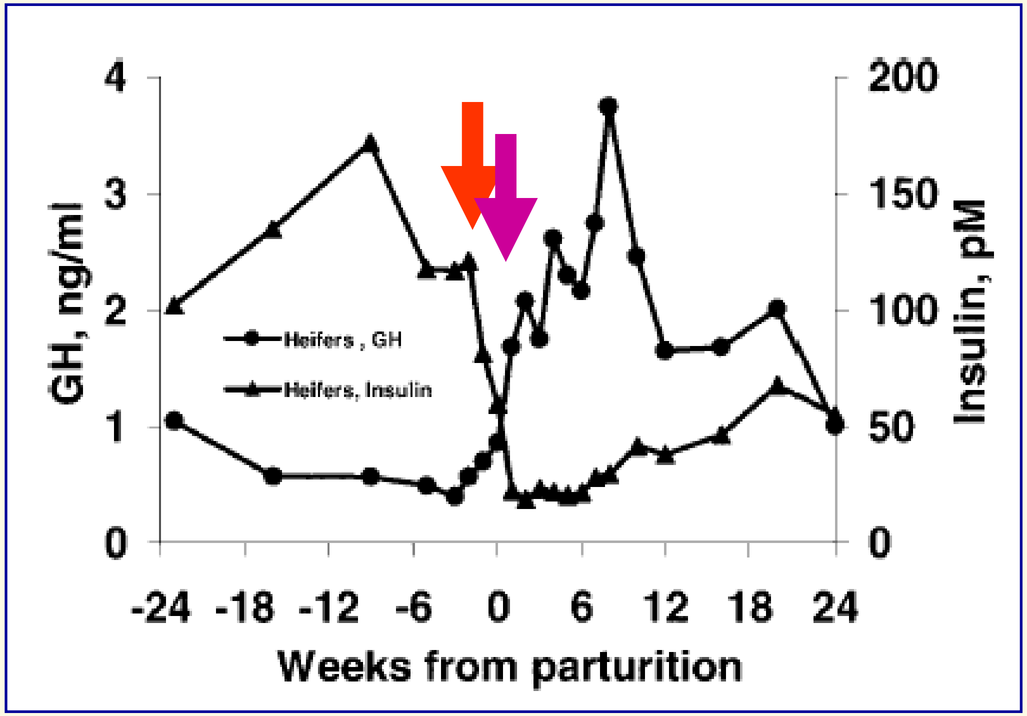
↑ **glucocorticoids**

↓ **thyroid hormones**

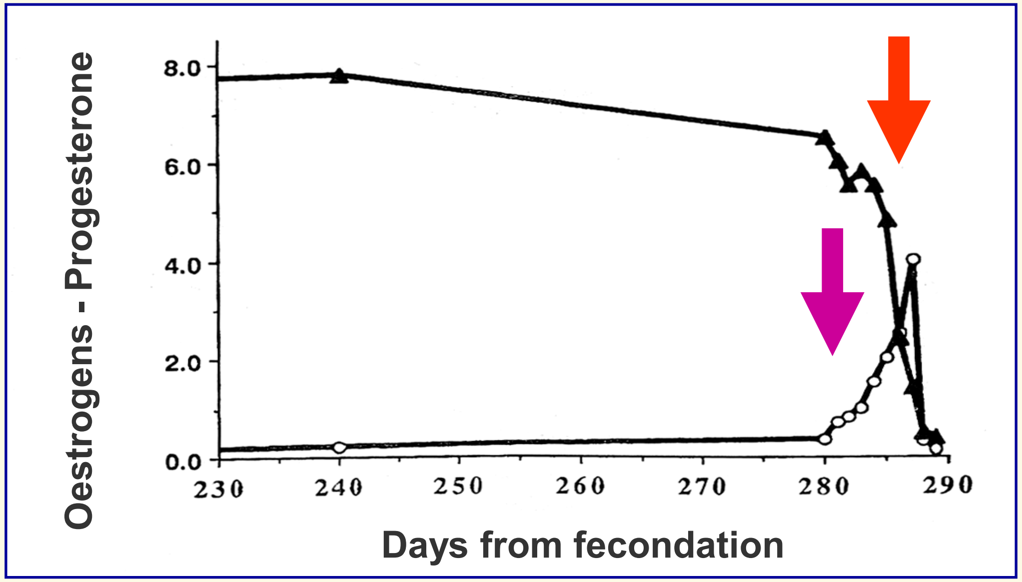
✓All these changes are related to the new metabolic status of the cow.

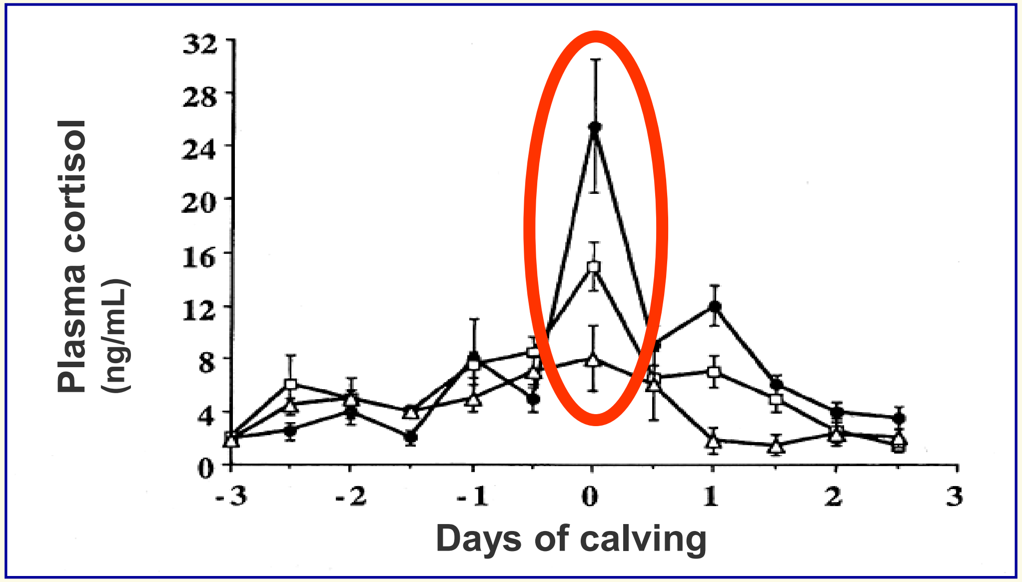
✓At the same time

- the mammary tissue develops,
- and food intake increases as well as food utilization.



(Ingvartsen and Andersen 2000)

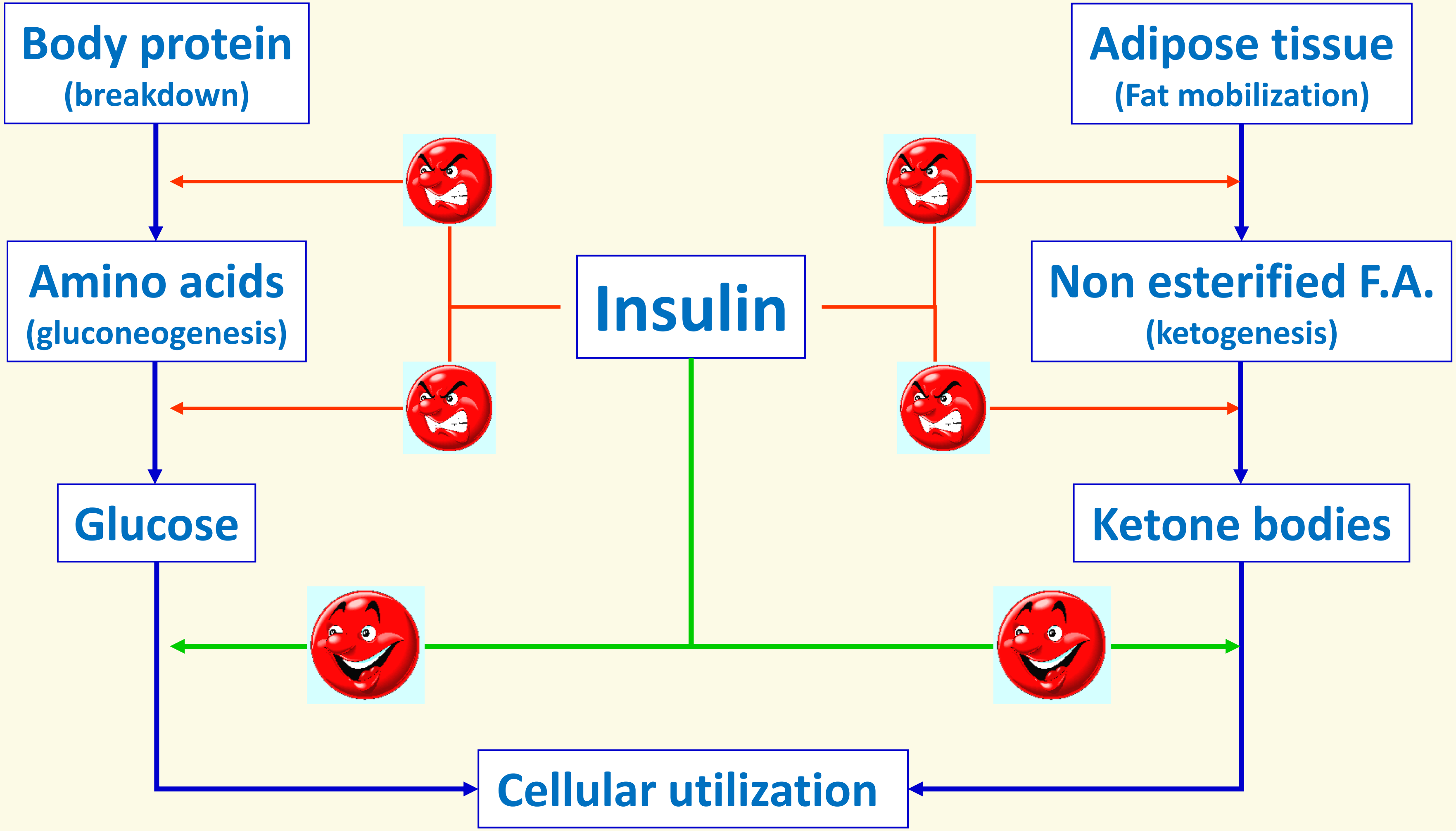




(Horst and Jorgensen 1982)

Cortisol & calcemia in paretic, non paretic, and borderline dairy cows

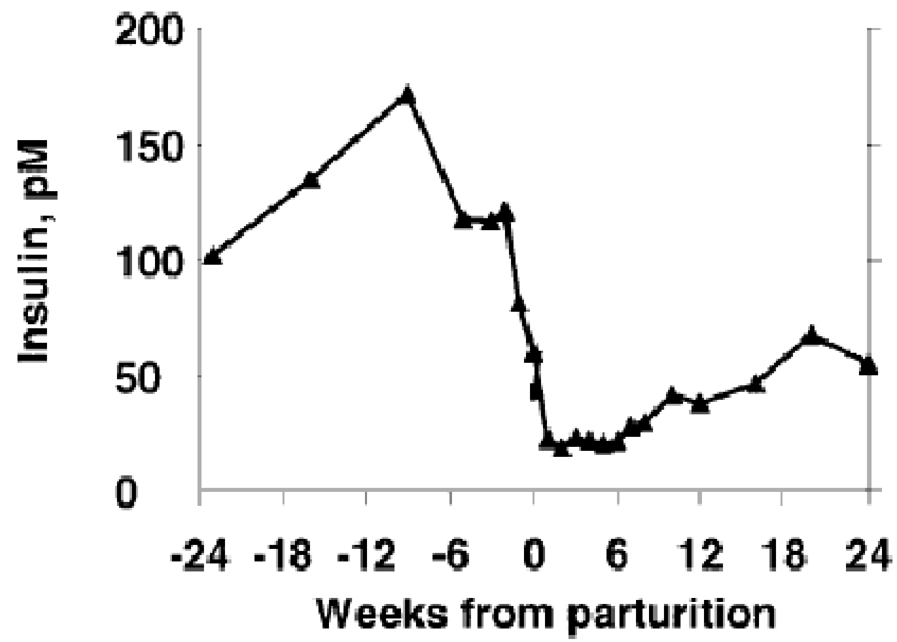
Insulin : main regulatory functions on nutrient utilization



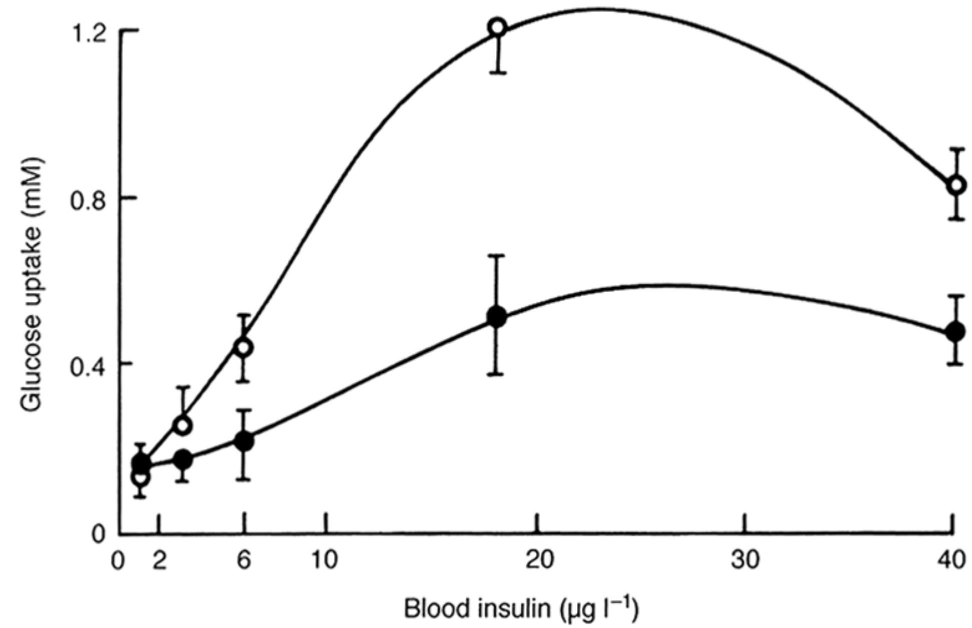
Temporarily, all anabolic and anti catabolic effects of insulin are suppressed

This leads to a major reduction in triglyceride synthesis, and predisposes to lipolysis through attenuation of the antilipolytic effect of insulin.

Plasma insulin - Insulin sensitivity - Consequences



Serum concentration of insulin during the periparturient period in heifers
(Ingvartsen and Andersen 2000)



Effect of insulin on the arterio-venous difference for glucose across the hindlimb of non-lactating sheep (○) and lactating sheep (●)
(Vernon *et al.*, 1990)

Main physiological adaptations occuring in early lactation (Bauman 2000)

Increased output

Mammary tissue
- ⬆ number of secretory cells
- ⬆ supply of blood
- ⬆ nutrient use

Increased input

Food intake
- ⬆ quantity

Digestive tract
- ⬆ size
- ⬆ absorptive capacity
- ⬆ rates of nutrient absorption

Main physiological adaptations occuring in early lactation (Bauman 2000)

Increased synthesis and redistribution of nutrients

Liver

Anabolic activity dramatically increases

- ⬆ gluconeogenesis
- ⬆ glycogen mobilization
- ⬆ protein synthesis

Oriented nutrient release:

Adipose tissue

- ⬆ lipolysis
- ⬇ fatty acid uptake and synthesis

Skeletal muscle

- ⬇ glucose utilization
- protein ➡ degradation ⬆ synthesis ⬇

Bone

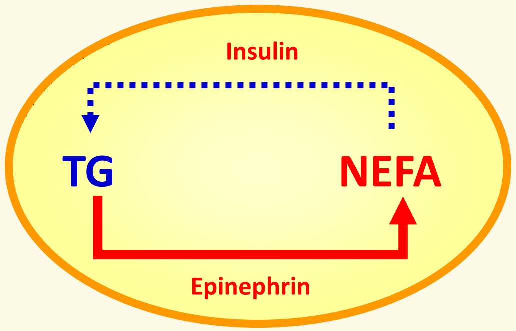
- ⬆ mobilization of Ca and P

All these changes contribute to sustain mammary function and export

Body condition at calving

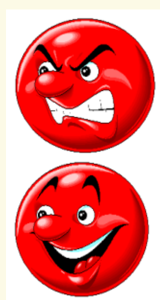
↑ BC ➡ ↑ Fat stores

↑ Stores ➡ ↑ Mobilization



↑ Energy intake

↑ Protein intake



- An excessive **body condition** at calving is a predisposing factor to fat release and fatty liver.
- The more the **fat cow** has lipid stores the more it releases fatty acids when nutritional and hormonal conditions favor lipolysis.
- **High energy level** in diets given prior to calving induce a more important weight gain and then weight loss, higher plasma non-esterified fatty acid levels, and higher hepatic lipid infiltration in early lactation.
- The effect of energy intake prior to calving can be modulated by **protein availability**.
Increasing the protein level by 15 % (that is from 14 to 16 % in the diet) allowed to a decrease in fat infiltration by up to two-thirds.

(Zom *et al.* 2011; Goselink *et al.* 2012; Grummer, 2013)

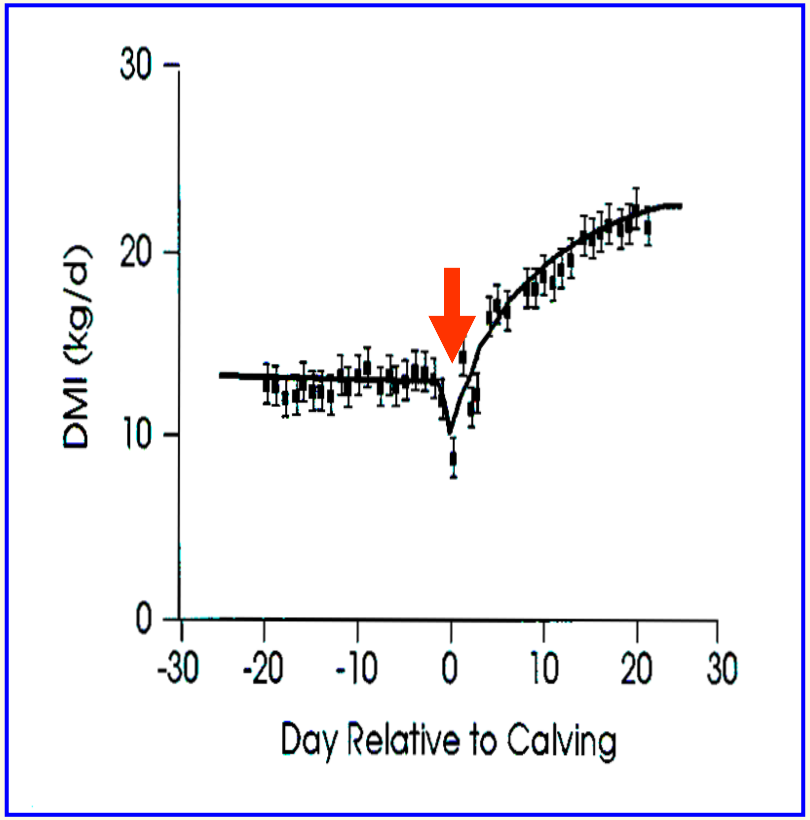
Body condition at calving

Excess body condition and important weight loss predispose strongly to fatty liver

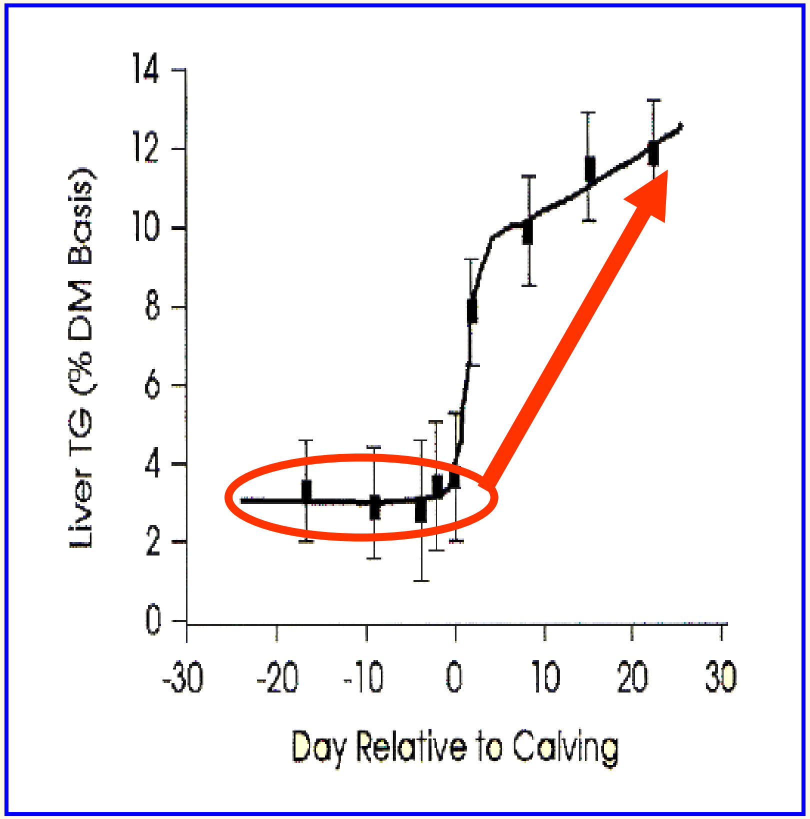
Too fat ➡ risk of diseases ⬆

Too lean ➡ production ⬇

Food intake and hepatic infiltration



Dry matter intake around parturition in dairy cows
(Vasquez-Anon *et al.* 1994)



Changes in liver T.G. around parturition in dairy cows
(Vasquez-Anon *et al.* 1994)

Intake level decrease by **30%** within the 2 last weeks prior to calving, which is responsible for fat mobilization.
Two weeks before calving, hepatic lipid level is approximately 5%. The day after calving, it reaches up to 10 to 15% in 3 cows out of 4.

(Zom, *et al.* 2011; Grummer, 2013)

Hepatic lipid metabolism: main ways

Liver lipid

1

Fatty acid oxidation:
Carnitine and mitochondrial oxidation,

2

Lipoprotein export / proteins:
apolipoprotein B100, MTP… and synthesis of VLDL

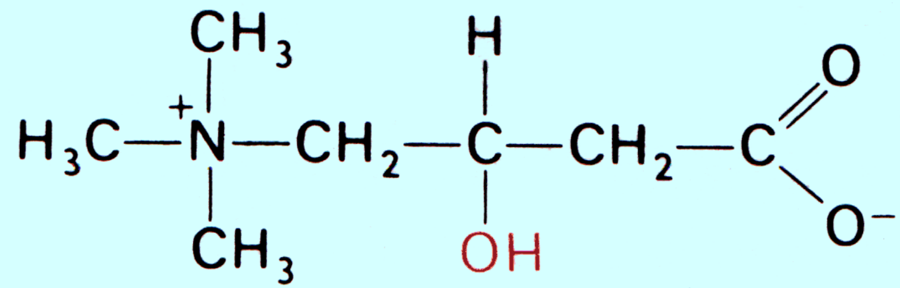
3

Lipoprotein export / lipotropics:
methionine, choline…
as precursors in protein or phospholipid synthesis

Carnitine and mitochondrial oxidation

•**Carnitine is an important key factor in liver fatty acid oxidation**

•Carnitine is able to **modulate the intracellular concentrations of free- and acyl-Coenzyme A.**



Carnitine

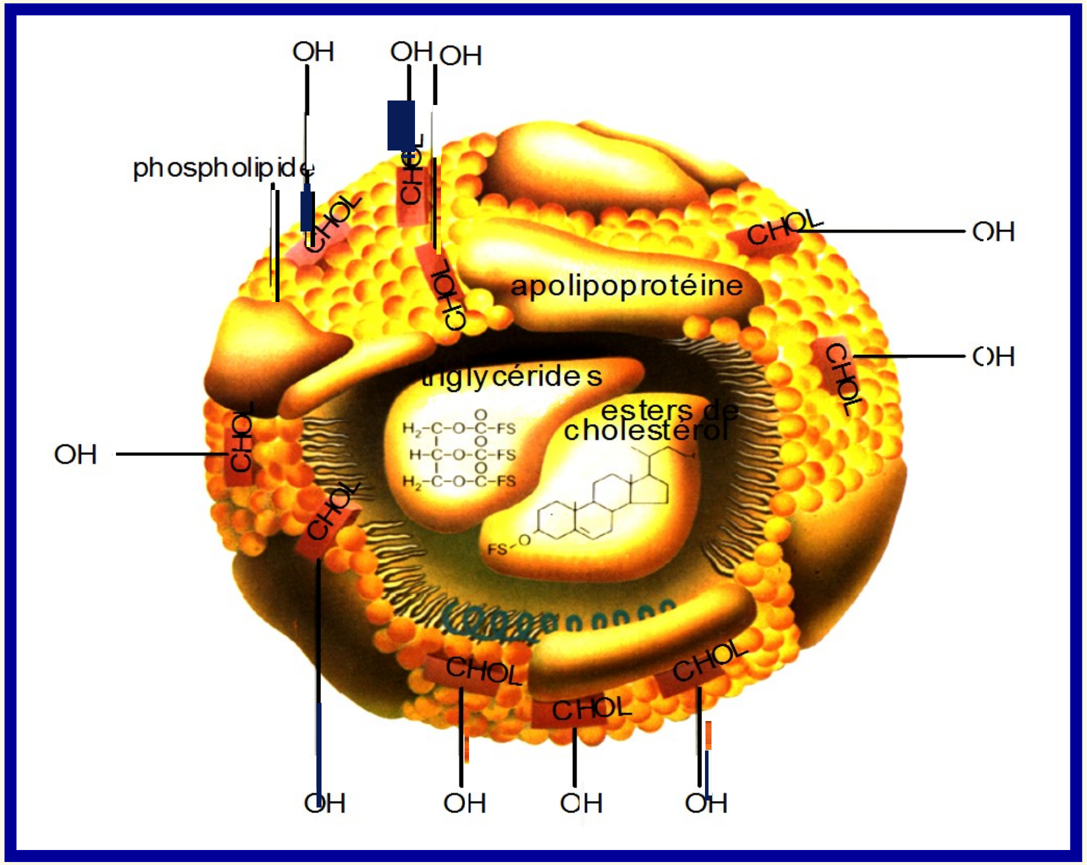
Carnitine is bio-synthetized from lysine and méthionine

Carnitine is a required cofactor for carnitine palmitoyltransferase-I **, which condenses**
Carnitine with activated long-chain fatty acids (LCFA) **for transport from cytosol into mitochondria;**

therefore, carnitine is essential **for mitochondrial β-oxidation of LCFA (lower in ruminants compared to non-ruminants.**
Hepatic β-oxidation of LCFA is stimulated by exogenous carnitine in several species.

(Owen *et al.*, 2001; Spaniol *et al.*, 2003; Carlson *et al.*, 2007; Goselink *et al.*, 2012)

Triglyceride export : Very low density lipoprotein (VLDL)



VLDL
size, structure and composition

300-800 Å

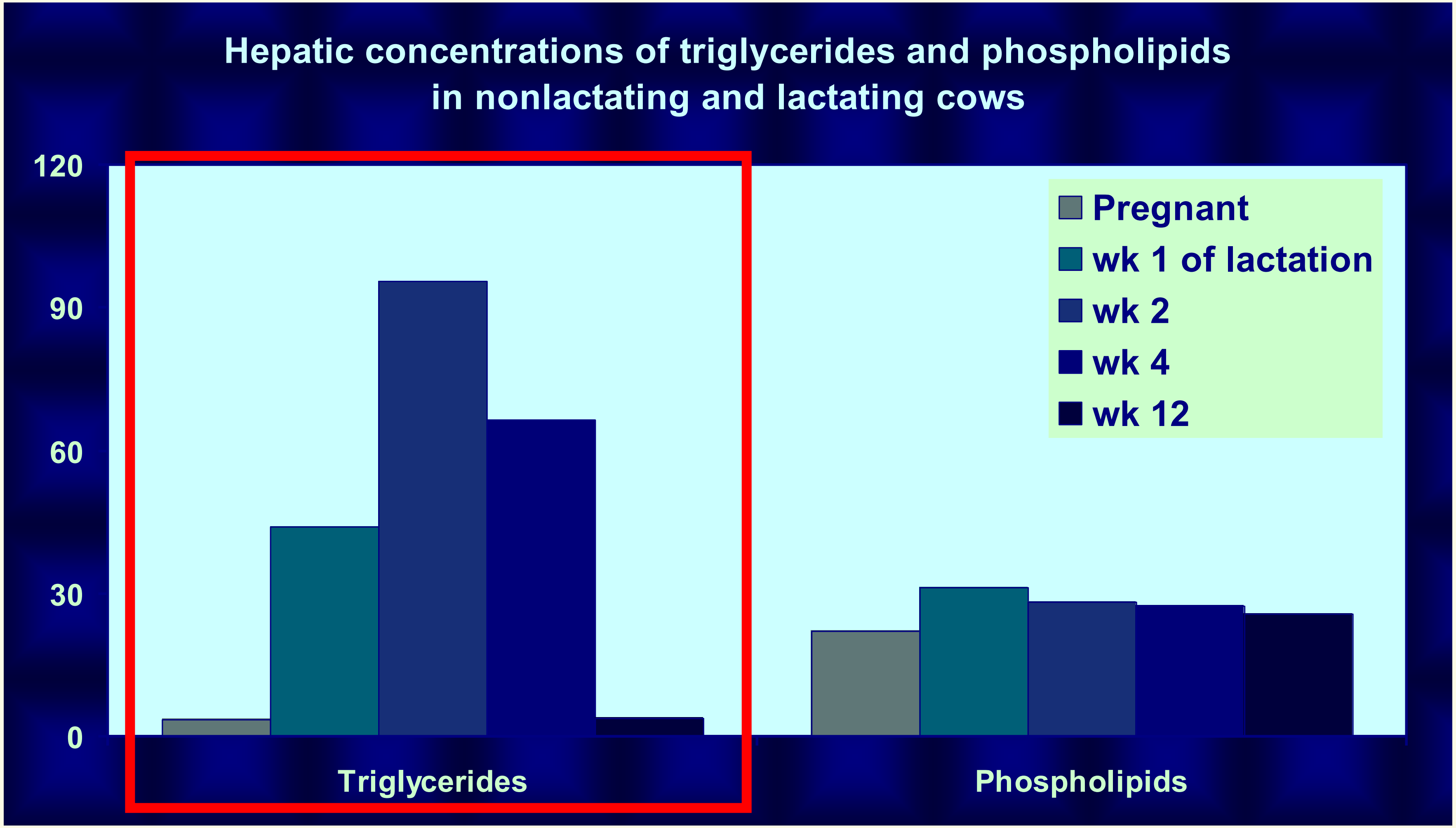
Apo B100, C-III, C-II, E

50-60 %	**Triglycerides**
14-22 %	**Cholesterol**
12-20 %	**Phospholipids**

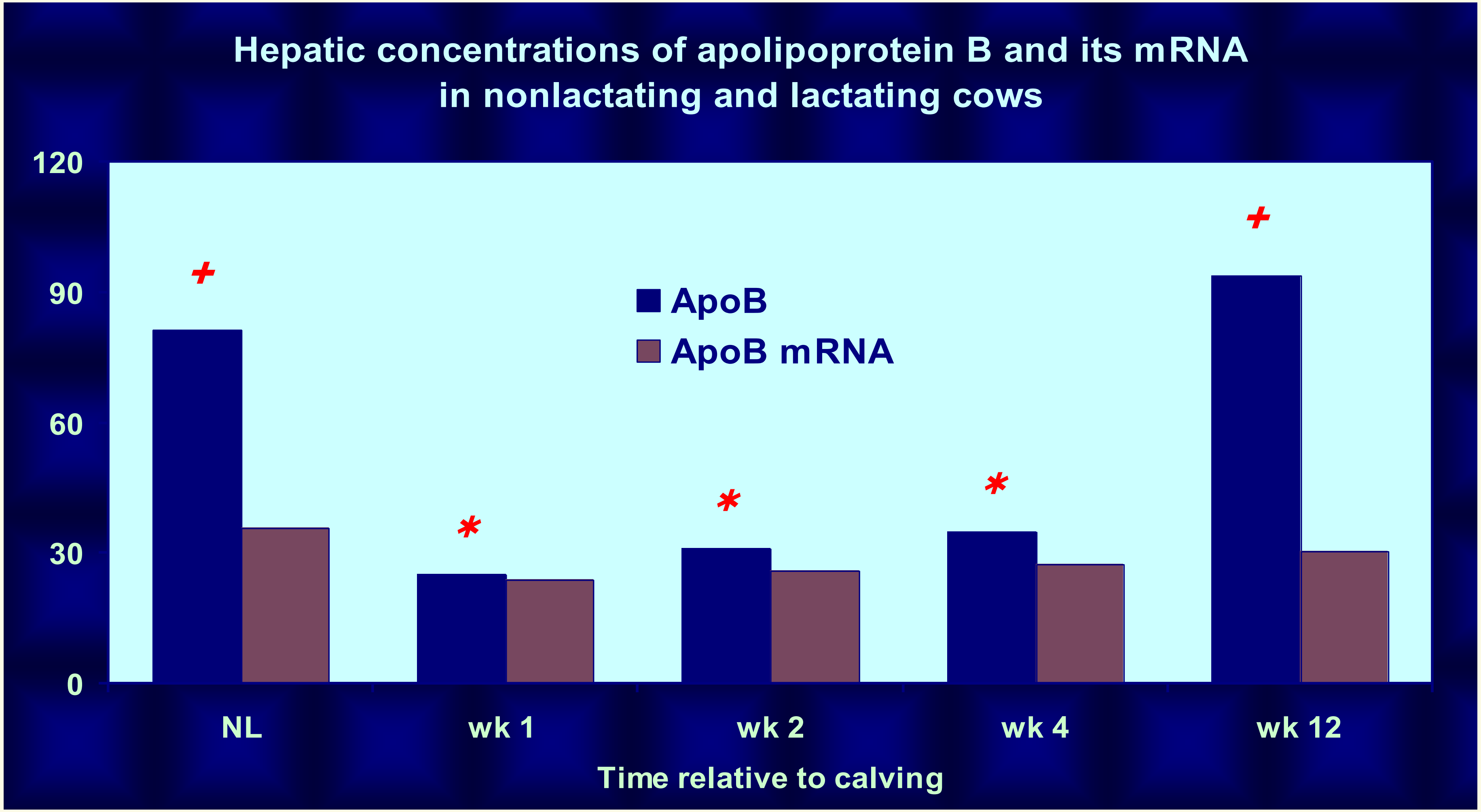
- **Low ability of ruminant liver to export triglycerides as part of VLDL : contribute to fatty liver**

- Two proteins play a major role in VLDL synthesis:
  - apolipoprotein B100 that is its main constitutive protein
  - and microsomal triglyceride transfer protein, which is needed for its assembly.

Liver apolipoprotein B100 in early lactation (Gruffat et al. 1997)



Liver apolipoprotein B100 in early lactation (Gruffat et al. 1997)



Microsomal triglyceride transfer protein inhibitors

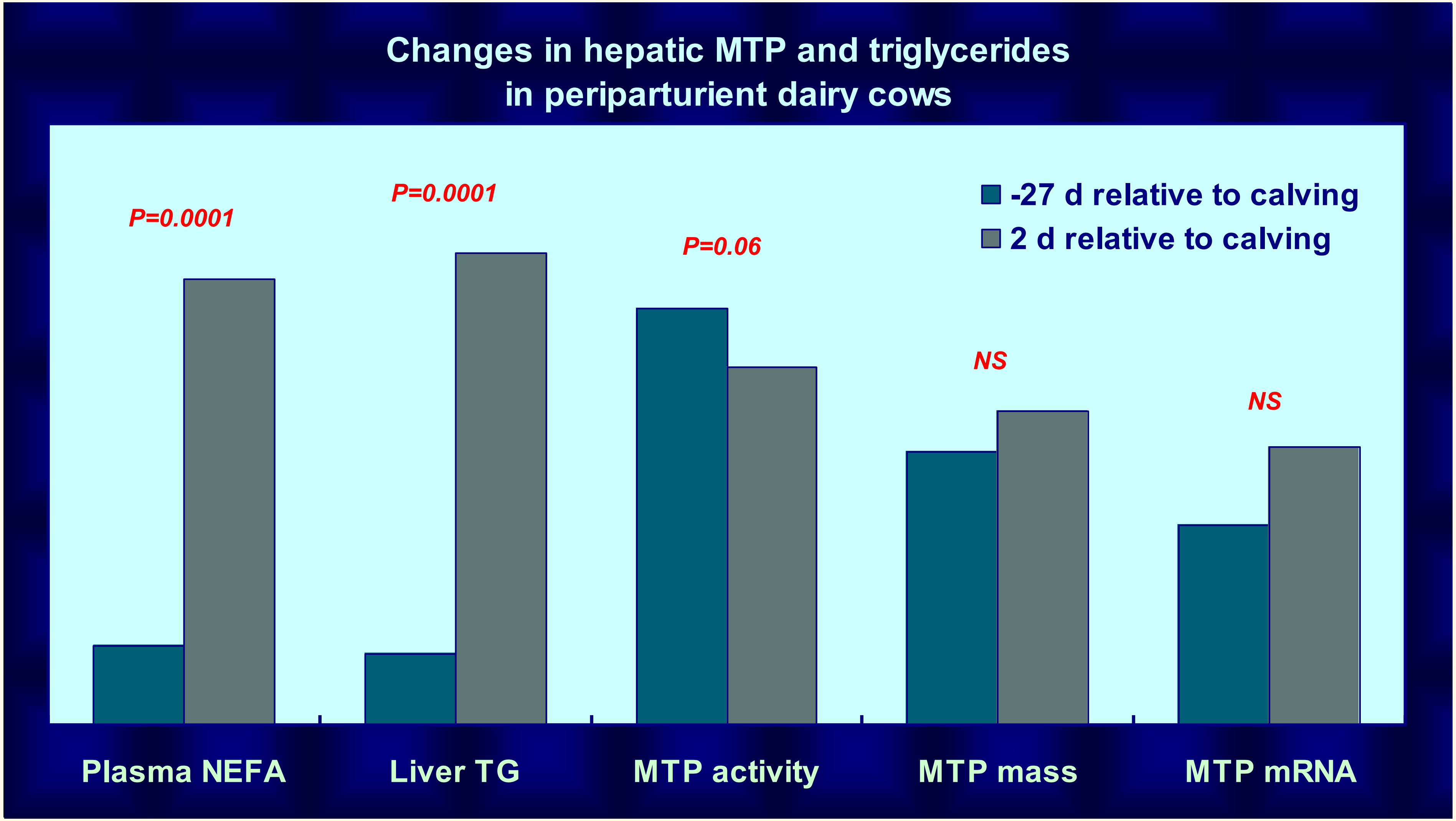
- MTP inhibitors have been tested for their potential role in the treatment of cardiovascular diseases

  - ✓ Block hepatic secretion of very low density lipoproteins (VLDL) and intestinal secretion of chylomicrons.
  - ✓ Lower low density lipoprotein (LDL) cholesterol and reduce postprandial lipemia.
  - ➡ Benefit in the treatment of atherosclerosis and consequent cardiovascular disease.

- Main adverse effect:

  The blockage of hepatic lipid secretion leads to fatty liver

Changes in hepatic microsomal triglyceride transfer protein and triglycerides in periparturient dairy cows (Bremmer et al. 2000)



(Bremmer *et al.* 2000; Goselink *et al.* 2012)

DL-methionine

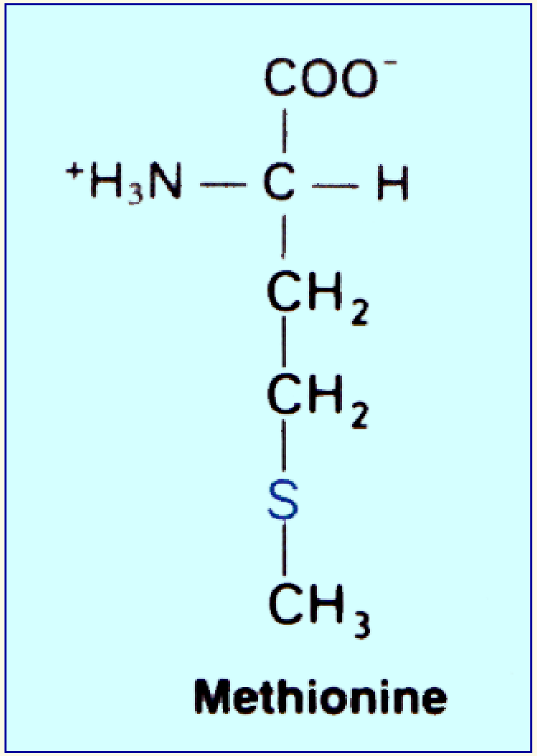
Among amino acids methionine plays a major role.

✓The limiting factor of **protein synthesis** in most dietary situations.
It could therefore limit

- protein synthesis (apolipoproteins…)
- carnitine synthesis (Met + Lys)

✓Its specific role as **lipotropic factor** has also been suggested:

- as other methyl group donor,
- it contributes to synthesis of phospholipids that are needed for VLDL assembly



Homocysteine → Methionine → Homocysteine / Vitamin B12, Folates

(Shibano et Kawamura, 2006; Goselink *et al*. 2012; Grummer, 2013)

L-methionine infusion – DL-methionine oral administration

- Intravenous infusions of L-methionine
  - ⬇ ketone body formation
  - ⬆ hepatic gluconeogenesis
  - ⬆ secretion of VLDL
  - ⬇ fatty acid infiltration
- Dietary supplements of DL-methionine
  - ➡ same effects

(Shibano et Kawamura, 2006)

Choline

Choline is crucial for normal function of all cells. …

Lipotropic effect : It is a precursor of phospholipids

Phospholipids (PC), are components of all cell membranes and lipoproteins that function to transport lipids through the circulatory system.

$$HO—CH_2—CH_2—\overset{+}{N}(CH_3)_3$$

Choline

Produced in the body by methylation ethanolamine

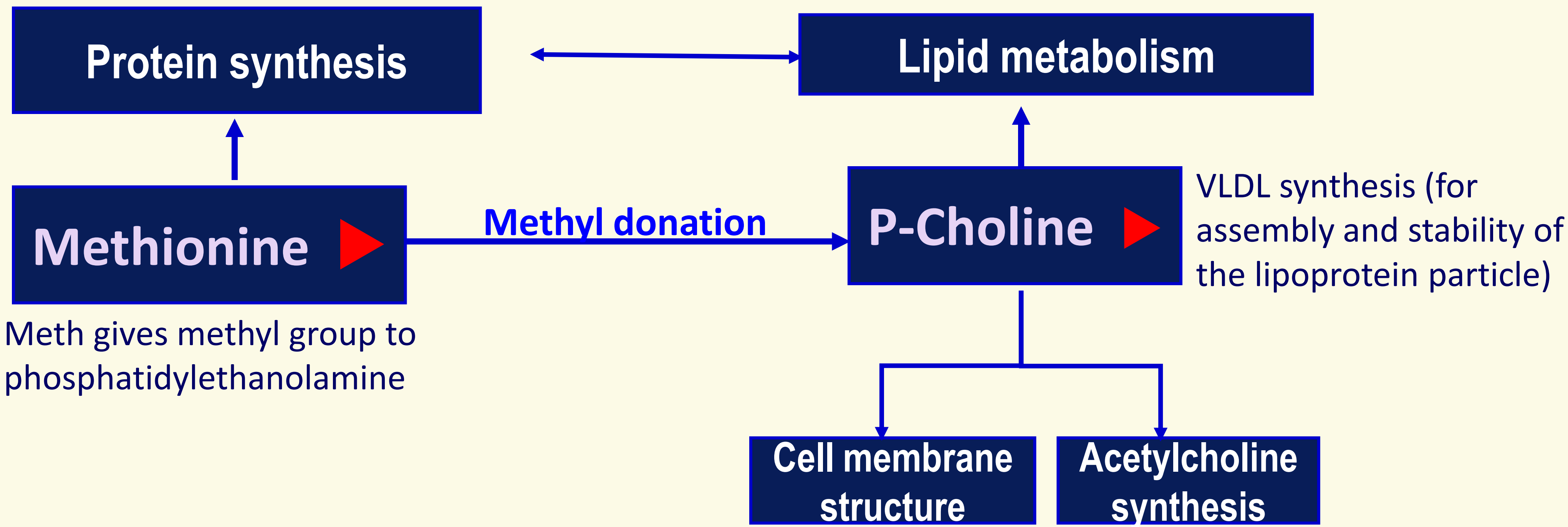
- ✓ Choline is a **source of methyl groups**, therefore, it can spare methionine and have interactions with other nutrients involved in one-carbon metabolism (e.g. folate).
- ✓ Choline is also a **component of acetylcholine**, an important neurotransmitter.

- ✓ **Choline deficiency** induces hepatic steatosis: in animals, as well as calves.
- ✓ **Rumen-protect choline supplementation** during the transition period improves hepatic fat export in periparturient dairy cows and this may potentially decrease the risk for metabolic disorders in the periparturient dairy cow.

(Zom, *et al.* 2011; Goselink *et al*. 2012; Grummer, 2013)

Interrelationships between methionine and choline in liver metabolism

Choline metabolism highly depends on methyl transfers, and therefore on methionine



✓ This indicates:

- Choline biosynthesis is an important outcome of methionine,
- and that **choline and methionine** play therefore central roles in hepatic lipid metabolism.

•**Choline** has an additional specific role in neurotransmitter synthesis and cell membrane structure as phosphatidylcholine,
and **methionine** has a specific role in protein synthesis.

Other nutritional factors (hepatoprotectors…)

- **Sorbitol** — **Choleretic agent**
- **Betaine**
- **Inositol**
- **Glutathione**
- **Orotic acid**

(Betaine, Inositol, Glutathione, Orotic acid:) **Cholagogues: lipotropic factors**

- **B vitamin, especially vitamin B12 and niacin**
- **Propylene glycol**

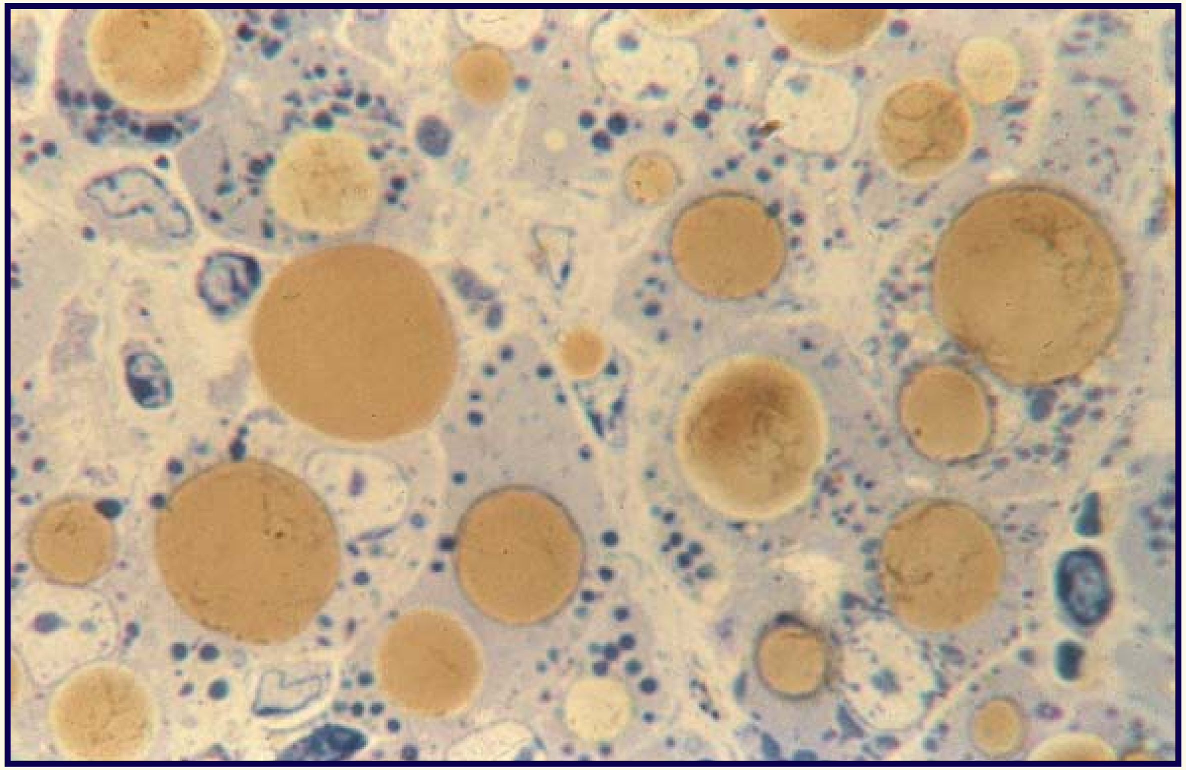
➤No experiment has been definitely conclusive regarding a lowering effect on incidence or severity of fatty liver.

➤They are more or less known as factors improving the overall hepatic function.Especially,

- daily drenching with half to one liter **propylene glycol increases glycemia** and **lowers plasma non esterified fatty acids.**

(Grummer, 2008 and 2013)

Conclusion



Causes

Solutions

Fatty liver : main causes

FATTY LIVER

1. **Negative energy balance:**
   Low appetite, low intake capacity, BC
2. **Excessive NEFA release:**
   Hormonal changes, management
3. **Low liver ability to oxidize and re-export FA**

Fatty liver : main solutions

FATTY LIVER

1 **Reduction of NEFA flux:**
adiposity, ration ingestibility, and energy balance

2 **Stimulation of liver lipotropic function:**
phospholipid and lipoprotein precursors

3 **Overall sustainance of hepatic functions**

Thank you for your attention!

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École Nationale Vétérinaire, Agroalimentaire et de l'Alimentation Nantes Atlantique

Santé et alimentation au cœur de la vie

European College of Veterinary and Comparative Nutrition
Residency class September 2015
Toulouse

CLINICAL ASSESSMENT AND TREATEMENT OF AN OBESE CAT

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Obesity in companion animals

Obesity = accumulation of excessive amounts of adipose tissue

excessive dietary intake | Inadequate energy utilization

↑ Risk of several chronic diseases :

- **Osteoarthritis**
- **Diabetes mellitus**
- **Hepatic lipidosis**
- **Respiratory distress**
- **Decreased heat tolerance**
- **Cardiac failure**
- **Kidney disease**
- **Skin disorders**

(Loftus, 2015; Laflamme, 2012)

Risk factors :

- ✓ Breed
- ✓ Age (middleage)
- ✓ Gender & Neutering
- ✓ Sedentary lifestyle & lack of exercise
- ✓ Endocrine diseases
- ✓ Drugs
- ✓ Feeding dietary factor
- ✓ Sociological factors
- ✓ Number of animals

(German,2006)

Clinical assessment

1) **Patient assesement :** review the medical record for associated concurrent health issue (hystory and physical examination)

2) **Feeding assessment :** food intake, physical activity

3) **BCS:** determine the degree to which the patient is overweight or obese

Essential goals to develop a feeding plan for weight loss management

1) Patient assessment

AXOUE:

- **10 years old**
- **neutered female**
- **domestic shorthair cat**

She was presented for routin geriatric health maintenance at Oniris veterinary teaching hospital.

History and physical examination

- Normal vital signs
- Dull hair coat
- BW 7.7 kg
- BCS 8/9
- MCS normal muscle mass
- Recurrent episodes of feline idopathic cystitis
- Low-intensity activity
- No other animals in the household

2) Feeding method assessment

Assessment is based on estimate of the *Maintenance Energy Requirement* (MER) that is the amount of energy needed to maintain animal at its current weight.

The prediction of MER is useful to make adjustement to the daily energy intake (DEI) for the weight loss plan.

Dietary history

<u>**The dietary history has as objectives to:**</u>

- **obtain an accurate accounting of all of food fed on a tipical day**
- **evaluate all the ways that the food is involved in interaction between the pet and the other members of the household**
- **reveal potential obstacles in advance and allow the weight loss plan to be tailored to the patient improving chances of successful outcomes.**

(Fascetti, 2012)

Dietary history

Axoue was fed :

- a dry specialty adult cat food free choice ED= 3.6 kcal ME/g

  ➔70 g/day (2 meals/day)

+

- moist grocery store cat food ED= 0.7 kcal ME/g

  ➔ 15 g once a day

Maintenance energy requirement =

255 kcal ME/day

3) Assessement of body condition

The Axoue BCS was assessed as 8/9 corresponding to 40% body fat.

Ideal body weight = current weight x (100 – percent body fat) /0.8

Axoue ideal BW → 5,8 kg

Feeding plan for weight loss

- **Calculation based on current food intake:**

requires knowledge of the number of calories patient is currently eating based on information obtained from his diet history.

- **Calculation based on estimated ideal BW:**

the use of resting energy requirement for optimal weight as an initial estimate of calories required for appropriate weight loss.

Treatment

- Choosing a calorie restriction food with an increased nutrient-to-calorie ratio should be considered to avoid excessive restriction of essential nutrients and to compensate the decreased bioavailability of these nutrients when fiber content is increased.

- Increasing feeding frequency and feeding with canned foods which are higher in moisture to improve satiety.

- Incorporating in the WL plan 10% daily energy intake in treats.

- Increasing exercise.

- Sensitizing the owner about importance of regulary nutritional assessments and respect of indications for success of diet planning.

(Laflamme,2012; Fascetti 2012)

WL feeding plan for Axoue

- 20 % DEI

↓

Nutritional assessment after 3-4 weeks

↓

Weight loss expected 1%-2% per week

<1% → 10% reduction of DEI
>2% → 10% increase of DEI

Axoue diet assessment

DAILY ALLOWANCE ENERGY : 255 kcal/d

20 % reduction

DEI 205 kcal ME/d

- 60 g of **a <u>reduced calorie food</u>**: 200 kcal ME (3.4 kcal ME/g)
- 15 g of moist grocery store food: 10 kcal ME (0.7 kcal ME/g <10% of DEI as treat)

The 2nd Axoue diet assessment

4 weeks after…

BW 7,7 kg

BCS 8/9

BW stable

10% reduction of DEI

DEI = 175 kcal ME/d

- 50 g of reduced calorie food: 170 kcal ME/d
- 15 g moist grocery store brand food: 10 kcal ME/d

The 3rd Axoue diet assessment

4 weeks after…

BW 7.2 kg ➔ <u>1.6 % BW loss per week</u>

BCS 8/9

MCS normal

The weight loss expected per week has been reached but owner reported that Axoue changed behaviour:

- increased mewing to require food
- stole food

➔ We decided to increase amount and change into a *moist reduced calorie food* *to improve satiety*

DEI = 175 kcal ME/d

- 80 g /day of reduced calorie moist food canned (ED 0.85 kcal ME/g)
- 30 g of reduced calorie dry food/day

4th diet assessement

4 weeks after…

BW 6.9 kg ➔ 1 % BW loss per week

BCS 7/9

- ✓ **MCS mild muscle wasting**
- ✓ **Axoue didn't like new canned food prescribed**

4^{th} diet assessement

Current FOOD 1	For 100 kcal ME
CP	11 g
CF	3.8 g
ENA	8.4 g
CFib	2.7 g
ED	3.4 kcal ME/g

FOOD 2	For 100 kcal ME
CP	11.6
CF	3.3 g
ENA	9 g
CFib	4.1 g
ED	3.2 kcal ME/g

DEI = 175 kcal ME/d

- **80g /day of reduced calorie moist food canned (ED 0.8 kcal ME/g)**
- **35 g of reduced calorie dry food/day (ED 3.2 kcalME/g)**

Discussion

After 4 months of diet Axoue has lost 10% of BW and she switched from BCS 8/9 to 7/9.

In three patient reassesments we adjusted feeding plan:

➔ appling 10% reduction to DEI to achieve 1%- 2% body weight loss per week considering change in BCS

➔ introducing moist food in small and multiple meals to improve satiety and acceptability

➔ switching from a first reduced calorie food to a second reduced calorie food higher in crude protein g/ 100 kcal ME to avoid loss of lean body mass.

Conclusion

Many overweight or obese cats are at risk of impaired health and reduced longevity

Efficacy of weight loss program in clinical setting can be a challenge…

Successful feeding program begins with a thorougly conducted diet history.

Follow-up rechecks are essential for monitoring and adjusting the plan to ensuring the success of the program.

Thank you for your attention

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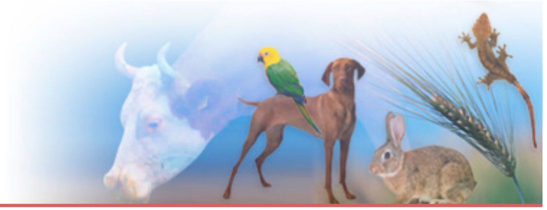


Effect of nutrition on the intestinal health of pigs – focus on microbiota

Review

Residency class 2015

Dr. med. vet. Kerstin Gerstner

Prof. Dr. med. vet. Annette Liesegang (supervisor)

ACCREDITED BY EAEVE/FVE

University of Bern | University of Zurich

vetsuisse-faculty

Overview

GI-Physiology

Critical points of nutrition in pigs

Factors affecting intestinal health – topics of actual interest

Summary & Conclusion

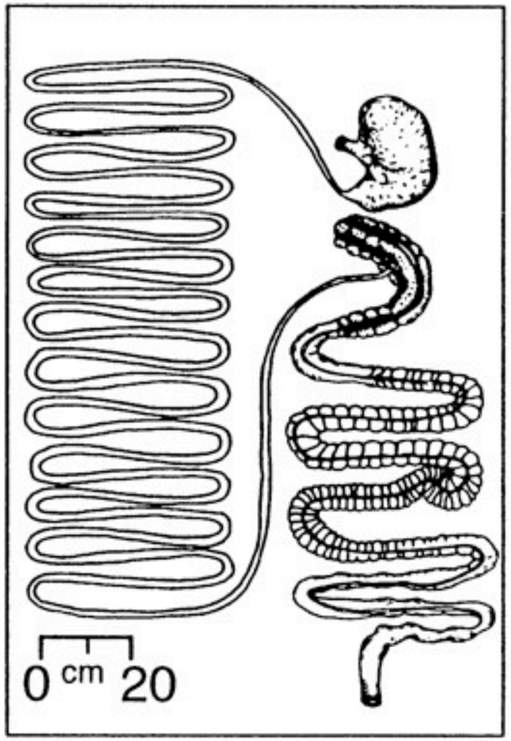
GI - physiology

Monogastric & omnivorous

Efficient enzymatic digestion of starch, sugar, proteins, fat in the small intestine (praecaecally)

Gastric acid→ deactivating bacteria in the diet

Partial digestion of plant fibre by microbiota in the large intestine



Pig
(Sus scrofa)
Body length: 125 cm

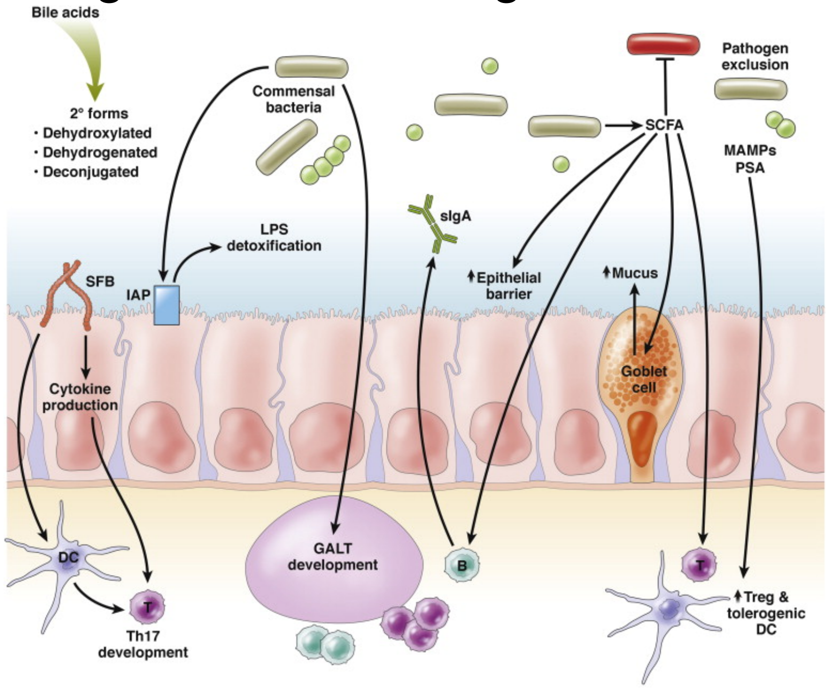
C. E. Stevens, I. D. Hume; Contributions of Microbes in Vertebrate Gastrointestinal Tract to Production and Conservation of Nutrients Physiological Reviews 1998

Influence of intestinal microbiome

Microbial fermentation particularly in the colon, to a lesser extent also in stomach & small intestine (SCFA detection)

Hindgut SCFA absorption→ 15-24% of maintenance energy for growing & finishing pigs (Yen et al 1991, Mc Burney et al1993)

SCFA might contribute to gastric ulcer formation (Argenzio et al 1996)



Ohland C.L.,Jobin C.; *Cellular and Molecular Gastroenterology and Hepatology* 2015 1, 28-40DOI: (10.1016/j.jcmgh.2014.11.004)

Argenzio RA, Eisemann J. Mechanisms of acid injury in porcine gastroesophageal mucosa. Am J Vet Res. 1996
Yen, JT; Nienaber, JA; Hill, DA; Potential Contribution Of Absorbed Volatile Fatty-Acids To Whole-Animal Energy Requirement In Conscious Swine; Journal Of Animal Science 1991

Critical points for nutrition & health

Nutrition of

the pregnant & lactating sow

(overfeeding or negative energy balance), MMA

weanling piglets

decreased FI followed by compensatory increased intake

→ predisposition of diarrhoea

(fattening pigs in the early phases)

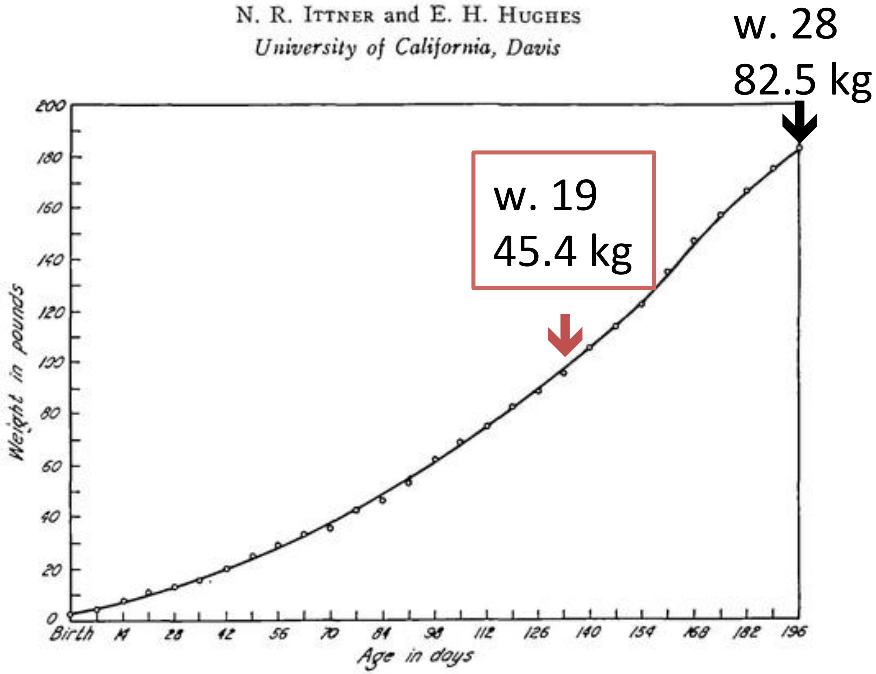
Spreeuwenberg, M.A., Verdonk, J.M., Gaskins, H.R., and Verstegen, M.W. (2001) Small intestine epithelial barrier function is compromised in pigs with low feed intake at weaning. *J Nutr*

Production in general

Goal: low costs, high performance, low pollution

A NORMAL GROWTH CURVE FOR SWINE

N. R. Ittner and E. H. Hughes
University of California, Davis

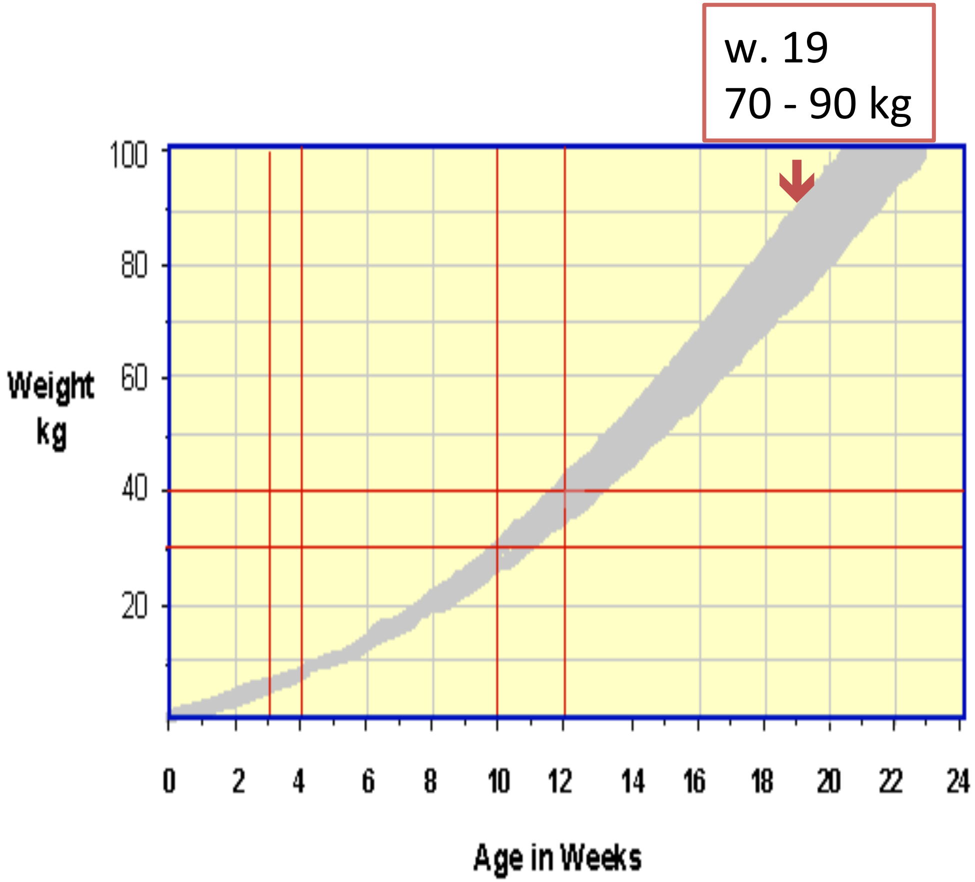


HOW 457 PIGS GREW UP

Figure 9

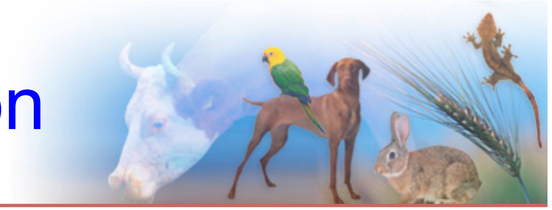
Average growth rate of 457 pigs, from birth to 196 days of age, in the University of California herd. The maximum rate of gain was at an age of about six months, after which the weekly gains began to decrease.

J Hered (1938) 29 (10): 385-386



Book: Garth Pig Stockmanship Standards; Dr. John Carr; 1998

Critical points of swine nutrition



Sows in reproduction

Goals: ≥ 13 piglets (≈1.5 kg birth weight)
fast birth without complications
loss of piglets until weaning <12%
service 4-5 d after weaning

Difficulties: overfeeding during gestation → birth complications, MMA
negative energy balance during lactation
→ bodyweight ↓, reproductive performance ↓

Supplemente zur Tierernährung für Studium und Praxis, 12. überarbeitete Auflage
Nutrient Requirements of Swine, NRC 2006

Critical points of swine nutrition

Sows in reproduction

MMA – prevention: feed restriction 1-2 days before birth

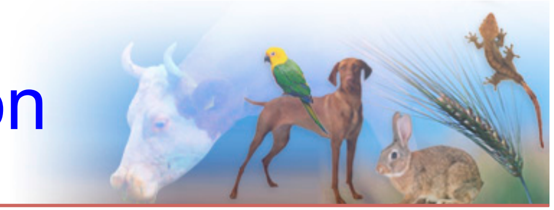
laxatives (wheat bran, Glauber's salt)

acidifying substances (acidification of urine, anion-cation-gap)

prebiotics

water!

Critical points of swine nutrition



Weaning

> d 21 (≈ d 25 – d 28)

supplementary feed > d 10 of age

stimulation of enzyme production & gastric acid secretion

changes in intestinal anatomy → increase crypt depth, villus length

adaption of intestinal microbiota

Lalles, J.P., Bosi, P., Smidt, H., and Stokes, C.R. (2007) Nutritional management of gut health in pigs around weaning. *Proc Nutr Soc*
Supplemente zur Tierernährung für Studium und Praxis, 12. überarbeitete Auflage
Nutrient Requirements of Swine, NRC 2006

Critical points of swine nutrition

After weaning – feeding recommendations:

feed restriction, small portions (avoid overeating)

restricted protein content (guarantee amino acid intake!)

fibre content ↑ ((>3%, <7%)↑ passage rate of feces, acidify feces)

hygienic quality of the feed ↑

add organic acids (↓ pathogens in the feed)

prebiotics

Lalles, J.P., Bosi, P., Smidt, H., and Stokes, C.R. (2007) Nutritional management of gut health in pigs around weaning. *Proc Nutr Soc*
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Nutrient Requirements of Swine, NRC 2006

Immune system maturation & microbiome

Birth of piglets: little/ no passive immunity→ need of antibodies (colostrum)
fecal flora similar to the fecal flora of the sow
fecal flora: mainly Firmicutes & Bacteroidetes

During 1st 14 d: mucosal immune system develops (e.g. Peyer's patches)
differentiation of fecal flora from the fecal flora of the sow, but still similar between littermates

≈ 28 d CD8+ T-cells infiltrate the intestine

≈ 6 w IgA production starts

Thompson CL, Wang B, Holmes AJ; The immediate environment during postnatal development has long-term impact on gut community structure in pigs;, The ISME Journal, 2008
Metabolic fingerprinting and fermentative capacity of the intestinal flora of pigs during pre- and post-weaning periods. Katouli M, Lund A, Wallgren P, Kühn I, Söderlind O, Möllby R; Journal of applied microbiology ; 1997.
Kim HB[1], Borewicz K, White BA, Singer RS, Sreevatsan S, Tu ZJ, Isaacson RE. Longitudinal investigation of the age-related bacterial diversity in the feces of commercial pigs. Vet Microbiol. 2011

Immune system maturation & microbiome

„cohabitation“ effect – similar fecal flora in cohoused pigs (not in siblings)

Fecal flora: unstable phases after weaning & moving to a fattening stable

Adults: Firmicutes & Spirochaetes

Fermentative capacity of fecal flora ↑ before weaning
↓ after dietary change (milk to solid feed to fattening diet)

Thompson CL, Wang B, Holmes AJ; The immediate environment during postnatal development has long-term impact on gut community structure in pigs; The ISME Journal; 2008
Katouli M, Lund A, Wallgren P, Kühn I, Söderlind O, Möllby R;Metabolic fingerprinting and fermentative capacity of the intestinal flora of pigs during pre- and post-weaning periods. Journal of applied microbiology ; 1997.
Kim HB[1], Borewicz K, White BA, Singer RS, Sreevatsan S, Tu ZJ, Isaacson RE. Longitudinal investigation of the age-related bacterial diversity in the feces of commercial pigs. Vet Microbiol. 2011
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Immune system maturation & microbiome

Microbiota detected around weaning:

Bacteroidetes and *Firmicutes*: predominant phyla present at **each age**

Microbiota of **suckling piglets**: *Bacteroides*, *Oscillibacter, Escherichia/ Shigella, Lactobacillus,* unclassified *Ruminococcaceae* genera

Microbiota of **weaned piglets**: increase of *Acetivibrio, Dialister, Oribacterium, Succinivibrio* and *Prevotella* genera

Lactobacillus fermentum: vertical transfer via breast milk or faeces

Prevotella: positively correlated with luminal secretory IgA concentrations and body weight

Mach N, Berri, M, Estelle J, Levenez F, Lemonnier G, Denis C, Leplat JJ, Chevaleyre C, Billon Y, Dore J, Rogel-Gaillard C, Lepage P; Early-life establishment of the swine gut microbiome and impact on host phenotypes; Environmental Microbiology Reports (2015)

Affecting intestinal health – mother's milk

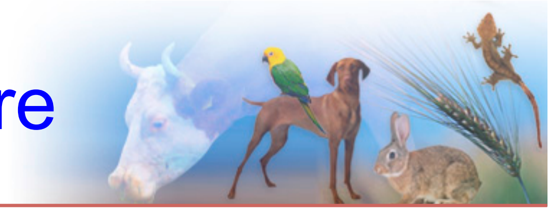
Similar "core microbial metatranscriptome" in the distal intestine

differences in bacterial genus:

- mother fed neonatal piglets: Prevotella
- neonatal piglets fed with an artificial formula: Bacteroides

Poroyko V, White JR, Wang M, Donovan S, Alverdy J, Liu DC, Morowitz MJ. Gut microbial gene expression in mother-fed and formula-fed piglets. PLoS One. 2010

Affecting intestinal health - fibre



Soluble fibre increase number & activity of microflora in the large intestine (Montagne et al 2003)

Increased total tract digestibility of fibre in pigs fed with chicory fibre (Liu et al 2013, Ivarsson et al 2012)

Increased total dietary fibre content→ decreased apparent protein digestibility & gross energy (Ivarsson et al 2012)

Ivarsson, E., Liu, H.Y., Dicksved, J., Roos, S., and Lindberg, J.E. (2012) Impact of chicory inclusion in a cereal-based diet on digestibility, organ size and faecal microbiota in growing pigs. *Animal* **6:** 1077–1085.
Ivarsson E, Roos S, Liu HY, Lindberg JE. Fermentable non-starch polysaccharides increases the abundance of Bacteroides-Prevotella-Porphyromonas in ileal microbial community of growing pigs. Animal. 2014
Liu H, Ivarsson E, Lundh T, Lindberg J, Chicory (Cichorium intynus L. and cereals differently affect gut development in broiler chickens & young pigs Journal of Animal Science and Biotechnology 2013
L. Montagne, J.R. Pluske, D.J. Hampson; A review of interactions between dietary fibre and the intestinal mucosa, and their consequences on digestive health in young non-ruminant animals; *Animal Feed Science and Technology*

Affecting intestinal health – proteins

Low protein (14% CP) vs. normal protein (20% CP) diet:

- ↓ feed intake
- ↓ weight gain,
- ↓ metabolites of protein and carbohydrate fermentation (ammonia, branched chain fatty acids, acetate)
- ↓ microbial diversity

(Luo et al 2015)

Luo Z, Li C, Cheng Y, Hang S, Zhu W. Effects of low dietary protein on the metabolites and microbial communities in the caecal digesta of piglets. Arch Anim Nutr. 2015

Affecting intestinal health - minerals

Pigs supplemented with an increased amount of zinc: performance↑; No effect on number of excreted *E. Coli* and enterococci or on the functions of circulating neutrophils (Jensen-Waern et al 1998)

Study dose: 2500 mg/kg feed vs. legislation limit of 150 mg/ kg

Enterobacteriaceae, *Escherichia* group & *Lactobacillus spp.* ↓ in weaned pigs fed with high amounts of zinc, effect diminished for *Enterobacteria* with increasing age, permanent for *Lactobacillus* species (Pluske 2013, Starke et al 2014)

Study dose: 2425 mg/kg feed vs. legislation limit of 150 mg/ kg

Starke IC, Pieper R, Neumann K, Zentek J, Vahjen W. The impact of high dietary zinc oxide on the development of the intestinal microbiota in weaned piglets. FEMS Microbiol Ecol. 2014
Pluske JR Feed- and feed additives-related aspects of gut health and development in weanling pigs. J Anim Sci Biotechnol. 2013
Jensen-Waern, M., Melin, L., Lindberg, R., Johannisson, A., Petersson, L., and Wallgren, P. (1998) Dietary zinc oxide in weaned pigs – effects on performance, tissue concentrations, morphology, neutrophil functions and faecal microflora. *Res Vet Sci*

Affecting intestinal health - minerals

Increased diversity of *E. coli* clones and a significantly higher rate of multiresistant *E. coli* in pigs fed with a high dose of zinc compared to pigs fed zinc in an amount covering the needs (Bednorz et al 2013)

High diversity & species richness in mucosa associated bacteria also at pars non-glandularis of the stomach of weaned pigs & *Lactobacillus*↑ by a diet rich in Ca & P vs. moderate Ca & P (Mann et al 2014)

Bednorz C, Oelgeschläger K, Kinnemann B, Hartmann S, Neumann K, Pieper R, Bethe A, Semmler T, Tedin K, Schierack P, Wieler LH, Guenther S The broader context of antibiotic resistance: zinc feed supplementation of piglets increases the proportion of multi-resistant Escherichia coli in vivo. Int J Med Microbiol. 2013
Mann, E., Schmitz-Esser, S., Zebeli, Q., Wagner, M., Ritzmann, M., and Metzler-Zebeli, B.U. (2014) Mucosa- associated bacterial microbiome of the gastrointestinal tract of weaned pigs and dynamics linked to dietary calcium-phosphorus. *PLoS ONE*

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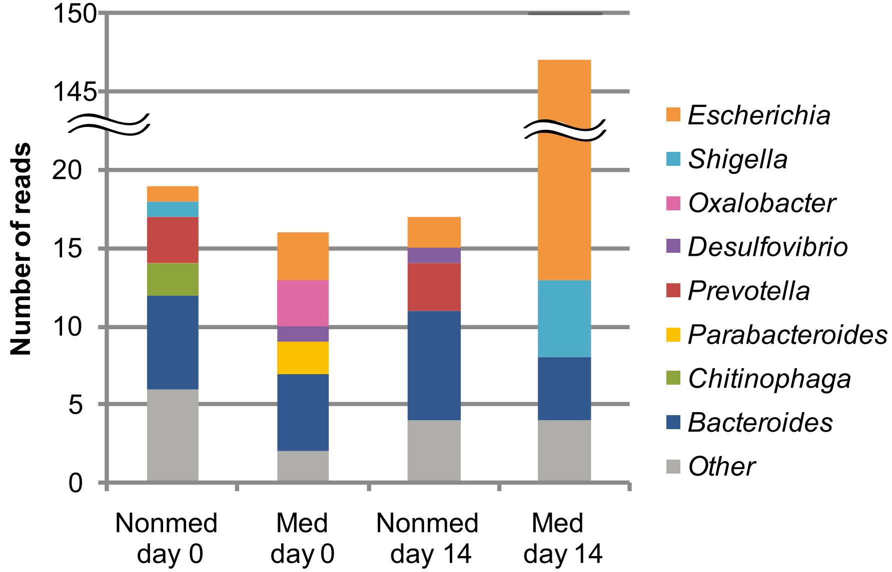
Affecting intestinal health - antibiotics

Antibiotics and to a lesser extent additional management procedures in early life affect composition & diversity of gut microbiota in piglets
(Schokker et al 2014)

Piglets raised in a highly controlled environment & subtherapeutic antibiotic treatment (Looft et al 2012):



Proteobacteria ↑ (driven by *E. coli*)

microbial functional genes related to energy production & conversion ↑

antibiotic resistance genes ↑

Schokker, D., Zhang, J., Zhang, L.L., Vastenhouw, S.A., Heilig, H.G., Smidt, H., *et al*. (2014) Early-life environmental variation affects intestinal microbiota and immune development in new-born piglets. *PLoS ONE*
Looft, T., Johnson, T.A., Allen, H.K., Bayles, D.O., Alt, D.P., Stedtfeld, R.D., *et al*. (2012) In-feed antibiotic effects on the swine intestinal microbiome. *Proc Natl Acad Sci USA*

Affecting intestinal health - environment

Significant similarity between stable communities developing in cohabiting pigs→ the outcome of gut colonization in piglets might be influenced by the immediate environment (Thompson et al 2008)

Piglets housed in environments of excessive hygiene:

impaired progression & stabilisation of an adult-type gut microbiota, despite the acquisition of a highly diverse microbiota in early life.

Firmicutes↓ in isolator-reared animals compared to outdoor-reared (Schmidt et al 2011)

Schmidt B, Mulder IE, Musk CC, Aminov RI, Lewis M, Stokes CR, Bailey M, Prosser JI, Gill BP, Pluske JR, Kelly D. Establishment of normal gut microbiota is compromised under excessive hygiene conditions. PLoS One. 2011
Thompson, C.L., Wang, B., and Holmes, A.J. (2008) The immediate environment during postnatal development has long-term impact on gut community structure in pigs. *ISME J*

Affecting intestinal health - probiotics

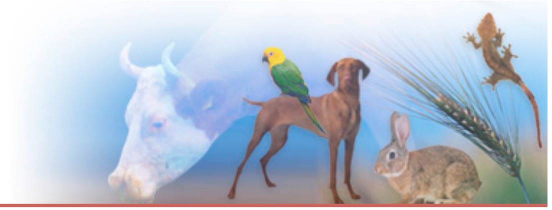
Weaning highly affects the gut microbiota (*Lactobacilli* ↓, lactic acid↑ ammonia↓ in weaned pigs; no effect on total VFA concentration)
(Konstantinov et al 2006)

Feeding *Enterococcus faecium* one month before birth of piglets led to an individually different increase of *Lactobacillus spp*. in sows and piglets
(Starke et al 2013)

Probiotic supplementation (*Lactobacillus*) has been shown to increase average daily gain, nutrient digestibility (e.g. protein) and improve immunity (by stimulating epithelial lymphocytes) (Yu et al 2008)

Konstantinov SR, Awati AA, Williams BA, Miller BG, Jones P, Stokes CR, Akkermans AD, Smidt H, de Vos WM; Post-natal development of the porcine microbiota composition and activities. Environ Microbiol. 2006
Starke IC, Pieper R, Neumann K, Zentek J, Vahjen W. Individual responses of mother sows to a probiotic Enterococcus faecium strain lead to different microbiota composition in their offspring. Benef Microbes. 2013
Yu, H.F., Wang, A.N., Li, X.J., and Qiao, S.Y. (2008) Effect of viable Lactobacillus fermentum on the growth performance, nutrient digestibility and immunity of weaned pigs. *J Anim Feed Sci*

Summary & conclusion



→ Early days of piglet's life are of utmost importance for the intestinal health of the pig's whole life

→ Intestinal health could be supported by dietary supplements like probiotics or diet formulations containing increased amounts of particular nutrients (e.g. zinc)
→ legislation limits & side effects

→ Intestinal health should be based on good management procedures for housing and feeding

«The» ideal diet or supplement to compensate management failures does not exist

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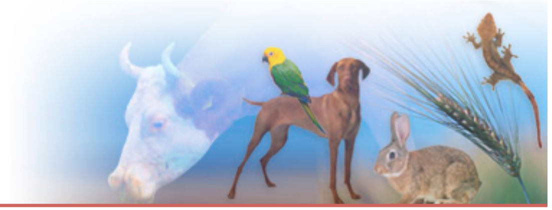
Literature



Kim HB, Borewicz K, White BA, Singer RS, Sreevatsan S, Tu ZJ, Isaacson RE. Longitudinal investigation of the age-related bacterial diversity in the feces of commercial pigs. Vet Microbiol. 2011

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Looft, T., Johnson, T.A., Allen, H.K., Bayles, D.O., Alt, D.P., Stedtfeld, R.D., *et al*. (2012) In-feed antibiotic effects on the swine intestinal microbiome. *Proc Natl Acad Sci USA* 109: 1691–1696.

Luo Z, Li C, Cheng Y, Hang S, Zhu W. Effects of low dietary protein on the metabolites and microbial communities in the caecal digesta of piglets. Arch Anim Nutr. 2015;69(3):212-26. doi: 10.1080/1745039X.2015.1034521

Mach N, Berri, M, Estelle J, Levenez F, Lemonnier G, Denis C, Leplat JJ, Chevaleyre C, Billon Y, Dore J, Rogel-Gaillard C, Lepage P; Early-life establishment of the swine gut microbiome and impact on host phenotypes; Environmental Microbiology Reports (2015)

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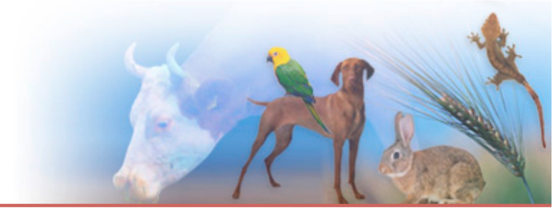

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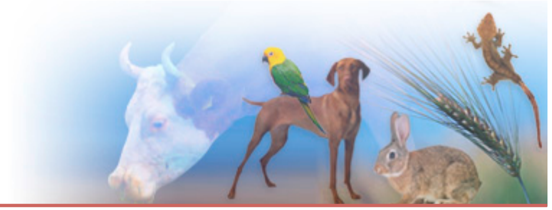

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Books:

Supplemente zur Tierernährung für Studium und Praxis, 12. überarbeitete Auflage, 2014

Nutrient Requirements of Swine, NRC 2006

Dog with chronic renal failure and pancreatitis - a case report

Britta Kiefer-Hecker
LMU Munich, Germany

„Snoopy“

History

- Labrador Retriever
- Male, spayed
- 8 years old
- 34 kg bodyweight, BCS 2,5/5
- Multidog (3) household
- Owner is nurse in vet clinic

Diagnosis

- Chronic renal failure (CRF)
- Pancreatitis

➢ **Dietary recommendation**

Blood chemistry

Serum parameter	Reference values	19.12.2014	
Urea mg/dl	9-29	**97**	↑
Crea mg/dl	<1.4	**5.6**	**↑**
P mmol/l	0.9-1.7	**2.1**	↑
Ca mmol/l	2.1-2.9	2.7	
Potassium mmol/l	3.9-5.8	4.9	
α-amylase U/l	< 1264	3176	↑
Lipase U/l	< 298	713	↑
cPLI* µg/l	> 200** & >400***	**446**	↑
Albumin g/dl	2.8-4.3	2.8	
Total protein g/dl	5.4-7.6	6.6	

*Canine pancreatic lipase, **questionable, ***suspected pancreatitis
CRF: values out of reference only since 75% damage, **Missing information of urine quality**: Specific gravity, proteinuria?, protein-creatinine-ration

IRIS
Stage 4

Suspected
pancreatitis

Dietary recommendations

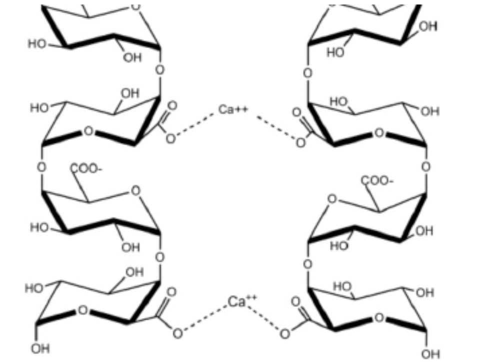
CRF

- Protein and Phosphorus ↓ (according to blood values)
- Protein quality ↑
- Fat and cereals ↑
- Sodium (↓), potassium (↑) according to serum profile
- B vitamins ↑
- Additionally: pectin (soluble fiber)
- Avoid anorexia

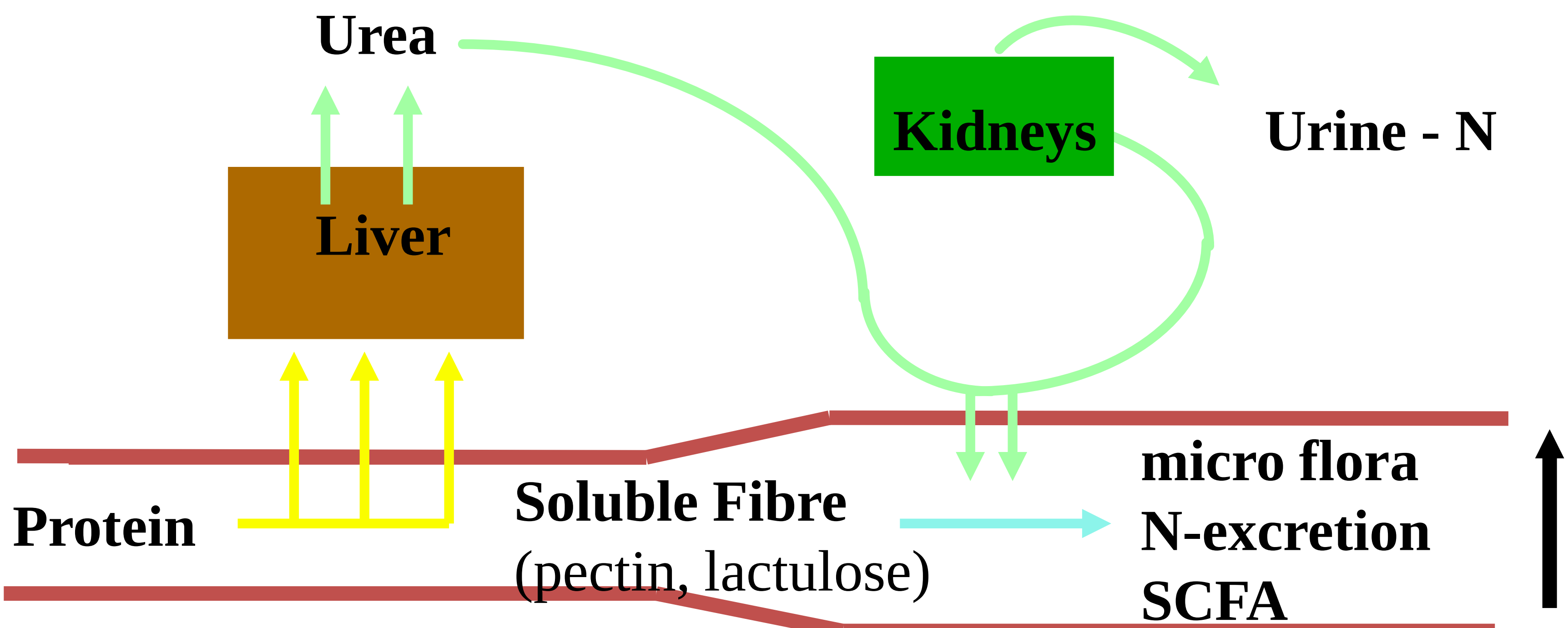
Pancreatitis

Usefull effects of soluble fiber in dietetic of CRF: **Nitrogen Trap**

Fixation of ammonia and polyamids through e.g. pectin

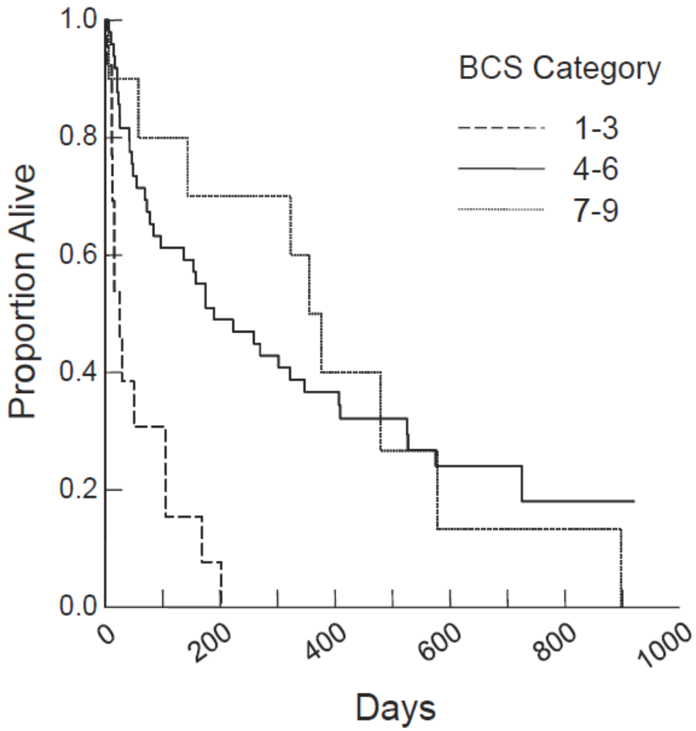


Nultsch 2001; Ochoa-Villarreal et al. 2012



Benefit of renal diet in dogs

- Clinical 2y double-blind study*, 38 dogs w naturally occurring CRF: renal diet** vs. typical maintenance diet
  - ➢ Delayed onset of uremic crises (615 vs. 252 days)
  - ➢ Improved quality of life: 72% less likely to have clinical signs
  - ➢ Improved survival time: lived more than twice as long when fed renal diet
- CKD dogs with lower BCS live shorter***



* *Jacob F et al. JAVMA 2002,* ** Hill's Prescription Diet™ k/d™ Canine, *** *Parker VJ et al, JVIM 2011*

Pancreatitis: Nutritional considerations

- Common practice: nothing per os in order to „rest“ the pancreas
  - little evidence for that
- Nutritional support is crucial → oral feeding if not vomiting (use antiemetics)
  - ~12 h after patient stops vomiting → offer small amount of fresh water → no vomiting → offer small amount of low-fat food → no vomiting: repeat this offer every few hours
- NPO only if vomiting cannot be controlled
- In canine patients: low-fat diet

Dietary recommendations

CRF

- Protein and Phosphorus ↓ (according to blood values)
- Protein quality ↑
- Fat and cereals ↑
- Sodium (↓), potassium (↑) according to serum profile
- B vitamins ↑
- Additionally: pectin (soluble fiber)
- Avoid anorexia

Pancreatitis

- Highly digestible diet
- Fat ↓
- Polyunsaturated fatty acids ↑
- Avoid anorexia

Important information for pet owners

- Diet will improve live through slow-down of progression but will not cure CRF
- Lifelong feeding of diet is required
- Dietary failure (snacks, exceptions) can cause worsening of the symptoms
- A pet with CRF needs more care and will be more expensive than a healthy pet
- Be careful with learned dietetic aversions (cats)

Actual feeding (december) - survey

*CRF, dog 34kg, BCS 2.5 /5	Amount (g/d)	ME (MJ)	Cp* (g)	Ca (mg)	P* (mg)	Sodium (mg)
Recommendation*		7.6	46	1830	1098	366
Content		7.6	116	3540	3192	2888
Cooked whole egg (without shell)	80	0.6	10	40	192	88
RC Hypoallergenic mod. energy, dry	200	3	46	1600	1200	800
RC Hypoallergenic, can	1000	4	60	1900	1800	2000

*chronic renal failure: Cp reco= 60% and P reco = 80% of healthy dog

Key factors	
Cp/ME (g/MJ)	15.3
Ca/P	1.1
CHO/DM	46.1
CFi/DM	5.2
EE/DM	15.9
P/ME (mg/MJ)	420
Sodium/ME (mg/MJ)	380
MJ/DM (MJ/100gDM)	1.6

Recommended diet

*CRF, dog 34kg, BCS 2.5 /5	Amount (g/d)	ME (MJ)	Cp (g)	Cfa (g)	Ca (mg)	P (mg)	Sodium (mg)
Recommendation*		7.6	46		1830	1098	366
Content		7.6	84	58	3026	1416	347
Cooked whole egg	80	0.6	10	10	40	192	88
Potatos	600	1.9	13	1	60	360	6
Carotts	300	0.6	3	0	150	105	90
Rice, cooked	400	1.8	9	0	8	151	8
Canola oil	7	0.3	0	7	0	0	0
Pork escalope	100	0.7	21	8	10	140	70
Salmon oil capsules	3	0.1	0	2	0	0	0
Curd (40% Fat/DM)	250	1.6	28	29	238	438	85
CaCO3	7	0	0	0	2520	0	0

*chronic renal failure: Cp reco= 60% and P reco = 80% of healthy dog

Plus pectin (0.5-1 g/kg BW/day, start with low dosis)

Plus phosphate binder

Key factors		
Cp/ME (g/MJ)	11.1	↓
Ca/P	2	↑
CHO/DM	58.2	↑
CFi/DM	1.6	↓
EE/DM	13.8	↓
P/ME (mg/MJ)	186	↓
Sodium/ME (mg/MJ)	46	↓
MJ/DM (MJ/100gDM)	1.8	↑

What the dog got instead till mid February

*CRF	Amount (g/d)	ME (MJ)	Cp (g)	Ca (mg)	P (mg)	Sodium (mg)
Recommendation*		7.6	46	1830	1098	366
Content		7.9	83	3794	1912	1115
Cooked whole egg	80	0.6	10	40	192	88
Potatos	400	1.2	8	40	240	4
Carotts	300	0.6	3	150	105	90
Rice, cooked	400	1.8	9	8	151	8
Canola oil	10	0.4	0	0	0	0
Curd (40% Fat/DM)	250	1.6	28	238	438	85
CaCO3	7	0	0	2520	0	0
RC Hypoallergenic, can	420	1.7	25	798	756	840

Key factors	
Cp/ME (g/MJ)	10.5
Ca/P	2
CHO/DM	57
CFi/DM	3.1
EE/DM	14.6
P/ME (mg/MJ)	242 ↑
Sodium/ME (mg/MJ)	141 ↑
MJ/DM (MJ/100gDM)	1.7

No pork, but still can food , no pectin, no phosphate binder and a few days without CaCo3

Blood chemistry and bodyweight

Serum parameter	**Reference values**	**19.12.2014**	**05.02.2015**	
Urea mg/dl	9-29	97	**118**	↑
Crea mg/dl	<1.4	5.6	6	↑
P mmol/l	0.9-1.7	2.1	**3.7**	↑
Ca mmol/l	2.1-2.9	2.7	2.8	
Potassium mmol/l	3.9-5.8	4.9	5.0	
α-amylase U/l	< 1264	3176	2235	↑
Lipase U/l	< 298	713	141	
cPLI* µg/l	> 200** >400***	446	**346**	↓
Albumin g/dl	2.8-4.3	2.8	2.5	↓
Total protein g/dl	5.4-7.6	6.6	5.6	
*Canine pancreatic lipase, **questionable, ***suspected pancreatitis				
Bodyweight (kg)		34	32,5	↓

IRIS
Stage 4

Questionable
pancreatitis

Dietary Recommendation 2

*CRF	Amount (g/d)	ME (MJ)	Cp (g)	Cfa (g)	Ca (mg)	P (mg)	Sodium (mg)
Recommendation*		7.6	46		1830	1098	366
Content		7.6	55	68	2869	1083	229
Potatos	650	2	14	1	65	390	7
Carotts	300	0.6	3	0	150	105	90
Rice, cooked	450	2	10	0	9	170	9
Canola oil	7	0.3	0	7	0	0	0
Salmon oil capsules	3	0.1	0	2.5	0	0	0
Curd (40% Fat/DM)	120	0.8	13	14	114	224	41
CaCO3	7	0	0	0	2520	0	0
Pork belly	100	1.7	12	42	10	140	70
Pork liver	15	0.1	3	1	1	54	12

Plus pectin (0.5-1 g/kg BW/day, start with low dosis)

Plus phosphate binder , plus vitamins and tracelements

Key factors		
Cp/ME (g/MJ)	7.2	↓
Ca/P	2	
CHO/DM	62.9	↑
CFi/DM	1.7	
EE/DM	16.4	↑
P/ME (mg/MJ)	143	↓
Sodium/ME (mg/MJ)	30	↓
MJ/DM (MJ/100gDM)	1.8	

Blood chemistry
8 weeks after reco 2

Serum parameter	reference values	19.12.2014	05.02.2015	24.04.15	
Urea mg/dl	9-29	97	118	**175**	↑
Crea mg/dl	<1.4	5.6	6	**14.9**	↑
P mmol/l	0.9-1.7	2.1	3.7	**4.4**	↑
Ca mmol/l	2.1-2.9	2.7	2.8	3.0	↑
Potassium mmol/l	3.9-5.8	4.9	5.0	4.9	
α-amylase U/l	< 1264	3176	2235	1960	
Lipase U/l	< 298	713	141	141	
cPLI* µg/l	> 200** >400***	446	346	199	↓
Albumin g/dl	2.8-4.3	2.8	2.5	2.7	
Total protein g/dl	5.4-7.6	6.6	5.6	6.4	
*Canine pancreatic lipase, **questionable, ***suspected pancreatitis					
Bodyweight (kg)		34	32,5	31,8	↓

IRIS
Stage 4

Stronger
Focus on
CRF

Begin of May

- Reduced overall health: vomiting and lethargy, reduced appetite and anorexia
- Treatment:
  - Antiemetic: Metoclopramid (MCP)
  - S.c. infusion of NaCl
  - Homeopathy treatment e.g. Heel Suc and Heel Hepa
  - Because of very low appetite: Owner feed what ever he eats (with phosphate binder Ipakitine)

- Only short improvement of overall health -> euthanasia



Dietetic adaptations and compliance

is crucial in multimorbid patients!



ECVCN

Nutritional management of chronic renal insufficiency, pancreatitis and diabetes mellitus in a senior cat

Case Report

16.09.2015

Anna Lineva

Chair of animal nutrition LMU Munich

First presented on 01.08.2013

- **Male neutered cat, 15 years old**
- **BW: 3.45 kg, BCS 5/9**
- **Diagnosed with chronical renal insufficiency (CRI): 2-BP (0.2) -AP2 (170)**
- **Pancreatitis and secondary EPI**
- **Clinical examination: anaemia**

	22.06.2015	Normal ranges
Urea	19.8	5.4 — 12.1 mmol/l
Creat	233	70 — 165 µmol/l
fPLI	50	< 5,4 µg/l
Glu	8.4	6.8 mmol/l
Phosphate	1.79	1.1 — 2.30 mmol/l

Therapy

ECVCN

Management of dehydration

Medication:

- **Amlodipine**
- **Prednisolone**
- **Kreon (Pancreatin)**
- **Aranesp**

Nutritional consultation

Nutritional management

Chronical kidney insufficiency

- Moderate protein, low phosphorus
- K and Na at requirements
- Vit. A at requirements
- Vit. D and Vit B x 2
- ω-3 FA
- Soluble fibre
- Water intake management

Pancreatitis

- Moderate fat
- High quality of nutrients
- ω-3 FA
- B12

Actual diet at first presentation

ECVCN

- **184 kcal / cat / day**
- **Home-made diet: chicken, eggs, rice, wheat bran, beet, cucumber**
- **High protein, moderate fat and carbohydrates**
- **Ca, trace elements deficient, invers Ca/P, high Na, low K**
- **Vitamin A deficiency**

Nutrient	**CP** (g/d)	**CFa** (%DM)	**Ca** (mg/d)	**P** (mg/d)	**Na** (mg/d)	**taurine**
Requirements (NRC)	11		153	119 ↓	36	0.1
Ration	21	15	65	193	219	0.3

Recommended diets 1, 2

ECVCN

- **The same level of ME**
- **High calorie / low protein meat sources (duck)**
- **Protein at reduced level (12.2 g/MJ ME)**
- **Moderate fat (+ ω-3 FA) / high carbohydrate level (rice)**
- **Phosphorus at reduced level (90% NRC)**
- **Complete supplementation (minerals, vitamins B x 2)**
- **Fermentable fiber (pectin, vegetables that were used before ↗)**

Nutrient	**CP** (g/d)	**CFa** (%DM)	**CH** (%DM)	**Ca** (mg/d)	**P** (mg/d)
Requirements (NRC)	11			153	119
Ration	11	12.2 → 15	48.8 → 40	167	124

First Feedback (06.09.2013)

ECVCN

- **Acceptance of diet # 2 was better**
- **BW: 3.45 kg → 3.15 kg**
- **The owner asked for some changes:**

Different protein sources (pork), less carbohydrates (+ potato mash)

	22.06.2015	07.08.2013	02.09.2013	Normal ranges
Urea	19.8	19.4	18.7	5.4 — 12,1 mmol/l
Creat	233	208	261	70 — 165 µmol/l
α-amylase, total	2454	1556	1478	500 — 1200 U/l
fPLI	50	27	5	< 5,4 µg/l
Glu	8.4	4.6	6.3	6.8 mmol/l
Phosphate	1.79	1.49	1.43	1.1 — 2.30 mmol/l

Recommended diet 3

ECVCN

- **High calorie / low protein meat sources**
- **Higher fat / low carbohydrate level**
- **Protein at reduced level (12.2 g/MJ ME)**
- **Phosphorus at reduced level (90% NRC)**
- **Complete supplementation (minerals, vitamins)**

Nutrient	**CP** (g/d)	**CFa** (%DM)	**CH** (%DM)	**Ca** (mg/d)	**P** (mg/d)
Requirements (NRC)	11			153	119
Ration	11	28.6	37.1	166	116

Six months later

ECVCN

- **Different variants of diet components**
- **Protein and phosphorus at reduced levels**
- **Fat and carbohydrates: variable**
- **Liver parameters and glucose slightly elevated**

	22.06.2015	07.08.2013	02.09.2013	29.10.2013	12.04.2014	Normal ranges
Urea	19.8	19.4	18.7	16.2	20.3	5.4 — 12.1 mmol/l
Creat	233	208	261	223	172	70 — 165 µmol/l
α-amylase, total	2454	1556	1478	2458	2206	500 — 1200 U/l
fPLI	50	27	5	5.2	5.0	< 5,4 µg/l
Glu	8.4	4.6	6.3	5.9	11.0	6.8 mmol/l
Phosphate	1.79	1.49	1.43	1.22	1.77	1.1 — 2.30 mmol/l

16.07.2014

- **+ Diagnosis „Diabetes mellitus“**

	02.09.2013	29.10.2013	12.04.2014	10.07.2014	Normal ranges
Urea	18.7	16.2	20.3	22	5.4 — 12.1 mmol/l
Creat	261	223	172	247	70 — 165 µmol/l
AST	31	44	94	165	12 — 45 U/l
ALT	50	33	92	206	18 — 60 U/l
Glu	6.3	5.9	11.0	13.8	6.8 mmol/l
Phosphate	1.43	1.22	1.77	1.49	1.1 — 2.30 mmol/l

Diet modification #4

ECVCN

- **No simple carbohydrates: beet or pumpkin**
- **Moderate carbohydrate level** (as acceptable)
- **Pearl barley** (low glycemic index)
- **Reduced protein and phosphorus levels**
- **Higher level of fermentable fibre**
- **High level of fat** (as tolerated)

Nutrient	**CP** (g/d)	**Cfa** (% DM)	**CH** (%DM)	**Cfi** (%DM)	**Ca** (mg/d)	**P** (mg/d)
Requirements (NRC)	11				153	119
Ration	12	33.3	19	7.4	163	113

01.08.2014

ECVCN

- **Glucose: fasting blood level returned to normal**
- **Insulin: no substitution recommended**
- **The patient was stable on diet #4 next 6 months**
- **Monthly monitoring of Urea, Crea, ALT, AST, fPLI, Glucose**

	29.10.2013	12.04.2014	10.07.2014	30.07.2014	Normal ranges
Urea	16.2	20.3	22	23	5.4-12.1 mmol/l
Creat	223	172	247	250	70-165 µmol/l
Glu	5.9	11.0	13.8	6.1	6.8 mmol/l
Phosphate	1.22	1.77	1.49	1.5	1.1-2.30 mmol/l

08.02.2015

ECVCN

- **Insulin 1 IU x twice daily**
- **First signs of muscle dystrophy**
- **Albumin and whole protein in blood normal**
- **The cat died in march 2015 from cardiac arrest**
- **Autopsy: no critical internal pathology**
- **IRIS stage of CKI 3 – BP – 1**

	12.04.2014	10.07.2014	30.07.2014	01.02.2015	Normal ranges
Urea	20.3	22	23	25	5.4 — 12.1 mmol/l
Creat	172	247	250	267	70 — 165 µmol/l
Glu	11.0	13.8	6.1	12.5	6.8 mmol/l
Phosphate	1.77	1.49	1.5	1.5	1.1 — 2.30 mmol/l

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Cushing's disease and obesity in a mare

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10th Residency class Sept 15th-16th 2015, Toulouse, France

Details on “Wiebke”

- 21 y old Warmblood mare
- 154 cm height at withers (stick)
- Easy keeper horse according to owner (i.e. thrifty phenotype)
- Current estimated BW ~ 550 kg
- Ideal BW ~ 500 kg
- Leisure horse, light work (5-6x/week trail ride for 1-1.5 h, occasionally dressage)
- Open stabling, on straw bedding, daily access to pasture during summertime

"Wiebke" - Medical history

- Podotrochlosis since the age of 6
- Arthritis of coffin joints in both forelegs
- Recurring inflammations of tendons, tendon lesions
- Overweight for several years
- March: ACTH on upper margin of reference range of 20 - 50 pg/ml[1]
- Skin alterations (neck, shoulders) since fall (shortly before nutrition consultation in November)
- October: ACTH 300 pg/ml => diagnosed with Equine Cushing's disease by local vet
- Treatment 1 mg/d Prascend® (pergolide mesylate = agonist of dopamine receptor)

Reason for presentation to the nutrition consultation service

- Request of the owner to check the current ration and to recommend changes to ration (if necessary), based on medical history of "Wiebke"

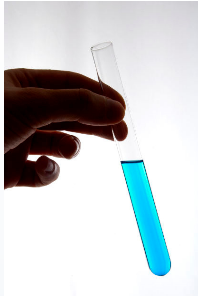
Equine Cushing's disease

- Syn.: pituitary *pars intermedia* dysfunction (PPID)
- Common neurodegenerative endocrine disease associated with ageing
- Loss of hypothalamic inhibition due to oxidative damage and in consequence higher production of pro-opiomelanocortin; increased circulating plasma concentrations of the cleavage products result in various clinical signs associated with PPID[2]
- With time, melanotroph hypertrophy, eventually adenomatous changes[2]
- ~ 20% of horses aged ≥15 years affected (PPID also seen in younger horses[3])

Common clinical signs in PPID

- Laminitis (esp. in mature/elderly horses)[4] – probably esp. in horses with insulin dysregulation as comorbidity[2]
- Hypertrichosis, abnormal hair-shedding patterns[4]
- Muscle atrophy leading to a "pot-belly" a/o "wasted topline" appearance[4]
- Abnormal fat distribution (especially periorbitally)[4]
- Lethargy, PD/PU, excessive sweating, susceptibility to secondary infections, infertility and (rarely) seizures[4]
- Suspensory ligament degeneration[5]

Laboratory diagnostics with PPID



- No 'gold standard' diagnostic test that can reliably identify <u>every</u> horse with PPID[2]
- Therefore, early onset difficult to diagnose unequivocally[2]
- Recommended diagnostic tests according to Durham et al.[4] are for example
  - Basal plasma ACTH concentration
  - Overnight dexamethasone suppression test
  - TRH stimulation test (measuring ACTH)
- Circannual variation in plasma ACTH[6] => consider when interpreting results

Obesity – possible causes and consequences

- Possible causes:
  - Overfeeding[7]
  - Disruption of seasonal patterns of feed intake and BW regulation[7]
  - Genetics[7]
  - Altered hormonal regulation of appetite and energy balance[7]
  - Lack of physical activity[7]
- Possible consequences:
  - Orthopaedic disorders such as laminitis, osteoarthritis[7]
  - Endocrine and metabolic disorders (equine metabolic syndrome, insulin resistance, glucose intolerance, hyperinsulinaemia, dyslipidaemia, hyperlipaemia and hepatic lipidosis[7]
  - Abdominal/intestinal disorders, e.g. pedunculated lipomas, small intestinal strangulation[7]
  - Miscellaneous, such as heat intolerance, exercise intolerance, exacerbation of an ageing-related pro-inflammatory state[7]

Dietary history of "Wiebke"

Ration during summertime	Ration during wintertime
5 kg late-maturity grass hay	5 kg late-maturity grass hay
10 kg pasture grass	1 kg late-maturity haylage
0.5 kg wheat straw	2.75 kg wheat straw
0.8 kg carrots	0.8 kg carrots
1 apple, 1 banana (2-3 x per week)	1 apple, 1 banana (2-3 x per week)
0.2 kg oats	0.2 kg oats
0.2 kg barley, crushed	0.2 kg barley, crushed
0.2 kg maize, crushed	0.2 kg maize, crushed
0.35 kg cereal concentrate for seniors	0.35 kg cereal concentrate for seniors
0.1 kg standard pellets	0.1 kg standard pellets
0.2 kg commercial mash mixture	0.2 kg commercial mash mixture
30 g mineral supplement	30 g mineral supplement
10 g brewer's yeast	10 g brewer's yeast
0.1 kg commercial treats	0.1 kg commercial treats
~ 59 MJ ME/d	**~ 59 MJ ME/d**

Key data in “Wiebke’s” diet

- Average ME intake ~ 59 MJ/d

  (maintenance requirements 0.52 MJ/ME/kg $BW^{0.75}$, i.e. ~ 55 MJ ME/d for ideal BW of 500 kg)[8]

- Summertime: Zn, Se deficient (Na: salt lick)
- Wintertime: Zn, Se, Vit. E deficient (Na: salt lick)
- Other nutrients meet or (slightly) exceed requirements[8]

Nutritional management of Equine Cushing’s disease

- In horses without laminitic episodes up to date
  - Good quality forage (pasture a/o hay)[7]
  - Low starch adult or „senior“ product with <3% added molasses and restricted starch from grains, if necessary to maintain BW/BCS[7]
  - Vitamin-mineral supplement
- In horses that already had laminitic episodes
  - Restricted access to pasture, when fructan/NCS* accumulation is greatest (early spring/late autumn or stressed pasture)[7]
  - Forage-based diet (preferably grass hay with low NCS content) with a forage balancer (vitamin-mineral supplement)[7]
  - No grain or sweet feeds (rich in starch a/o sugars)[7]

*NCS non-structure carbohydrates

Management of obesity

- "eat less – exercise more" – management recommendations by Geor et al.[7]:
  - Assessment of "baseline data" such as BW, BCS, other morphometric measurements, assessment of hooves for "founder lines"; monitoring of these parameters during weight loss programme
  - Increase recognition of trainers/owners for overweight/obesity
  - **Evaluation of current feeding programme and housing**
    - **Decrease/removal of grains/calorie-dense feed/treats**
    - **Evaluation of quality of current forage => preferably later maturity hay with low energy content**
    - **Vitamin-mineral supplement (or low calorie "ration balancer" with high quality protein)**
    - **Restricted access to pasture grazing (maybe with muzzle - high risk for colic/laminitis etc., if lost unnoticedly while on pasture)**
  - Assessment of workload
  - Setting of goals for weight loss (weight loss of ~ 0.5 % of BW per week reasonable)
  - Gradual increase of physical activity (intensity and duration), if possible (laminitis); increased workload should be maintained even after goal BW/BCS is obtained

Dietary recommendations for "Wiebke"

Ration during summertime	Ration during wintertime
5 kg late maturity grass hay	5.5 kg late maturity grass hay
10 kg pasture grass	
0.5 kg wheat straw	2.5 kg wheat straw
1.25 kg carrots	1.75 kg carrots
0.1 kg wheat bran	0.1 kg wheat bran
0.25 kg "low glycaemic prebiotic" (commercial product for horses with EMS or PPID)	0.25 kg "low glycaemic prebiotic" (commercial product for horses with EMS or PPID)
80 g vitamin-mineral supplement	70 g vitamin-mineral supplement
25 g selenium supplement	25 g selenium supplement
10 g brewer's yeast	10 g brewer's yeast
50 g low energy commercial treats	50 g low energy commercial treats
~ 48.5 MJ ME/d	**~ 48.5 MJ ME/d**

EMS Equine metabolic syndrome

Key data on „Wiebke‘s“ dietary recommendation and follow-up

- Decrease in daily energy supply of 17 – 18 %

  (gradual weight loss mandatory, since horses with PPID combined with overweight have bad prognosis due to the risk of developing laminitis)

- Supply with sufficient amounts of other nutrients
- Reduction of non-structure carbohydrates in the diet
- Increase of physical activity, if possible

- <u>Outcome:</u>
  - “Wiebke” lost weight gradually and under treatment with pergolide the plasma concentration of ACTH returned to the reference range
  - After 2 months the commercial product used to make “Wiebke” eat her supplements was replaced by a similar product from another manufacturer, since “Wiebke” refused to eat it any longer
  - “Wiebke’s” medical situation stabilised under treatment and dietary adjustment

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THE Zn SIGNIFICANCE IN WEANING PIGS

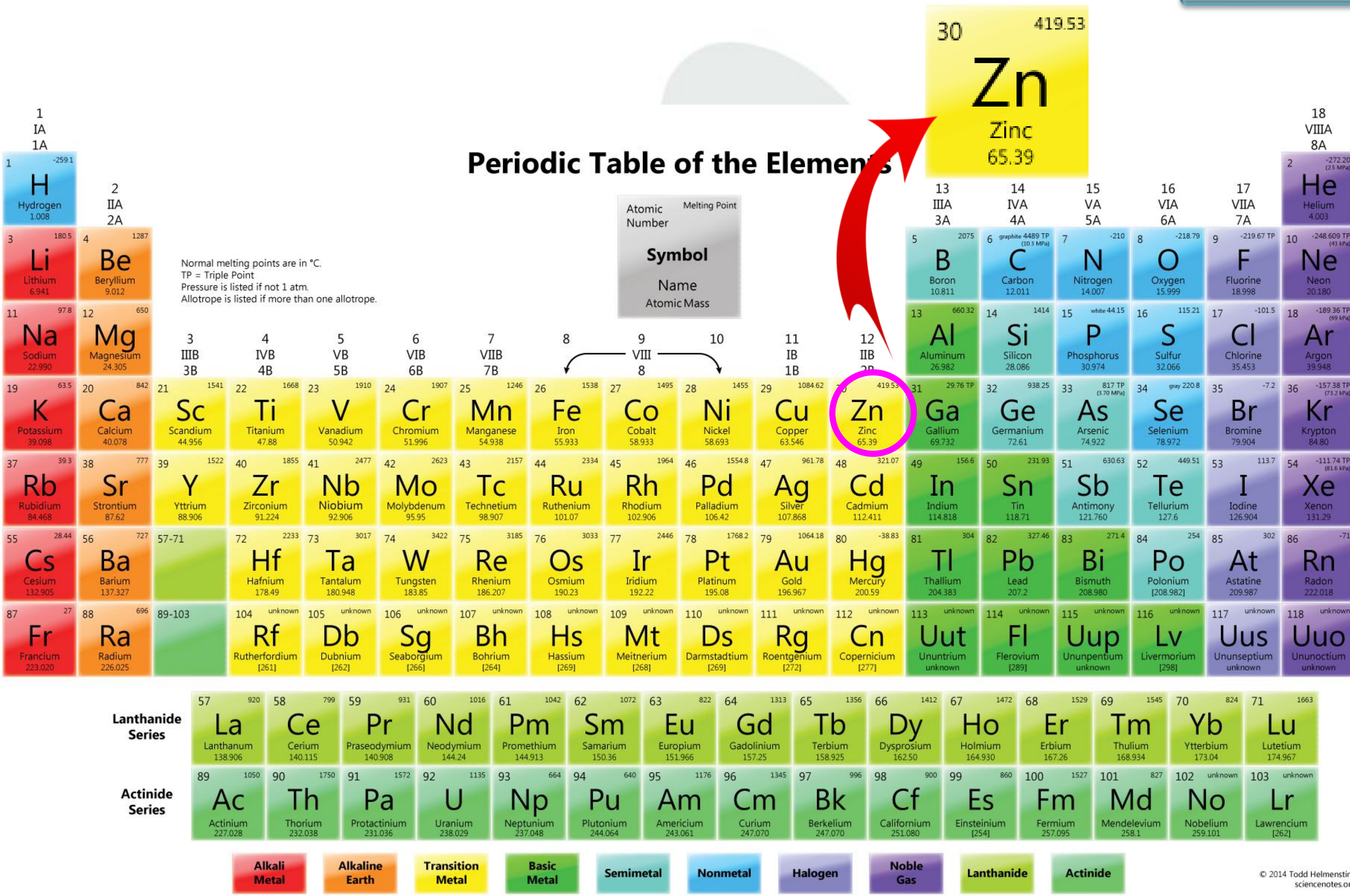
Jenifer Molina Tena. Hospital Clinic Veterinari UAB. Barcelona (Spain)

OUTLINE

- INTRODUCING Zn
- Zn METABOLISM
- Zn DEFICIENCY
- Zn EXCESS
- Zn AS ANTIDIARRHEAL TREATMENT
- SUMMARY

INTRODUCING Zn

- Zn: Essential mineral that is naturally present in some foods, added to others, and available as a dietary supplement.
- Zn is used as a cofactor and structural element > 300 enzymes. Zn is involved in numerous aspects of cellular metabolism and in many biological functions *(solomons, 2013)*.



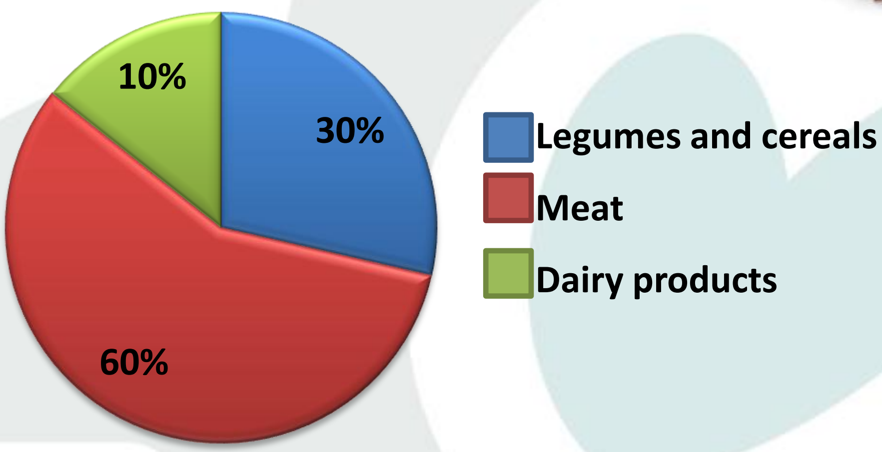
The largest amounts of Zn are found in Australia, Asia, and the United States.

Food groups	Zn content (mg/Kg)	Phytate content (g/Kg)
Liver, kidney (beef, poultry)	42-61	0
Meat (beef, pork)	29-47	0
Poultry (chicken, duck)	18-30	0
Seafood (fish, etc.)	5-52	0
Eggs	11-14	0
Dairy (milk, cheese)	4-31	0
Seeds, nuts (sesame, almond)	29-78	17.6-47.1
Beans, lentils (soy, chickpea)	10-20	1.1-6.2
Whole-grain cereals (wheat,maize, brown rice)	5-32	2.1-6.2
Refined cereal grains (white, flour, white rice)	4-8	0.3-4.4
Bread	9	0.3
Tubers	3-5	0.9-1.3
Vegetables	1-8	0-1.2
Fruits	0-2	0-0.6

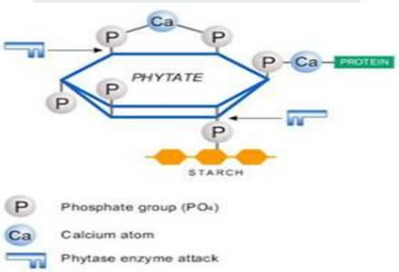
Adapted from the International MiniList

- Best sources: red meat, organ meat and shellfish (↑bioavailable Zn)

  - Developed countries:

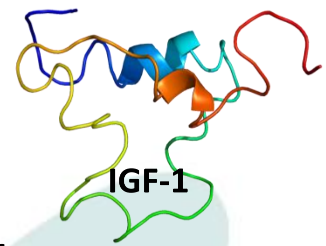


- Major sources in pigs: legumes and cereals *(Gibson, 1994)*
- Whole grain cereals = phytate → inhibit Zn bioavailability



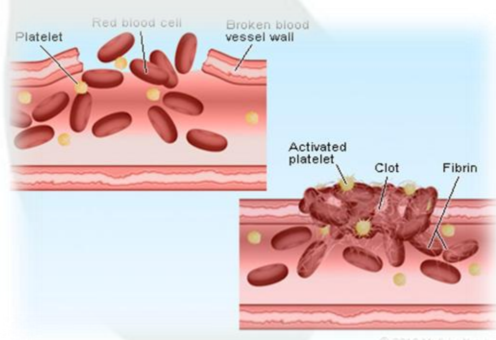
Zn functions

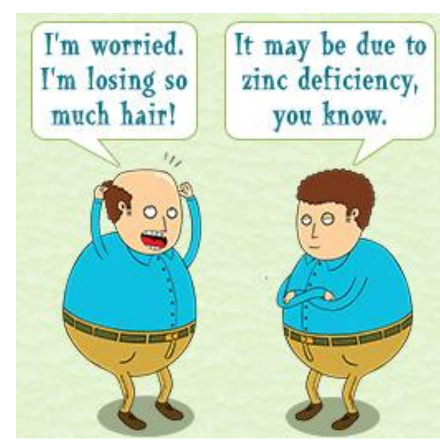
- Growth:
  - Stimulate connective tissue development and maintenance.
  - Stimulate bone mineralization
  - Regulate the function of IGF1



- Essential for innate and adaptative immunity
- Antioxidant agent:
  - Keep bio membrane stability

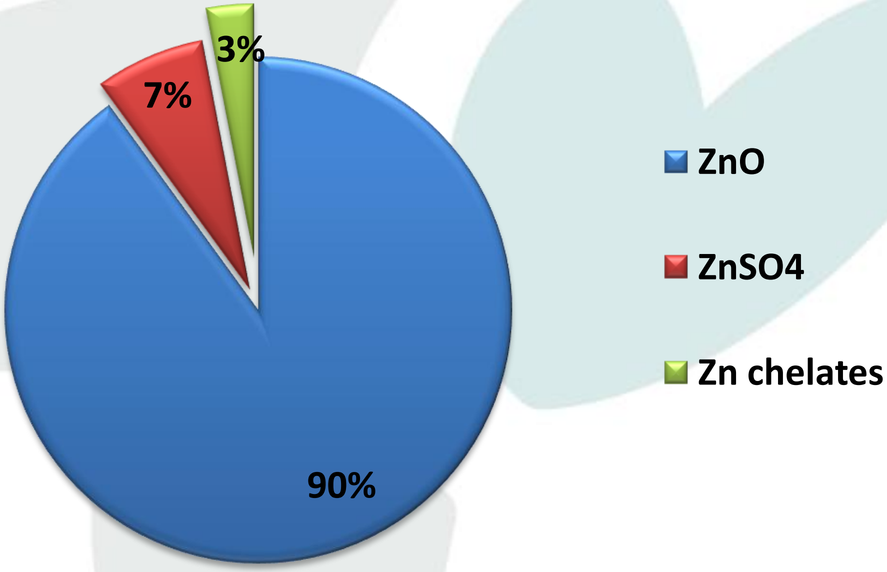
- Wound healing
- Stabilization of DNA and RNA
- Blood clotting
- Appetite control
- Nervous system
- Vision system
- Reproduction system





Types of Zn supplementation

- Two categories:
  - Inorganic: oxide, sulfate, chloride, carbonate
  - Organic: lactate, acetate, chelate of aa



- ZnO/ $ZnSO_4$ = cheaper → commonly used by food industries

- Acetate and sulfate = ↑solubility = ↑absorbable Zn? (controversial studies)
- Effects ZnO in-feed:

↑ Gene expression of antimicrobial peptides in SI

↑IGF-1 and IGF-1R expression in SI mucosa

Positive effect on stability and diversity of microbiota

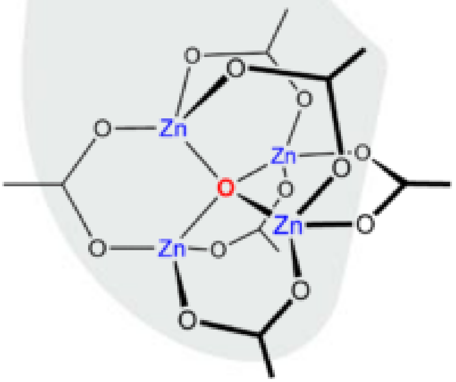
Bactericide

Electrolyte secretion from enterocytes

Zn availability

- The absorbed and retained Zn as a % of intake is <50% *(NRC,2012)*
- Variability of ZnO availability 39-88% relative to $ZnSO_4$. *(Schell and Kornegay 1996)*

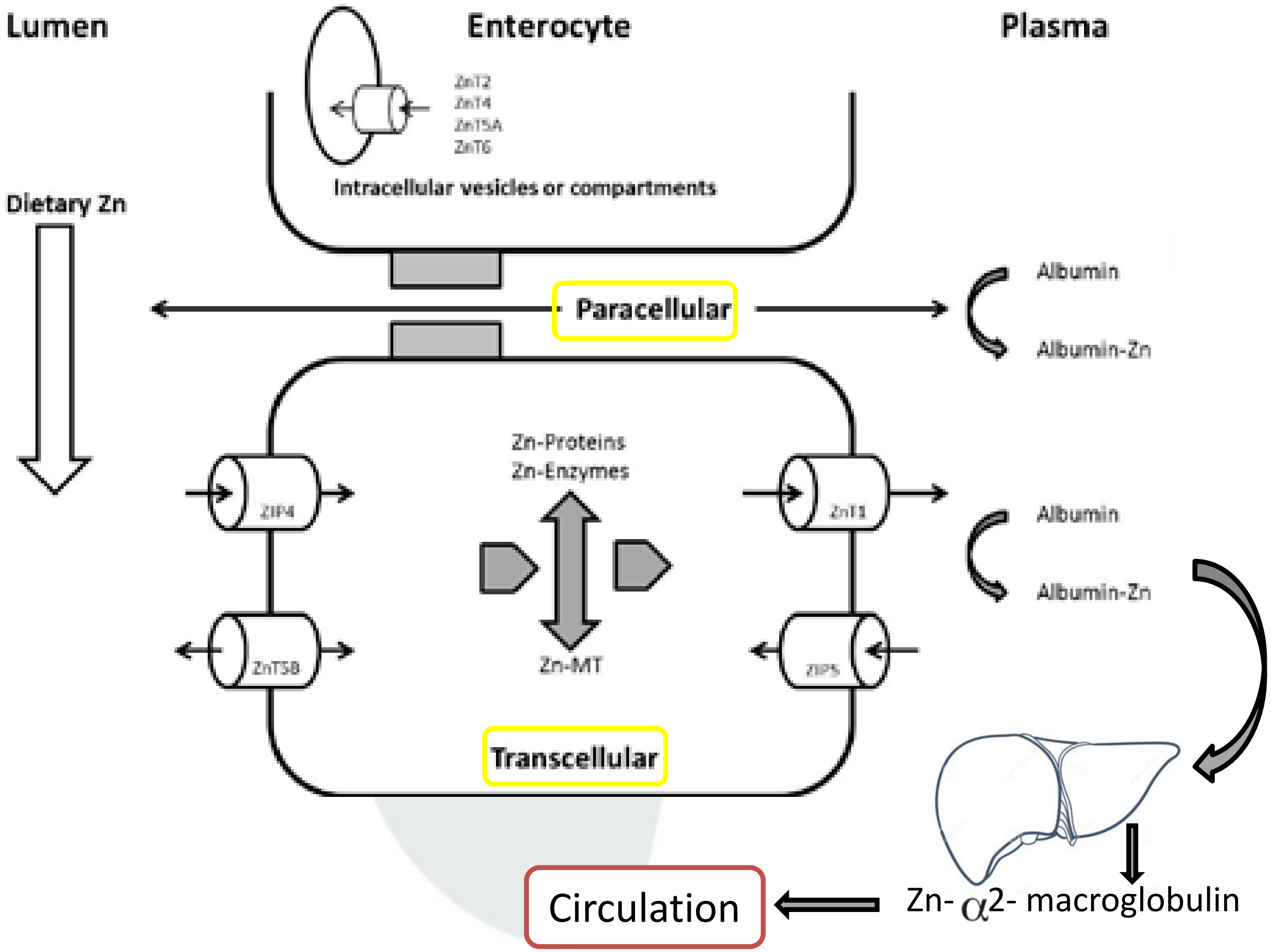
- Bioavailability organic complexes vs. ZnSO4 → no differences *(cheng et al. 1998)*



Zn: DIGESTION AND ABSORPTION

Absorption process in the small Intestine

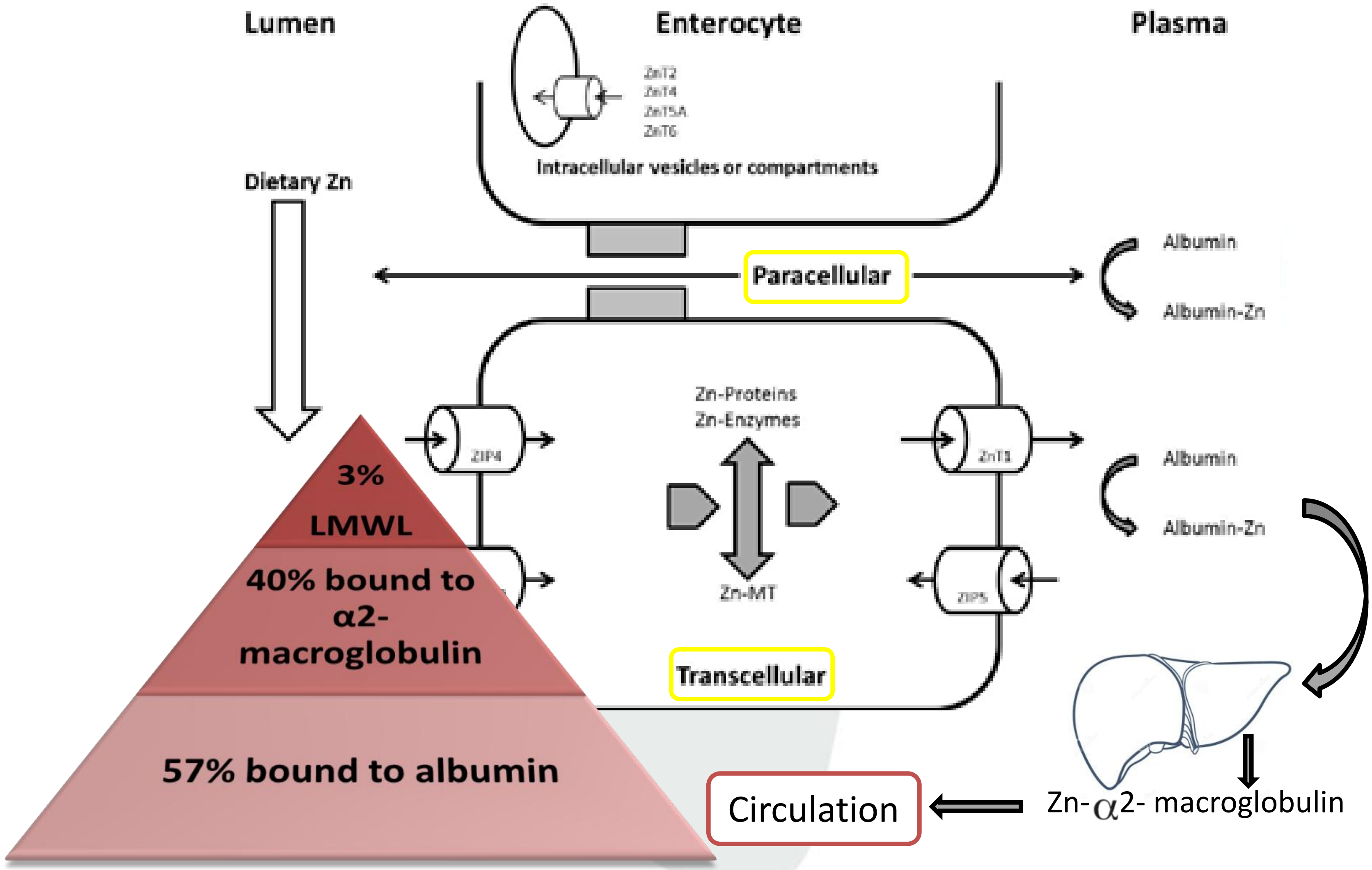
Mainly in jejunum



Adapted from Grider, (2013). Model for intestinal zinc absorption.

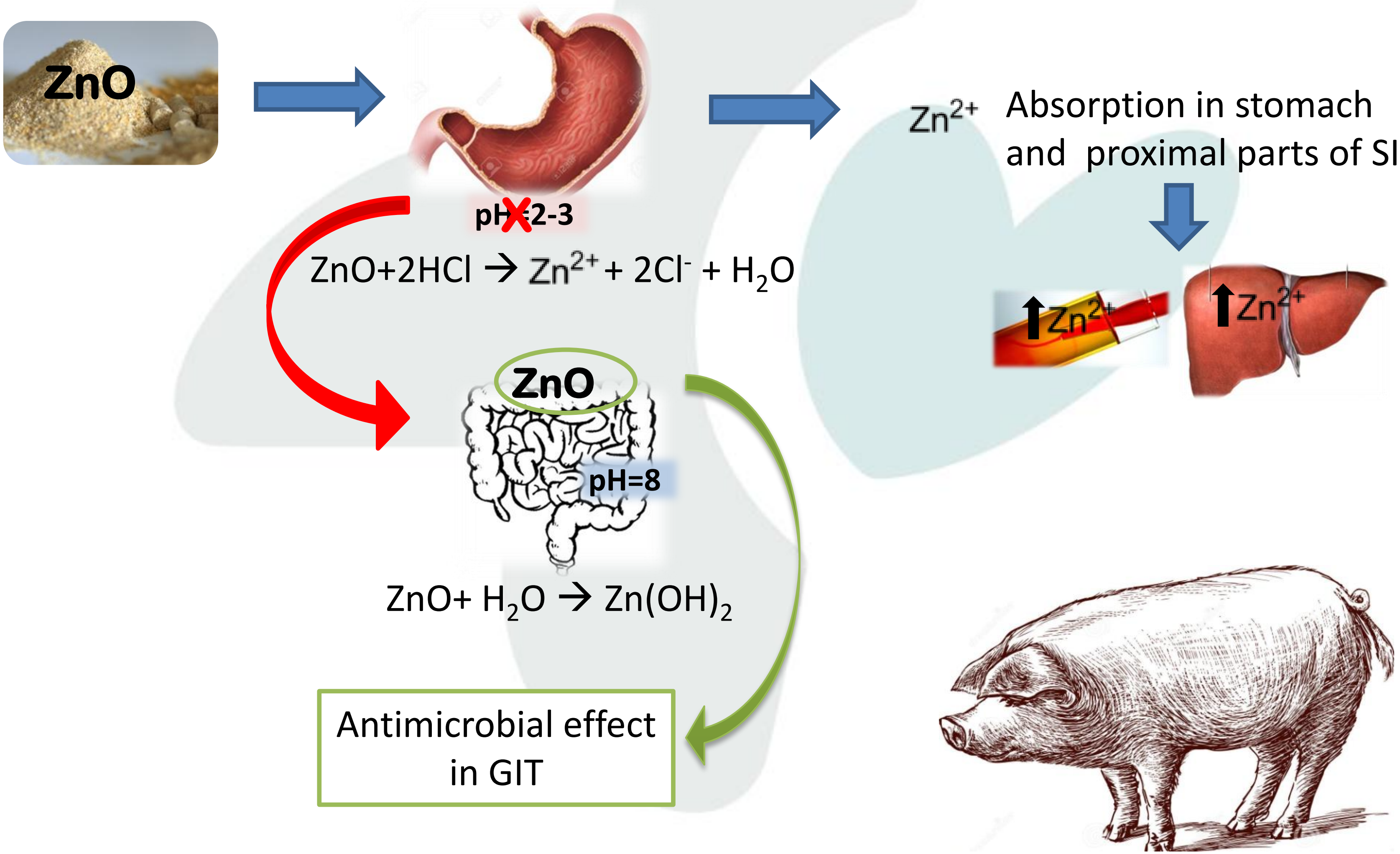
Absorption process in the small Intestine

Mainly in jejunum

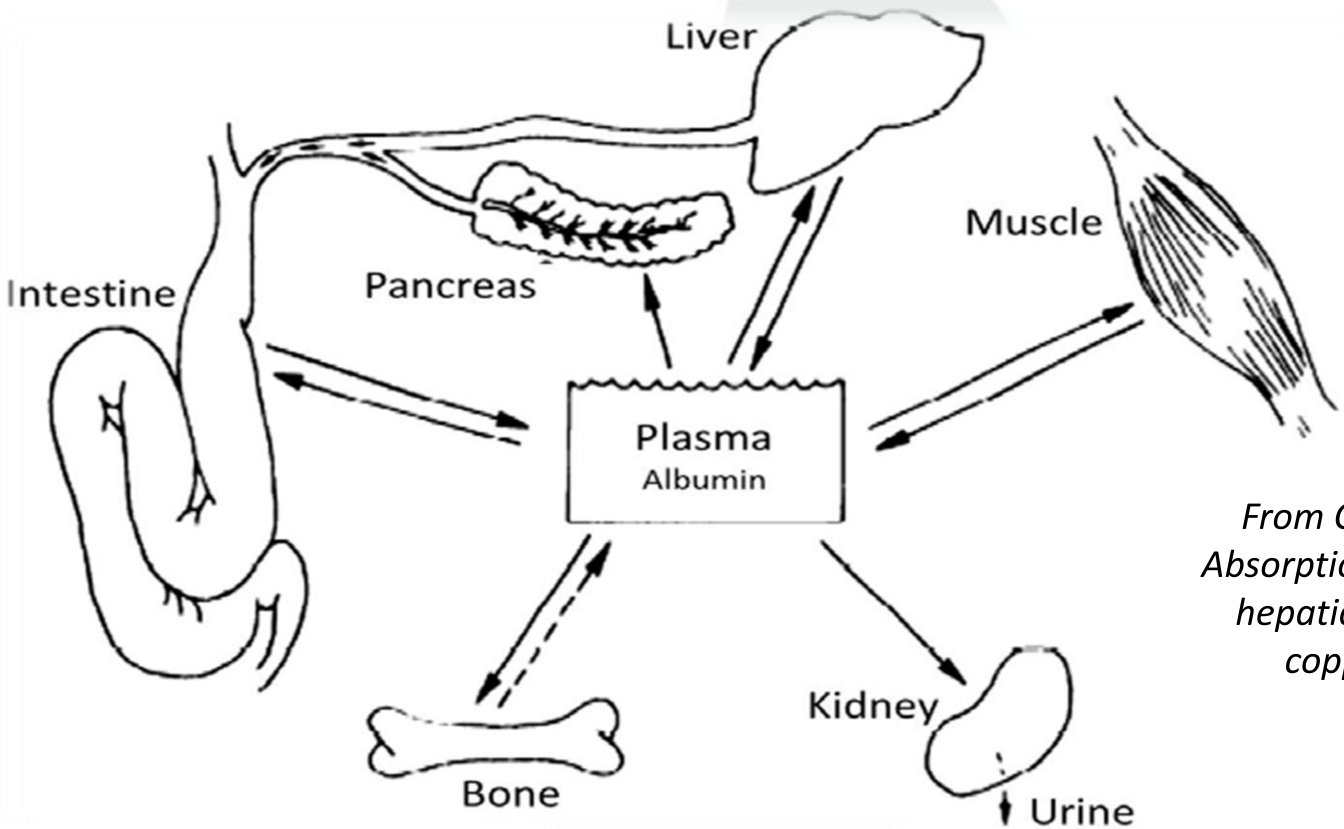


Adapted from Grider, (2013). Model for intestinal zinc absorption.

ZnO absorption process



Zn metabolism



From Cousins, (1985). Absorption, transport, and hepatic metabolism of copper and zinc.

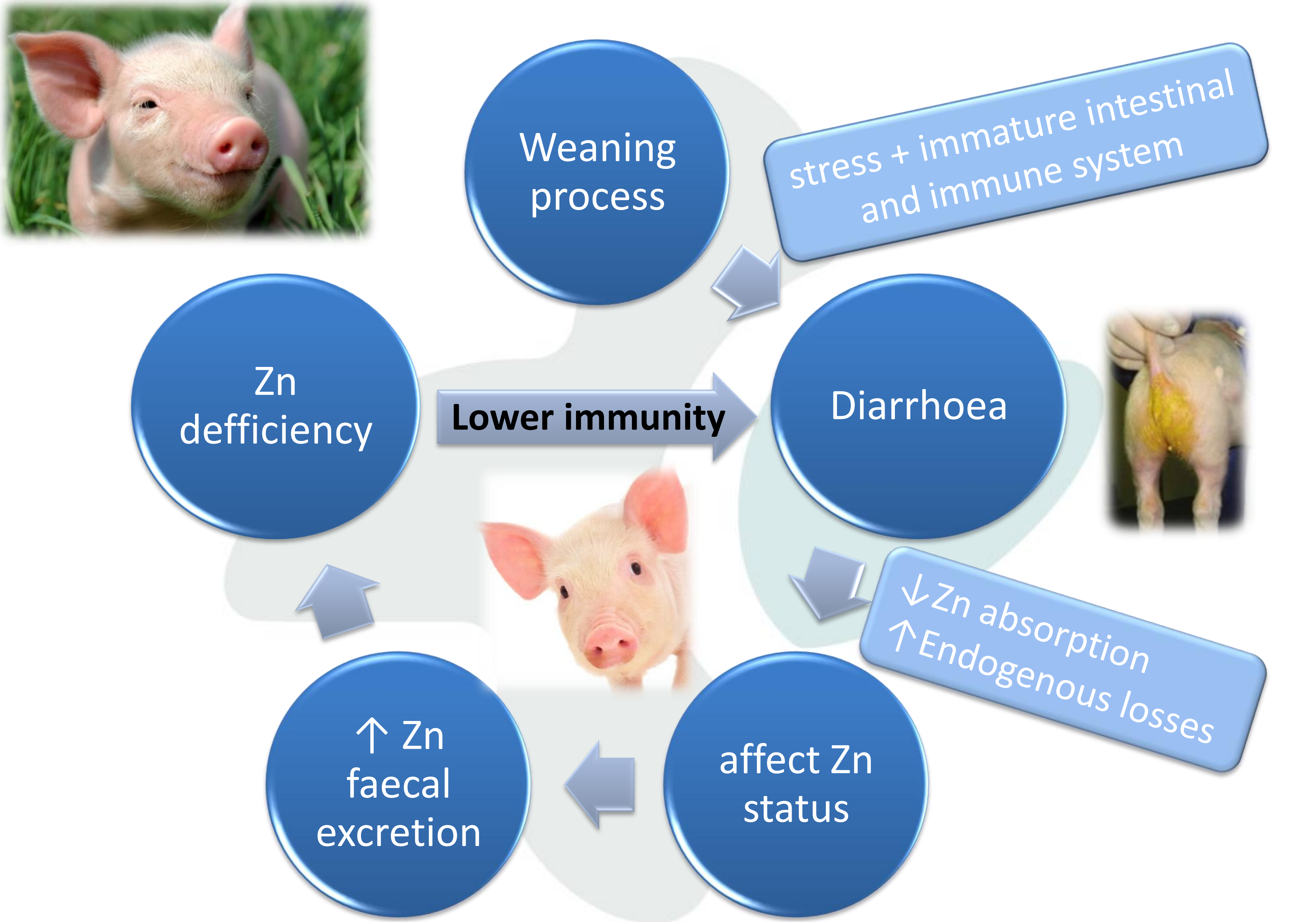
- Zn excretion: faeces (≈90%); urine (≈10%).
- Endogenous Zn GI secretions (pancreatic, bile,...) > consumed in the diet → most of it can be reabsorbed.

Zn DEFICIENCY IN PIGS

- Causes:
  - Genetic (1ary)
  - Poor intake due to ↑phytate, malabsorption states (IBD...) or long term parenteral nutrition (2ary)
  - Increased utilization: sepsis, trauma, Vit.A and Vit. D deficiency and Fe deficiency.
  - Diarrhoea
- Growth retardation
- Depletion of enzyme activity in tissues.

Difficult to diagnose

- First symptoms: ↓appetite and ↓ growth (few days).
- Other symptoms: ↑risk of infections (↓immunity), ↓ taste and smell, alopecia, impaired wound healing and infertility.



Weaning process
stress + immature intestinal and immune system
Diarrhoea
↓Zn absorption
↑Endogenous losses
affect Zn status
↑ Zn faecal excretion
Zn defficiency
Lower immunity

Zn EXCESS/TOXICITY IN PIGS

- As general rule → Zn is not toxic consumed in the diet *(Grider, 2013).*
- More probable in long term exposure.

- In piglets:
  - P deficiency.
  - Poor performance, inflammation and haemorrhages in multiple organs *(Brink et al., 1959)*.
  - ↑ Growth? Unclear!
- Optimum dosage for diarrhoea control =2500 mg Zn/Kg diet.
- Dose =4000-5000 mg Zn/Kg diet → adverse effects.

SIGNIFICANCE OF Zn IN PIGLETS

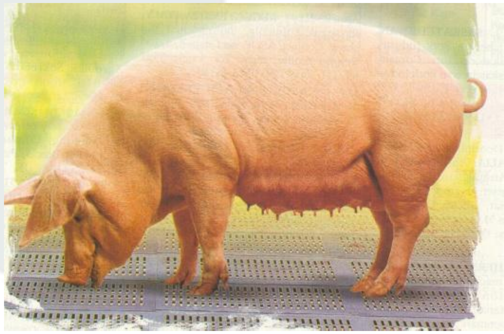
- Commercial conditions → weaning at 21-28 days → stress + immature intestinal and immune system → changes in GI tract physiology, microbiology and immunology.

Environmental
Social
Dietary

- Period after weaning = sub-optimal growth and ↑ incidence of intestinal disturbances (diarrhoea) = ↑mortality.

Pre-weaning situation

- Micronutrients depends on the input during later gestation and lactation.
  - *Caine et al., 2009* → supplementing gestating sows with 250 mg/Kg of Zn = ↑ serum [Zn] in days 7 and 14 after birth.
  - Zn content: colostrum (≈15.70 mg/Kg) > later milk (≈5.69 mg/kg).
- > parturitions = poorer mineral status (total body mineral content), but not in milk.



Post-weaning situation

- DECREASED FEED INTAKE → sub-optimal growth.

Changes in GIT
- Size
- Protein turnover rate
- Microbiota mass

Alterations in GIT functions
- Digestive
- Absorptive
- GIT barrier
- Immune functions

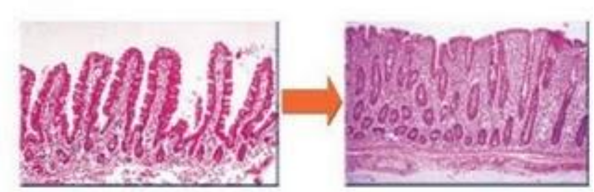
Affected Zn
- Bioavailability
- Absorption

- ↓gastric acid secretion capacity (↑pH), ↓ gastric motility and ↓ empting rate

↓

POST-WEANING DIARRHOEA

- Villus atrophy, crypt hyperplasia, alteration of brush border enzymes



↓

MALABSORPTION OF NUTRIENTS.

Zn AS ANTIDIARRHEAL TREATMENT

- Main problem nowadays in piglets (after weaning).
- Treatment:
  - AB → controversial (resistance + effect in the human consume meat)

  - ZnO – major used supplement→ concerns about the environment.

- Zn supplementation of 2000-3000 mg/Kg:
  - ↓diarrhoea
  - ↑ growth rates
- Mechanisms of action unknown. Hypothesis:
  - ZnO control the pathogenic bacterial
  - ↓Fermentation of digestible nutrients in the proximal part of the GIT = ↑E available = ↑ growth
- Zn treatments →plasma Zn values ≈ 1.5 mg/L → No weight gain with values <1.5 or > 3 mg/L.

ENVIRONMENTAL CONSEQUENCES OF ZN SUPPLEMENTATION

↑Levels Zn supplementation >10 days

Excretion of Zn in faeces

Toxicity to plants and soil microorganisms

Environmental concern in pig farm areas

ZnO has to be registered as a drug.

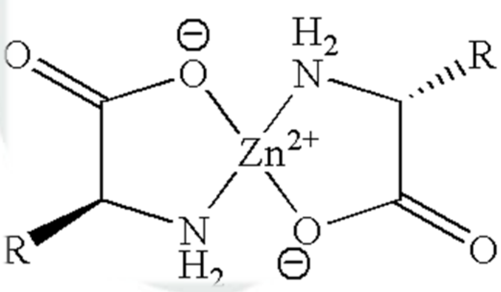
- Recommended posology: 100 mg ZnO/Kg BW for 14 days post-weaning.
- Used in ↑[] and > days → under veterinary prescription.

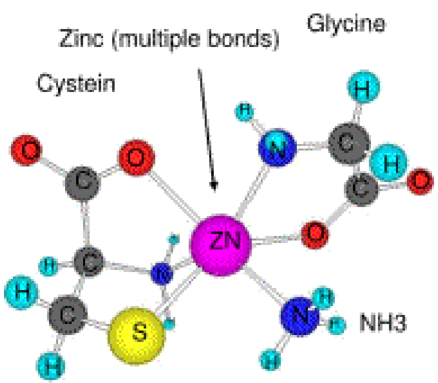
No control on the use.

Maximum content of Zn in feed additives: 150 mg/Kg *(SCAN, 2003)*

Alternatives to ZnO

- Organic Zn compounds: amino acid chelates - Zn methionine, Zn lysine,... → more environmentally friendly.
  - Results are inconsistent (*Van Heugten et al., 2003*)
  - Kind of chelate is an important factor (*Nitrayova et al., 2012*)
- Better with the environment, but no data about the antidiarrheal effect.





SUMMARY

- Weaning in commercial conditions produces a drop in [Zn] plasma, reaching the lowest level 2-3 days post-weaning.
- The drop in [Zn] plasma produce changes in GI tract physiology, microbiology and immunology leading to diarrhoea and increasing the piglets mortality.
- The use of Zn as a treatment is empirical → not accepted studies about its mode of action.
- The use of Zn as ZnO in pig feed industry is accepted for prevention and treatment of diarrhea in early weaned pigs.

SUMMARY

- ZnO < soluble than Zn sulfate, Zn chloride, Zn acetate or Zn chelates and is related with environmental issues.
- $ZnSO_4$ could be an alternative to ZnO, but is not able to ↑[Zn] in serum in piglets and have palatability concerns.

THANKS FOR YOUR ATTENTION

QUESTIONS?

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ECVCN Residents Class 2015

Ketogenic diet in a dog with refractory idiopathic epilepsy

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BACKGROUND

Epilepsy is one of the most common serious neurological conditions in dogs and the prevalence is estimated to be from 0.5% to 5.7%

Most dogs have idiopathic epilepsy and they are often managed successfully with standard antiepileptic drugs, but 30% of cases are refractory to treatment

Refractory Epilepsy,
when its quality of life is compromised by:

- frequent and severe seizures despite of an appropriate drug therapy
- side effects of the medication

BACKGROUND

Currently, many dogs with refractory epilepsy are eventually euthanased or die during uncontrollable seizures (Arrol et al., 2012)

Therefore, non-pharmacological treatment options are becoming important

The Antiepilectic Effect Of Fasting was noted almost 100 years ago (Geyelin, 1921) and the ketogenic diet (KD) was introduced in that same year for the treatment of epilepsy (Wilder, 1921).

KETOGENIC DIET is high in fat, low in carbohydrates and has adequate amounts of protein, based on minimum daily requirements (Kossoff, 2004)

BACKGROUND

KETOGENIC DIET – CLINICAL TRIAL

IN HUMAN:

Clinical trials have demonstrated that approximately 50% of children with refractory epilepsy who receive the KD will have at least 50% reduction in seizures (Henderson et al., 2006, Neal et al., 2008, Kossoff et al., 2009 and Kessler et al., 2011)

IN DOG:

Only two abstracts describe the use of a KD in dogs with refractory idiopathic epilepsy (Patterson et al., 2005; Pagani et al. 2014).
Dogs receiving the ketogenic food over a period of 2 months had significantly decrease of seizure frequency than controls, but there was no significant difference in urine ketosis.

CLINICAL CASE

EMMA

Border Collie, intact female, 5 years,
17 Kg, BCS= 4/9

- October 2013: Diagnosis of idiopathic epilepsy
- Cluster seizures (6-7 for 15 seconds) every two months
- Seizures refractory to treatment with standard antiepileptic drugs (phenobarbital 6 mg/Kg BID and potassium bromide 18 mg/Kg BID): genetic resistance to Phenobarbital (ABCD-1)

KETOGENIC DIET

December 2014: non-pharmacological treatment options

EMMA received a KETOGENIC FOOD over a period of 2 months

The ketogenic diet was high in fat (**65 % d.m**.), low in Nfe (**7% d.m.**) and had adequate amounts of protein (**25% d.m.**), based on minimum daily requirements

11% of total fat was composed of medium-chain triglyceride (MCT)

An Adequate fluid intake has been necessary to prevent constipation and kidney stones

During the clinical trial, the treatment with antiepileptic drugs was kept constant and equal to that administered before starting

KETOGENIC DIET

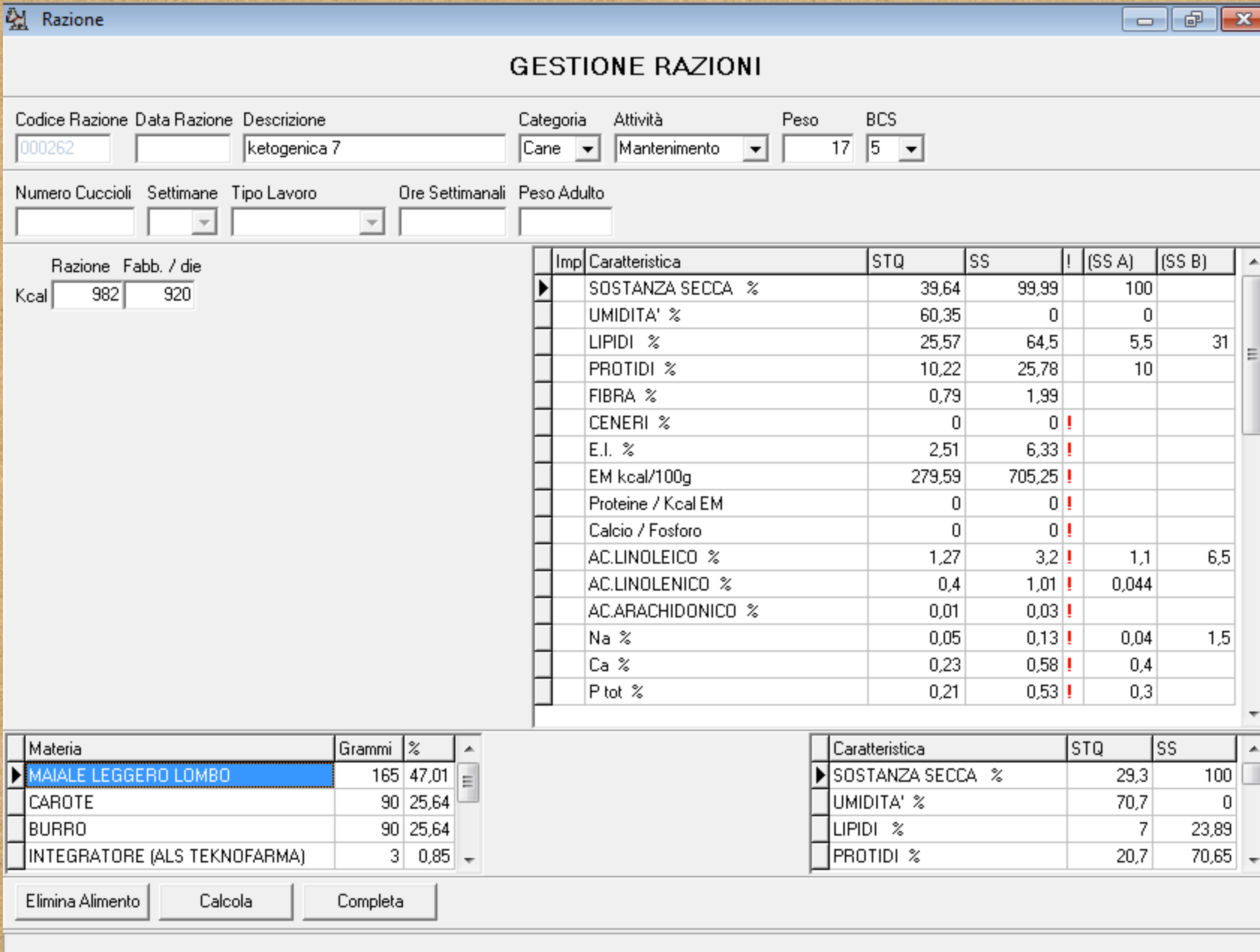
DER: 110 X (17)*0,75 = 920 Kcal/die

Ingredients	Gramme	%
Pork meat	165	47,02
Carrots	90	25,64
Butter	90	25,64
MCT oil	3	0,85
Mineral and Vitamine supplement	3	0,85
Total	351	100

content of MCT in coconut oil: 58,2%

content of MCT in butter: 6,3%

11% of total fat (65%) was composed of medium-chain triglyceride (MCT)



Razione

GESTIONE RAZIONI

Codice Razione	Data Razione	Descrizione	Categoria	Attività	Peso	BCS
000262		ketogenica 7	Cane	Mantenimento	17	5

Numero Cuccioli	Settimane	Tipo Lavoro	Ore Settimanali	Peso Adulto

	Razione	Fabb. / die
Kcal	982	920

Imp	Caratteristica	STQ	SS	!	(SS A)	(SS B)
	SOSTANZA SECCA %	39,64	99,99		100	
	UMIDITA' %	60,35	0		0	
	LIPIDI %	25,57	64,5		5,5	31
	PROTIDI %	10,22	25,78		10	
	FIBRA %	0,79	1,99			
	CENERI %	0	0	!		
	E.I. %	2,51	6,33	!		
	EM kcal/100g	279,59	705,25	!		
	Proteine / Kcal EM	0	0	!		
	Calcio / Fosforo	0	0	!		
	AC.LINOLEICO %	1,27	3,2	!	1,1	6,5
	AC.LINOLENICO %	0,4	1,01	!	0,044	
	AC.ARACHIDONICO %	0,01	0,03	!		
	Na %	0,05	0,13	!	0,04	1,5
	Ca %	0,23	0,58	!	0,4	
	P tot %	0,21	0,53	!	0,3	

Materia	Grammi	%
MAIALE LEGGERO LOMBO	165	47,01
CAROTE	90	25,64
BURRO	90	25,64
INTEGRATORE (ALS TEKNOFARMA)	3	0,85

Caratteristica	STQ	SS
SOSTANZA SECCA %	29,3	100
UMIDITA' %	70,7	0
LIPIDI %	7	23,89
PROTIDI %	20,7	70,65

Elimina Alimento | Calcola | Completa

FOLLOW UP

FOLLOW UP PERIOD of seizure frequency and laboratory results:

- the day before starting the therapy (T0)
- at 15 days (T1)
- at the end of the trail food period of 2 month (T2)

LABORATORY TESTS performed has been the evaluation of :

- Levels of urinary ketones by a urinalysis strips (Siemens MULTISTIX 10SG: in the presence of acetoacetic acid produces a color change : Acetone and B-hydroxybutyric acid are not detected with this method)
- Complete blood analysis
- Phenobarbitalemia and Bromuremia

SEIZURE FREQUENCY was recorded 24 hours 24 by the owners and analyzed by the neurologist

FOLLOW UP

SEIZURE FREQUENCY : important decrease of seizure frequency (only one episode (2 crises during 5-8 seconds) over a period of 6 months)

URINARY KETONE BODIES: changeable urine concentration of acetoacetic acid

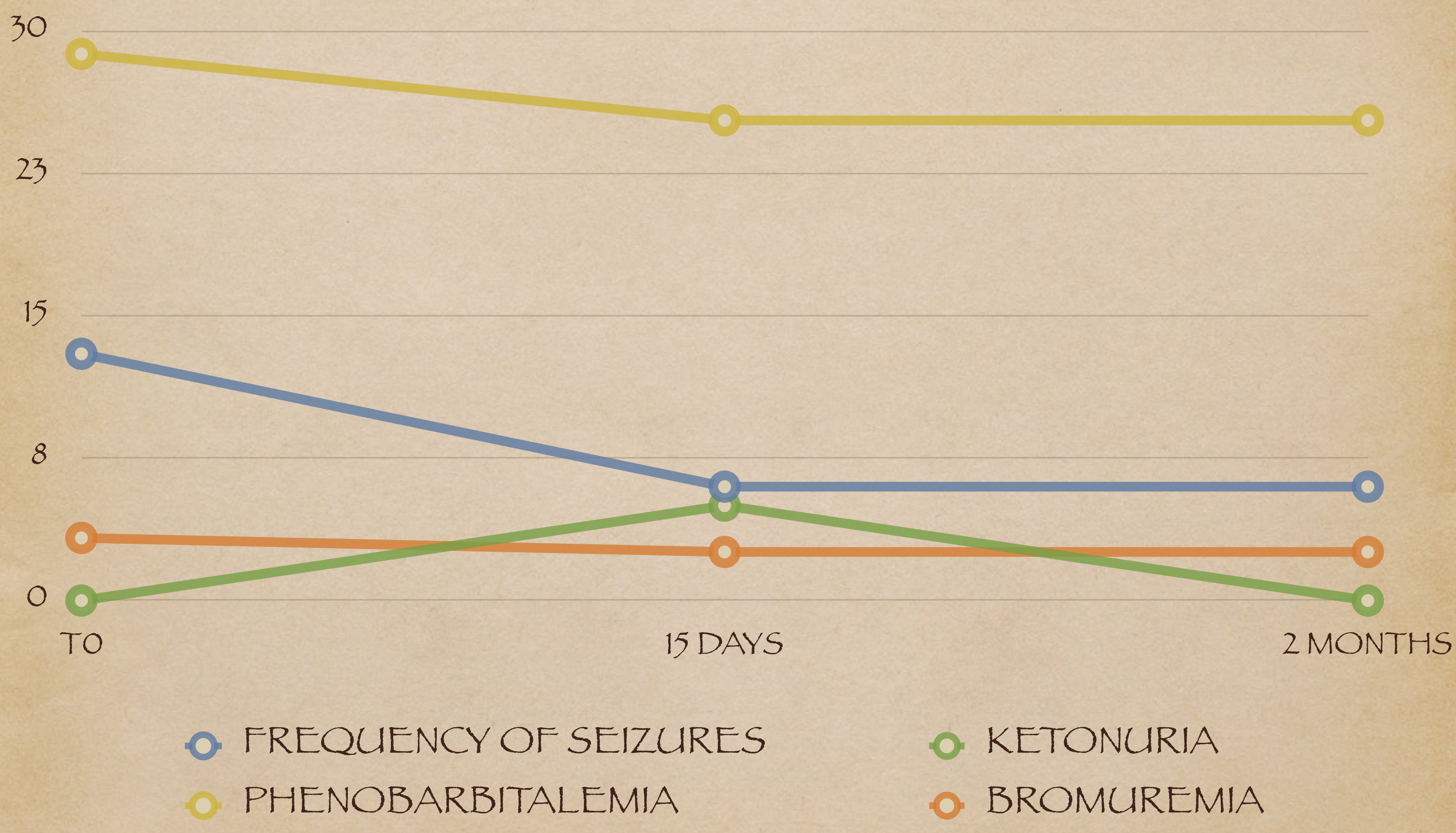
BODY WEIGHT : increase from 17 Kg to 19,6 Kg

CLINICAL SIGNS: After 6 months of ketogenic food: arise acute episode of VOMITING after eating

FOLLOW UP

Analysis	T0	T1	T2
Ketonuria (mg/dl)	no detectable	5	no detectable
Phenobarbitalemia (20-35microg/ml)	28,8	/	25,3
Bromuremia (1000-2000 microg/ml)	3309	/	2564

FOLLOW UP



30
23
15
8
0
TO
15 DAYS
2 MONTHS
FREQUENCY OF SEIZURES
KETONURIA
PHENOBARBITALEMIA
BROMUREMIA

DISCUSSION

WHY "UNSTABLE URINARY KETONE BODIES, BUT CLINICAL IMPROVEMENT"?

A. URINALYSIS STRIPS uses sodium nitroprusside reagent, which, in the presence of acetoacetic acid produces a color change, BUT during ketosis, the normal ratio of 1:1 of β-hydroxybutyrate (βHB) and acetoacetic acid shift to an important elevation of βHB acid.

It would be useful to include in future cases the simultaneous evaluation of blood concentration of **β-hydroxybutyrate acid**

DISCUSSION

WHY "UNSTABLE URINARY KETONE BODIES, BUT CLINICAL IMPROVEMENT"?

B. The precise antiepileptic mechanism of action of the KD still remains unknown (Schwartzkroin, 1999; McNally and Hartman, 2012),

BUT IS PRESUME TO BE MULTIFACTORIAL:

KETONE BODIES

- **Acetone**: suppresses seizures in animal model (Likhodii SS, 2003)
- **Acetoacetate:** neuroprotective against the excitatory neurotransmitter glutamate (Massieu L, 2003)
- **β-hydroxybutyrate**: structurally similar to GABA, inhibitory neurotransmitter (Morris AA, 2005)
- **Ketosis:** increase of oxaloacetate consumption: glutamate is shunted to GABA synthesis (Yudkoff M, 2004)

CHANCE IN LIPIDS

ACIDOSIS AND DEHYDRATION

ALTERED ENERGY STATE

DISCUSSION

WHY "arise acute episode of VOMITING after eating"?

11% of total fat was composed of medium-chain triglyceride (MCT): MCT oil is rapidly absorbed by the gastrointestinal tract, it is often associated with symptoms including abdominal cramps, diarrhea, nausea, and vomiting

Human study suggests to change MCT oil with corn oil without loss of seizure efficacy (Woody RC, 1988)

WHY "weight gain"?

Pet-owner: more energy-dense foods tend to be more palatable but learn to consume them in smaller portion sizes.

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Thank you for your attention

Food allergy and genetic predisposition to dilated cardiomyopathy in a female Doberman

Dr. Nadine Paßlack

Institute of Animal Nutrition

Freie Universität Berlin, Germany

Case description / Anamnesis

- „Mercedes“: Doberman, female, intact, 6 years old

- Suspected food allergy (dermatological signs, especially paws and vulva)

- Initial appointment at the Nutrition Consultation Service: March 23, 2015

Case description / Anamnesis

- Mercedes is healthy otherwise, but shows a genetic predisposition to dilated cardiomyopathy (DCM) (parents and brothers died)

- Request of the owner:

1. Home-cooked diet for the treatment of the food allergy
    - Mercedes tolerates salmon and potatoes

2. Supplements to support heart function (?) -> Taurine, L-carnitine, vitamin E,…

Dietary recommendations

- Diets:

Ingredients	Diet 1	Diet 2	Diet 3
Salmon[1]	425 g	425 g	425 g
Rice[2]	320 g	-	-
Noodles[2]	-	300 g	-
Potato flakes[3]	-	-	320 g
Oil (e.g. linseed oil, fish oil)	28 g	28 g	40 g
Vitamin-Optimix Sensitive[4]	10 g	10 g	8 g
Calcium carbonate	1 g	1 g	2,5 g
VMP-pills[5]	-	-	2 g
Cellulose	10 g	10 g	-

[1] Amount given for raw salmon, but it should be cooked after weighing
[2] Amount given for raw noodles/rice, but it should be cooked after weighing
[3]Amount given for raw potato flakes, but they should be mixed with warm water and soak for approximately 5 minutes
[4, 5] Vitamin and mineral supplements

- Supplements to support heart function: Taurine:
  - **Kittleson et al. (1997):** American cocker spaniels with DCM and taurine deficiency → supplementation of taurine and L-carnitine → blood values within the normal range and improvement of cardiac parameters
  - **Sanderson et al. (2001):** Dogs fed protein-restricted diets showed taurine deficiency; development of canine DCM secondary to taurine deficiency; taurine supplementation led to an improvement of cardiac parameters
  - **Fascetti et al. (2003):** Taurine deficiency in dogs with DCM → improvement of cardiac function with supplementation of taurine
  - **Bélanger et al. (2005):** Reversible taurine-deficient DCM in golden retrievers
  - **Ko et al. (2007):** Large dogs showed lower taurine biosynthesis compared to small dogs
  - **Vollmar et al. (2013):** Taurine deficiency occurred in dogs with and without DCM

- Supplements to support heart function: L-carnitine
  - **Costa and Labuc (1994):** Supplementation of carnitine did not resolve DCM in boxers
  - **Freeman (1998):** Carnitine might not be a causative factor in the pathogenesis of canine DCM; carnitine deficiency is possibly a secondary event in some dogs with DCM

Background

- Supplements to support heart function: n-3-fatty acids
  - **Freeman et al. (1998):** Improved cardiac cachexia and muscle mass; no effect on heart size or heart function
  - **Freeman et al. (1998; 2006):** Increased n-3-plasma-concentration after supplementation
  - **Smith et al. (2007):** Fish oil reduced arrhythmia in Boxers with arrhythmogenic right ventricular cardiomyopathy
  - **Smith et al. (2007); Lavie et al. (2009); Freeman (2010):** Anti-inflammatory, anti-arrhythmogenic effects, improved endothelial function, reduced platelet aggregability; antithrombotic effects

- Supplements to support heart function: Antioxidants
- **Sagols and Priymenko (2011):** Oxidative stress → heart cell damage; supplementation of antioxidants (e.g. Coenzyme Q10, vitamins, polyphenols) for neutralization of free radicals

- Little data available in dogs with heart disease
  - **Tripathi and Hegde (1997):** Alpha-tocopherol pretreatment in dogs with experimentally induced left anterior descending coronary artery occlusion → myocardial infarct size ↓, percent necrosis in the left ventricular mass ↓ compared to untreated animals
  - **Freeman et al. (2005):** Some antioxidants ↓ and biomarkers of oxidative stress ↑ in dogs with congestive heart failure

- Recommendations in the present case:
  - Supplementation of taurine and carnitine especially in case of deficiencies
  - N-3-fatty acid supplementation (e.g. fish oil) might be beneficial
  - Due to the vitamin supplements in the calculated diets, no additional supplementation of antioxidants like vitamin E is necessary

Follow-up

- April 1, 2015: Owner feeds diet based on salmon and rice without vitamins and minerals (as recommended for the first weeks); dermatological signs ↑, diarrhea
  - Recommendation: potato flakes instead of rice
  - Feedback: Dog tolerates diet based on salmon and potato flakes, dermatological signs ↓

- May 21, 2015: pustules on vulva when feeding VMP-pills (vitamin and mineral supplement)

Follow-up

- April 1, 2015: Owner feeds diet based on salmon and rice without vitamins and

ks); dermatological signs ↑, diarrhea

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zoetis

GEBRAUCHSINFORMATION

EMB717

VMP-TABLETTEN

Ergänzungsfuttermittel für Hunde und Katzen mit Vitaminen, Mineralstoffen und Proteinen

Gehalte an Inhaltsstoffen

33 %	Rohprotein
30 %	Rohasche
6,5 %	Calcium
3 %	Rohfett
5,3 %	Phosphor
1,8 %	Magnesium
1 %	Rohfaser

Ernährungsphysiologische Zusatzstoffe je kg

Vitamine, Provitamine und chemisch definierte Stoffe mit ähnlicher Wirkung:

Vitamin A (E672)	700 000 I.E.
Vitamin D_3 (E671)	10 000 I.E.
Vitamin E (α-Tocopherolacetat)	2 300 mg
Vitamin B_1	500 mg
Vitamin B_2	500 mg
Vitamin B_6	250 mg
Vitamin B_{12}	500 µg
Nicotinsäureamid	2 500 mg
Folsäure	30 mg
Biotin	12 000 µg

Verbindungen von Spurenelementen:

Kupfer (E4) als Kupfer-(II)-sulfat, Pentahydrat	45 mg
Eisen (E1) als Eisen-(III)-oxid	6 000 mg
Mangan (E5) als Mangan-(II)-carbonat	100 mg
Zinkoxid	2 000 mg

Zusammensetzung

Hefen
Mineralstoffe
Zucker
Fleisch und tierische Nebenerzeugnisse

zoetis

Follow-up

- **Recommendation:** to increase the amount of „Vitamin-Optimix Sensitive“ in order to remove the VMP-pills

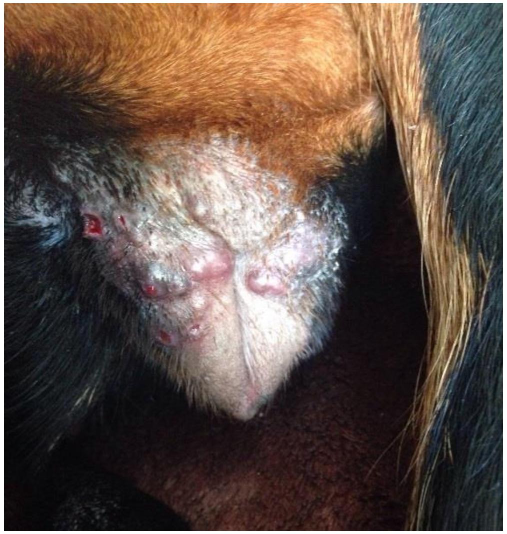
Ingredients	Diet 3
Salmon[1]	425 g
Potato flakes[2]	330 g
Oil (e.g. e.g. linseed oil, fish oil)	40 g
Vitamin-Optimix Sensitive[3]	10 g
Calcium carbonate	2,5 g

[1] Amount given for raw salmon, but it should be cooked after weighing
[2] Amount given for raw potato flakes, but they should be mixed with warm water and soak for approximately 5 minutes
[3] Vitamin and mineral supplement

Follow-up

- June 10, 2015: Dog tolerates the diet based on salmon and potato flakes with all supplememts; no dermatological signs

- July 2, 2015: Pustules on vulva



Follow-up

- Recommendation: to replace the dietary protein source -> pig instead of salmon; supplementation of biotin and zinc

Ingredients	Diet 4	Diet 5
Pig meat[1]	320 g	360 g
Potato flakes[2]	280 g	-
Corn flakes[3]	-	195 g
Oil (e.g. e.g. linseed oil, fish oil)	32 g	40 g
Vitamin-Optimix Sensitive[4]	11 g	11 g
Canestro Biotin Forte[5]	1 g	1 g
Iodized table salt	-	0.5 g

[1] Amount given for raw pig meat, but it has to be cooked after weighing
[2] Amount given for raw potato flakes, but they should be mixed with warm water and soak for approximately 5 minutes
[3] Amount given for raw corn flakes, but they should be cooked and soak for a few minutes
[4] Vitamin and mineral supplement
[5] Biotin and zinc supplement

Follow-up

- Feedback (July 24, 2015): Owner did not change the protein source to date, since dermatological signs improved; owner noticed that dog tolerates cooked but not raw salmon
  - Change of allergenic potential of protein due to heat treatment?

- Owner will stop feeding raw salmon and observe dermatological signs. In case that pustules still occur, dietary protein source will be replaced

…To be continued…

Discussion

- Some things to discuss…

…Mineral and vitamin supplements: Animal protein → allergy symptoms

…Impact of heat process on allergenic potential of protein?

…(Further) recommendations for dogs with a predisposition to DCM?

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Freie Universität Berlin

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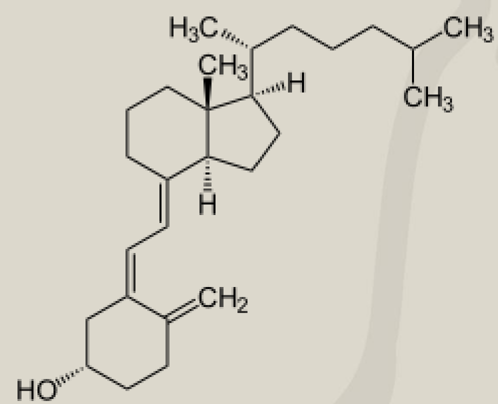
Stiftung Tierärztliche Hochschule Hannover
University of Veterinary Medicine Hannover, Foundation

A Case of Vitamin D Intoxication in Alpacas



http://upload.wikimedia.org/

Christine Ratert

Outline

- The case: - anamnesis (reported symptoms, diagnostics done before, pathological findings)
  - background information: vit. D intoxication
  - feed analysis
  - results and discussion
  - therapy/feeding advice
  - references

http://pixabay.com/static/uploads/photo/2012/04/26/22/15/alpaca-43324__180.jpg

The case: anamnesis, symptoms

Anamnesis:

- **farm with alpacas (including 32 stallions, 42 mares and foals)**
- **feeding of alfalfa hay and two variants of a special complementary feed for alpacas**
- **housing on paddocks with only small residuals of grass**
- **worse body condition and some animals worse general condition**

  → consultation of veterinarian

The case: anamnesis, symptoms

Anamnesis: diagnostic of the veterinarian

- **blood sample of four animals → high vitamin D levels**
- **worse general condition**

Reception order → clinic for small ruminants, TiHo

The case: pathological findings

Findings: Clinic of small ruminants

Vorberichtlich zeigte die Stute seit dem Vortag ein reduziertes Allgemeinbefinden mit Untertemperatur und vermehrtem Liegen. Eine Vorbehandlung durch den Haustierarzt erfolgte bereits mit Metamizol, Gastrogard und Elektrolyten per os.
Bei der Aufnahmeuntersuchung befand sich die Stute in Brust-Bauchlage und konnte nicht aufgestellt werden. Die Bauchwand war nicht vermehrt gespannt. Das Tier war hochgradig abgemagert. Bei der Manipulation, um einen venösen Zugang zu legen, zeigte das Tier kurzzeitig Maulatmung und geriet in Seitenlagen. Es erfolgte eine erste Versorgung mit einer Infusion, Antibiose und einem Schmerzmittel. Eine Blutuntersuchung ergab Hinweise auf eine Niereninsuffizienz (Creatinin- und Harnstoffwerte waren im Blut erhöht). Aus einer Kotprobe konnte kein okkultes Blut als Hinweis auf das Vorliegen eines Magengeschwüres nachgewiesen werden.
Trotz intensiver Therapie verendete die Stute am Morgen des [redacted]
Der Tierkorper wurde in Absprache mit Ihnen an das Institut für Pathologie zur Sektion weitergeleitet. Das klinisch unauffällige Fohlen wurde von Ihnen am selben Tag abgeholt.

Bei der Sektion wies die Stute einen sehr schlechten Ernährungszustand auf, der wahrscheinlich zu dem nachgewiesenen hypoproteinämischen Erguss in der Bauchhöhle geführt hat. Die Stute war tragend mit einem weiblichen Fetus. Im Bereich des ersten Kompartimentes konnte eine gering- bis mittelgradige Gastritis mit einem hochgradigen, fibinreichen Ödem in der Submukosa (Gewebeschicht unter der Schleimhaut) festgestellt werden. Des Weiteren zeigten beide Nieren eine gering- bis mittelgradige, chronische, interstitielle Nephritis, eine gering-bis mittelgradige, intersititielle Fibrose sowie hochgradige, intratubuläre mineralisierte Konkremente. Die Ablagerung der Konkremente in den Nieren kann u. a. Folge einer ungenügenden Wasseraufnahme, einer Hyperkalzämie sowie einer Überdosierung von Vitamin D sein. Eine genaue Abklärung der Ursache ist jedoch in den meisten Fällen nicht möglich.
Als Todesursache wurde ein akutes Herz-Kreislaufversagen festgestellt, vermutliche infolge der Veränderungen sowohl an den Nieren als auch am Magensystem.

The case: pathological findings

Anamnesis: diagnostic of the clinic for small ruminants, TiHo

- clinical examination of one mare: cachexia, renal dysfunction (crea↑, urea↑), no signs of gastric ulcer (occult blood)…
- pathological analysis: ascites (hypoproteinaemic, low grade gastritis, low to middle grade interstitial nephritis and low to middle grade interstitial fibrosis, and high grade mineralized intratubular concrements (potential cause: reduced water intake, hypercalcaemia, vit. D intoxication).
  Cause of death: cardiovascular failure.

⇨ **Consultation of the Institute of Animal Nutrition – suspected vit. D intoxication**

The case: background information

Hypervitaminosis D (cattle; Stöber 2006):

- **aetiology**: exzessive oral or parenteral supply with vit. D_2, D_3 or metabolites
  - Trisetum flavescens in grass or hay
  - other plants containing vit. D or –metabolites
  - iatrogen (prophylaxis of hypocalcaemia)
- **clinical signs**: apathia, circulatory dysfunction, polyuria ...
- **pathological findings**: calcification of soft tissues (endocardium, blood vessels, kidneys, lungs)
- **diagnosis**: mostly post-mortem
- **therapy**: unknown
- **prophylaxis**:
  - prevention of intake of toxic plants
  - treatment according to dosage recommendation

http://www.botanikus.de

The case: feed evaluation/feed analyses

Visual appraisal alfalfa hay:

macroscopy:	green colour
	no hints on occurrence of trisetum flavescens
	no blossoms visible
	high proportion of stems
smell:	aromatic
grip:	bulky structure

→ No further analyses

The case: feed evaluation/feed analyses

Visual appraisal complementary feed 1:

macroscopy: green-brown pellets

smell: low-grade roast smell

grip: dry

→ vitamin D-analysis

The case: feed evaluation/feed analyses

Visual appraisal complementary feed 2:

macroscopy: dark green pellets

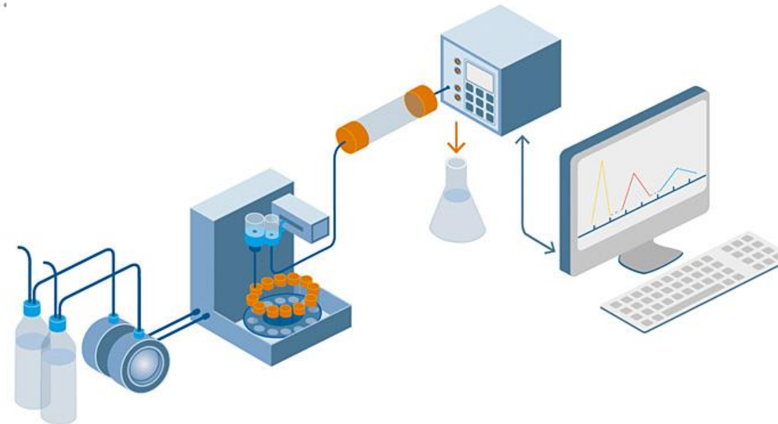
smell: low-grade smell of fatty acids

grip: dry

→ **vitamin D-analysis**

The case: results

Laboratory analysis Vitamin D_3:



http://hiq.lindegas.com

Sample: complementary feed 1+2 (as fed)

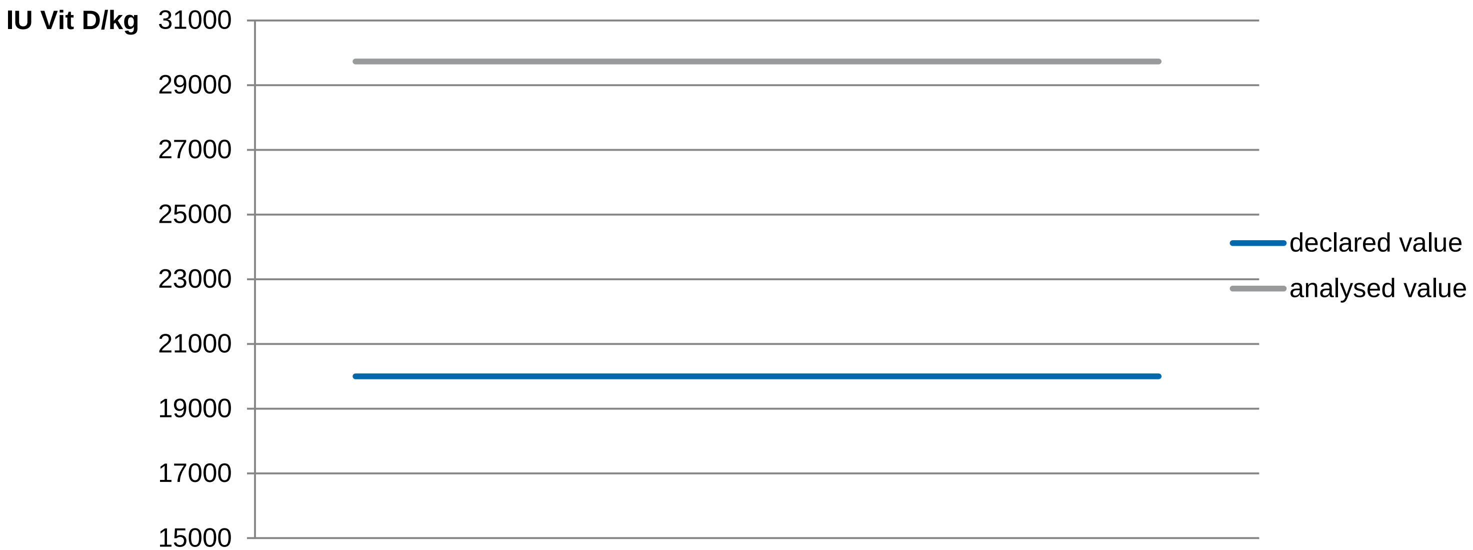
Method: HPLC

Results: complementary feed 1: < 1000 IU/kg diet (not declared)
complementary feed 2: 29730 IU/kg diet (declared: 20000 IU/kg)

→ **How to evaluate the difference from the declared value?**

The case: results

technical latitude amounted to: 10 % of the declared content (Reg. (EG) 767/2009)
analytical latitude amounted to: 28 % relative of the analysed value (VDLUFA 2014)



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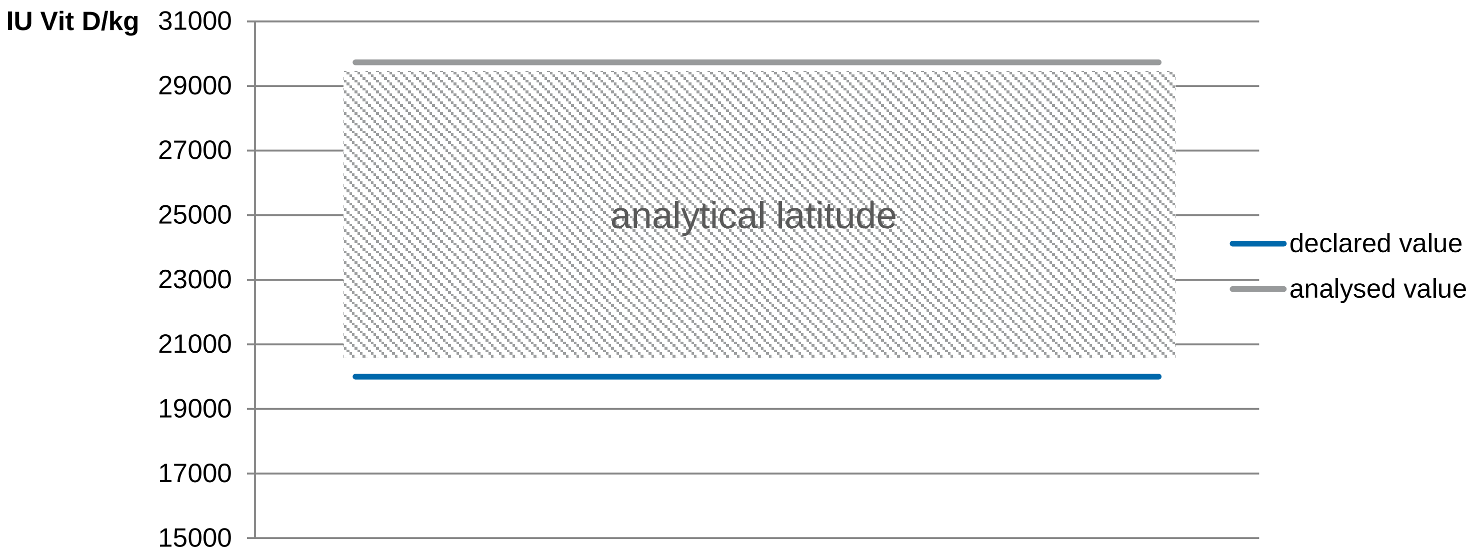

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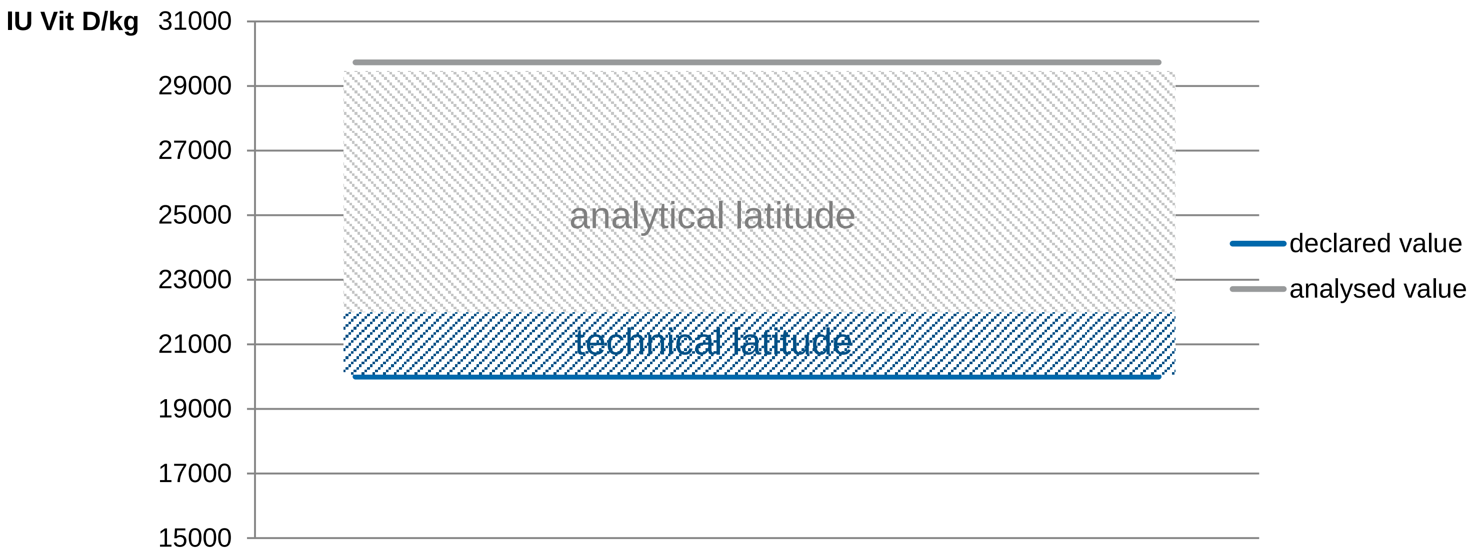

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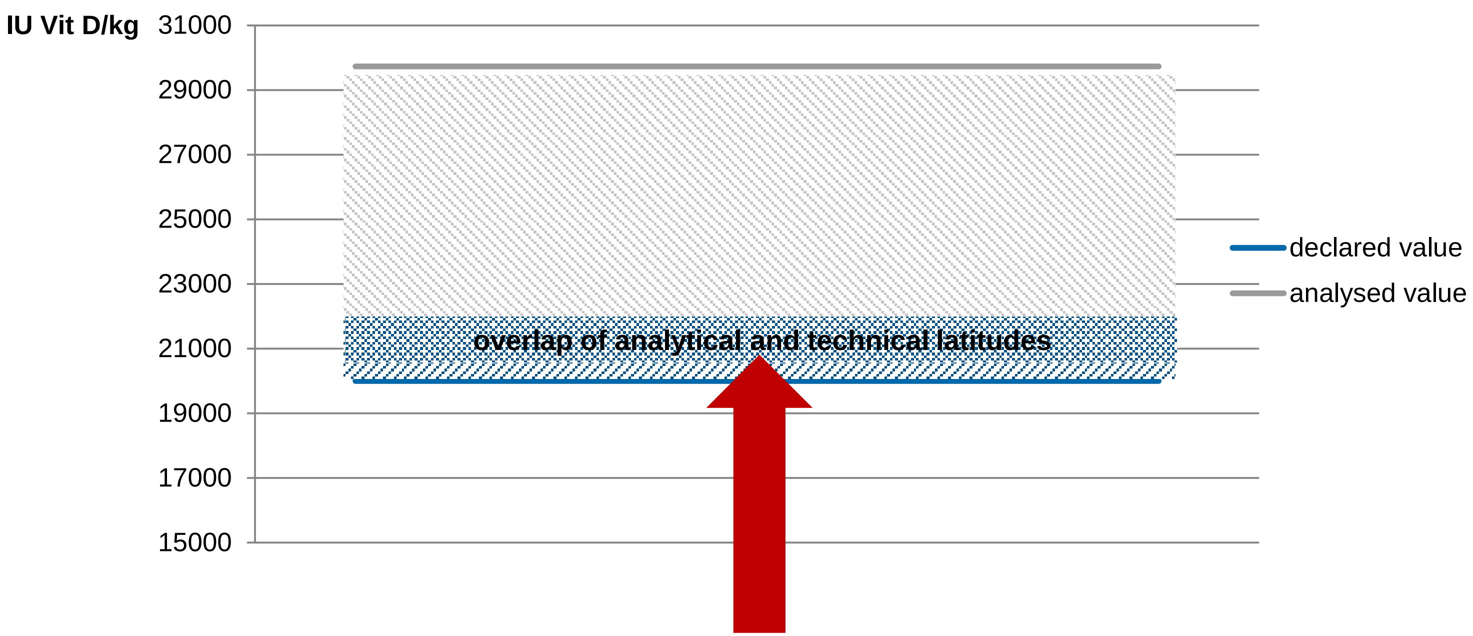


The analysed vit. D content does not deviate beyond the analytical and technical latitudes from the declared value.

→ The analysed content complies with the declared content.

The case: discussion

No feed-related problem?

The case: results and discussion

Gathering of further information

Amount/composition of ration (mares, about 65 kg bw):

1.8 kg complementary feed 1
1.5 kg complementary feed 2
1.76 kg alfalfa hay

The case: results and discussion

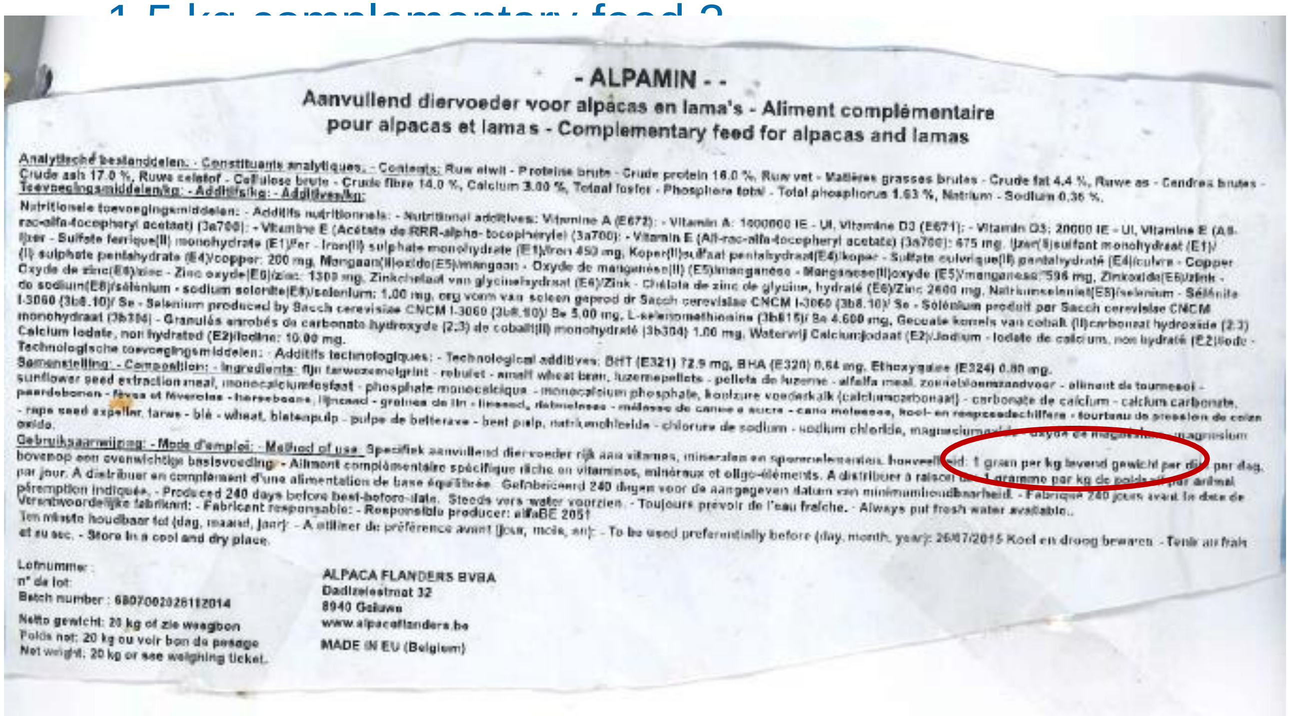
Gathering of further information

Amount/composition of ration (mares, about 65 kg bw):

1.8 kg complementary feed 1

1.5 kg complementary feed 2

Complementary feed 2:



- ALPAMIN - -

Aanvullend diervoeder voor alpacas en lama's - Aliment complémentaire pour alpacas et lamas - Complementary feed for alpacas and lamas

Analytische bestanddelen: - Constituants analytiques: - Contents: Ruw eiwit - Protéine brute - Crude protein 16.0 %, Ruw vet - Matières grasses brutes - Crude fat 4.4 %, Ruwe as - Cendres brutes - Crude ash 17.0 %, Ruwe celstof - Cellulose brute - Crude fibre 14.0 %, Calcium 3.00 %, Totaal fosfor - Phosphore total - Total phosphorus 1.63 %, Natrium - Sodium 0.36 %.

Toevoegingsmiddelen/kg: - Additifs/kg: - Additives/kg:

Nutritionele toevoegingsmiddelen: - Additifs nutritionnels: - Nutritional additives: Vitamine A (E672): - Vitamin A: 1000000 IE - UI, Vitamine D3 (E671): - Vitamin D3: 20000 IE - UI, Vitamine E (All-rac-alfa-tocopheryl acetaat) (3a700): - Vitamine E (Acétate de RRR-alpha- tocophéryle) (3a700): - Vitamin E (All-rac-alfa-tocopheryl acetate) (3a700): 475 mg. IJzer(II)sulfaat monohydraat (E1)/ IJzer - Sulfate ferrique(II) monohydrate (E1)/Fer - Iron(II) sulphate monohydrate (E1)/Iron 450 mg, Koper(II)sulfaat pentahydraat(E4)/koper - Sulfate cuivrique(II) pentahydraté (E4)/cuivre - Copper (II) sulphate pentahydrate (E4)/copper: 200 mg, Mangaan(II)oxide(E5)/mangaan - Oxyde de manganèse(II) (E5)/manganèse - Manganese(II)oxyde (E5)/manganese: 596 mg, Zinkoxide(E6)/zink - Oxyde de zinc(E6)/zinc - Zinc oxyde(E6)/zinc: 1300 mg, Zinkchelaat van glycinehydraat (E6)/Zink - Chélate de zinc de glycine, hydraté (E6)/Zinc 2600 mg, Natriumselenie(E8)/selenium - Sélénite de sodium(E8)/sélénium - sodium selenite(E8)/selenium: 1.00 mg, org vorm van seleen geprod dr Sacch cerevisiae CNCM I-3060 (3b8.10)/ Se - Sélénium produit par Sacch cerevisiae CNCM I-3060 (3b8.10)/ Se - Selenium produced by Sacch cerevisiae CNCM I-3060 (3b8.10)/ Se 5.00 mg, L-selenomethionine (3b815)/ Se 4.600 mg, Gecoate korrels van cobalt (II)carbonaat hydroxide (2:3) monohydraat (3b304) - Granulés enrobés de carbonate hydroxyde (2:3) de cobalt(II) monohydraté (3b304) 1.00 mg, Watervrij Calciumjodaat (E2)/Jodium - Iodate de calcium, non hydraté (E2)/Iode - Calcium iodate, non hydrated (E2)/Iodine: 10.00 mg.

Technologische toevoegingsmiddelen: - Additifs technologiques: - Technological additives: BHT (E321) 72.9 mg, BHA (E320) 0.64 mg, Ethoxyquine (E324) 0.80 mg.

Samenstelling: - Composition: - Ingredients: fijn tarwezemelgrint - rebulet - small wheat bran, luzernepellets - pellets de luzerne - alfalfa meal, zonnebloemzaadvoer - aliment de tournesol - sunflower seed extraction meal, monocalciumfosfaat - phosphate monocalcique - monocalcium phosphate, koolzure voederkalk (calciumcarbonaat) - carbonate de calcium - calcium carbonate, paardebonen - fèves et féveroles - horsebeans, lijnzaad - graines de lin - linseed, rietmelasse - mélasse de canne à sucre - cane molasses, kool- en raapzaadschilfers - tourteau de pression de colza - rape seed expeller, tarwe - blé - wheat, bietenpulp - pulpe de betterave - beet pulp, natriumchloride - chlorure de sodium - sodium chloride, magnesiumoxide - oxyde de magnésium - magnesium oxide.

Gebruiksaanwijzing: - Mode d'emploi: - Method of use: Specifiek aanvullend diervoeder rijk aan vitamines, mineralen en sporenelementen. hoeveelheid: 1 gram per kg levend gewicht per dier per dag, bovenop een evenwichtige basisvoeding. - Aliment complémentaire spécifique riche en vitamines, minéraux et oligo-éléments. A distribuer à raison de 1 gramme par kg de poids vif par animal par jour. A distribuer en complément d'une alimentation de base équilibrée. Gefabriceerd 240 dagen voor de aangegeven datum van minimumhoudbaarheid. - Fabriqué 240 jours avant la date de péremption indiquée. - Produced 240 days before best-before-date. Steeds vers water voorzien. - Toujours prévoir de l'eau fraîche. - Always put fresh water available..

Verantwoordelijke fabrikant: - Fabricant responsable: - Responsible producer: alfaBE 2051

Ten minste houdbaar tot (dag, maand, jaar): - A utiliser de préférence avant (jour, mois, an): - To be used preferentially before (day, month, year): 26/07/2015 Koel en droog bewaren. - Tenir au frais et au sec. - Store in a cool and dry place.

Lotnummer:
n° de lot:
Batch number: 6807002026112014

Netto gewicht: 20 kg of zie weegbon
Poids net: 20 kg ou voir bon de pesage
Net weight: 20 kg or see weighing ticket.

ALPACA FLANDERS BVBA
Dadizelestraat 32
8940 Geluwe
www.alpacaflanders.be
MADE IN EU (Belgium)

The case: results and discussion

Gathering of further information

Amount/composition of ration (mares, about 65 kg bw):

1.8 kg complementary feed 1
1.5 kg complementary feed 2
1.76 kg alfalfa hay

vitamin D requirements of alpacas (Kamphues et al. 2014)

cattle: 5-10 IU/kg bw/day
sheep: 5 IU/kg bw/day

65 kg bw, 10 IU/kg bw/day: requirement - 650 IU vit. D/animal/day

intake of vit. D: not less than **44595 IU/animal/day**

The case: results and discussion

Correct definition of the “complementary feed”?

REGULATION (EC) No 767/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 13 July 2009
on the placing on the market and use of feed, amending European Parliament and Council Regulation (EC) No 1831/2003 and repealing Council Directive 79/373/EEC, Commission Directive 80/511/EEC, Council Directives 82/471/EEC, 83/228/EEC, 93/74/EEC, 93/113/EC and 96/25/EC and Commission Decision 2004/217/EC

⇨ “complementary feed’ means compound feed which has a high content of certain substances but which, by reason of its composition, is sufficient for a daily ration only if used in combination with other feed“

⇨ “mineral feed’ means complementary feed containing at least 40 % crude ash”

Crude ash-content in the complementary feed 2: 17 %

⇨ **correct definition!**

The case: therapy/feeding advice

...

Thank you for your attention!

Questions?

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REGULATION (EC) No 767/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 July 2009

on the placing on the market and use of feed, amending European Parliament and Council Regulation (EC) No 1831/2003 and repealing Council Directive 79/373/EEC, Commission Directive 80/511/EEC, Council Directives 82/471/EEC, 83/228/EEC, 93/74/EEC, 93/113/EC and 96/25/EC and Commission Decision 2004/217/EC

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In: DIRKSEN, G., GRUENDER, H.-D., STOEBER, M. (2006): Innere Medizin und Chirurgie des Rindes. Parey in Medizinverlage Stuttgart GmbH & Co. KG

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Vitamin D metabolism

Isabelle Ruhnke[1,2], Mingan Choct[2], Jürgen Zentek[1]

[1] Freie Universität of Berlin, Berlin, Germany
[2] University of New England, Armidale, Australia

Freie Universität Berlin

HOUGHTON TRUST

une University of New England

Poultry CRC

Outline

1) Vitamin D metabolism

2) Mode of action / clinical signs

3) Therapeutic use

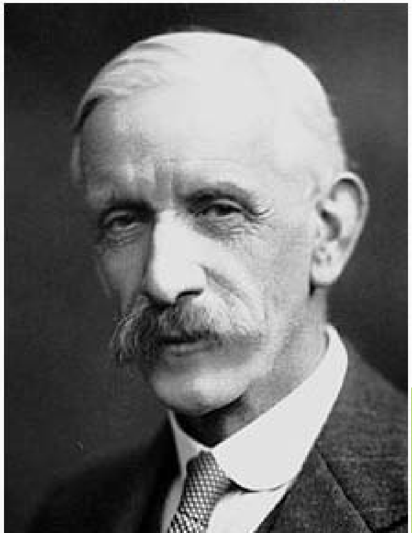
https://www.google.fr/imgres?imgurl=http%3A%2F%2Fnutritionbyerin.com%2Fwp-content%2Fuploads%2F2015%2F07%2F549960-59517-

Vitamins

- Organic compounds that are required to be consumed in small amounts for normal growth and maintenance of animal life
- Does not take into account:

  → MO providing vitamin in GI tract (Vitamin B)
  → Provitamins the can be synthesised (Vitamin D)

Sir Frederick Gowland Hopkins



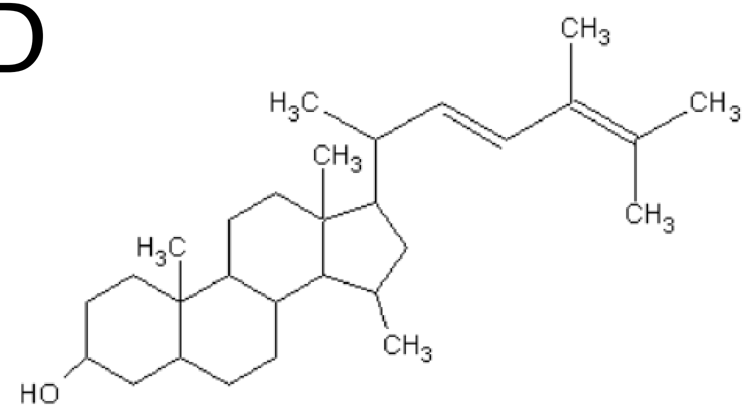
www.wikipedia.de

- Improve animal health
- Enhance the quality of the product

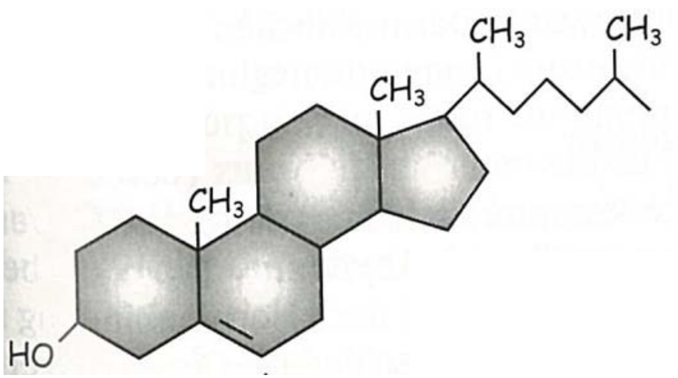
- Fat soluble (Vitamins A,D,E,K)
- Water soluble
  - Occurrence and characteristics are related to solubility

Vitamin D

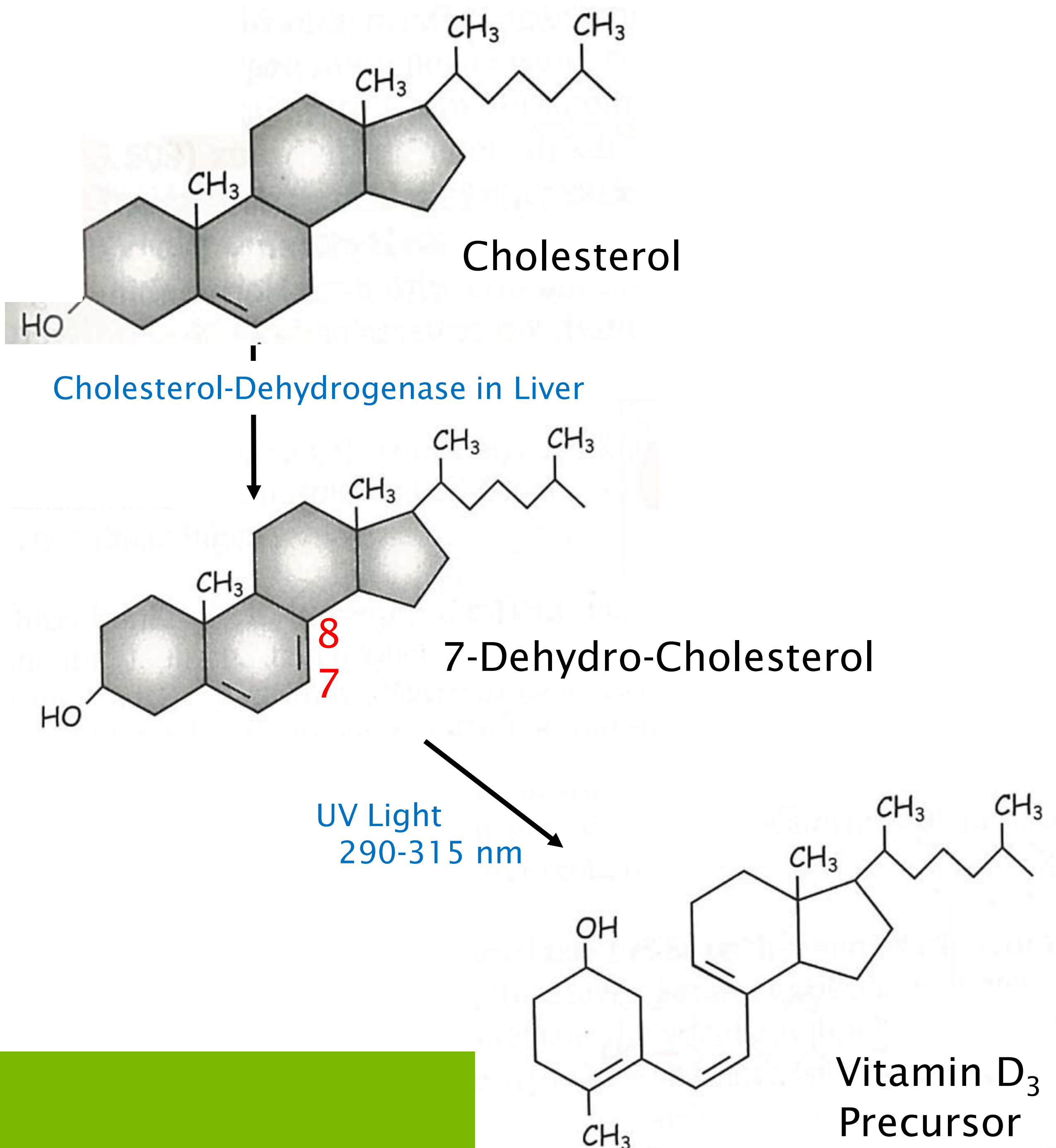
- Vitamin D_2:
  - Plant vitamin D, true vitamin
  - Ergosterol → ergocalciferol
  - UV-light dried roughages, dead leaves

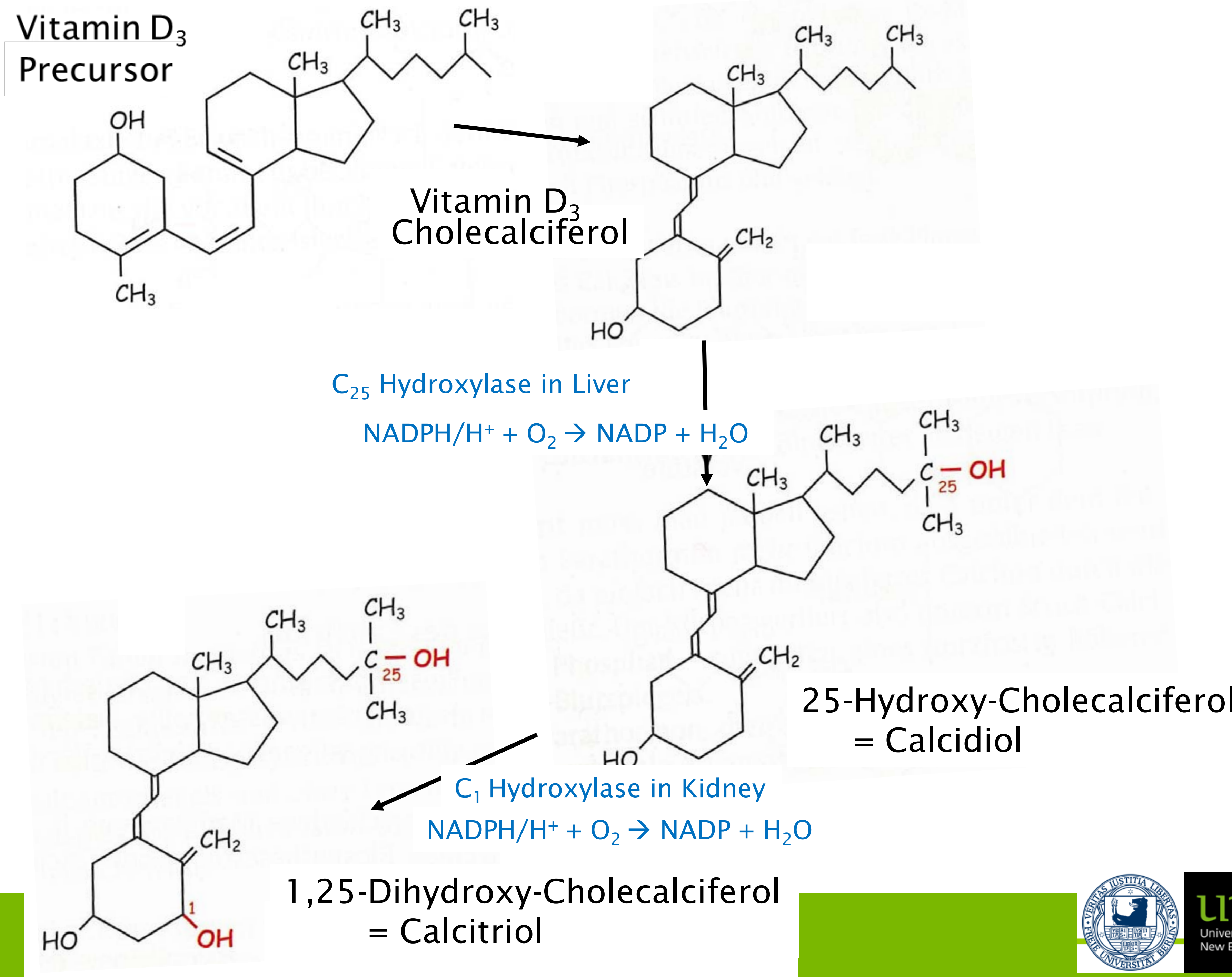


- Vitamin D_3:
  - Animal vitamin D, hormone
  - Cholesterol → cholecalciferol
  - Organ specific (liver, egg yolk)



- Vitamin D_1:
  - Impure activated sterol, mainly D_2 → abolished


CH3
CH3
CH3
CH3
HO
Cholesterol
Cholesterol-Dehydrogenase in Liver
CH3
CH3
CH3
CH3
8
7
HO
7-Dehydro-Cholesterol
UV Light
290-315 nm
CH3
CH3
CH3
OH
CH3
Vitamin D3
Precursor


Vitamin D3
Precursor
Vitamin D3
Cholecalciferol
C25 Hydroxylase in Liver
NADPH/H+ + O2 → NADP + H2O
25-Hydroxy-Cholecalciferol
= Calcidiol
C1 Hydroxylase in Kidney
NADPH/H+ + O2 → NADP + H2O
1,25-Dihydroxy-Cholecalciferol
= Calcitriol
OH
CH3
CH2
HO
25
1

Horses

- Extremely low plasma levels (pg/l vs.ng/l)

- C_1-Hydroxylase activity nearly undetectable
- CaBP less active

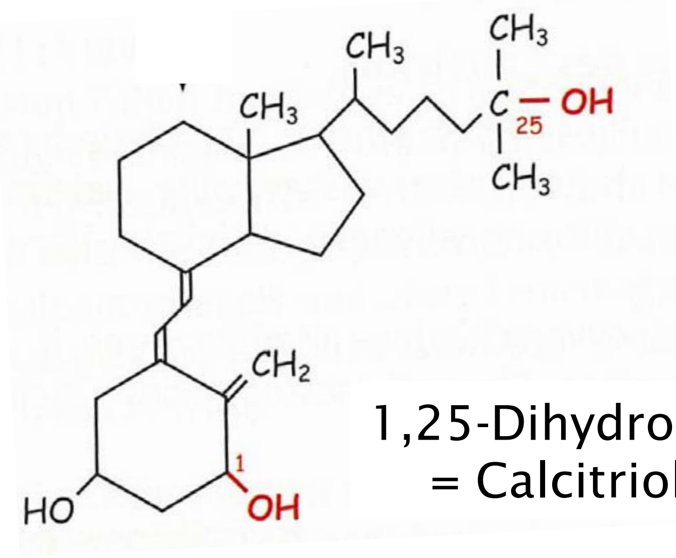
→Vitamin D does not play a key role in C/P homeostasis

Summary 1

- Difference Vitamin D_2/Vitamin D_3
  - hay/liver oil
  - endogenous cholesterol

- Species specifics:
  - Poultry: very limited use of D_2
  - Cats & dogs: food dependent
  - Horses: extremely low metabolic activity

- Newborns are often deficient because of limited uptake and limited enzyme development



1,25-Dihydroxy-Cholecalciferol
= Calcitriol

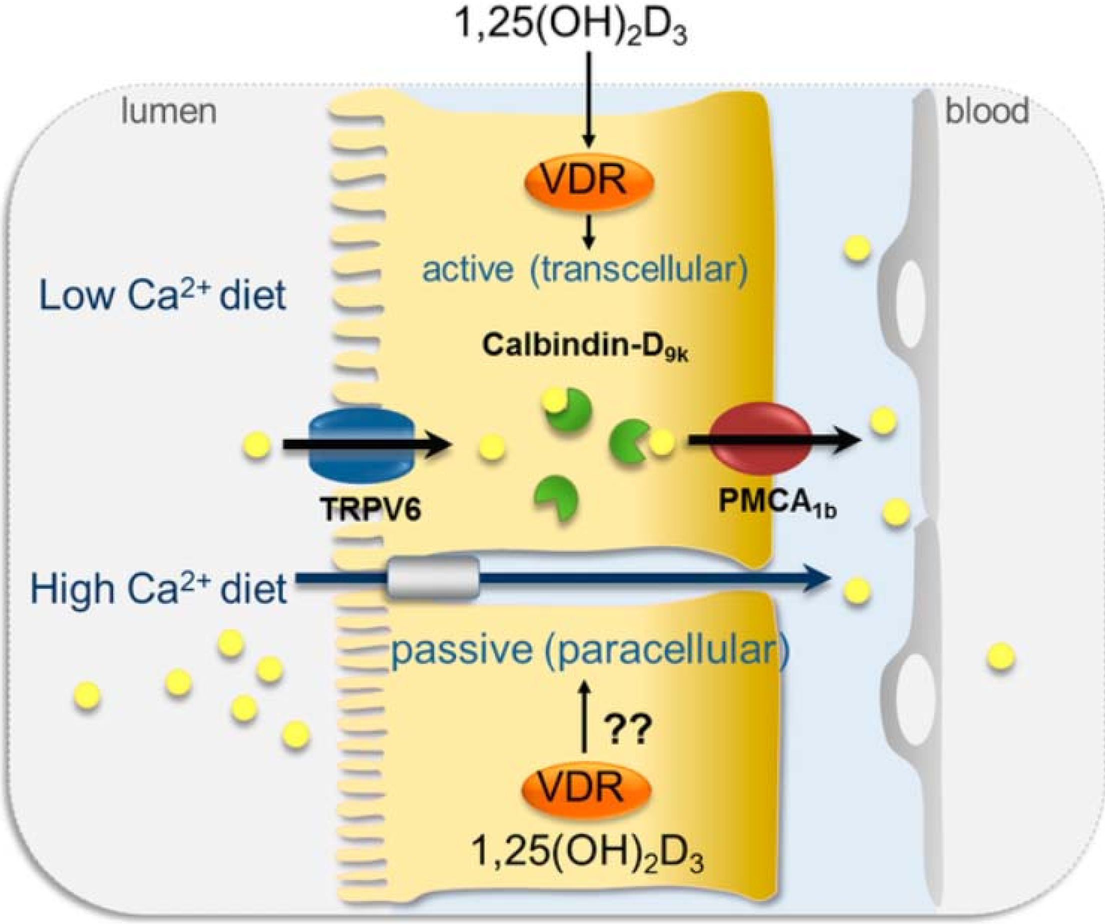
intestine/uterus
CaBP

bones

immune system

- Calcium homeostasis
- Phosphorus reabsorption
- Immune system function

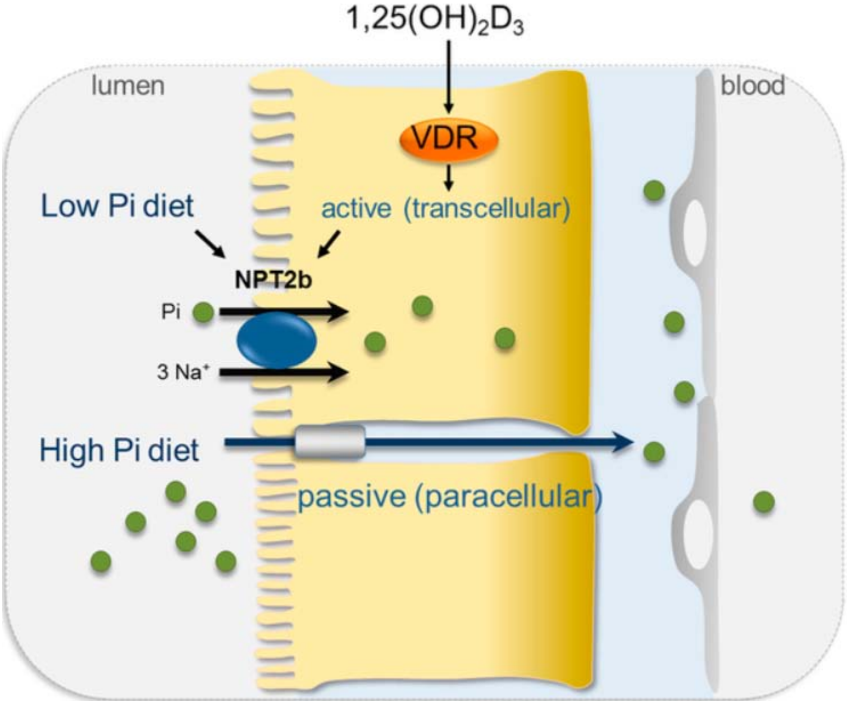
Calcium Binding Protein (CaBP)



Christakos, S., Lieben, L., Masuyama, R., & Carmeliet, G. (2014). Vitamin D endocrine system and the intestine. *BoneKEy reports*, *3*.

Phosphorus absorption

- Enhanced intestinal absorption



Christakos, S., Lieben, L., Masuyama, R., & Carmeliet, G. (2014). Vitamin D endocrine system and the intestine. *BoneKEy reports*, *3*.

- Enhanced renal absorption

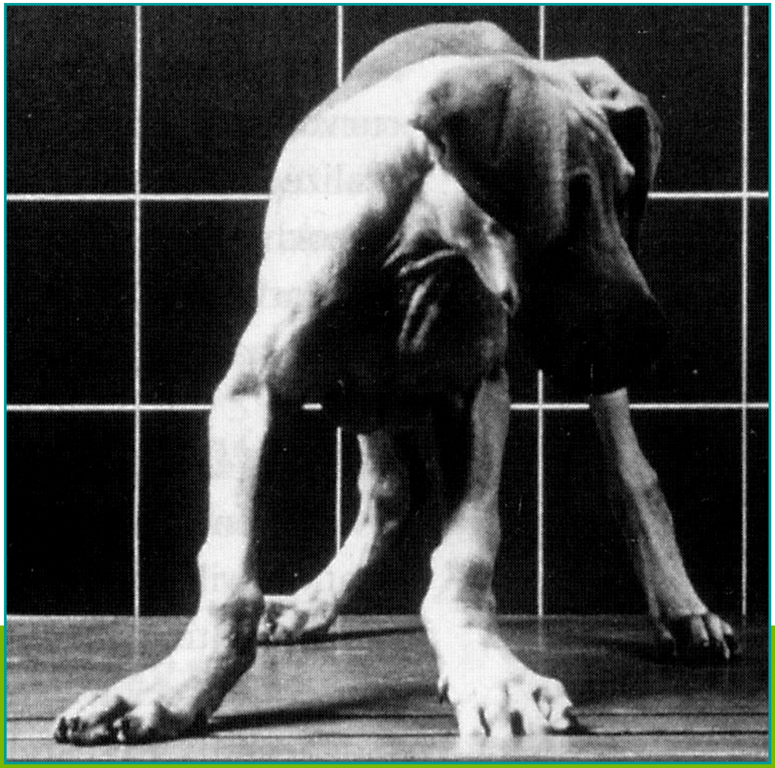
Vitamin D deficiency

- Rickets
  - Cattle: swollen joints, arching back
  - Pigs: enlarged joints, stiff joints, broken bones, paralysis
  - Poultry: bones and beak soft & rubbery, retarded growth, weak legs, reduced egg production, reduced egg shell quality
  - Companion animals: skeletal deformation

- Osteomalacia
  - Uncommon in farm animals (impaired gait, tetanus, reduced egg shell quality, reduced hatchability)
  - Pregnant and lactating animals cave!

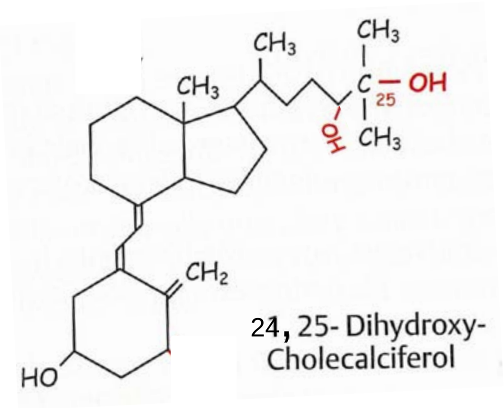
Hypervitaminosis

- Enhanced Calcium mobilization
  - Calcification of arteria
  - Renal tubuli
  - Joints
  - Other organs (liver, spleen, lung)



Hazewinkel, 1985

Excessive Vitamin D:



- Storage form:
  24, 25 Hydroxy-Cholecalciferol

- Excretion via bile, faeces, urine

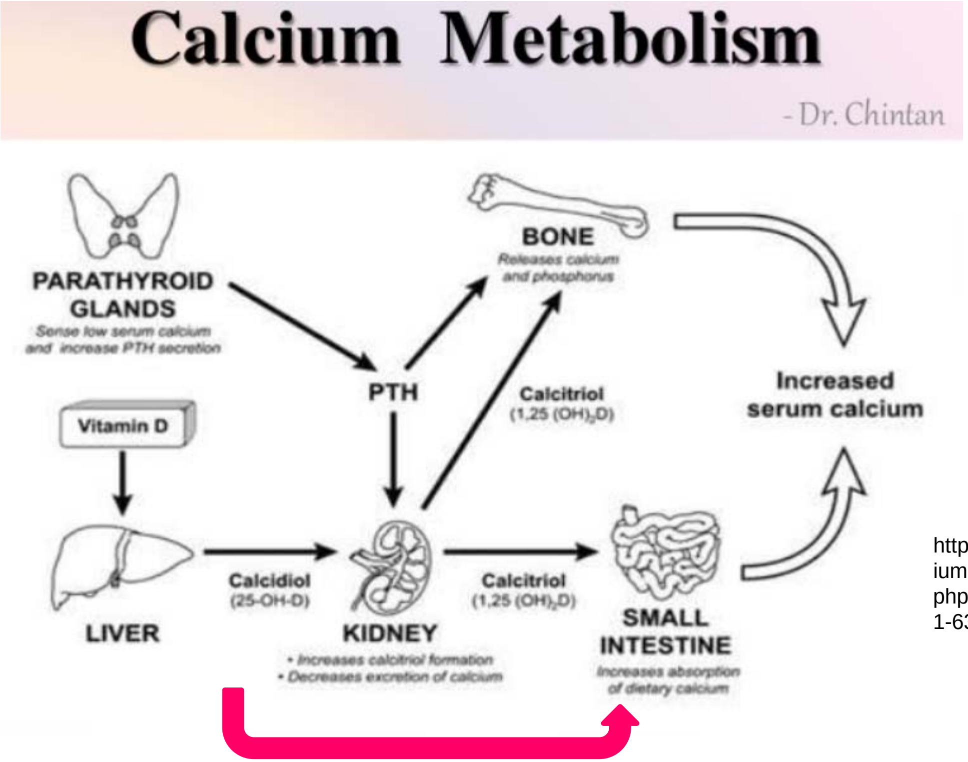
- 1,25-$(OH)_2$-Vit D_3:
  1, 24 (OH)+glucuronic/sulfuric acid → bile

- Calcitonin:
  Secreted from C-cells of thyroid, direct counter play of PTH
  → increases renal Ca & P excretion
  → increases bone mineralisation

Summary 2

- Hormonal activity
- Difference Calciferol/Calcidiol/Calcitriol/Calcitonin
- Close interplay with Calcium/Phosphorus -> clinical signs

Impact on Calcium re-absorption



http://image.slidesharecdn.com/calciummetabolism-140920220021-phpapp01/95/calcium-metabolism-1-638.jpg%3Fcb%3D1411250444

- Vitamin D → promotes net bone deposition when given therapeutically (PTH absence)

- Use 25-$(OH)_2$-D_3 (Calcidiol) rather than 1,25-$(OH)_2$-D_3 (Calcitriol)!
  - Bypasses the PTH – control of Vitamin D action
  - Achieve greater bone deposition/reduction in re-absorption
  - Low risk of toxicity
  - Ease of inclusion in feed
  - Potentially more absorption & conversion of Ca in product

- 1 IU of Vitamin D:

  Vitamin D activity of 0.025 crystalline Vitamin D_3

- Requirement
  - Minimal: avoids symptoms of deficiency, ensures physiologic metabolic function
  - Optimal: animal can use its full potential

- Recommended standard
  - Safety addition

Vitamin D requirement in humans

25-(OH)-D_3 (Calcidiol) level of

- > 30 nmol/l lower all-cause mortality
- > 78 nmol/l beneficial for bone health
- > 90 nmol/l full cancer prophylaxis
- > 100 nmol/l benefits in countering infections
- > 120 nmol/l lowest mortality

→ Average level in 2/3rd of northern climate population: 67 nmol/l

Immune System

- Direct regulation on IL-40 and others
- Reduced risk for infectious diseases
- Reduced risk for food allergy
- Impact on Inflammatory Bowel Diseases
- Chemopreventative: colorectal cancer

http://img.medscapestatic.com/pi/meds/ckb/67/35567tn.jpg

Take home message

- Difference Vitamin D_2/Vitamin D_3
- Difference Calciferol/Calcidiol/Calcitriol
- Interplay with Calcitonin/PTH

Be aware of the impact of serum Vitamin D levels on animal health!

https://www.google.fr/imgres?imgurl=http%3A%2F%2Fwww.wallpaperhi.com%2Fthumbnails%2Fdetail%2F20130226%2Fsunset%252520australia%252520kangaroos%2525201920x1280%252520wallpaper

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une
University of New England

Feeding of an adult mini pig

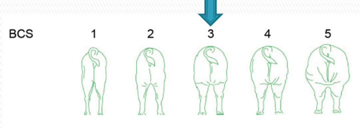
Residency class 15th to 16th september 2015
Stephanie Schmitt

Anamnesis

- Mini Pig „Berta“
- 1 year old
- ca. 30kg

Anamnesis

Ideal body weight



Proc. Spinosi, tuber coxae palpable
→ BCS 2-3

→ slight underweight

Diet

- commercial Mini Pig diet
- Fruits: apples, banana, grapes, tangerines
- Vegetables: carrotes, salad, potatos, cucumber
- Other: dried bread, acorns

Diet

Commercial mini pig diet
Ingredients:
CP12.5%
crude fat 3%
CA 12.5%
CF 6.5%
lys 0.55%
met 0.23%
Ca 0.75%
P 0.54%
Na 0.15%

Problems in mini pig nutrition

- **Overweight/obesity**
- Urolithiasis

→ Diet low in energy
High in fibre
Meeting mineral requirements

BUT

No requirements for mini pigs are defined

Requirements

- Extrapolation from recommendation of an adult boar (bw 250kg)
- ME MJ: 5.6 MJ
- Crude protein: 32g
- Lysine: 0.8g
- Calcium: 1.3
- Digestible phosphorus: 0.4
- Potassium: 0.16g

Diet revision

feed	Amount [kg]	DM [g]	ME [MJ]	Cp [g]	Lys [g]	Ca [g]	dP [g]	Na [g]
Versele Pet Pig muesli	0.15	132	1.93	18.8	0.83	1.1	0.41	0.2
Apple	0.18	27	0.36	0.5	0.03	0.0	0.01	0.0
banana	0.1	26.1	0.30	1.2	0.06	0.0	0.01	0.0
Dried bread	0.025	23	0.22	0.1	0.04	0.0	0.02	0.1
Carottes	0.1	13	0.20	1	0.04	0.1	0.02	0.0
Grapes	0.1	19	0.24	0.7	0.02	0.0	0.01	0.0
tangarine	0.1	14	0.17	0.7	0.03	0.0	0.01	0.0
Salad	0.1	8.5	0.06	1.7	0.06	0.0	0.01	0.0
potato	0.1	22	0.31	2.1	0.06	0.0	0.03	0.0
Cucumber	0.05	2	0.03	0.3	0.01	0.0	0.00	0.0
acorns	0.1	67	0.21	0.8	0.00	0.1	0.00	0.0
supply	1.105	354	4.0	28	1.2	1.3	0.5	0.4
requirement			5.6	32	0.8	1.3	0.4	0.2

➡ Energy supply: 77% of estimated requirements
Crude protein supply meet 81% of supposed requirements

Aim of diet improvement

- Increase of ME not minerals
- Satisfaction of chewing needs

Diet recommendation

- Commerical pet pig muesli
  - High mineral concentration
  - →Amount =/↓
- Fruits
  - High in energy
  - High in fibre
  - →Amount ↑
- Vegetables
  - high in fibre
  - →Amount ↑ ↑

Diet adaptation

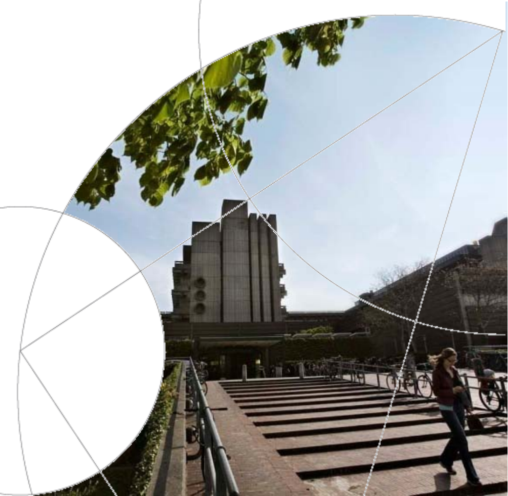
feed	Amount [kg]	DM [g]	ME [MJ]	Cp [g]	Lys [g]	Ca [g]	dP [g]	Na [g]
Versele Pet Pig muesli	0.14	123.2	1.8	17.5	0.8	1.1	0.38	0,2
Apple	0.15	22.5	0.3	0.5	0.02	0.0	0.01	0,0
banana	0.15	39.15	0.5	1.8	0.1	0.0	0.02	0,0
Dried bread	0.03	23	0.2	0.1	0.04	0.0	0.02	0,1
Carottes	0.3	39	0.6	3	0.1	0.2	0.05	0,1
Grapes	0.15	28.5	0.4	1.1	0.02	0.0	0.01	0,0
tangarine	0.15	21	0.3	1.1	0.05	0.0	0.02	0,0
Salad	0.3	25.5	0.2	5.1	0.2	0.1	0.03	0,0
potato	0.15	33	0.5	3.2	0.1	0.0	0.05	0,0
Cucumber	0.3	12	0.2	1.8	0.1	0.0	0.03	0,0
acorns	0.1	67	0.2	0,8	0	0.1	0.00	0,0
supply	1.915	434	5.0	36	1.5	1.5	0.6	0,5
requirement			5.6	32	0.8	1.3	0.4	0,16

➡ Diet higher in energy, but still moderate
Diet higher in crude protein
Diet only a little bit higher in Ca and P

A combination of commercial and homemade diet for a Greyhound suffering from concurrent protein losing nephropathy, azotemia and acute pancreatitis.

Kathrine Stenberg, DVM, Ph.D. Student, resident ECVCN

Supervisor Charlotte R. Bjornvad, DVM, Ph.D.
Dipl. ECVCN, Professor in Companion Animal Internal Medicine



Agenda

1. History, clinical presentation, previous and current diagnostics
2. Nutritional problem list
3. Nutritional recommendations for a dog with protein losing nephropathy and for a dog with acute pancreatitis respectively
4. Calculations
5. Diet formulation
6. Conclusion
7. Considerations
8. Follow up, owner compliance

Residency class 2015, Toulouse

History

- "Sixten", 6.5 year old Greyhound, intact male
- History of polydipsia
- Exercise intolerance and stiffness in the neck, treated with physiotherapy
- Father died of renal failure at the age of 8 years
- Sixten is a carrier of a neuropathy gene seen in Greyhounds (A deletion in the N-myc downstream regulated gene 1 (NDRG1)[1]) , this has currently no effect on his nutritional requirements

1. Drögemüller C et al. PLoS One. (2010) Jun 22;5(6):e11258

Diagnostics performed at referring vet, February 2015-March 2015

- CBC and biochemistry within reference levels
- normal USG 1026-1035 (ref. 1013-1045[1])
- Proteinuria +++
- UPC 1.1-3.7 (ref. 0-1[1])
- Low T4 (0.5 µg/dl, ref. 1.3-4.5 µg/dl)
- Normal TSH (0.25 ng/ml, ref. <0.6 ng/ml)
- Low free T4 (2.9 pmol/L, ref. 7.7-47.6 pmol/L)
- Low free T3 (3.2 pmol/L, ref. 3.7-9.2 pmol/L)

1. Stockham SL & Scott MA. Fund Vet Clin Path, 2nd Edition

Clinical presentation, April 2015

- BCS 4/9, weight 45 kg

- Diet: RC renal + k/d canned + boiled rice + cooked chicken
- Supplement: Phosphate binder (Pronefra)
- Amounts unknown

- Presenting complaint: increased water intake (600-1000 ml/day), less active the past few months

- Unremarkable clinical exam
    - T: 38.5 °C
    - P: 60 per min
    - R: 24 per min
    - BP systolic 132-162.

Diagnostics, April 2015 at University Hospital

- CBC and biochemistry within reference levels
- Normal TEG coagulation analysis
- USG 1029 (ref. 1013-1045[1])
- Proteinuria ++++, increased UPC (2.2, ref. 0-1[1])
- Snap test Borrelia and Anaplasma - neg
- Normotensive (systolic: 150 mm Hg, diastolic: 93 mm Hg, ref. 150/95[2])

- Diagnosis: Low grade protein losing nephropathy without azotemia or hypoalbuminemia, USG within reference level, normotensive

- Treatment: ACE inhibitor (Fortekor vet, Novartis, 0,5 mg/kg SID)

1. Stockham SL & Scott MA. Fund Vet Clin Path, 2nd Edition
2. Ettinger & Feldman. Textbook Vet Int Med, 6th Edition

Clinical presentation, May 2015

- Recheck PLN and thyroid status
- BCS 4/9, weight 45 kg
- Presenting complaint: diarrhea today, exercise intolerance
- Clinical exam
    - T: 38.3 °C
    - P: 64 per min
    - R: 20 per min
    - Signs of pain during abdominal palpation in the cranial abdomen

Diagnostics, May 2015 at University Hospital

- CBC and biochemistry within reference levels, except creatinine: 132 µmol/L (40-130 µmol/L)
- USG 1022-1032 (ref. 1013-1045[1])
- Proteinuria +++, increased UPC (2.5, ref. 0-1[1])
- Low T4 (6.85 nmol/L, ref. 11.2-40.8 nmol/L)
- Normal TSH (0.14 ngl/ml, ref. 0-0.5 ng/ml)
- Low free T4 (7.53 pmol/L, ref. 7.7-47.6 pmol/L)

- Diagnosis: Low grade protein losing nephropathy with azotemia, USG within reference level, normotensive. Hypothyroidism- possible euthyroide sick syndrome.

- Treatment: Levothyroxine sodium (Forthyron flavoured vet, 10 µg/kg BID)
- Continue treatment: ACE inhibitor (Fortekor vet, Novartis, 0,5 mg/kg SID)

1. Stockham SL & Scott MA. Fund Vet Clin Path, 2nd Edition

Clinical presentation, June 2015

- Presenting complaint: diarrhea the past week, flatulent, depressed today, anorexia today

- Clinical exam
    - T: 38.5 °C
    - P: 64 per min
    - R: 20 per min
    - Signs of pain during abdominal palpation in the mid-caudal abdomen

Diagnostics, June 2015 at University Hospital

- cPLI: positive
- Quantitative cPLI: 250 µg/L (ref. 0-200 µg/L)
- Ultrasound: no abnormal findings on abdominal ultrasound

- Diagnosis:
    - Low grade protein losing nephropathy, IRIS stage II (proteinuric + AP0)
    - Concurrent hypothyroidism, possible euthyroide sick syndrome
    - Low grade acute pancreatitis

- Treatment:
    - Levothyroxine sodium (Forthyron flavoured vet, 10 µg/kg BID)
    - ACE inhibitor (Fortekor vet, Novartis, 0,5 mg/kg SID)
    - Maropitant (Cerenia, Orion, 1 mg/kg once)
    - Tramadol (Tradoloan, Nordic Drugs, 1,1 mg/kg TID)

Feeding regimen, June 2015

- Stabile weight, 45 kg
- Picky eater

- Kidney diet:
    - Royal Canin Renal
    - Hill's k/d canned diet
    - Boiled rice
    - Cooked chicken
    - Phosphate binder (Pronefra, Virbac)

- Changed to Hill's i/d low fat diet due to pancreatitis

- -> Nutrition service contacted

Nutrition problem list

1. Low grade protein losing nephropathy
2. Azotemia IRIS stage II (proteinuric + AP0)
3. Acute low grade pancreatitis
4. Possible hypothyroidism
5. Picky eater

We were asked to

- Evaluate the feeding regimen
- Owner would like to continue feeding a diet based on kidney diets but supplemented with chicken and rice
- Propose a well balanced feeding regimen for the adult dog with PLN and concurrent azotemia and pancreatitis based on Royal Canin Renal dry food and Hill's k/d canned food and providing supplements

Recommendations

PLN and azotemia

- Protein 14-20 %DM
- P 0.2-0.5 %DM
- Na <0.3 %DM
- K 0.4-0.8 %DM
- Omega-3 0.4-2.5% DM

Pancreatitis

- Protein 15-30 %DM
- Fat ≤15 %DM
  non-obese and non-hypertriglyceridaemic dogs
- Fat ≤10 %DM
  obese and hypertriglyceridaemic dogs

Jacob F et al. JAVMA. (2002) 220; 1163-1170
Jacob F et al. Proc ACVIM. (2004) 828
Kerl ME & Johnson PA. Clin Tech in Small Animal Pract. (2004) 19;1; 9-21
Parker VJ & Freeman LM. Compend Contin Educ Vet. (2012) Jul;34(7):E6
Hand et al, Small Animal Clinical Nutrition, 5th edition

Calculations of energy and nutrient requirements

- Energy requirement calculations (NRC 2006)
  - Inactive pet dog, Ideal body weight: 45 kg.
  - DER = 95 x $BW^{0.75}$ = 1650 kcal

- Protein
  - NRC recommended allowance: 3.28 g/$kgBW^{0.75}$ => 57.1 g protein /day
  - NRC minimal requirement: 2.62 g/$kgBW^{0.75}$ => 45.6 g protein /day

- Fat
  - NRC recommended allowance: 1.8 g/$kgBW^{0.75}$ => 31.32 g fat /day
  - NRC adequate intake: 1.3 g/$kgBW^{0.75}$ => 22.62 g fat /day
  - NRC safe upper limit: 10.8 g/$kgBW^{0.75}$ => 187.92 g fat /day

Calculations of nutrient requirements

- Essential fatty acids (EPA + DHA)
    - NRC recommended allowance: 0.03 g/kgBW$^{0.75}$ => 0.52 g EPA + DHA /day
    - Safe upper limit 0.37 g/kgBW$^{0.75}$ => 6.44 g/day

- P
    - NRC recommended allowance = adequate intake: 0.1 g/kgBW$^{0.75}$ => 1.74 g P /day

- Na
    - NRC recommended allowance: 26.2 mg/kgBW$^{0.75}$ => 455.9 mg Na /day
    - NRC minimal requirement: 9.85 mg/kgBW$^{0.75}$ => 171.39 mg Na /day
    - Safe upper limit >15 g/kg DM at energy density 4000 kcal/kg=> >6.12 g /day

- K
    - NRC recommended allowance = adequate intake: 0.14 g/kgBW$^{0.75}$ => 2.44 g K /day

Royal Canin renal dry diet

As fed:

Energy: 3995 kcal/ 1000 g

Protein: 16%

Fat: 18%

EPA+DHA: 0.41%

P: 0.2%

Na: 0.2%

K: 0.7%

Moisture: 9.5%

DM:

Energy: 4.41 kcal/g DM

Protein: 17.7% DM

Fat: 19.9% DM

EPA+DHA: 0.45%

P: 1.28% DM

Na: 0.22% DM

K: 0.77% DM

Data from Danish product book, Royal Canin

Analyse	Mængde
Arachidonsyre (%)	0.07
Aske (%)	4.3
Biotin (mg/kg)	1.1
Calcium (%)	0.72
Fibre (%)	2.2
Diætetiske fibre (%)	7.2
DL-methionin (%)	0.33
EPA/DHA (%)	0.41
Fedt (%)	18.0
Linolsyre (%)	3.85
Lutein (mg/kg)	5.0
Omsættelig energi (beregnet med NRC85) (kcal/kg)	3840.0
Omsættelig energi (målt) (kcal/kg)	4090.0
Methionin Cystin (%)	0.6
Vand (%)	9.5
Nitrogenfri ekstrakt (NFE) (%)	50.0
Omega-3 (%)	0.82
Omega-6 (%)	3.99
Fosfor (%)	0.2
Protein (%)	16.0
Stivelse (%)	45.0
Taurin (mg/kg)	2000.0
A-Vitamin (IE/kg)	19000.0
C-Vitamin (mg/kg)	200.0
E-Vitamin (mg/kg)	600.0
Polyfenoler fra grøn te og vindruer (mg/kg)	1280.0

http://www.royalcanin.dk

Hill's k/d canned diet

As fed:

Energy: 1390 kcal/ 1000 g

Protein: 4.5%

Fat: 7.9%

Omega-3: 0.57%

P: 0.07%

Na: 0.05%

K: 0.11%

Moisture: 70.3%

DM:

Energy: 4.67 kcal/g DM

Protein: 15% DM

Fat: 26.5% DM

Omega-3: 1.9% DM

P: 0.24% DM

Na: 0.17% DM

K: 0.37% DM

Data from Danish product book, Hill's

	FÆRDIGT PRODUKT	TØRSTOF	kcal/100g
A-vitamin[10]	10000 IU/kg	33647 IU/kg	720 IU
Beta-karoten	0.45 mg/kg	1.5 mg/kg	0.03 mg
C-vitamin[10]	21 mg/kg	71 mg/kg	1.5 mg
D-vitamin[10]	490 IU/kg	1649 IU/kg	35 IU
E-vitamin[10]	165 mg/kg	555 mg/kg	12 mg
Fedt	7.9 %	26.5 %	5.7 g
Fibre (rå)	0.1 %	0.5 %	0.1 g
Fosfor	0.07 %	0.24 %	50 mg
Kalcium	0.23 %	0.77 %	166 mg
Kalium	0.11 %	0.37 %	79 mg
Kulhydrat (NFE)	16.1 %	54.1 %	11.6 g
Magnesium	0.04 %	0.12 %	26 mg
Natrium	0.05 %	0.17 %	36 mg
Omega-3 fedtsyrer	0.57 %	1.92 %	410 mg
Omega-6 fedtsyrer	1.29 %	4.34 %	929 mg
Protein	4.5 %	15 %	3.2 g
Taurin	0.03 %	0.11 %	23 mg
Vand	70.3 %	0 -	50.6 g

	FÆRDIGT PRODUKT	TØRSTOF
kcal/100g	139	467
kJ/100g	581	1955
kcal/dåse	514	
Non-Proteinholdige kalorier	89 %	
Mål urin pH	6.8 - 7.2	

http://www.hillspet.dk/da-dk

Diet formulation

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
3	Foderberegninger til hund, proteintabende nefropati + azotæmi+pancreatitis																				
4	Ejer ønsker at supplere kommercielt foder med kylling og ris																				
5	(requirements **protein, rask hund**, 175 g/kg DM (44-70 g/1000 kcal ME), **fat** 85 g/kg DM (21,3 g/1000kcal), **calcium** 12 g/kg DM (3 g/1000 kcal me), phosphor 10 g/kg DM (2,5 g/1000 kcal ME)																				
6	Energifordeling anbefaling fra Ca and Fe nutrition, rask hund: vedligehold: prot 24%, fedt 38%, Kulhydrat 38%																				
7	Anbefalinger fra SACN ved prot tabende nefropati og azotæmi: prot 14-20 %DM; P 0,2-0,5 %DM; Na <0,3% DM, K 0,4-0,8% DM																				
8	Anbefalinger fra SACN ved pancreatitis: Prot 15-30%DM, fedt ≤ 15 %DM																				
9																					
10			DM		protein % as fed	fedt % as fed	kulhydrat % as fed	fiber % as fe	Ca % as fed	P % as fed	Na % as fed	Mg % as fed	K % as fed	EPA/DHA/Omega 3 % as fed	energi, kj/100 g	beregnet					
11	k/d vådfoder		29,7		4,5	7,9	16,1	0,1	0,23	0,07	0,05	0,04	0,11	0,57	581	636,72					
12	Renal tørfoder		90,5		16	18	45	2,2	0,7	0,2	0,2	na	0,7	0,41	1671	1684,09					
13	kylling uden skind		22,80		19,30	2,70	0,00	0,00	0,01	0,20	0,06	na	0,32		448,00	421,02					
14	Oksekød (hakket, magert)		31,70		20,70	10,00	0,00	0,00	0,01	0,19	na				749,00	716,77					
15	Hytteost 4,5% fedt (vælges pga lav Cu indhold)		21,10		12,50	4,50	2,70	0,00	0,06	0,13	0,4	0,01			431	420,1924					
16	grøntsager kogte eller dåse		10,00		2,00	0,10	6,00	1,00	0,12	0,09	0,20	na			1130,00	136,47					
17	kogt ris (hvide)**		27,40		2,00	0,10	24,10	0,10	0,04	0,10	0,37	na	0,03		109,00	436,78					
18	kogt ris (brune)**		30,00		2,50	0,60	25,20	0,30	0,01	0,07	0,28	na			119,00	482,00					
19	kartofler		20,00		2,10	0,10	16,60	0,50	0,01	0,05	0,00	0,03			318,00	314,00					
20	æg		26,30		12,90	11,50	0,90	0,00	0,05	0,21	0,12	0,01			380,00	658,29					
21	Aptus Multidog		85,80		2,60	1,70		4,50	29,00	16,00	1,40				106,60						
22	Kanavit 37		100,00		25,00	9,00		0,10	1,00	0,72											
23	Kanavit tabletter (Ca, P, Mg i g per tabl)		100,00		1,00	1,00		1,00	0,12	0,09		0,00									
24	Kanavit pulver (vitamin og mineraler, calcium)		100,00						25,00	0,01		0,82									
25	Kanavit calcium og trace minerals pr tablet (g)		100,00		5,00	1,00		1,00	0,10	na											
26	vegetabilsk olie		100,00			100,00					na	0,35			3766,00	3733,20					
27	fiskeolie		100,00			100,00						na			3766,00	3733,20					
28																					
29			total g	DM	g protein	g fedt	g NFE	g fiber	g calcium	g fosfor	g Natrium	g Magnesium	g Kalium		energi						
30	k/d vådfoder		175,00	51,98	7,88	13,83	28,18	0,18	0,403	0,123	0,088	0,070	0,193	0,998	1016,75	318,36					
31	Renal tørfoder		200,00	181,00	32,00	36,00	90,00	4,40	1,400	0,400	0,400	na	1,400	0,820	3342,00	842,04					
32	kylling uden skind		50,00	11,40	9,65	1,35	0,00	0,00	0,005	0,100	0,030	na	0,160	0,000	224,00	210,51					
33	Oksekød (hakket, magert)		0,00	0,00	0,00	0,00	0,00	0,00	0,000	0,000	na				0,00	358,39					
34	Hytteost		0,00	0	0,00	0,00	0	0,00	0,000	0,000	0,000	0,000			0	210,0962					
35	grøntsager kogte eller dåse		0,00	0,00	0,00	0,00	0,00	0,00	0,000	0,000	0,000	na			0,00	136,47					
36	1 L kogte ris (svarer til 600 g)		500,00	137,00	10,00	0,50	120,50	0,50	0,200	0,500	1,850	na	0,150	0,000	545,00	1310,35					
37	kogt ris (brune)		0,00	0,00	0,00	0,00	0,00	0,00	0,000	0,000	0,000	na			0,00	1445,99					
38	kartofler		0,00	0,00	0,00	0,00	0,00	0,00	0,000	0,000	0,000	0,000			0,00	942,01					
39	æg (1 stk 50 g)		0,00	0,00	0,00	0,00	0,00	0,00	0,000	0,000	0,000	0,000			0,00	658,29					
40	Aptus Multidog (i g, Ca+P, 1 tabl pr 5 kg, 1 tabl = 1,3 g)		0,00	0,00	0,00	0,00		0,00	0,000	0,000	0,000				0,00	0,00					
41	Kanavit 37 pulver (g) Ca+P, ca 1-2 g pr 5 kg		0,00	0,00	0,00	0,00		0,00	0,000	0,000					0,00	0,00					
42	Kanavit tabletter pr tabl (Ca, i g, 1 tabl pr 5 kg)		0,00	0,00	0,00	0,00		0,00	0,000	0,000		0,000			0,00	0,00					
43	Kanavit pulver (vitamin og mineraler, Ca+P) (i g)(1 ske= ca 5 g, 5 g pr 5 k		0,00	0,00					0,000	0,000	0,000	0,000									
44	Kanavit calcium og trace minerals pr tablet (Ca+P, pr tablet, Ca i g)		0,00	0,00	0,00	0,00		0,00	0,000	na											
45	vegetabilsk olie (3 spsk= 45 ml, 1 tsk=4g, 1 spsk=12g)		0,00	0,00	0,00	0,00					na	0,000			0,00	261,32					
46	Fiskeolie (15 ml = 2 spsk)		0,00	0,00	0,00	0,00						na			0,00	0,00					
47	Total		925,00	381,38	59,53	51,68	238,68	5,08	2,01	1,12	2,37	0,070	1,903	1,818	769,00	5533,43					
48	energi				996,21	1821,96	3960,10														
49	% energi				14,70	26,88	58,42														
50	% pr DM				15,61	13,55	62,58	2,64	0,53	0,29	0,62	0,02	0,50	0,48	Svarer til en Ca:P ratio på		1,79	*			
51	g/1000 kcal ME				36,43	31,62	146,06	3,11	1,23	0,69	1,45	0,04	1,16	1,11							
52															HUSK (1 måleske= 1,5 g):		5	=> g fiber total =		10,08	
53	E behov hund, Sixten, 45 kg, BCS 4/9				Kj/blanding	Kcal/bl	kJ/kg feed	kcal/g DM													
54	MER normal aktiv hund: 1650 kcal/dag				6778,26	1634,10	7327,85	4,28													

kyl+ris | kyl+ris+pancreatitis | kyl+kart+pancreatitis

Proposed diet

175 g k/d canned food

+

200 g RC Renal dry food

+

50 g cooked chicken without skin, unsalted water

+

500 g boiled white rice, unsalted water

+

5 g Psyllium husks or 5 tbsp. boiled grated zucchini, unsalted water

Energy intake pr. day: 1634 kcal

Total amount of food pr. day: 925 g

	Sixten, proposed diet	Recommended requirements, Amt./kg BW$^{0.75}$ (NRC 2006)	Recommended requirements 95 kcal/BW$^{0.75}$ (fediaf 2014)	Recommended requirements (SACN, 5th ed.), PLN and azotemia	Recommended requirements (SACN, 5th ed.), pancreatitis
Energy density	4.25 kcal/g DM				
Protein	59.53 g/day 15.6 %DM	RA 57.1 g/day Min 45.6 g/day	Min 86.0 g/day	14-20 %DM	15-30 %DM
Fat	51.68 g/day 13.6 %DM	RA 31.32 g/day AI 22.62 g/day SUL 187.9 g/day	Min 22.69 g/day		≤15 %DM
EPA+DHA, Omega-3	1.82 g/day 0.48 %DM	RA 0.52 g/day SUL 6.44 g/day		0.4-2.5 %DM	
Phosphorus	1.12 g/day 0.29 %DM	RA=AI 1.74 g/day	Min 1.91 g/day Max 6.6 g/day	0.2-0.5 %DM	
Sodium	520 mg/day 0.13 %DM	RA 455.9 mg/day Min 171.39 mg/day SUL 6.19 g/day	Min 480 mg/day Max 7.43 g/day	≤0.3 %DM	
Potassium	1.9 g/day 0.5 %DM	RA 2.44 g/day	Min 2.39 g/day	0.4-0.8 %DM	
Fiber	5.08 g/day 2.64 %DM				

Conclusion, the proposed diet

- All nutrients:
  - Above min. requirements and under SUL – NRC
  - Within recommendations – SACN for PLN and pancreatitis
- Protein
  - High in protein – NRC
  - Below recommendations- fediaf
  - Within recommendations - SACN
- Fat, EPA and DHA, Omega-3
  - High, under SUL - NRC and fediaf
  - Within recommendations – SACN
- P
  - Low in P – NRC and fediaf
  - Within recommendations – SACN
- Na
  - High in Na, under SUL – NRC and fediaf
  - Within recommendations – SACN
- K
  - Low in K – NRC and fediaf
  - Within recommendations – SACN

NRC 2006
Fediaf 2014
SACN, Hand et al 5th edition

Nutrients compared to NRC recommendations

	Sixten, proposed diet	Sixten, RC renal dry diet	Sixten, Hill's i/d dry diet	Sixten, Hill's i/d low fat dry diet	Recom. Require, Amt./kg $BW^{0.75}$ (NRC 2006)	Recom. Require, 95 kcal/$BW^{0.75}$ (fediaf 2014)	Recom. Require, (SACN, 5th ed.), PLN and nephropathy	Recom. Require, (SACN, 5th ed.), pancreatitis
Protein	59.53 g/day 15.6 %DM ↑	66.1 g/day 16 %DM ↑↑	107 g/day 23.5 %DM ↑↑↑	116 g/day 23.5 %DM ↑↑↑↑	RA 57.1 g/day Min 45.6 g/day	86.0 g/day	14-20 %DM	15-30 %DM
Fat	51.68 g/day 13.6 %DM ↑↑	74.34 g/day 18 %DM ↑↑↑↑	59.6 g/day 13 %DM ↑↑↑	36.1 g/day 7.3 %DM ↑	RA 31.32 g/day AI 22.62 g/day SUL 187.9 g/day	22.69 g/day		≤15 %DM

Conclusion
Protein: Proposed diet < renal
Fat: Proposed diet < i/d, Proposed diet > i/d low fat
Proposed diet: high in protein and fat compared to NRC

Conclusion

- The proposed diet meets the SACN[1] recommendations for diets for dogs with PLN with azotemia and dogs with acute pancreatitis.
- The diet is below the fediaf[2] protein recommendations, but above the NRC[3].
- Although the diet is high in fat according to the NRC[3] and fediaf[2] recommendations the diet has an acceptable level of fat as the dog is non-obese and non-hypertriglyceridaemic (SACN[1])
- The amount of protein (g/day) is lower in the proposed diet than a commercial renal diet and the amount of fat (g/day) is lower than in a commercial intestinal diet.
- It is possible to formulate a well balanced diet for a dog with PLN with azotemia and concurrent acute pancreatitis, although one should be aware of the level of fat in the diet when using a renal diet as a main ingredient

1. Hand et al, 5th edition
2. Fediaf 2014
3. NRC 2006

Considerations

- NRC recommendations are low in protein compared to fediaf
- This renal diet is high in fat compared to NRC recommendations
- This intestinal diet is high in fat compared to NRC recommendations
- Homemade diets vary considerably in nutrient contents depending on raw ingredients, preparation and methodology[1]
- Recipes can be highly variable and result in inappropriate diets. Many recipes would not meet nutritional and clinical needs of individual patients and should be used cautiously for long-term feeding.[2]

1. Davies M. Vet Rec. (2014) 174: 352
2. Larsen JA et al. J Am Vet Med Assoc. (2012) Mar 1;240(5):532-8.

Follow up, owner compliance

- Sixten is generally in good health
- Has had recurrent diarrhea, colitis, before he started on the kidney diet.
- Improved on probiotics and intestinal diet but recurrence of diarrhea when owner tried to changed to kidney diet
- Positive for Clostridia -> metronidazol and amox+clav treatment at referring vet
- Current diet: Hill's i/d Low fat canned diet + RC GI low fat dry diet + Psyllium husk
- Owner is not interested in change to kidney diet at the moment

Thank you for listening

	Sixten, proposed diet	Sixten, RC renal dry diet	Sixten, i/d dry diet	Sixten, i/d low fat dry diet	Recommended requirements, Amt./kg BW$^{0.75}$ (NRC 2006)	Recommended requirements (SACN), PLN and nephropathy	Recommended requirements (SACN), pancreatitis
Energy density	4.25 kcal/g DM	4.5 kcal/g DM	3.9 kcal/g DM	3.6 kcal/g DM			
Amount per day	925 g	413 g	458.7 g	494.5 g			
Protein	59.53 g/day 15.6 %DM	66.1 g/day 16 %DM	107 g/day 23.5 %DM	116 g/day 23.5 %DM	RA 57.1 g/day Min 45.6 g/day	14-20 %DM	15-30 %DM
Fat	51.68 g/day 13.6 %DM	74.34 g/day 18 %DM	59.6 g/day 13 %DM	36.1 g/day 7.3 %DM	RA 31.32 g/day AI 22.62 g/day SUL 187.9 g/day		≤15 %DM

COMPRESSION FRACTURES IN A LARGE BREED PUPPY

Moran Tal Gavriel

DVM, DVSc Student in Clinical Nutrition

Case Advisors: Dr. Verbrugghe, Dr. Parr
Program Advisor: Dr. Verbrugghe

TESS, 6 MONTHS, FI, GIANT SCHNAUZER

- Presented December 15, 2014
  - Yelped and tried to bite when owner lifted her
  - Hunched and laying down

TESS, 6 MONTHS, FI, GIANT SCHNAUZER

- Reluctance to walk, diarrhea, vomiting, leaking urine (1 month)
- Hematuria (4 days)
- **rDVM** Urinalysis (free catch) – WBC, pH 8 → Clavamox
  CBC – mild anemia
  Biochemical panel – elevated Alk Phos
- "Episodes" of lameness (RH)
  - Pain, trembling
  - Could not jump or walk down the stairs
  - Choppy gait

HOMEMADE DIET

TESS, 6 MONTHS, FI, GIANT SCHNAUZER

- Tense, rigid muscles on HL bilaterally
- Severe tachypnea
- Painful on abdominal palpation
- Urinary incontinence when relaxed – UTI?
- Lack of proprioception and hopping bilaterally in HL
- Knuckling bilaterally in HL
- Hunched posture, weakly ambulatory with assistance
- Lumbar pain and pain with extension of hips
- Other - WNL

BW – 20.36kg
BCS – 5/9
MCS – mild muscle wasting

DECEMBER 16, 2014

Pediatric Clinical Pathology

Benita von Dehn, DVM

Vet Clin Small Anim, 2014; 44: 205-219.

- **CBC**
  - WBC – 19.7 X 10^9/L (4.9 – 15.4 X 10^9/L)
  - Segmented neutrophil count – 16.55 X 10^9/L (2.9-10.6 X 10^9/L)
- **Biochemical Panel**

Parameters	Results	AHL Reference Range	Puppy Reference Range (4-6 months)
Ca	2.11 ↓	2.5 – 3 mmol/L	2.5 – 3.3 mmol/L
Alk Phos	473 ↑	22 – 143 U/L	126 – 438 U/L
CK	1058 ↑	40 – 255 U/L	40 – 192 U/L
Amylase	1238	299 – 947 U/L	≤1683

DECEMBER 16, 2014

- **Urinalysis**

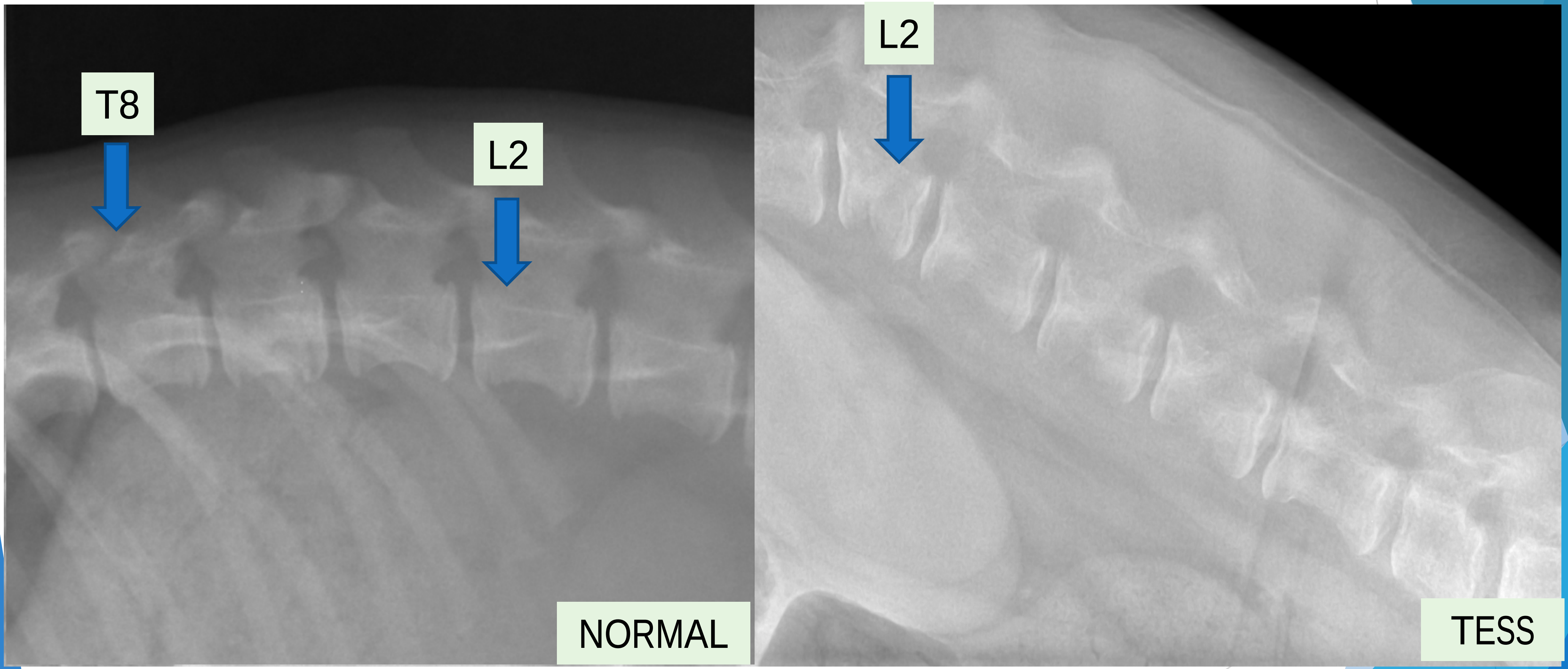
Parameters	Results	Reference Range
RBC	8-10	0 / 400 x
Clarity	Cloudy	
Bacteria	3	
Leukocytes	200-250	0 / 400 x
Urobilinogen	3.2	0 umol/L
Blood	2	0

- Beta E. coli (10^5 cfu/mL) (December 18, 2014)

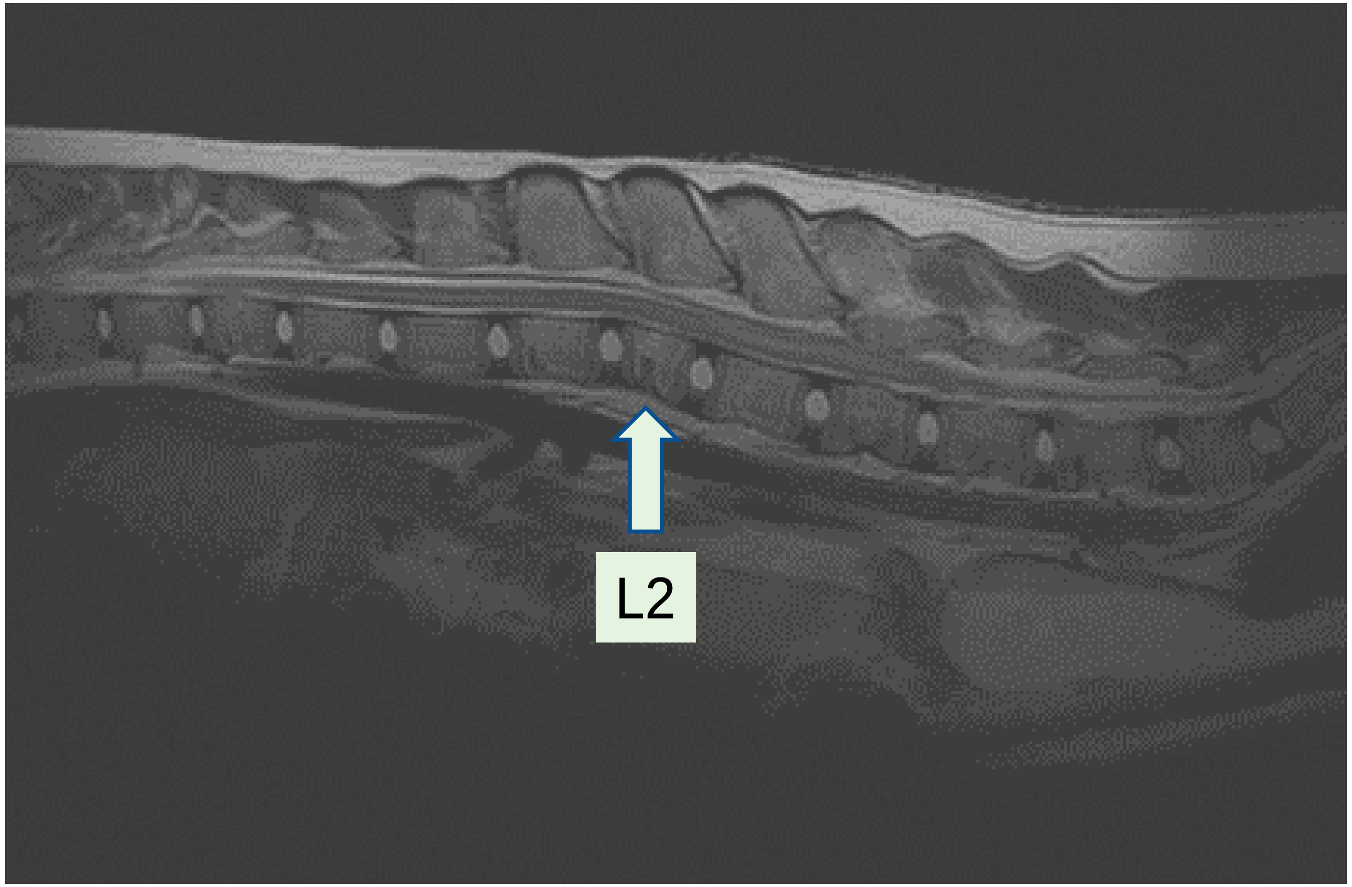
INITIAL DIFFERENTIAL DIAGNOSES

- Discospondylitis
- Autoimmune meningomyelitis
- Spinal empyema
- Trauma (fracture/luxation)
- Parasytic myelitis (toxoplasma, neospora)
- Nutritional secondary hyperparathyroidism

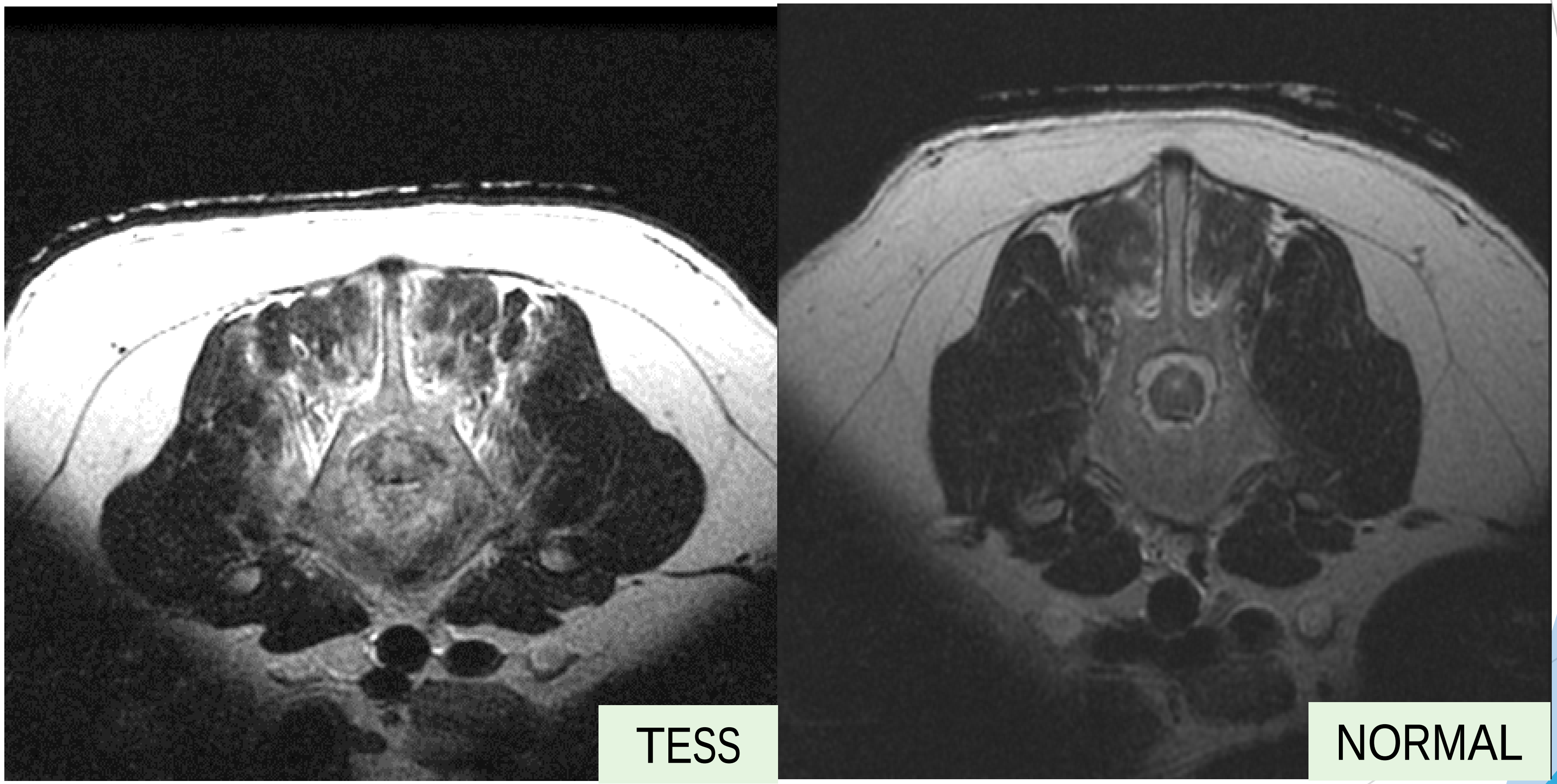
RADIOGRAPHS



MRI



MRI



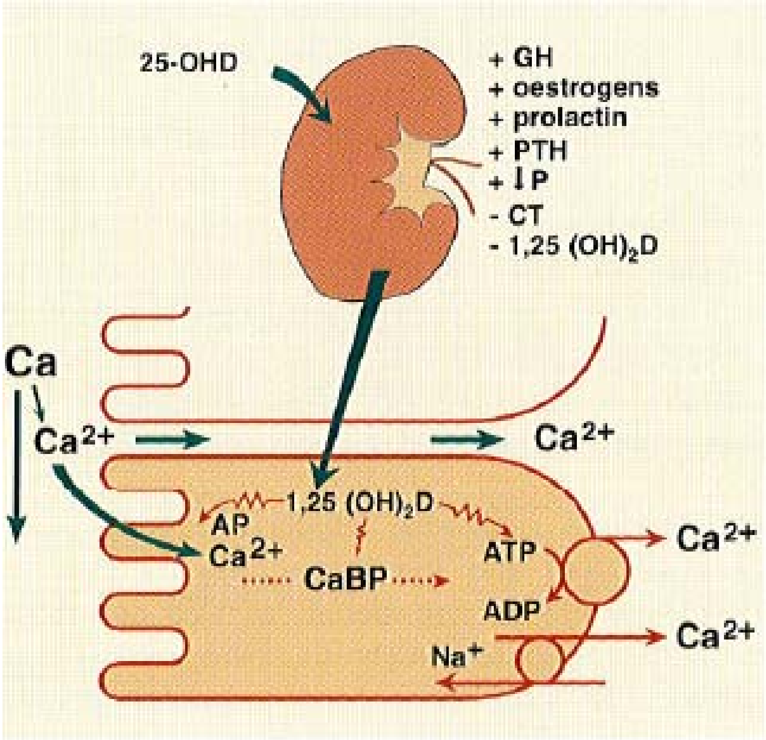
TESS, 6 MONTHS, FI, GIANT SCHNAUZER

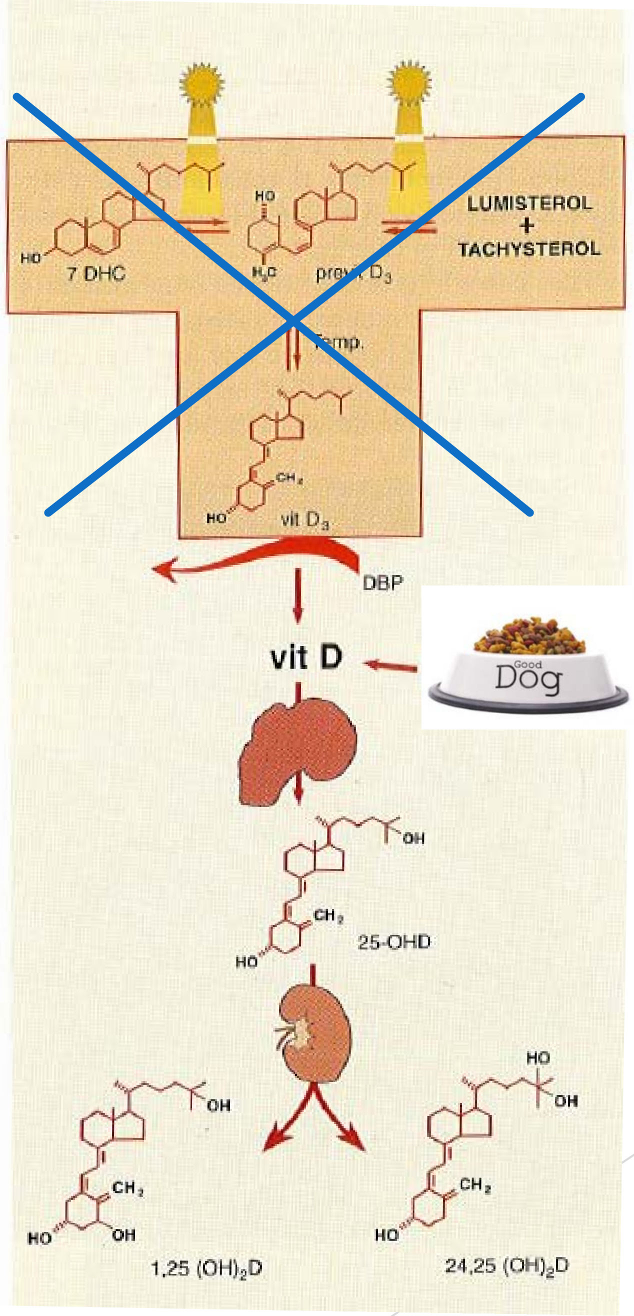
- Lesion localised to T3-L3 segments
- MRI findings → acute fracture in L4
  - Contrast enhancement
    - Active bone remodelling **OR**
    - Secondary to diffuse osteopenia

Primary DDx: Nutritional secondary hyperparathyroidism

Secondary DDx: Genetic disease → osteogenesis imperfecta

NUTRITIONAL SECONDARY HYPERPARATHYROIDISM





Rijnberk, 1996

NUTRITIONAL SECONDARY HYPERPARATHYROIDISM

NUTRITIONAL SECONDARY HYPERPARATHYROIDISM OCCURRING IN A STRAIN OF GERMAN SHEPHERD PUPPIES

Kayo KAWAGUCHI, Ignacia Syjuco BRAGA Ⅲ, Akemi TAKAHASHI, Kenji OCHIAI and Chitoshi ITAKURA

Jpn. J. Vet. Res., 1993; 41(2-4): 89-96

Metabolic bone disease and hyperparathyroidism in an adult dog fed an unbalanced homemade diet

Metabole botafwijkingen en hyperparathyroïdie bij een volwassen hond na consumptie van een slecht uitgebalanceerd huishouddieet

[1]A. Verbrugghe, [2]D. Paepe, [2]L. Verhaert, [3]J. Saunders, [4]J. Fritz, [1]G.P.J. Janssens, [1]M. Hesta

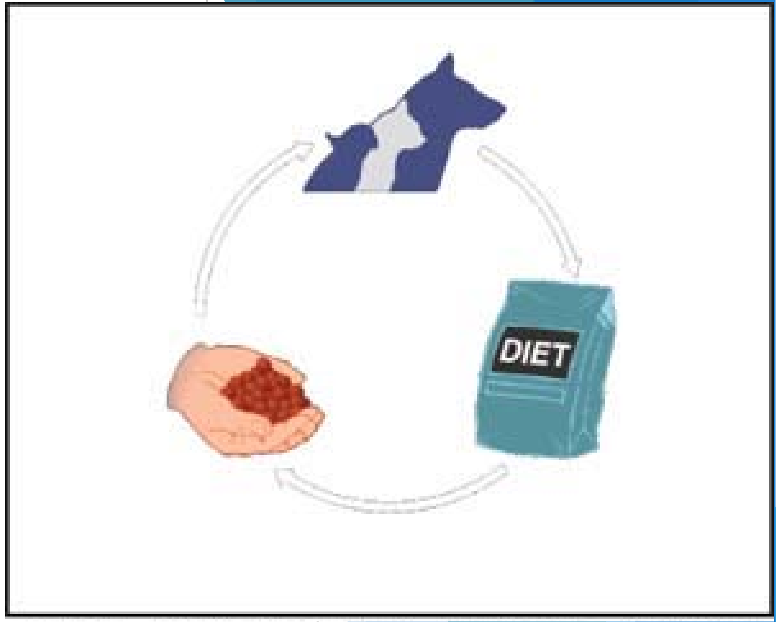
Vlaams Diergeneeskundig Tijdschrift, 2011; 80: case report 61.

Influence of Calcium and Phosphorus Intake on the Apparent Digestibility of These Minerals in Growing Dogs[1,2]

Britta Dobenecker[3]

J. Nutr., 2002; 132: 1665S-1667S

DIET ANALYSIS - RECIPE



HOME MADE DIET RECIPE (BATCH FOR 2 WEEKS)	
2 lbs. regular beef	2 red apples
2 cups grated carrots	3 eggs
2 cups green beans and broccoli	3-4 cups brown rice flour
2-3 tbsp. refined sunflower oil	1/2 cup oat bran

- 1/2 cup white organic rice, apples and carrots throughout the day
- 1 tsp. bone meal (manufacturer unknown)
- 1 capsule cod liver oil (manufacturer unknown)
- 4 meals a day

WSAVA
Global Veterinary Community

BALANCE IT (https://secure.balanceit.com/)

Total calories fed: 6797.8 kcal/day OR 338% of the calculated requirement

Protein calories: 14.7%

1% 25% 35% 100%

Fat calories: 25.1%

1% 25% 35% 100%

Carbohydrate calories: 60.2%

1% 30% 50% 100%

14.7% ME Protein 25.1% ME Fat 60.2% ME Carbohydrate

Calculated Energy Requirement Range 100% 6797.834 kcal

Min kcal/day (50% MER):1006
Max kcal/day (150% MER):3019

Nutrients	% of Requirement	Amount (per Meal)		Requirement Range
[203] Protein	59.4%	37.331	g	(62.9 to [no max] g)
[511] Arginine	151.3%	2.677	g	(1.77 to [no max] g)
[512] Histidine	166.8%	1.051	g	(0.63 to [no max] g)
[503] Isoleucine	129.0%	1.664	g	(1.29 to [no max] g)
[504] Leucine	144.5%	2.977	g	(2.06 to [no max] g)
[505] Lysine	111.2%	2.446	g	(2.2 to [no max] g)
[1001013] Methionine-cystine	93.0%	1.405	g	(1.51 to [no max] g)
[1001017] Phenylalanine-tyrosine	114.1%	2.899	g	(2.54 to [no max] g)
[502] Threonine	86.3%	1.432	g	(1.66 to [no max] g)
[501] Tryptophan	49.3%	0.281	g	(0.57 to [no max] g)
[510] Valine	147.6%	2.022	g	(1.37 to [no max] g)
[204] Total lipid (fat)	123.3%	28.238	g	(22.9 to [no max] g)
[618] 18:2 undifferentiated	200.3%	5.809	g	(2.9 to [no max] g)
[205] Carbohydrate, by difference	100.0%	148.880	g	(0 to [no max] g)
[421] Choline, total	39.6%	134.389	mg	(339.653 to [no max] mg)
[435] Folate, DFE	127.0%	63.495	mcg_DFE	(50 to [no max] mcg_DFE)
[406] Niacin	344.0%	11.352	mg	(3.3 to [no max] mg)
[410] Pantothenic acid	124.4%	3.607	mg	(2.9 to [no max] mg)
[405] Riboflavin	67.9%	0.428	mg	(0.63 to [no max] mg)
[404] Thiamin	218.6%	0.634	mg	(0.29 to [no max] mg)
[320] Vitamin A, RAE	216.9%	930.051	mcg_RAE	(428.7 to 21428.7 mcg_RAE)
[418] Vitamin B-12	902.0%	0.054	mg	(0.006 to [no max] mg)
[415] Vitamin B-6	453.4%	1.315	mg	(0.29 to [no max] mg)
[323] Vitamin E (alpha-tocopherol)	33.7%	4.714	IU, Vit E	(14 to 286 IU, Vit E)
[301] Calcium, Ca	74.0%	2.146	g	(2.9 to 3.5 g)
[1000000] Chloride	0.0%	0.000	g	(1.29 to [no max] g)
[312] Copper, Cu	122.5%	2.573	mg	(2.1 to 71 mg)
[1000001] Iodine	0.0%	0.000	mg	(0.43 to 14 mg)
[303] Iron, Fe	32.5%	7.475	mg	(23 to 857 mg)
[304] Magnesium, Mg	153.6%	0.169	g	(0.11 to 0.86 g)
[315] Manganese, Mn	358.1%	5.014	mg	(1.4 to [no max] mg)
[305] Phosphorus, P	82.8%	1.905	g	(2.3 to 4.6 g)
[306] Potassium, K	52.5%	0.892	g	(1.7 to [no max] g)
[317] Selenium, Se	92.3%	0.028	mg	(0.03 to 0.57 mg)
[307] Sodium, Na	22.5%	0.194	g	(0.86 to [no max] g)
[309] Zinc, Zn	37.5%	12.762	mg	(34 to 286 mg)
[1000021] Ca:P ratio	118.6%	1.127	n/a	(0.95 to 2.05 n/a)
[328] Vitamin D (D2 + D3)	155.2%	221.871	IU, Vit D	(143 to 1429 IU, Vit D)

DEFICIENCIES:
Protein, choline, B2, vit. E, Ca, Cl, I, Fe, P, Na, K, Se, Zn

DIET ANALYSIS - LABORATORY

Nutrient Analysis (%)	Tess' Homemade Diet (as fed)	Tess' Homemade Diet (%DM)	NRC (2006) Recommended Allowance	AAFCO (2014) Min. Req. for growth
Moisture	54.07			
Protein (N X 6.25)	8.49	18.484	17.5 %DM	22%DM
Calcium	0.04	0.087	1.2 %DM	1 %DM
Phosphorus	0.17	0.370	1.0 %DM	0.8 %DM
Ca:P ratio		1:4	1.2:1	1.25:1
*Vitamin D (cholecalciferol)	Below Detection Limit	Below Detection Limit	55.2IU/100gDM	50IU/100gDM

VITAMIN D TOXICITY PROFILE (December 18, 2014)

Parameters	Results	Reference Range
Parathyroid hormone	4.6	0.5 – 5.8 pmol/L
25-Hydroxy vitamin D	8 ↓	60 – 215 nmol/L
Ionized calcium	1.5	1.25 – 1.45 mmol/L

DECEMBER 16, 2014

Parameters	Results	AHL Reference Range	Puppy Reference Range (4-6 months)
Ca	2.11	2.5 - 3 mmol/L	2.5 - 3.3 mmol/L
Alk Phos	473	22 - 143 U/L	126 - 438 U/L
CK	1058	40 - 255 U/L	40 - 192 U/L
Amylase	1238	299 - 947 U/L	≤1683

DECEMBER 16-17, 2014

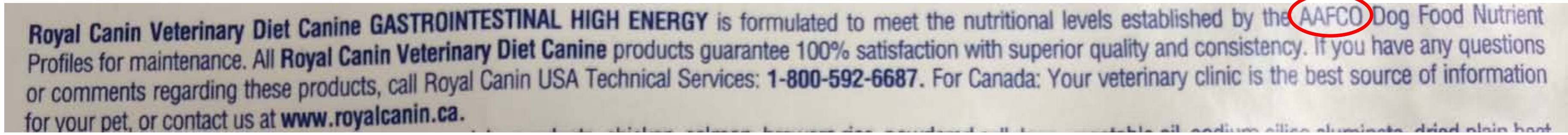
Medications

- Hydromorphone
- Dexamedetomidine
- Fentanyl patch
- Meloxicam
- Tramadol
- Gabapentin
- Cephazolin
- Famotidine

DECEMBER 16-17, 2014

Diet while in Hospital

- Royal Canin Vet Diet GI High Energy (canned, UNKNOWN AMOUNTS)


Royal Canin Veterinary Diet Canine GASTROINTESTINAL HIGH ENERGY is formulated to meet the nutritional levels established by the AAFCO Dog Food Nutrient Profiles for maintenance. All Royal Canin Veterinary Diet Canine products guarantee 100% satisfaction with superior quality and consistency. If you have any questions or comments regarding these products, call Royal Canin USA Technical Services: 1-800-592-6687. For Canada: Your veterinary clinic is the best source of information for your pet, or contact us at www.royalcanin.ca.

Nutritional Support Plan….

GROWING LARGE BREED PUPPY KEY NUTRITIONAL FACTORS (I)

- **Energy** Requirements – 2.0-2.5 X RER
  - Prevention of obesity (Hand et al, 2010)
- Adequate **Protein** Levels - 23-31% DM
  - Arginine = essential AA for puppies (Nap et al, 1993)
- **Fat** - Min. of 8.5% DM
  - DHA + EPA 0.05% DM (DHA:EPA → 2:3) (NRC, 2006)
  - Conversion of polyunsaturated fatty acids to DHA → essential for growth (Bauer et al, 2006)

GROWING LARGE BREED PUPPY
KEY NUTRITIONAL FACTORS (II)

- **Calcium** 0.8-1.4% DM (aim towards 1.2%)
- **Phosphorus** 0.7-1.2% DM
- **Ca:P ratio** 1.1:1-1.3:1

Nutritional Risks to Large-Breed Dogs: From Weaning to the Geriatric Years

Susan D. Lauten, PhD

Vet Clin Small Anim, 2006; 36: 1345-1359

ABSORPTION CONSIDERATIONS IN PUPPIES

Growth hormone modulates cholecalciferol metabolism with moderate effects on intestinal mineral absorption and specific effects on bone formation in growing dogs raised on balanced food

M.A. Tryfonidou[a,*], M.S. Holl[a], M.A. Oosterlaken-Dijksterhuis[a], M. Vastenburg[b], W.E. van den Brom[a], H.A.W. Hazewinkel[a]

Domestic Animal Endocrinology, 2003; 25: 155-174

Intestinal Calcium Absorption in Growing Dogs Is Influenced by Calcium Intake and Age but Not by Growth Rate[1]

M. A. Tryfonidou,[2*] J. van den Broek,† W. E. van den Brom* and H.A.W. Hazewinkel*

The Journal of Nutrition, 2002; 132: 3363-3368

ROYAL CANIN MAXI PUPPY

Nutrient Analysis	Maxi Puppy (%DM)	AAFCO (2014) Min. Req. for Growth (%DM)
Crude Protein	✓28.18	22
Crude Fat	✓15.03	8
Calcium	✓1.14	1
Phosphorus	✓0.85	0.8
Ca:P	✓1.3	1.25:1

Metabolizable Energy = 364.6 kcal/100g (346 kcal/cup)

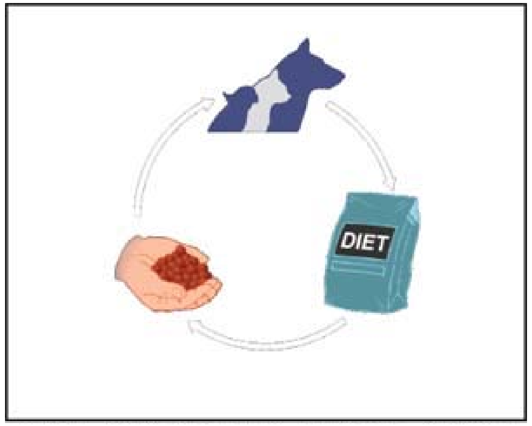
Recommended amount: 388g or 4 and 1/8 cups over 3-4 meals

DECEMBER 18, 2014

- **Medications**
  - Fentanyl patch 100mcg/h (over 3 days)
  - Tramadol 100mg, 1 capsule PO TID
  - Gabapentin 100mg, 2 capsules PO TID
  - Meloxicam 1.5mg/mL, measure to 20kg mark, PO QD
  - Cephalexin 500mg, 1 tablet PO TID
- **Nutrition Support Plan**
  - Continue with Royal Canin Maxi Puppy
  - Treats < 10% daily energy intake
  - Adjustments according to weight, BCS, MCS and age

FEBRUARY 2, 2015

- Highly improved
- **Residual ataxia**
- Nutritional assessment:
  - Wt = 24kg
  - **BCS = 6/9**
  - MCS = mild muscle wasting
- Fed recommended RC Maxi Puppy **AND**
  - Apples and carrots
  - Table scrapes
  - Salmon skin rolls
  - Two knuckle bones a week



Treats > 10% daily energy intake

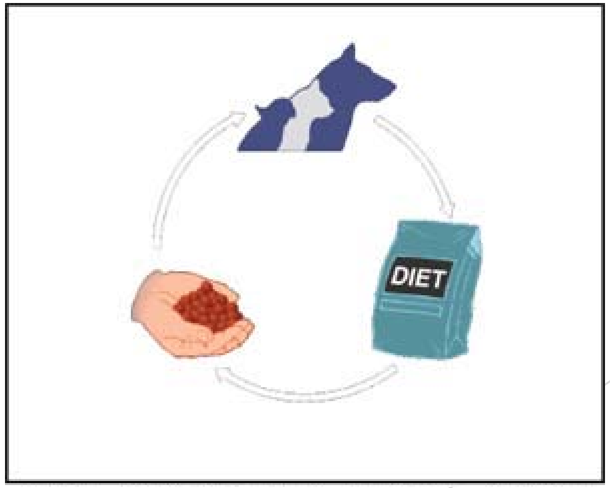
TAKE HOME MESSAGES

- COMPLETE AND BALANCED DIET!

AAFCO
Association of American Feed Control Officials

- Follow large breed puppy requirements
- Diet history form

THE WORLD SMALL ANIMAL VETERINARY ASSOCIATION
WSAVA
Global Veterinary Community



TAKE HOME MESSAGES

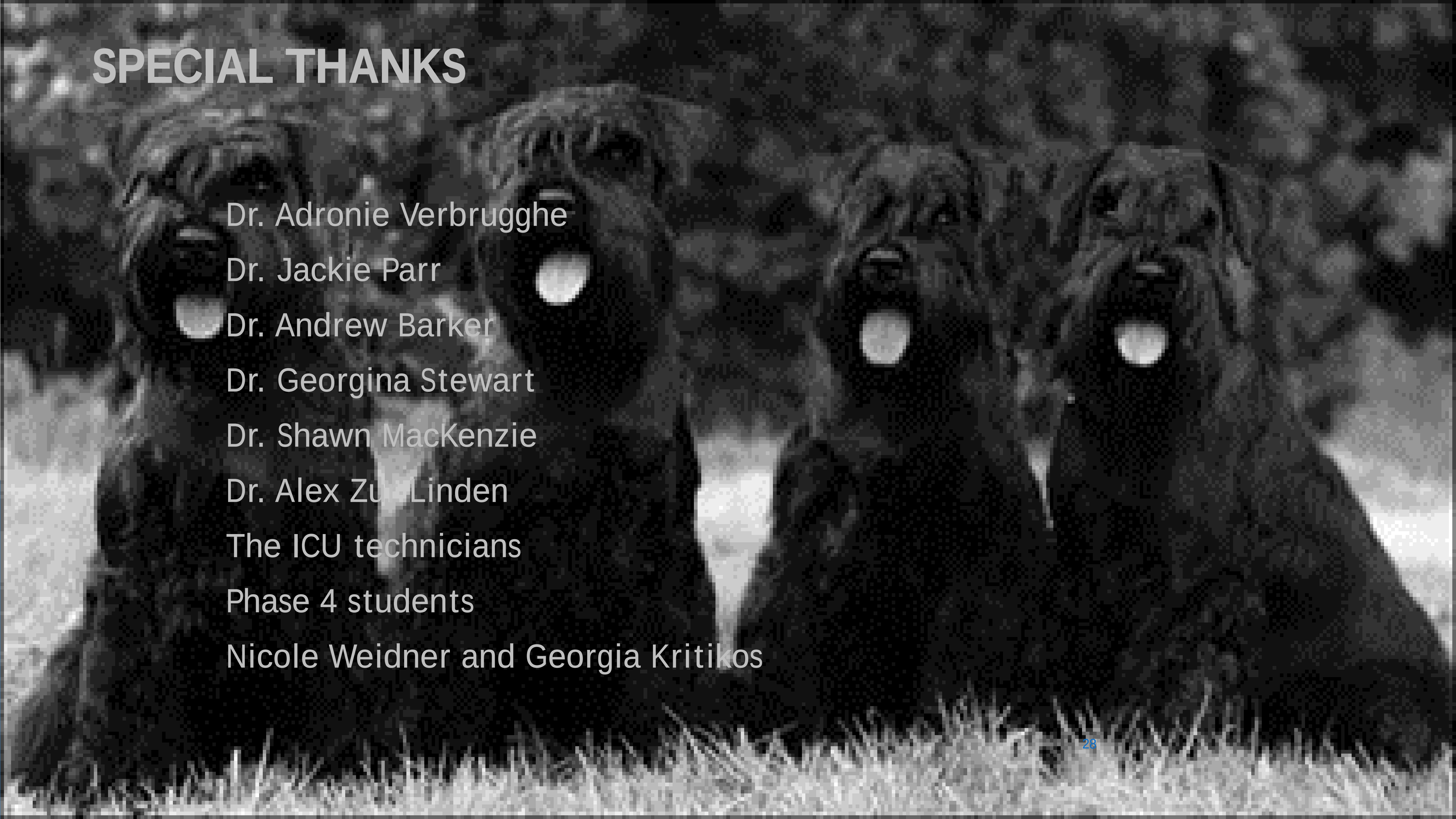
Handling Alternative Dietary Requests from Pet Owners

Jacqueline M. Parr, DVM, MSc[a,b,*],
Rebecca L. Remillard, PhD, DVM[c,d,e]

Vet Clin Small Anim, 2014; 44: 667-688

Maintain empathy and understanding for owner - believe they are doing the BEST for their pet.

- **Homemade diet (HMD):**
  - **Nutrition consult!**
  - Quick assessment for a HMD recipe
    - Protein, carbohydrates, lipids, calcium, multivitamin and trace mineral source
    - Ca:P – especially in a large breed puppy
- **Treats < 10%** daily energy intake



SPECIAL THANKS

Dr. Adronie Verbrugghe

Dr. Jackie Parr

Dr. Andrew Barker

Dr. Georgina Stewart

Dr. Shawn MacKenzie

Dr. Alex Zur Linden

The ICU technicians

Phase 4 students

Nicole Weidner and Georgia Kritikos

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- Tryfonidou, M.A., Van Den Broek, J., Van Den Brom, W.E., Hazewinkel, H.A.W. Intestinal calcium absorption in growing dogs is influenced by calcium intake and age but not by growth rate. J. Nutr., 2002; 132: 3363-3368.
- Parr, J.M., Remillard, R.L. Handling Alternative Dietary Requests from Pet Owners. Vet Clin Small Anim, 2014; 44: 667-688.

UNIVERSITEIT GENT

FACULTY OF VETERINARY MEDICINE
approved by EAEVE

Iron overload disease in browser rhinoceroses in captivity.

Vandendriessche Veerle
ECVCN Residency Class 2015

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Laboratory of Animal Nutrition
veerle.vandendriessche@UGent.be

Small Animal Nutrition

Iron overload disease in browser rhinoceroses

- ✓ Introduction
- ✓ Iron metabolism
- ✓ Rhino anatomy and gastro-intestinal tract physiology
- ✓ Diet composition wild & captivity
- ✓ Past treatments applied
- ✓ Current/future research
- ✓ Discussion

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Small Animal Nutrition

Introduction

- Rhinoceros species:
  - Diceros bicornis
  - Dicerorhinus sumatrensis
  - Ceratotherium simum
  - Rhinoceros unicornis

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Introduction

- ✓ Occurence of IOD or captivity aquired hemosiderosis:
  - ❑ Only in captive animals
  - ❑ Only in the two browser species
  - ❑ But also in

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Introduction

- ✓ Diagnosis of IOD in the past = necropsy

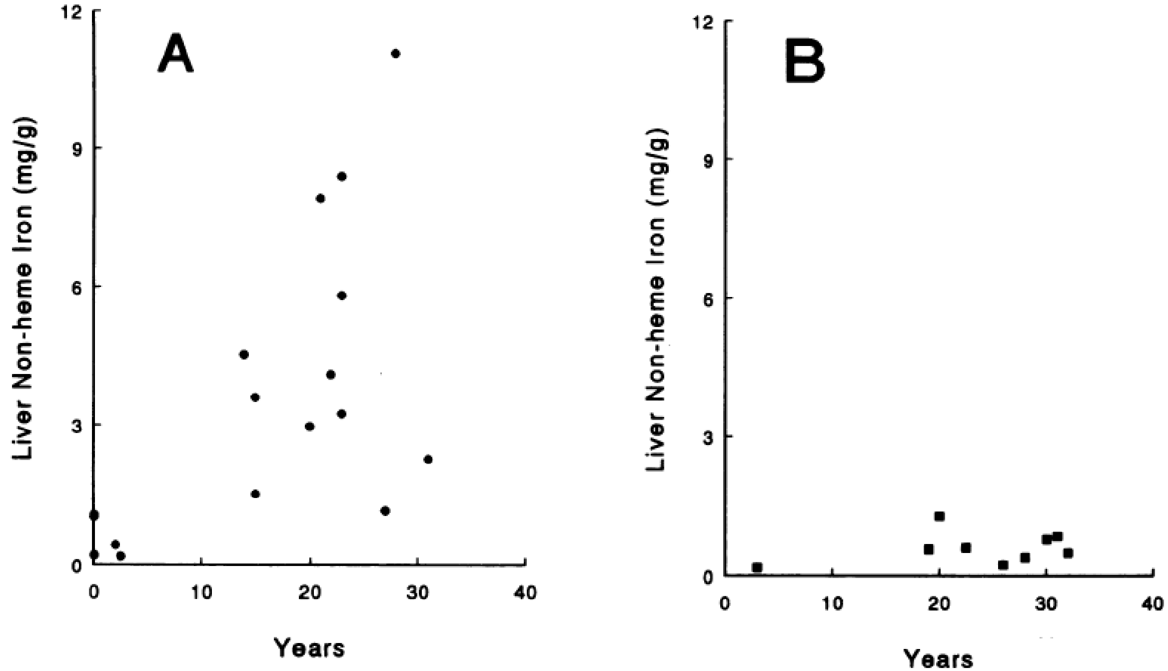
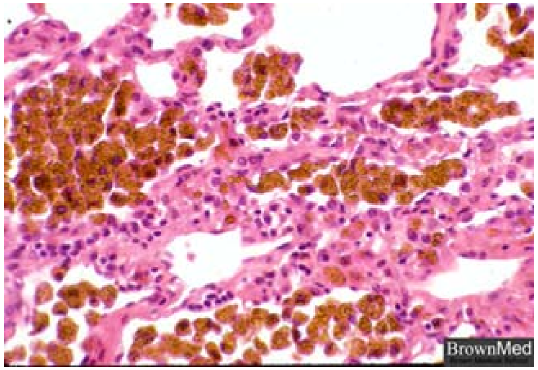
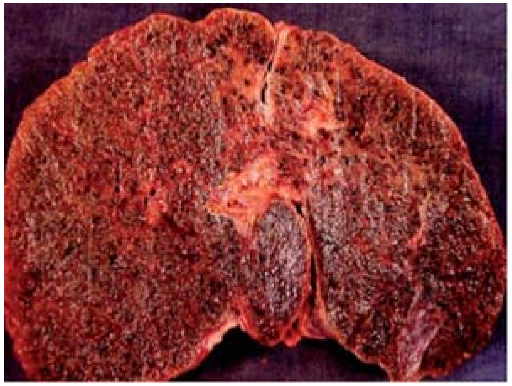


Figure 1. The relationship of liver nonheme iron to age or time in captivity in black (**A**) and white (**B**) rhinoceroses. (*N* = 18 for black rhinoceroses, *N* = 9 for white rhinoceroses.





Smith et al, 1995; Kock et al, 1992; Miller et al, 2012

Introduction

Species	No.	Iron (μg/dl)
Captive:		
Adult *D. bicornis*	69–70	227 ± 107
Juvenile *D. bicornis*	26–30	236 ± 135
D. sumatrensis	13–14	131 ± 47
C. simum	21–24	121 ± 43
R. unicornis	6–11	122 ± 31
Free-ranging in Southern Africa:		
D. bicornis	21–26	83 ± 32
C. simum	15–20	64 ± 11
Reference ranges:		
U.S. Equine		50–198
University of California, Los Angeles, Hematology Research Lab		65–165

Paglia & Tsu, 2012

Introduction

✓ Diagnosis of IOD in the present:

1. Compare ferritine to baseline values
2. MRI (visceral iron excess) or liver biopsy
3. Rule out aquired overload
4. Genetic origin

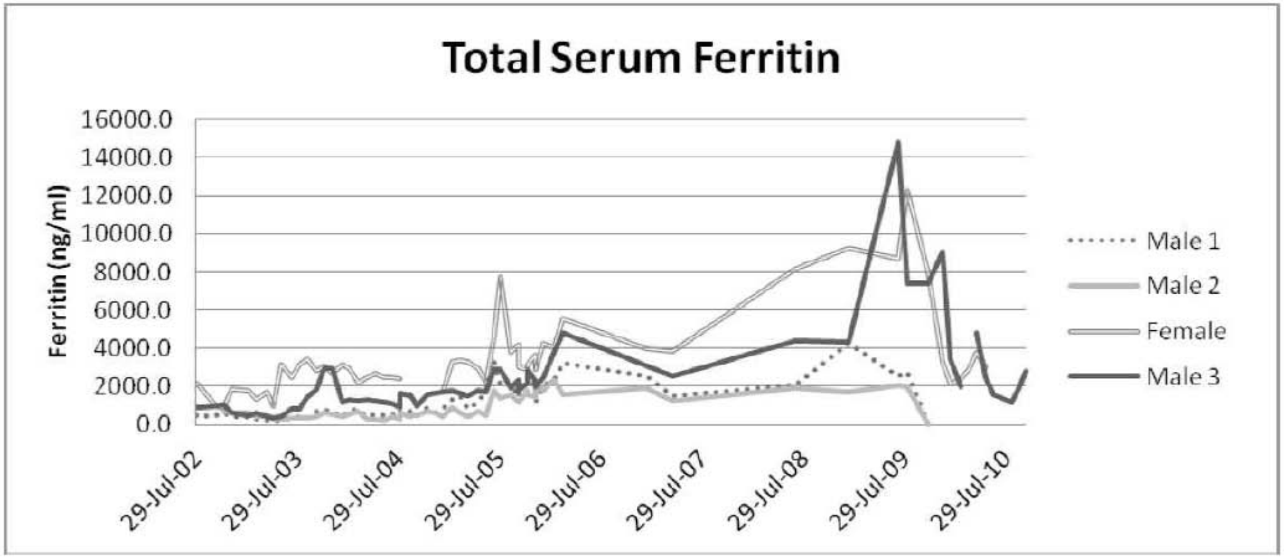
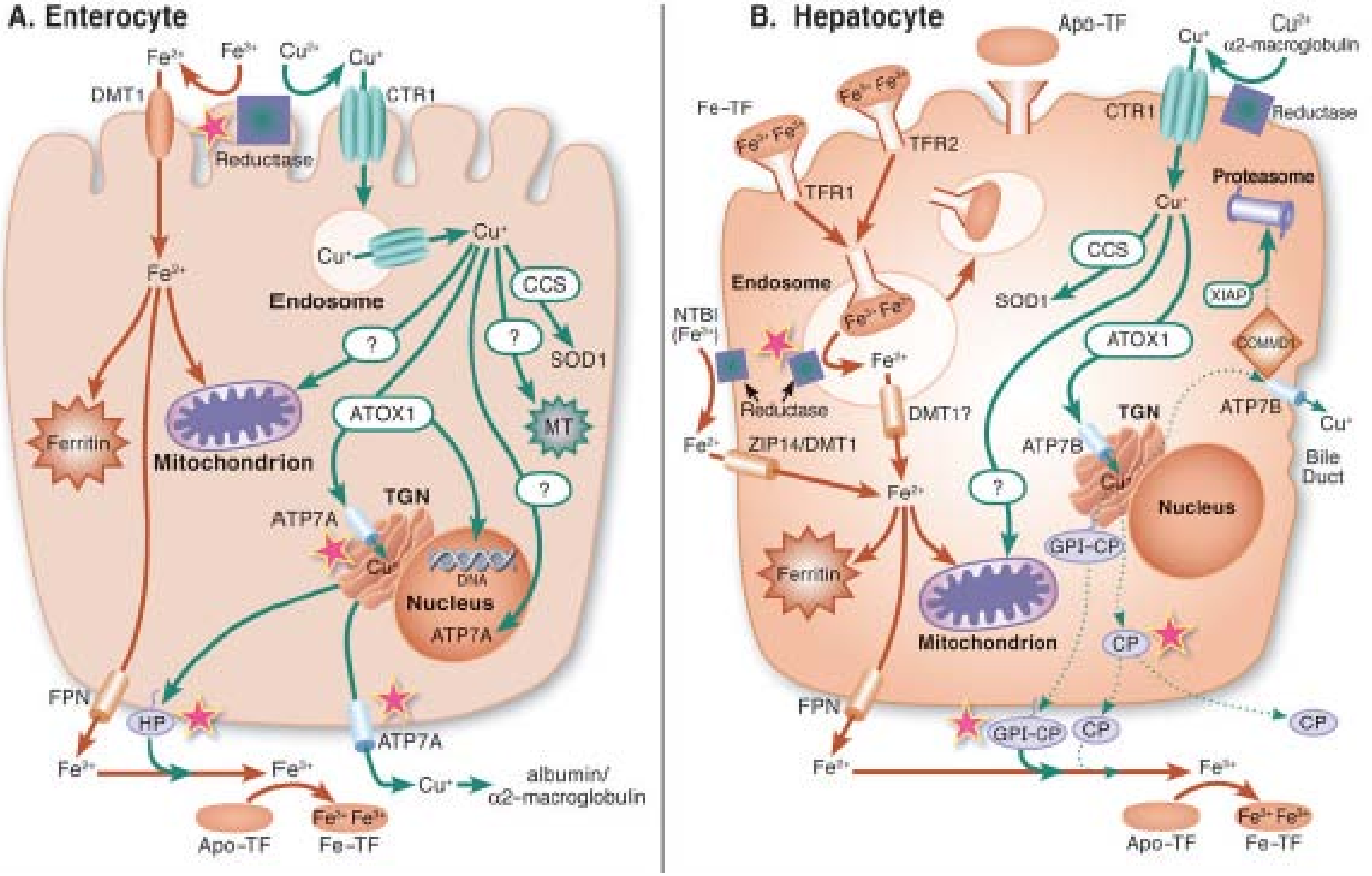


Figure 2. Total serum ferritin in 3:1 captive black rhinoceroses (*D. bicornis*) in a mixed-species savannah exhibit.

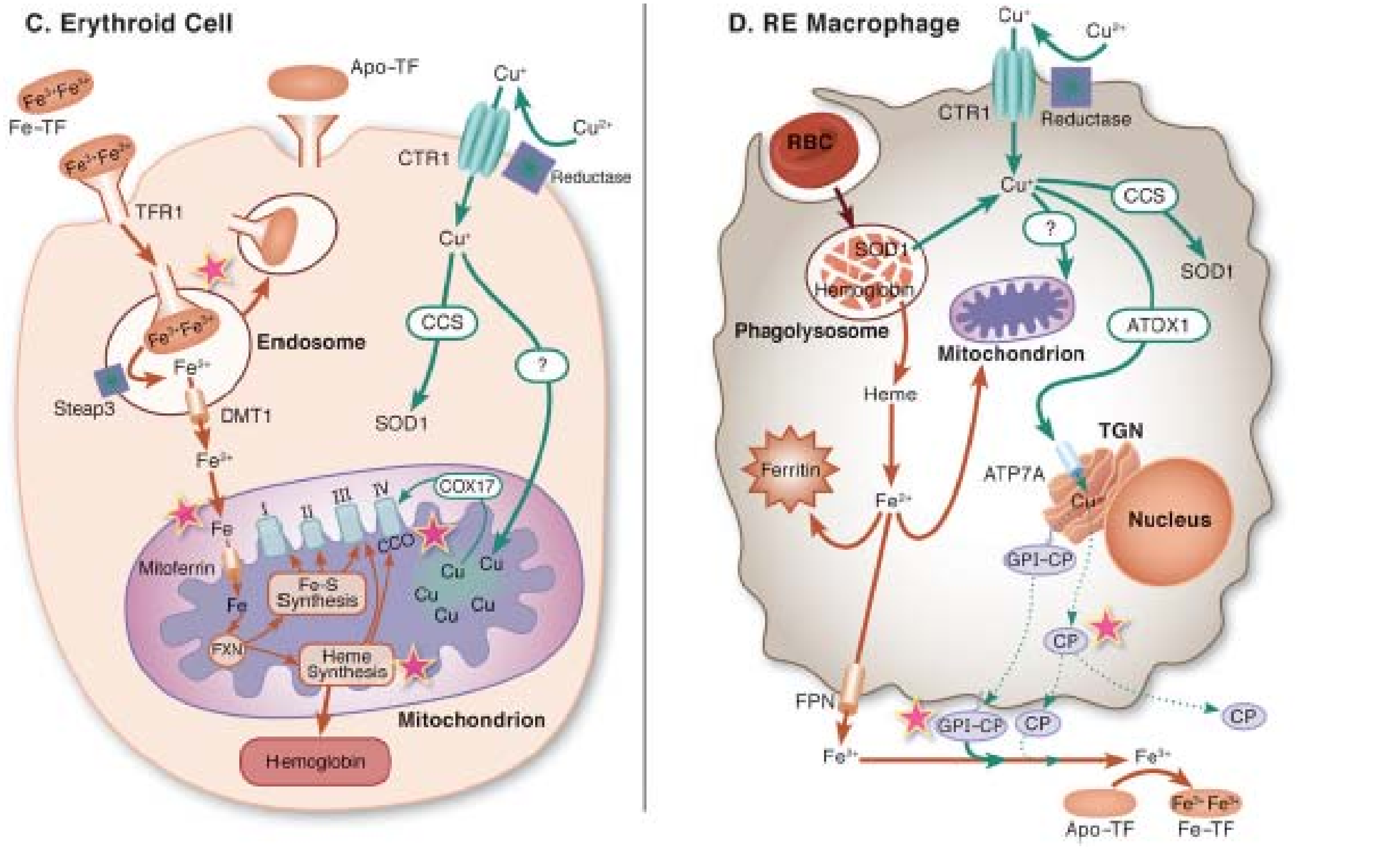
Mylniczenko et al, 2012

Iron metabolism



Collins et al, 2010

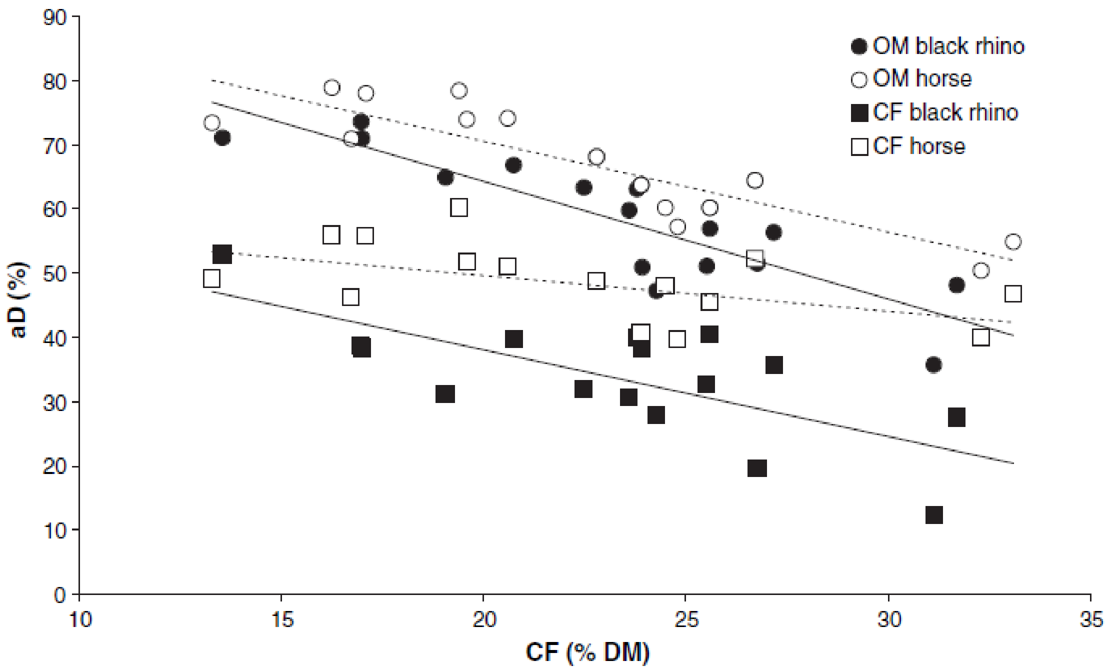
Iron metabolism

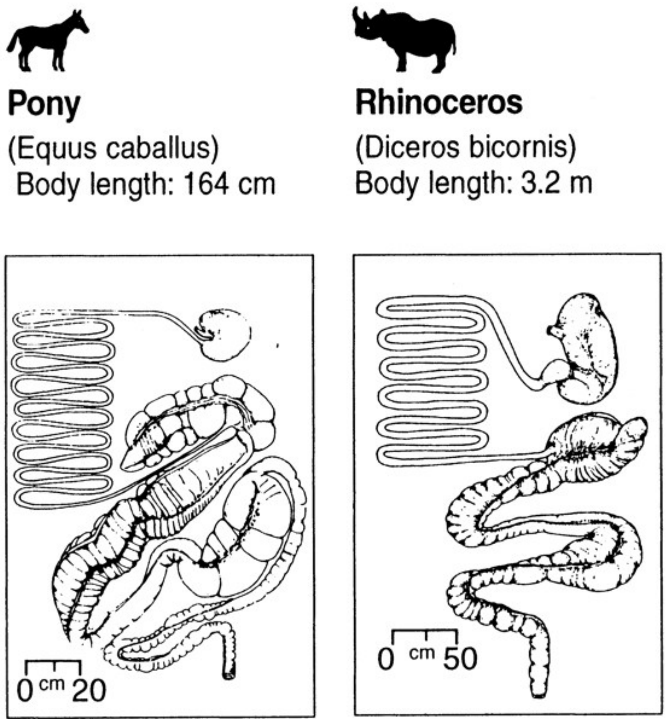


Collins et al, 2010

Rhino anatomy and digestibility characteristics

- ✓ Hindgut fermenter
- ✓ Species ≠ retention time
- ✓ Species ≠ digestibility
- ✓ ≠ horses





Clauss et al, 2006; Steuer et al, 2010

Rhino anatomy and digestibility characteristics

✓ Tannin Binding Salivatory Proteins (TBSP)

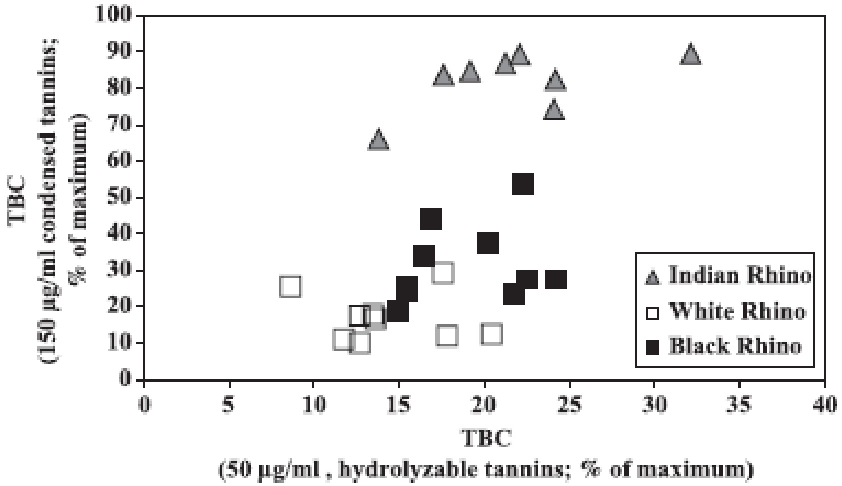


Fig. 1. Tannin-binding capacity (TBC) of salivary proteins of captive individuals of three rhinoceros species on regular zoo diets for tannic acid (a hydrolysable tannin) and quebracho (a source of condensed tannins).

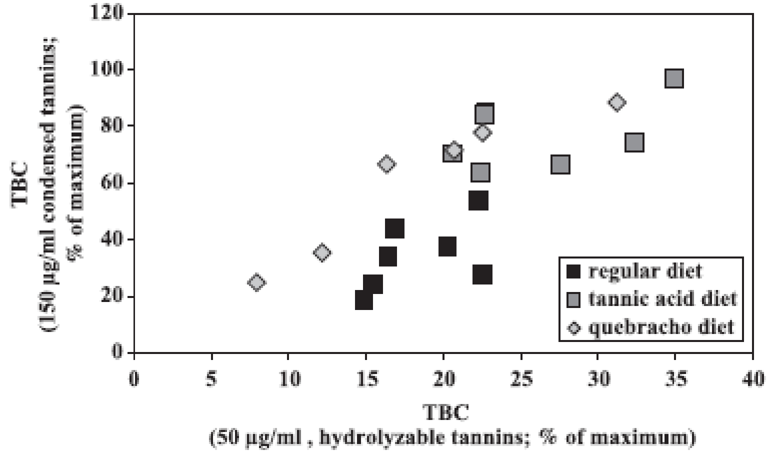


Fig. 2. Tannin-binding capacity (TBC) of salivary proteins of individual captive black rhinos on their regular zoo diet and on diets supplemented either with tannic acid or quebracho. TBC for tannic acid (a hydrolysable tannin) and quebracho (a source of condensed tannins).

Clauss et al, 2005

Diet composition wild black rhino's

Table 1 Diet composition (fresh matter) in free-ranging black rhinoceroses (*Diceros bicornis*)

Proportion of ingested diet (%)			
Shrubs and trees	Herbs	Grass	Source
87–95	5–13	0 (one observation)	Joubert and Eloff (1971)
54–81	18–41	0	Mukinya (1977)
81–94	6–19	0	Hall-Martin et al. (1982)
47–93	5–51	0	Oloo et al. (1994)
93–95	3–5	1	Atkinson (1995)
56–76	1–11	0–1	Pole (1995)
69	31	0	Hennig and Gindrig (2001)

Clauss et al, 2006

Diet composition wild black rhino's

	Plant species[a]	Biomass (%)	Bites (%)
1	*Grewia robusta*		
2	*Coddia rudis*		
3	*Plumbago auriculata*		
4	*Euclea undulata*		
5	*Azima tetracantha*		

van Lieverloo et al, 2009; Ghebremeskel et al, 1991; Dierenfeld et al, 1995

Diet composition wild black rhino's

Table 1. Seasonal variation of the iron content in the diet of three free-ranging black rhinoceros (*Diceros bicornis*) populations.

	Early dry season	Late dry season	Flushing period
Waterberg Plateau Park	61.2 ± 8.7^{aA}	49.5 ± 10.9^{bA}	50.7 ± 8.3^{bA}
Tswalu Kalahari Reserve	100.2 ± 14.8^{aB}	136.7 ± 47.0^{bB}	175.0 ± 31.5^{cB}
Great Fish River Reserve	76.4 ± 14.2^{C}	86.1 ± 19.0^{C}	84.2 ± 20.0^{C}

Fe (ppm) dry matter

Table 2. Seasonal variation of the condensed tannin content in the diet of three free-ranging black rhinoceros (*Diceros bicornis*) populations.

	Early dry season	Late dry season	Flushing period
Waterberg Plateau Park	4.3 ± 0.5^{aA}	4.3 ± 0.5^{bA}	3.4 ± 0.6^{cA}
Tswalu Kalahari Reserve	1.8 ± 0.7^{aB}	1.7 ± 0.7^{aB}	2.8 ± 1.6^{bAB}
Great Fish River Reserve	3.3 ± 1.6^{aC}	3.4 ± 1.5^{aA}	1.9 ± 1.7^{bB}

Helarey et al, 2012

Diet composition of captive black rhino's

Table 1. Measured consumption and iron content on a dry matter basis of diet items consumed by four black rhinoceroses at Disney's Animal Kingdom in July 2011 (current as of submission)

Maintenance items (fed daily)	Consumed (g/animal/day)	Fe (ppm) dry matter
Timothy hay	9,670	76
Disney's Animal Kingdom Wild Herbivore Pellet 5Z0X	6,810	306
Bermuda hay	4,280	180
Browse	~11,000	See values below
Training	~3,800	51 ± 15[a]
Enrichment	~1,800	134 ± 35[a]
Varieties of browse offered		
Willow (spring/summer months)	8,500	135
Banana (spring/summer months)	2,270	110
Elaeocarpus (winter only)	2,270	102
Ear leaf acacia (winter only)	7,500	72
Pine cones (1× a week in season)	640	251

[a] Average "Training" iron value calculated based on analysis of carrots, apples, sweet potato, watermelon, oatmeal, and low-starch primate biscuit; Average "Enrichment" iron value calculated based on analysis of cucumber, carrot, romaine lettuce, green leaf lettuce, zucchini, endive, kale, and bean paste; Both are shown as averages plus or minus standard errors.

Mylniczenko et al, 2012; Clauss et al, 2012

Diet composition of captive black rhino's

MINERAL	FORAGE		TEMPERATE			MAINTENANCE RECOMMENDATION FOR HORSES[4]
	BLACK RHINOCEROS[1]	WHITE RHINOCEROS[2]	BROWSE[3]	LUCERNE[3]	GRASS[3]	
mg/kg DM						
Fe	82 (12–215; $n=28$)	177 (91–220; $n=6$)	120 (64–191; $n=12$)	180	129 (46–391; $n=10$)	40–70
Mn	60 (1–269; $n=28$)		92 (14–248; $n=12$)	40	74 (37–147; $n=9$)	40
Cu	5 (1–12; $n=28$)	4 (3–6; $n=6$)	11 (7–20; $n=12$)	11	6 (4–9; $n=6$)	10
Zn	14 (3–67; $n=28$)	23 (16–35; $n=6$)	53 (13–121; $n=12$)	24	19 (15–23; $n=5$)	40

Clauss & Hatt, 2006

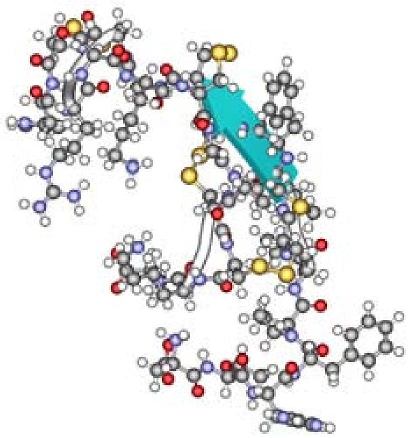
Past/current treatments

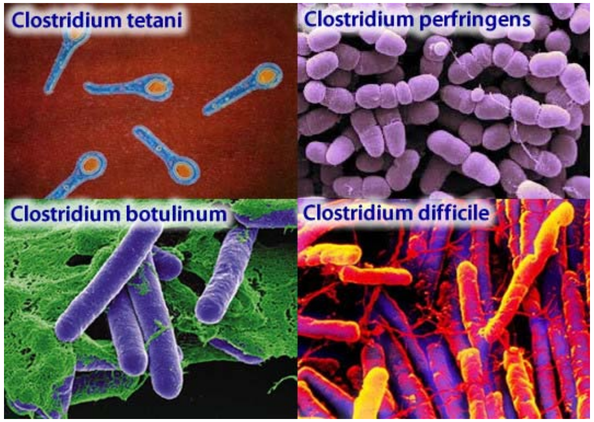
- ✓ Limit uptake of dietary iron to 300mg Fe/kg DM/day
  - ❑ Add more browse to their diet
  - ❑ Develop concentrates with lower Fe and Vit C content
  - ❑ Use hays with higher tannins or phenolics
  - ❑ White, ionized salt blocks
  - ❑ Analyse water source (< 0,3ppm Fe)
  - ❑ Routine analysis of all diet components
- ✓ Add iron chelators (mimosine)?
- ✓ Phlebotomy (effect on hepcidine)?

Clauss et al, 2012; Lanvin 2012

Current/future research

- ✓ Diet-related hemolysis?
- ✓ Role of hemolysin producing bacteria?
- ✓ Difference in iron excretion between wild and captive rhino's?
- ✓ Difference in hepcidine levels?
- ✓ ≠ intestinal bacterial species?
- ✓ Copper deficiency?
- ✓ Other minerals?
- ✓ Stress?
- ✓ Insulin resistance?
- ✓ Develop BCS





Nielsen et al, 2012; Ganz & Nemeth, 2012; Ganz et al, 2012

Conclusion

From a nutritionists point of view, there are still a lot of unknowns concerning the development of IOD in captive browser rhino's =>

Thank you

Laboratory of Animal Nutrition
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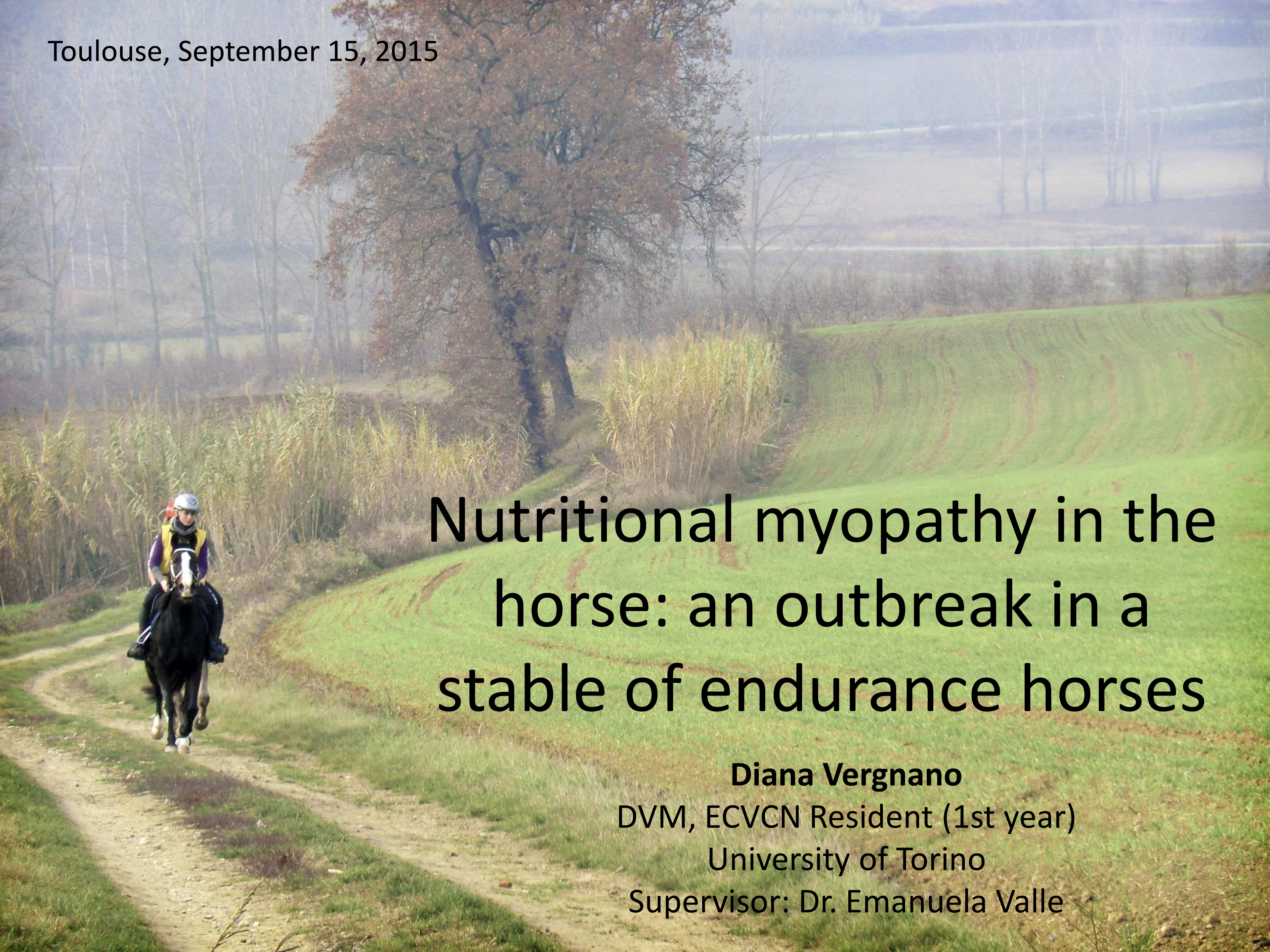
UNIVERSITEIT GENT

Small Animal Nutrition

Iron overload disease in browser rhinoceroses

- **Review of laboratory and necropsy evidence for Iron Storage Disease aquired by browser rhinoceroses.**
- Donald E. Paglia and I-Hsien Tsu
- Journal of Zoo and Wildlife Medicine 43 (3)
- 2012



Toulouse, September 15, 2015

Nutritional myopathy in the horse: an outbreak in a stable of endurance horses

Diana Vergnano
DVM, ECVCN Resident (1st year)
University of Torino
Supervisor: Dr. Emanuela Valle

The nutritional consultant service received a phone call…

- **When:** March 2015, rainy period
- **Who:** veterinarian
- **Where:** endurance stable in Piedmont, Cuneo
- **Why:** suspected poisoning

Anamnesis

Horses involved: **two horses** of the same stable with similar symptoms

Another horse showed similar symptoms in autumn and died

Anamnesis

<u>Horse 1: Duke</u>

- Arabian horse, 12 years, gelding, BCS 4, 500 kg
- Sudden onset of clinical signs:

  fasciculations, muscle tremors,

  dysphagia, recumbency
- The day before participated in an Endurance competition

Anamnesis

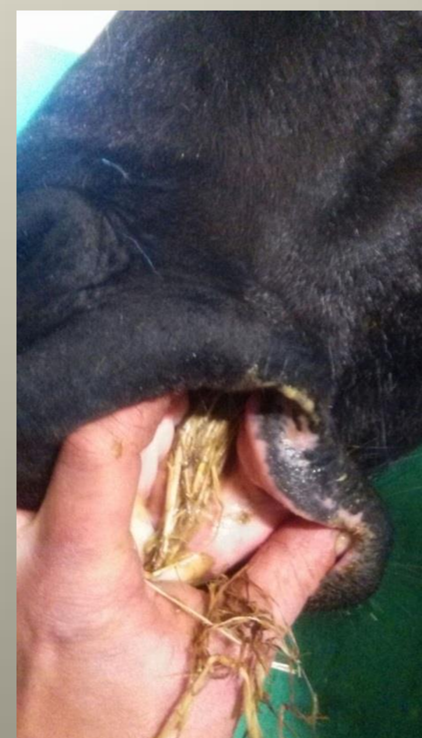
Horse 2: Desdemona

- Pony breed, 15 years, female, BCS 5.5, 250 kg
- Clinical signs appeared one day after Duke's
- Symptoms: dysphagia, ptyalism, mucosal hyperhemia, muscle fasciculation

Anamnesis

<u>Horse 2: Desdemona</u>

Dysphagia: involvement of tongue, pharyngeal and masticatory muscles



Anamnesis

Anamnesis

Anamnesis

Feed composition

- First cut meadow hay, poor quality
- Concentrate: mixed flaked cereals

Roughage/Concentrate Ratio
70:30

Diagnosis – Laboratory findings

Hematological analysis:

Duke

↓RBC: 5,94 (6,8-12,9)*
↓HCT: 27,5 (30-53)
↓HB: 10,4 (11-19))

slight normochromic normocytic **anemia**
(normal leucocytes and platelets)

Desdemona

↓RBC: 5,6 (6,8-12,9)
↓HCT: 25,8 (30-53)
↓HB: 10,9 (11-19)
↓Lym 850 (1500 – 7700)

moderate normochromic normocytic **anemia**
moderate lymphopenia

*Lab reference values

Diagnosis – Laboratory findings

Biochemical analysis:

Duke

↓PT: 5,3 (5,6-8 mg/dl) *
↑Azotemia: 30,1 (10-25 mg/dl)
↓Crea: 0,88 (1,2-1,9 mg/dl)

↑CK: 558 (60-330 U/l)
↑LDH: 1215 (300-720 U/l)
↑AST: 717 (140-320 U/l)
↑ALP: 579 (60-320 U/l)
↑Bil: 3,65 (0,2-1,9 µmol/l)

↓ Ca: 8,1 (9-13 mg/dl)
↓ Na: 122 (133-150 mmol/l)
↓ Cl: 82 (97-109 mmol/l)
↓ K: 2,7 (3-5,3 mmol/l)
↓ Mg: 1,54 (1,6-2,9 mg/dl)

Desdemona

↑ Azotemia: 45,3 10-25 mg/dl)
↓ Crea: 1,1 (1,2-1,9 mg/dl)

↑ CK: 1651 (60-330 U/l)
↑ LDH: 1221 (300-720 U/l)
↑ AST: 906 (140-320 U/l)
↑ ALP: 1102 (60-320 U/l)
↑ Bil: 6,8 (0,2-1,9 µmol/l)

↓ Ca: 8,9 (9-13 mg/dl)
↓ Na: 128 (133-150 mmol/l)
↓ Cl: 94 (97-109 mmol/l)

*Lab reference values

Diagnosis: main findings

Principal localization of symptoms: **muscles**

Hematological analysis: slight anemia

Biochemical analysis: ↑ CK, LDH, AST

↓ Serum Calcium level

Differential Diagnosis

- Botulism
- Acute form of grass sickness
- Acute piroplasmosis
- Tetanus
- Ionophore intoxication
- Nutritional myopathy
- Plant intoxication (atypical myopathy)
- Exertional rhabdomyolysis syndrome

Robinson and Sprayberry, 2008

Differential Diagnosis: rule out of....

- ~~Botulism~~
- ~~Acute form of grass sickness~~
- ~~Acute piroplasmosis~~
- ~~Tetanus~~
- ~~Ionophore intoxication~~
- Nutritional myopathy
- ~~Plant intoxication (atypical myopathy~~)
- ~~Exertional rhabdomyolysis syndrome~~

Do not cause severe hypocalcemia nor marked CK increase

Need for feed contamination: not found

Need for toxic plants: not found

Not in multiple animals

Robinson and Sprayberry, 2008

Differential Diagnosis: Feed Analysis

- Feed composition: vitamin E and Selenium content

Desdemona	Intakes	Requirements
Vit E	155,6 IU	250 IU
Se	0,26 mg	0,5 mg

- Piedmont: area of low selenium concentration in the soil

Lindberg, 2013; NRC, 2007, Zeyner and Harris, 2013

Differential Diagnosis: Vit E and Se

Test for serum Selenium and Vitamin E

Duke

Se: 26 (100-200 ug/l)* → Low Se ↓

Vit E: 0,8 (>1 mg/l) → Low Vit E ↓

Desdemona

Se: <10 (100-200 ug/l) → Low Se ↓

Vit E: 9,3 (>1 mg/l) → Normal Vit E

*Lab reference values

Diagnosis

Nutritional Myopathy

Nutritional Myopathy

<u>Nutritional myodegeneration</u>

Deficiency of:

- Selenium
- Vit E (not always)

Poorly aerated, acid soils
Soils originated from volcanic rock
Soils with a high content of iron or sulfur

Biological antioxidants prevent cellular damage from reactive oxygen species resulting from normal cellular metabolism

Poor quality hay
Rancid feed
Prolonged storage of grass/grains
Addition of fish or plant oils

Aleman, 2008; MacLeay, 2009

Nutritional Myopathy

Any age (from 2 months)

The onset of nutritional myodegeneration in adult horses probably requires some stress factors such

- transport
- change of environmental conditions
- exertion

Ludvikova, 2005

Nutritional Myopathy

Forms

Peracute

Arrhythmias
Tachypnea
Dyspnea
Myalgia
Recumbency
Sudden death

Subacute

Severe weakness
Muscle fasciculation
Myalgia
Lethargy
Dysphagia
Trismus
Ptyalism

Aleman, 2008; MacLeay, 2009

Diagnosis

Nutritional Myopathy: Laboratory findings:

- Acute increase of CK and AST
- Severe hypocalcemia
- Hyperproteinemia
- Azotemia
- Hyponatremia
- Hypochloremia
- Hyperkalemia
- Hyperphosphatemia
- Respiratory Acidosis
- Myoglobinuria

Aleman, 2008; MacLeay, 2009, Robinson and Sprayberry, 2008

Therapy

- No physical activity
- Supportive care: fluids
- Administration of selenium (1mg/day PO)
- Administration of vitamin E (5’000-10’000 IU/day PO) if deficient

Aleman, 2008; MacLeay, 2009; McGorum, Pirie, Keen, 2013

Therapy

Which form of Selenium should be used?

PO administration better than IM

- Organic Source ⇨ probably more efficently utilized (not confirmed to date)
- Inorganic Source: Sodium Selenite

Coenen, 2013, NRC, 2007

Therapy

<u>Which form of Vitamin E should be used?</u>

α-tocopherol and α-tocopheryl acetate:

most biologically available forms

Vitamin E	RRR-form (natural)	All-rac-form (synthetic)
α-tocopherol	1.49 IU/mg	1.10 IU/mg
α-tocopheryl acetate	1.36 IU/mg	1.00 IU/mg

Zeyner and Harris, 2013

Therapy: new diet formulation

- Maintain roughage/concentrate ratio at max 70:30
- Use a better quality hay
- Allow access to pasture

<u>For all the horses in the stable</u>

Therapy: new diet formulation

- Introduction of a feed supplement

Additives per kg:

Vitamin E 100˙000 mg (all-rac-alpha-tocopheryl acetate - 3a700)

Selenium 10,5 mg (organic form - 3b8.10)

Recommended dosage: 25-50 g

Therapy: new diet formulation

- Introduction of a feed balancer for all the stable

INGREDIENTS PER KG

Crude protein 9,9 %

Crude fiber 11,0 %

Crude Fat 8,0 %

Crude Hay 10,0 %

Calcium 1,3 %

Phosphorus 0,5 %

Vitamin E 400 IU

Selenium 0,7 mg

Recommended dosage:
150-300 g/100 kg BW

Therapy: new diet formulation

	Feed supplement 50 g	Feed balancer 1’000 g	Total
Vitamin E	5’000 IU	400 IU	5’400 IU
Selenium	0,52 mg	0,7 mg	1,22 mg

Follow up

- **Duke:** died prior to starting therapy
- **Desdemona:** started to recover after 2 weeks
- **Stable:** no more cases, periodic exams are fixed

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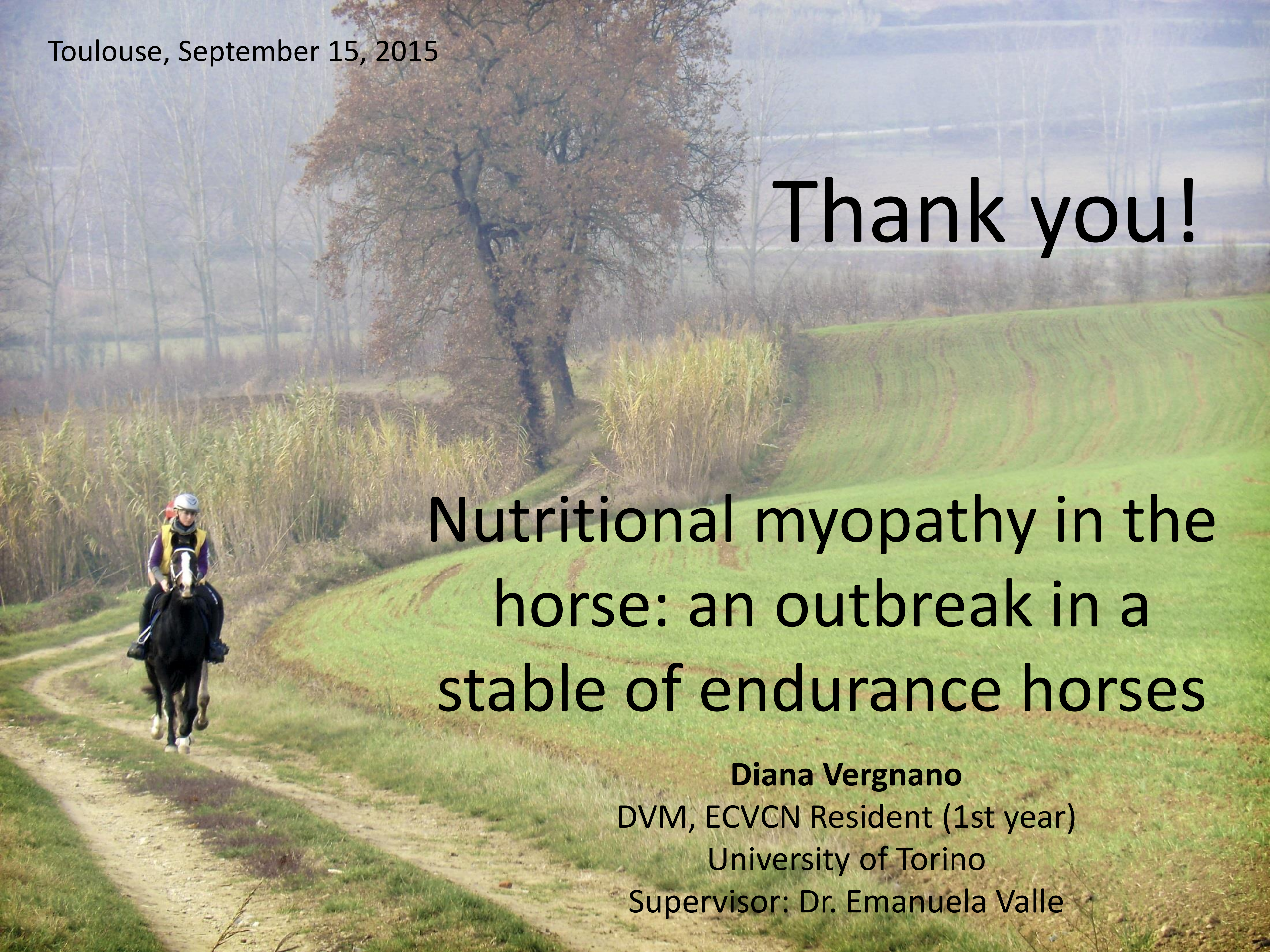

Toulouse, September 15, 2015

Thank you!

Nutritional myopathy in the horse: an outbreak in a stable of endurance horses

Diana Vergnano
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Energy and nutrient costs of infectious diseases in animals

C. Visscher
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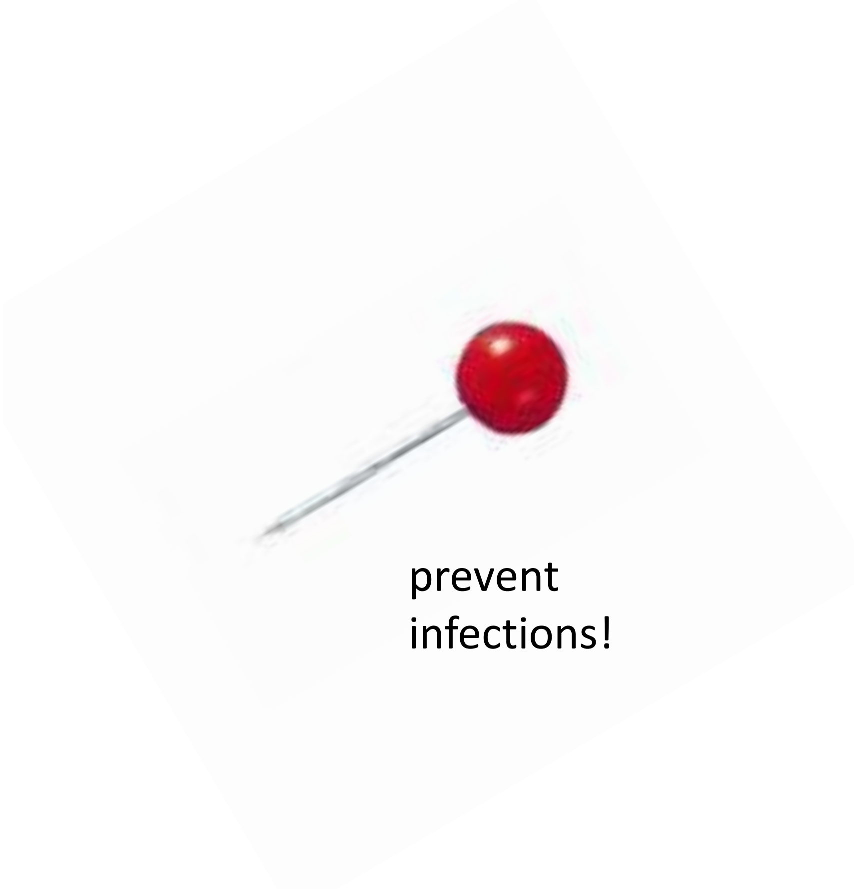
Outline

- The way, infections affect energy and nutrient balance
- Quantifying of costs
- Practical examples
- One example for limiting the costs
- Conclusion

first off—there are two ways to optimize performance...



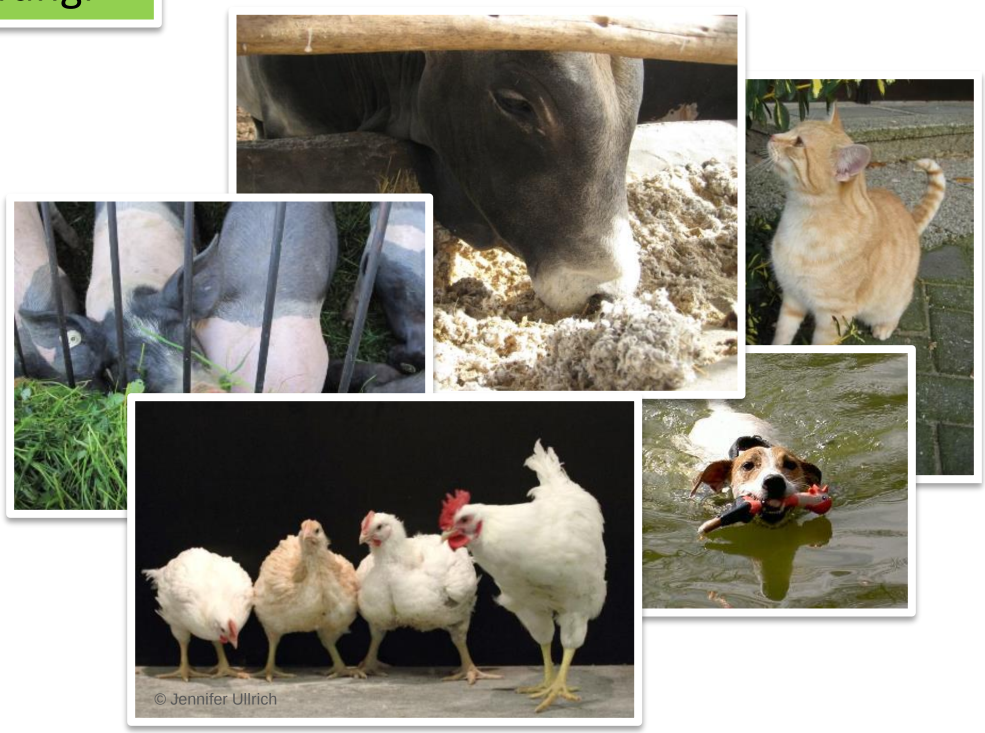
1. optimize feed + environmental conditions

2. reduce energy and nutrient costs through prevention

potential pathogens

fungi

protozoa



viruses

helminths

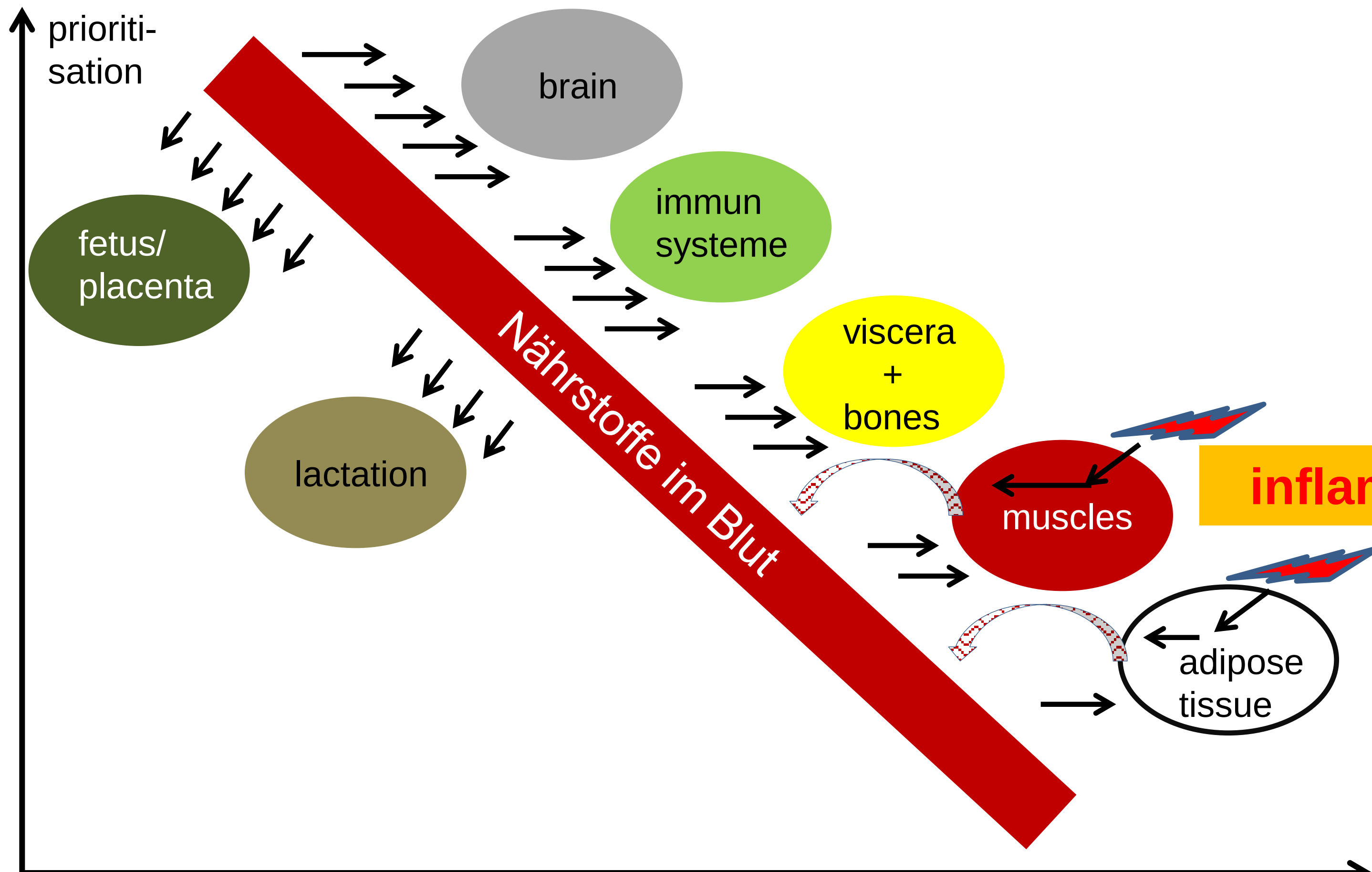
bacteria

Kaspers 2014: Vertebrates need a fully functional immune system to survive

Mechanisms of innate and acquired immunity (TIZARD 2013)

part	innate immune system	adaptive immune system
characterization	permanently ready for action	turned on by antigens
involved cells	Macrophages, dendritic cells, neutrophils, natural killer cells	T- and B-cells
evolutionary history	ancient	recent
onset	very fast (min to h)	slow (days to weeks)
specifity	rather low, common microbial structures	antigen-specific
power	potentially overwhelmed	rarely overwhelmed
memory	no	pronounced
efficiacy	does not improve	improves with exposure

prioritization of supply



Ranking of the different organs with respect to their ability to utilize nutrients and nutrient release in case of infection/inflammation (modified after ELSASSER et al. 2007)

Which adaptive reactions are there?

Infections – adaptive reactions

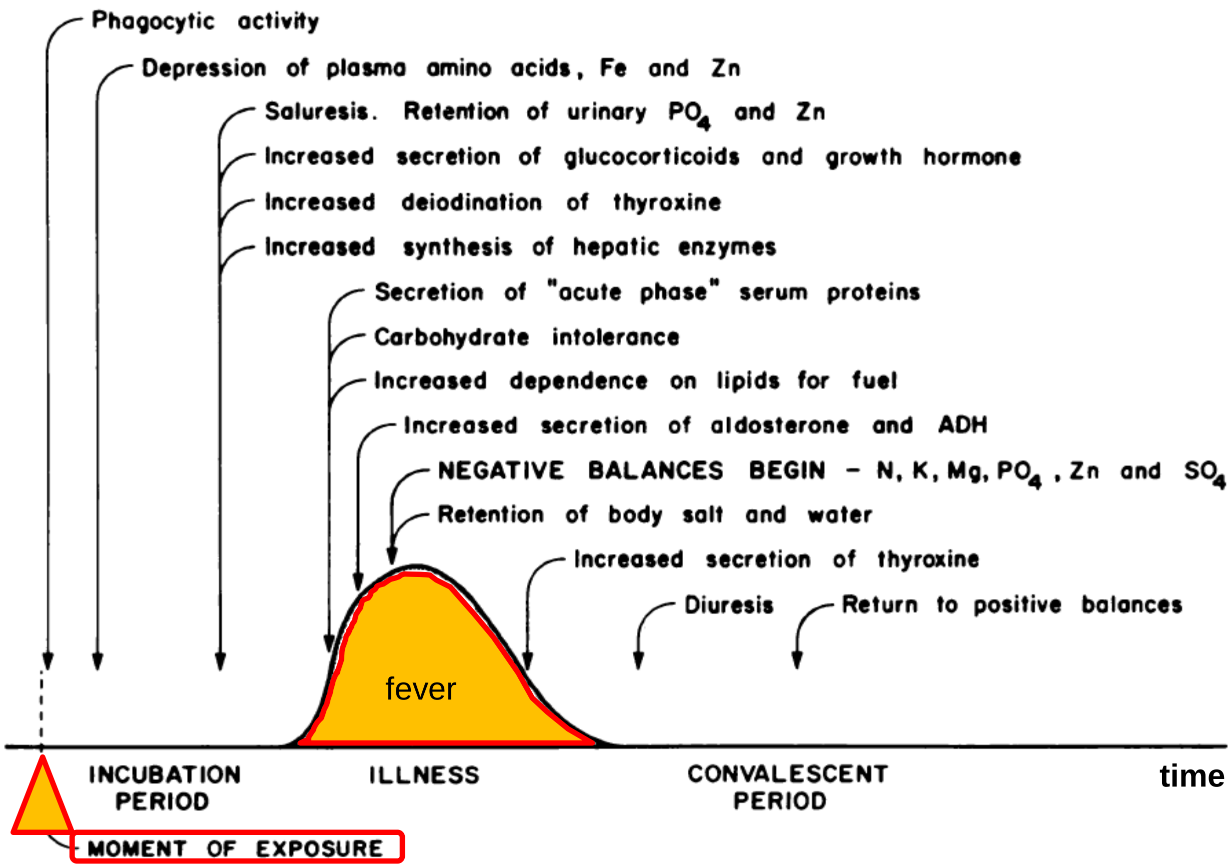
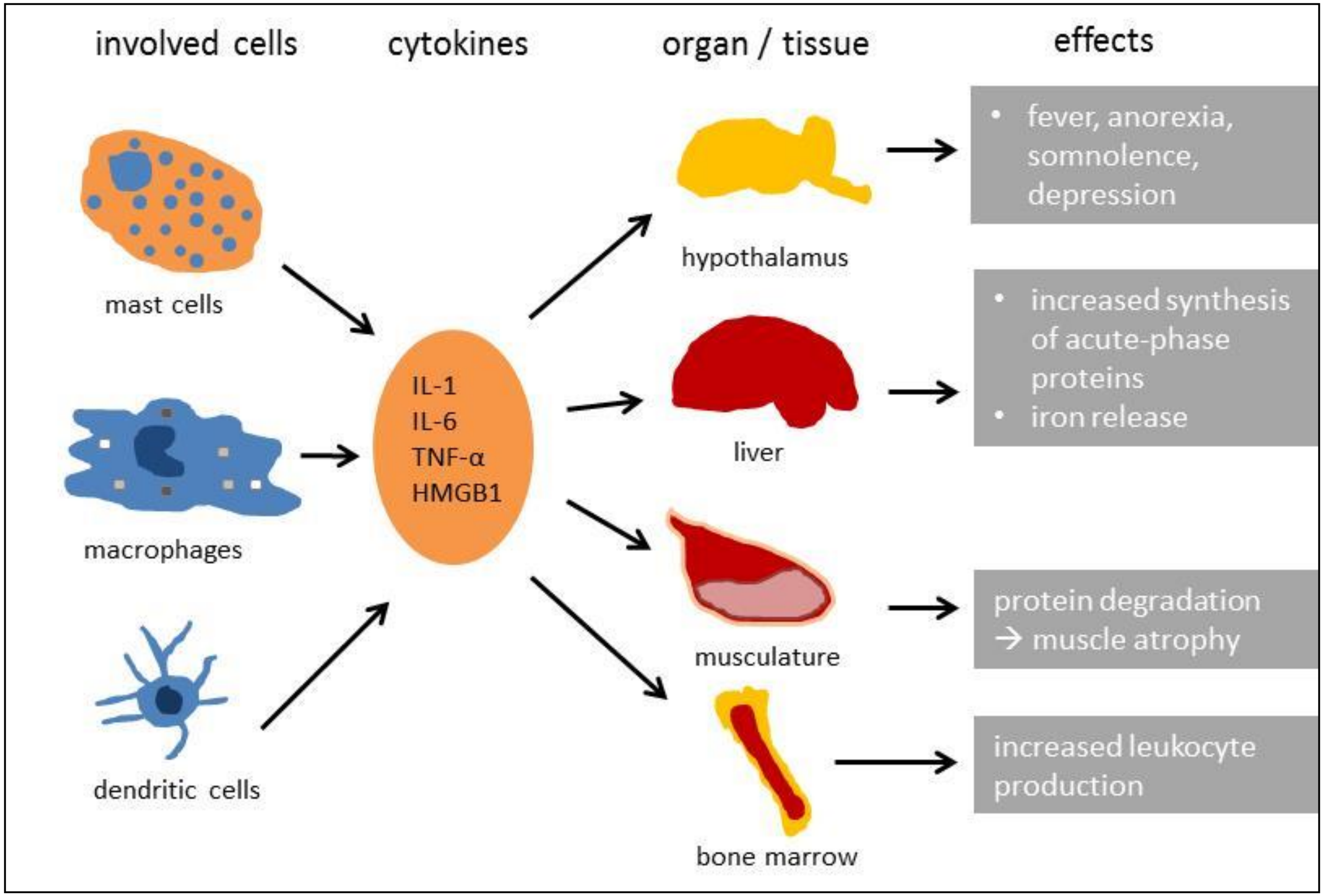


FIG. 1. Schematic representation of the sequence of nutritional responses that evolves during the course of a "typical" generalized febrile infectious illness (5).

William R. Beisel,[3] *M.D., F.A.C.P. The American Journal of Clinical Nutrition* 30: AUGUST 1977, pp. 1236–1247. Printed in U.S.A.



Typical reactions in the body or in tissues and organs to inflammatory stimuli. Systemic effects are based essentially on the effects due to release of the four major cytokines by sentinel cells, mast cells, macrophages and dendritic cells (modified from Le Floc'h et al. 2004, Tizard, 2013). The major sickness-inducing cytokines are IL-1, IL-6, TNF-α and the high-mobility group box protein 1 (HMGB1); from Visscher (2014).

inflammatory response

Infection →

mediators: IL-1, IL-6, TNF-α

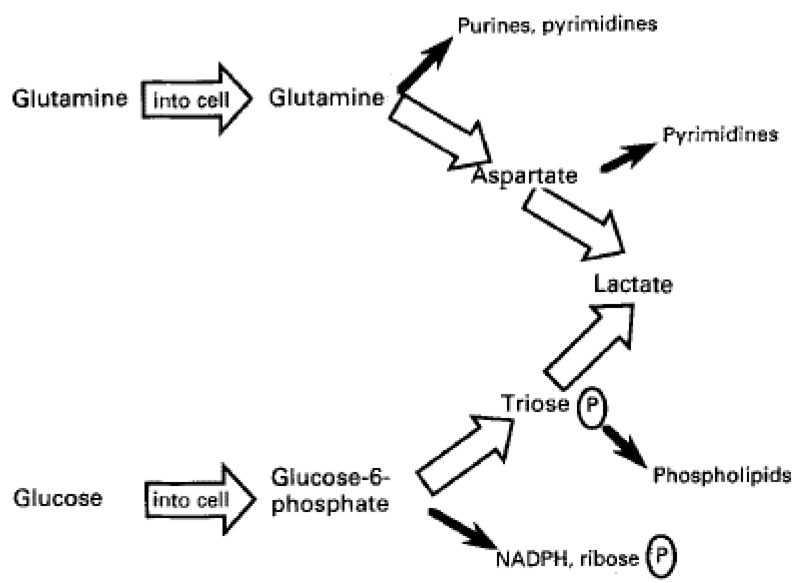
musculature	brain	liver
protein degradation (amino acid release…)	inappetence fever reaction	acute-phase-reaction glycogenolysis gluconeogenesis (moderate infections – gluconeogenesis + 100-200 %)

+ 1°C = 15-30 % higher basal metabolic rate

based on Kaspers 2011

What cells of the immune system need…

- glutamine
- glucose

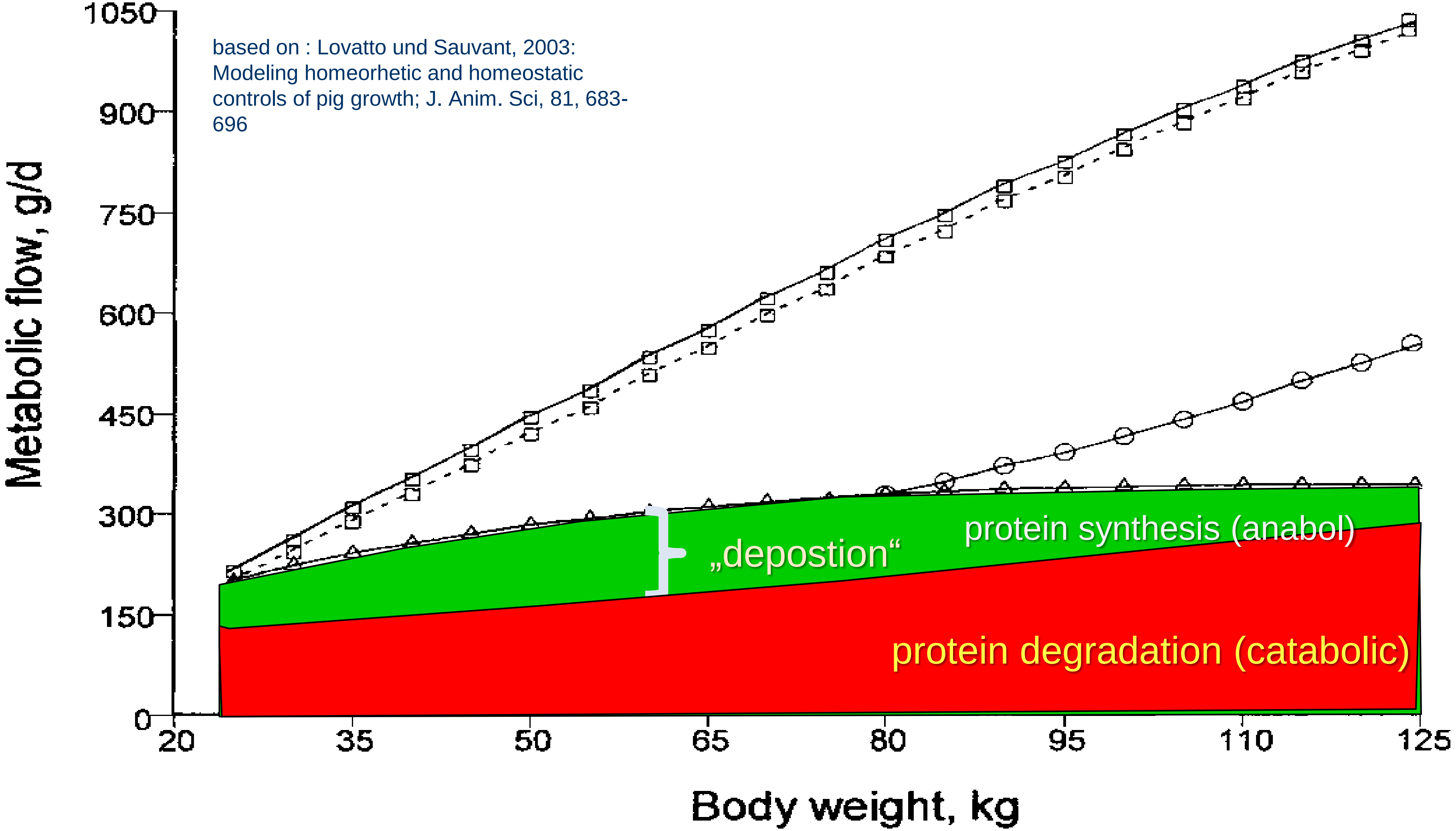


- possibly using
  of ketone bodies

an unfavourable way of providing of nutrients

- The amino acid pattern of muscle protein breakdown differs from the current requirement to combat infection
- the negative nitrogen balance is the inevitable consequence of this catabolic response to provide amino acids for the defense
- The extent of these adverse metabolic response increases depending on the severity of the infection

growth....



Simulated metabolic fluxes of protein and lipids for the growth of pigs. Anabolic and catabolic nutrient flows are characterized by solid and dotted lines; □ = visceral proteins, Δ = body protein, o =fats

How to analyze?

- The immune system is not restricted in an allocated organ
- The immune system cells migrate throughout the body
- The immune system is consists out of many different components
- The immune system changes its functional states
- The components of the immune system do compete for the same resources energy and amino acids
- You can not measure the "immunocompetence"

based on Kaspers 2014

How to analyze?

In vitro

Stimulation of individual components of the immune system

→ Analysis of energy needs

→ Analysis of nutrient requirements

↓

Extrapolating to the whole body

based on Kaspers 2014

Klasing 1998

- The mass of all constituents and products of the immune system (cells and proteins) is less than 5 % of body mass in chickens
- Leucopoiesis during an immune response accounts for less than 1 % (lysine requirement) of daily weight gain of a growing chicken

→ Costs are minimal compared with growth and egg production

Example lysine

I.G. Colditz / Livestock Production Science 75 (2002) 257–268 261

Utilisation of lysine for maintenance of the immune system and during an immune response in chickens (adapted from Klasing and Calvert, 1999)

Process	Maintenance		LPS challenged	
	Production mg/kg/day	Cost µmol lys/kg/day	Production mg/kg/day	Cost µmol lys/kg/day
Leucopoiesis	650	45.5	1300	90.9
Ig synthesis	114	65.6	121	69.6
Acute phase proteins	~0	~0	710	386
Total for immunity	764	111	2131	546
% for immunity		1.17		6.71

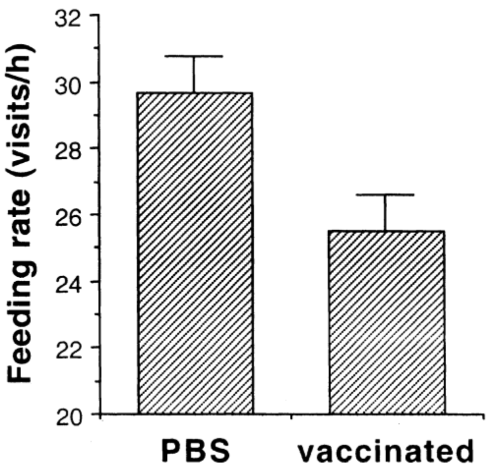
How to analyze?

In vivo

stimulation of the immune system → Analysis of the effect on other characteristics: basal metabolism, growth, litter size, **behavior,** performance, synthesis

protein-Antigen

↓



Raberg et al. Ecology Letters 2000; 3, 382-386

based on Kaspers 2014

In vivo costs of a stimulation of the immune system…

Effect of stimulation of the immune system (adaptive) on the basal metabolic rate (modified by Scanes and Braun 2013)

species	changes in energy maintenance requirements (in %)*	Quelle
House sparrow (Passer domesticus)	+ 29	MARTIN et al. (2003)
Great tit (Parus major)	+ 9	OTS et al. (2001)
Blue tit (Parus caeruleus)	+ 8 bis 13 (n.s.)	SVENSSON et al. (1998)
Common quail (Corturnix corturnix)	-~7	BOUGHTON et al. (2007)

* following phytohemagglutinin challenge

In vivo costs of a stimulation of the immune system…

Estimated energy costs (percentage increase in the basal metabolic rate relative to the control) of vertebrate animals for the immune response after different treatments (modified after Lochmiller and Deerenberg 2000); from Visscher (2014)

species	immuno-stimulation through	costs (in %)	source
human	sepsis and injury	57	CLARK et al. (1996)
	sepsis	30	KREYMANN et al. (1993)
	sepsis	30	CARLSON et al. (1997)
	typhoid vaccination	16	COOPER et al. (1992)
	sickle cell disease	15	BOREL et al. (1998)
rat	inflammation (due turpentine-injection	28	COOPER et al. (1994)
	IL-1 infusion	18	TOCCOBRADLEY et al. (1987)
mouse	KLH challenge[a]	30	DEMAS et al. (1997)
sheep	endotoxins	28	FEWELL et al. (1991)
	endotoxins	10-49	BARACOS et al. (1987)
duck	endotoxins	23	MARAIS et al. (2011)

vaccination: +16 %   sepsis:+ 57 %↑

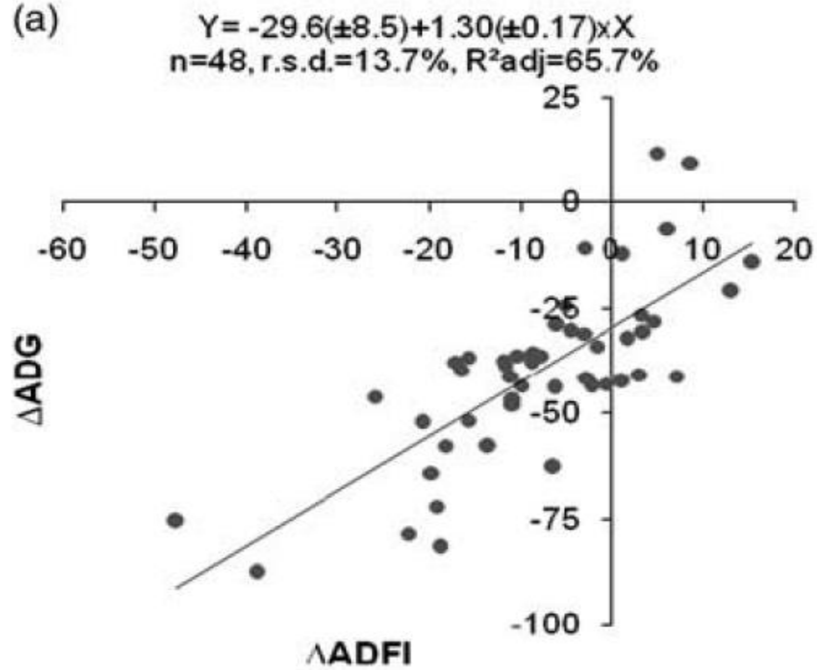
In vivo costs of a stimulation of the immune system...

Estimated changes (percentage change compared to the control) in feed intake (FI), average daily gain (ADG), nitrogen excretion in the urine (N), protein degradation rate (PAR), protein synthesis rate (PSR) and total body protein content (BPC) in vertebrates under the influence of immuno-stimulation (modified after Lochmiller and Deerenberg 2000); from Visscher (2014)

species	interventionEingriff	parameter	change (in %)	source
swine	PRRS[a]-vaccination + LPS	FI ADG	-15 -21	SPURLOCK et al. (1997)
poultry	HVT[b]-vaccination	FI	-3	LEE u. REID (1977)
	SRBC[c]	FI ADG	0 0	HENKEN and BRANDSMA(1982)
	SRBC	ADG	-13	KLASING et al. (1987)
	endotoxins	ADG	-18	
huuman	sickle cell disease	PAR PSR	+32 +38	BOREL et al. (1998)
	sepsis	N- (Harn)	+160	CARLSON et al. (1997)
	sepsis and injury	BPC	-12	CLARK et al. (1996)
rat	sepsis	PAR	+40	HOBLER et al. (1998)

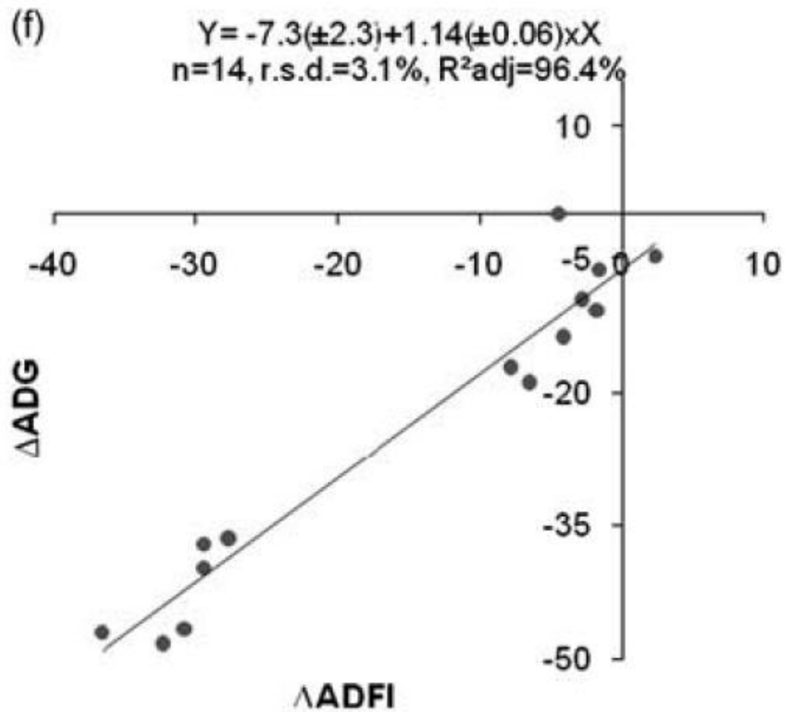
feed intake -15 % body weight -13 % protein catabolism +40 %

[a] endotoxin + five times the recommended dose of a PRRSV-Vaccine; [b] Herpes Virus of Turkey; [c] sheep red blood cells



Pastorelli et al. 2011

Relationship between the change in feed intake (ΔADFI) and growth (Δ ADG) of pigs challenged with digestive bacterial infections (a). Responses are expressed as results of the challenged pigs relative to that of a control group. The lines represent the linear or the quadratic model adjustments. Estimated parameters differed from zero (P ,0.05).



Relationship between the change in feed intake (ΔADFI) and growth (Δ ADG) of pigs challenged with respiratory diseases (f). Responses are expressed as results of the challenged pigs relative to that of a control group. The lines represent the linear or the quadratic model adjustments. Estimated parameters differed from zero (P ,0.05).

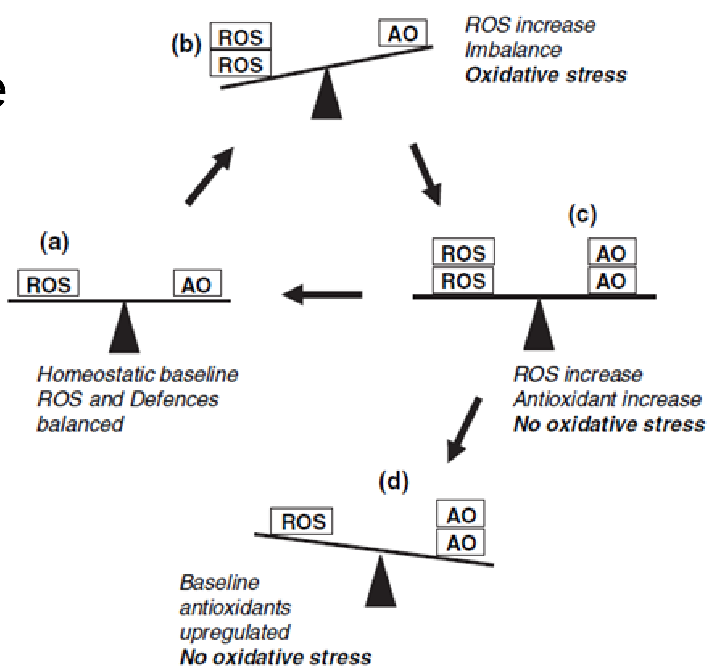
Costs of an immune response

- **Energy costs** - changes in metabolic rate after immunological stimulation (acute phase reaction, leukocyte proliferation, antibody production)
- **Synthesis costs** - Acute phase reaction requires the greatest amount of nutrients (including AS for gluconeogenesis; carotenoids, Se, Vit E.)
- **Preventing autoimmune reactions** - high stress can cause cell death and muscle damage - the body comes into contact with self-antigens - autoimmune response - prevention by secretion of stress hormones in order to suppress the immune system

based on Hasselquist und Nilsson 2012

Costs of an immune response

- not only costs due to *activation* of the immune system, but also as a result of the by-products of an immune response overcoming
  → oxidative stress - high amounts of reactive O_2 compounds due to macro-phage activity, inflammation and fever
  - with short-term and long-term consequences
  - these could be very important !!



based on Hasselquist und Nilsson 2012 and Monaghan et al. 2009

Costs of an immune response

- Vaccination can reduce the production of reactive oxygen species?
  → positive effect on - for example - inflammatory lung changes

VIRAL IMMUNOLOGY
Volume 24, Number 6, 2011
© Mary Ann Liebert, Inc.
Pp. 475–482
DOI: 10.1089/vim.2011.0040

Intranasal Delivery of an Adjuvanted Modified Live Porcine Reproductive and Respiratory Syndrome Virus Vaccine Reduces ROS Production

Basavaraj Binjawadagi[1] Varun Dwivedi[1] Cordelia Manickam[1]
Jordi B. Torrelles[2] and Gourapura J. Renukaradhya[1]

based on Binjawadagi et al. 2011

In vivo costs of a stimulation of the immune system…

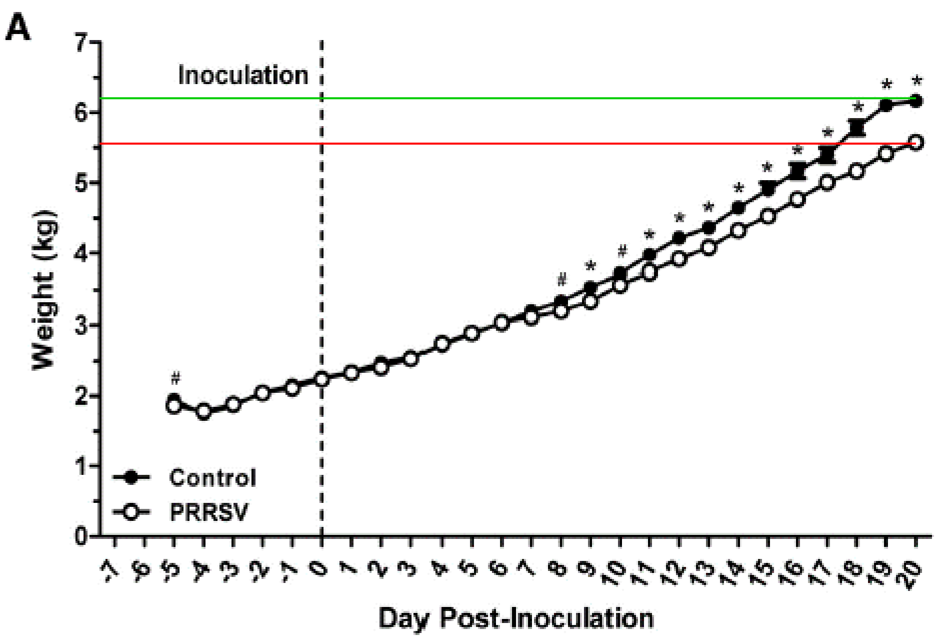
early infections

2120 • The Journal of Neuroscience, February 5, 2014 • 34(6):2120–2129

Behavioral/Cognitive

Respiratory Viral Infection in Neonatal Piglets Causes Marked Microglia Activation in the Hippocampus and Deficits in Spatial Learning

Monica R. P. Elmore,[1,2] Michael D. Burton,[1,2] Matthew S. Conrad,[2,3] Jennifer L. Rytych,[2] William G. Van Alstine,[4] and Rodney W. Johnson[1,2,3]
[1]Department of Animal Sciences, [2]Integrative Immunology and Behavior Program, and [3]Neuroscience Program, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801, and [4]Department of Comparative Pathobiology, Purdue University, West Lafayette, Indiana 47907

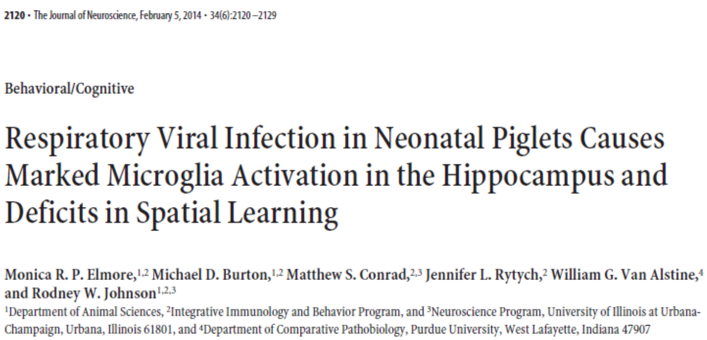


Δ=0,6 kg body mass

based on Elmore et al. 2014

Early infections

- per kg weight gain a piglet needs 4.1 liters of milk
  →i.e. Δ 0.6 kg bw corresponds to 2.46 l sow's milk
- one kg milk contains 5 MJ ME
  → i.e. the piglet has a 12.3 MJ ME lower nutrient turn over
  - by a lower feed intake
  - by increased costs (energy / nutrient costs and oxidative stress)
  - due to effects in the sow?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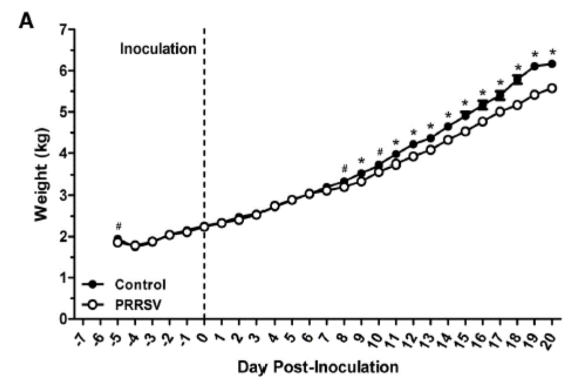


based on Elmore et al. 2014

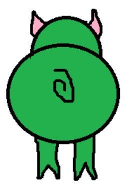
Dissecting effects of metabolizable protein and energy nutrition on resistance to parasites.

Host and Ref. [a]	Metabolizable energy ($MJ/kg^{0.75}/day$)		Metabolizable protein ($g/kg^{0.75}/day$)		FEC (epg)	Worm burden (total)
Growing lambs						
Bown et al. (1991)[b]	Low	0.61	Low	5.5	1,299,000	39,300
	High	0.70	Low	5.5	2,851,000	45,700
	Low	0.69	High	10.0	2,017,000	17,800
Kahn et al. (2001)[c]	Low	0.50	Low	3.90	2000	12,320
	Low	0.50	High	5.41	1850	11,333
	High	0.58	Low	3.47	850	7313
	High	0.62	High	5.85	2200	9770
Twin-rearing ewes Donaldson et al. (1998)	Low	1.28	Low	10.80	2000	11,474
	Low	1.37	High	14.35	260	3397
	High	1.43	Low	10.31	2500	16,253
	High	1.48	High	12.30	250	3738
Pregnant ewes Houdijk et al. (2001c)	High	0.54	High	3.87	25	–
	Low	0.38	High	3.61	25	–
	Low	0.38	Low	2.26	100	–
Lactating rats Sakkas et al. (2009)	Low	0.81	Low	10.07	1228	160
	Low	0.80	High	14.72	357	121
	High	1.06	Low	10.07	1454	218
	High	1.04	High	14.33	333	153

[a] The data in this table are derived from the original data presented in the references given.
[b] FEC data given as eggs per day.
[c] Personal communications.

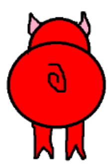
Infections in a different light…

Group / treatment classification



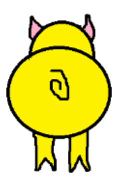
VAC- CF-

Not vaccinated, without clinical findings



VAC- CF+

Not vaccinated, faeces PCR positive,
with clinical findings (soft to liquid faeces)



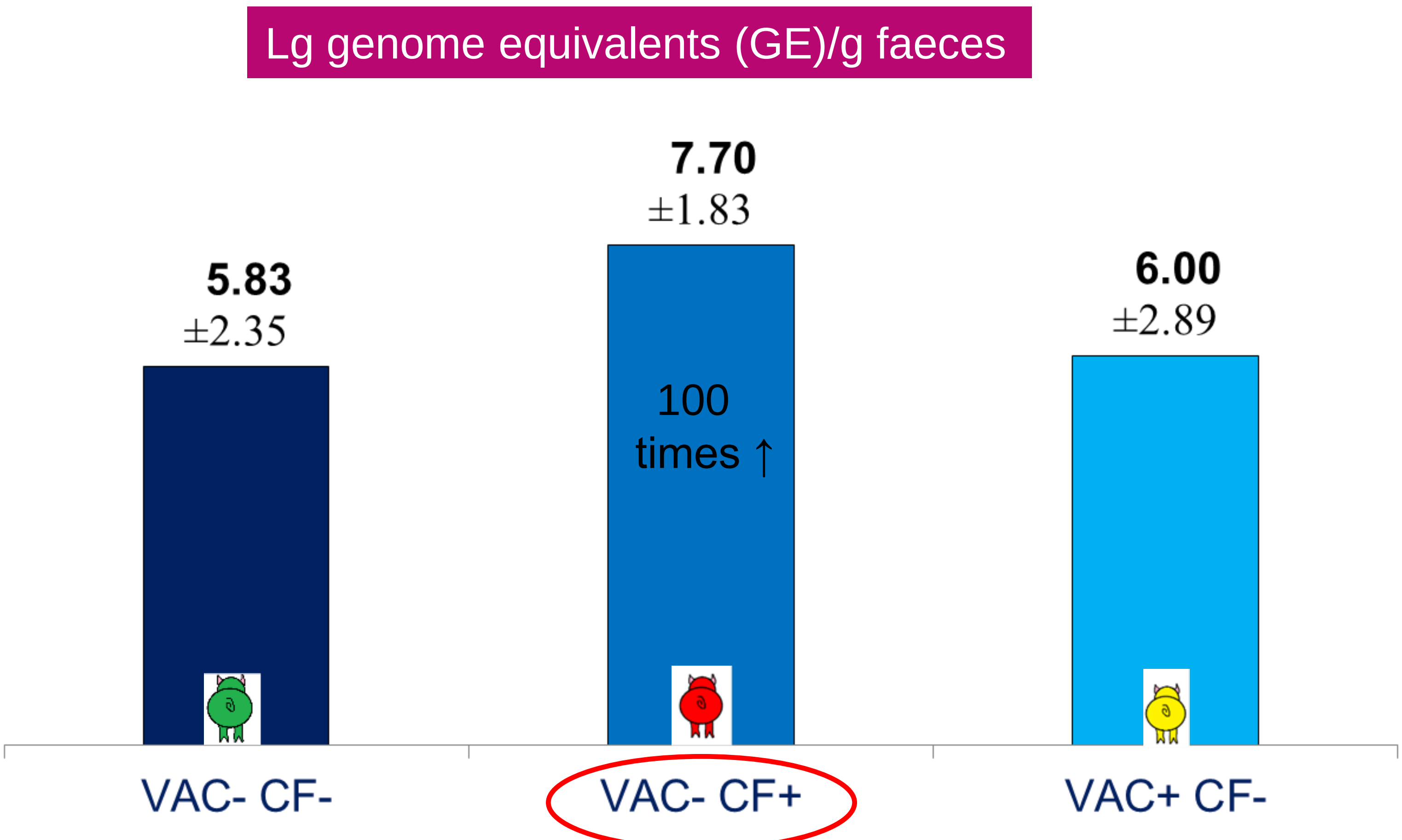
VAC+ CF-

Vaccinated (Enterisol®Ileitis), without clinical findings

Results (1)

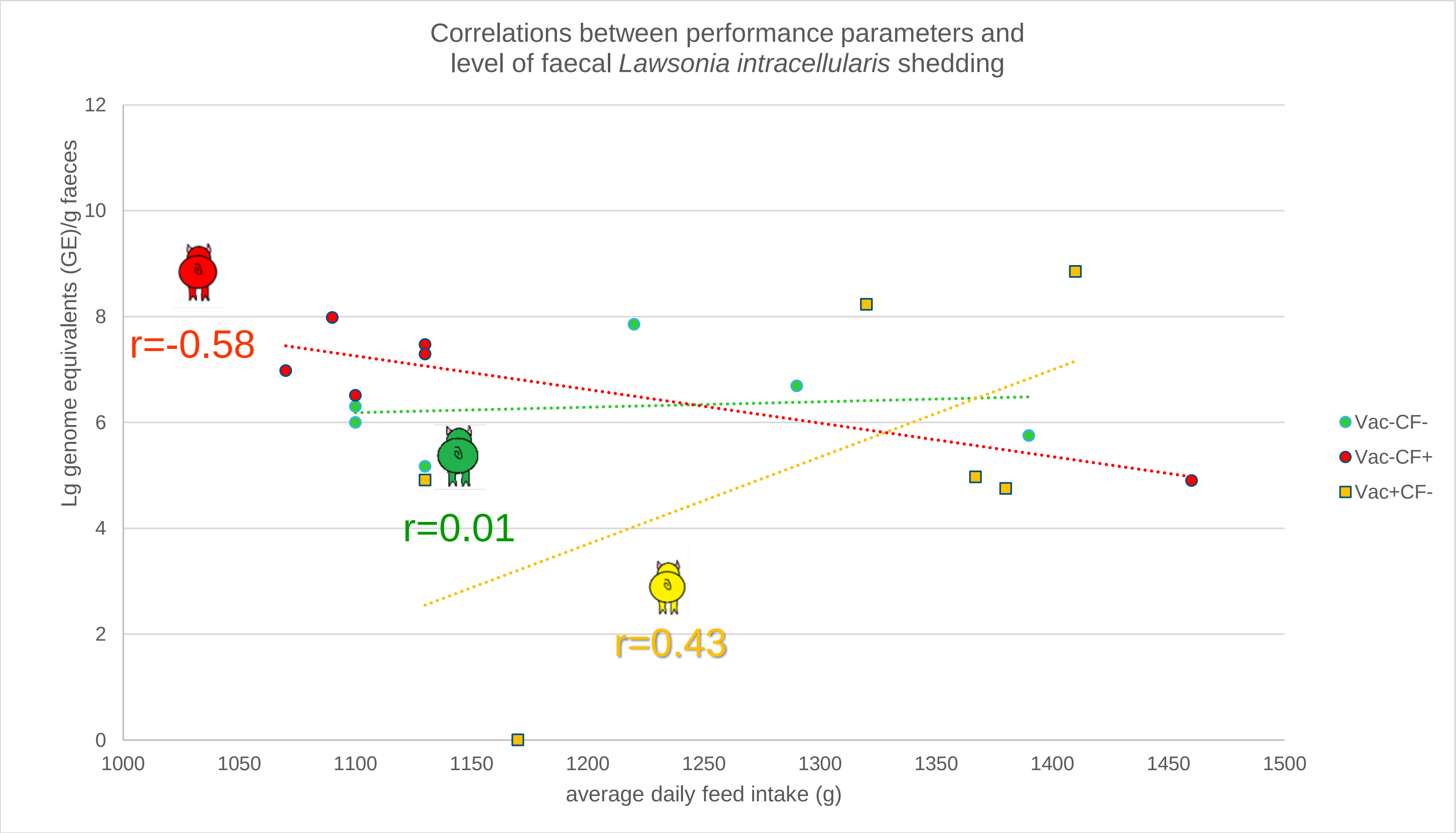
Shedding of *Lawsonia intracellularis* via faeces in pigs

Faecal shedding of *L.i.* during the digestibility trial, detected by quantitative PCR



Results (2)

Correlations

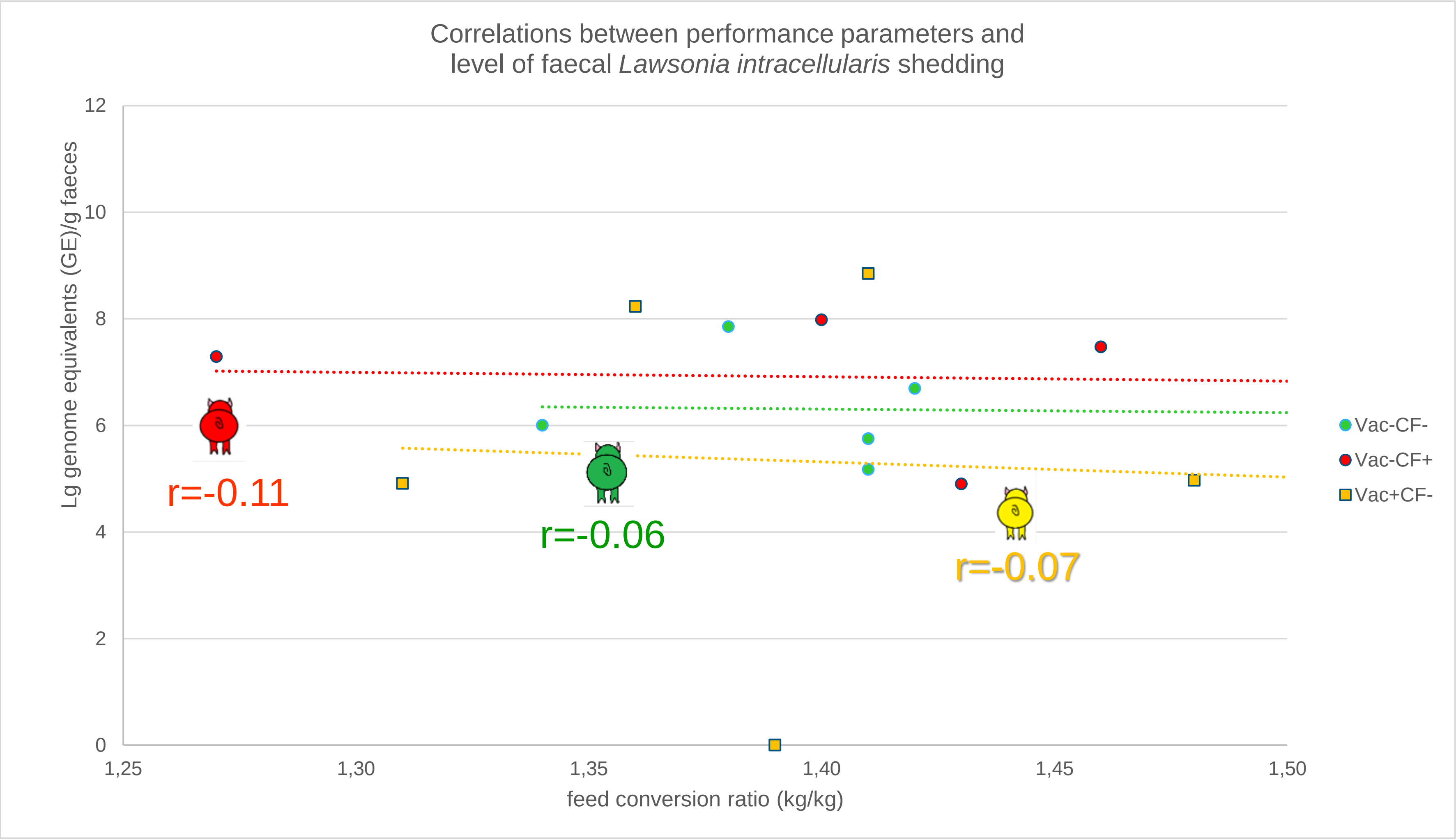


Results (3)

Correlations

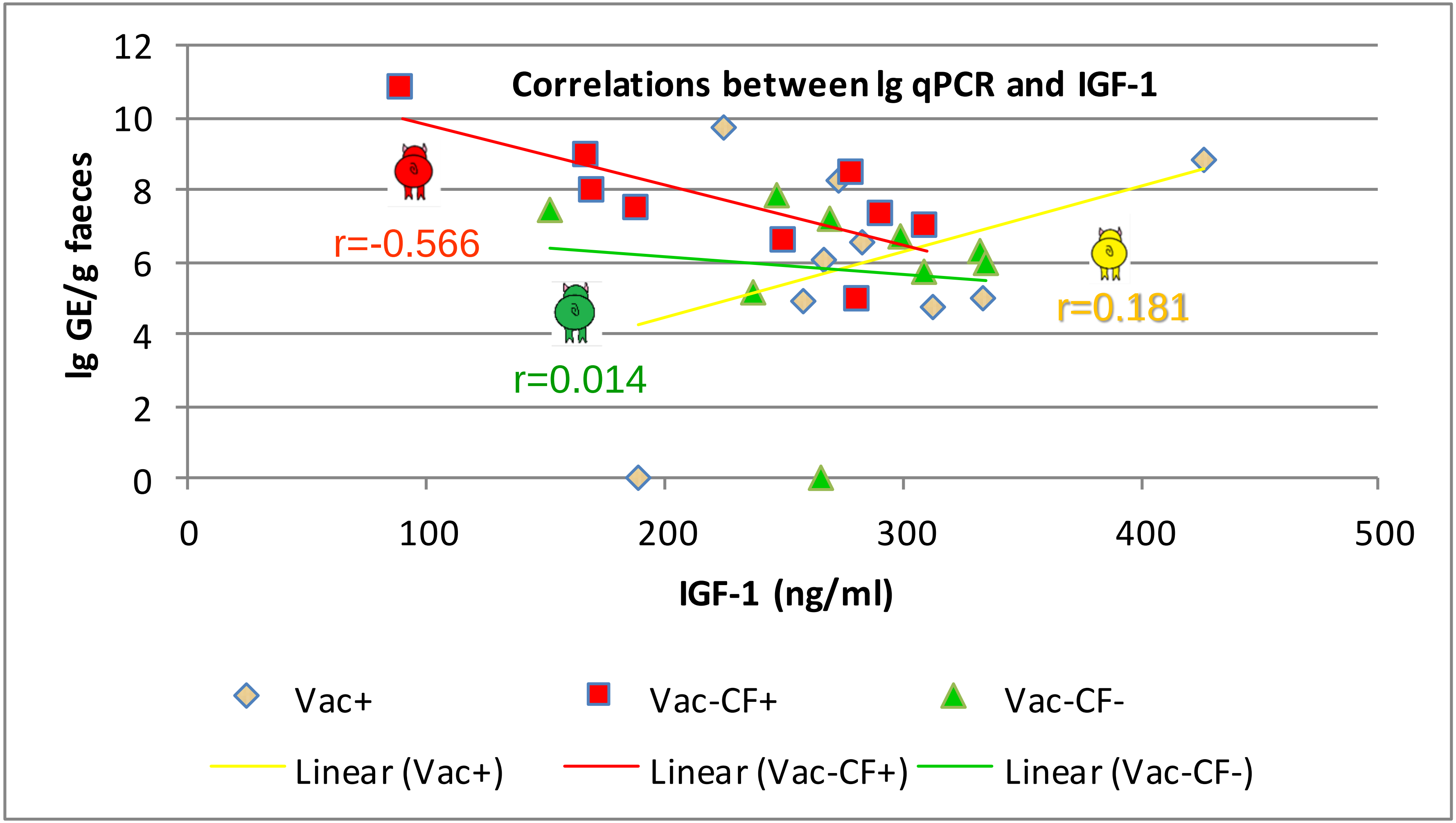
Results (4)

Correlations



Results (5)

Correlations



Results (6)

Explanation

7.2.2 Post-inflammatory metabolic responses: Plasma IGF-1 and IGF-1 mRNA remained reduced 8 weeks post-infection, long after reduced food intake and other acute-phase responses to infection had resolved (Elsasser et al, 1995). This suggests that the regulation of appetite and body weights are separable events and that disease can uncouple the normally tight association between appetite and growth. The delay in IGF-1 recovery from infection relative to recovery of appetite probably explains the stunting that is often observed with severe disease.

What we are learning…

- Effects of immunological challenges with all its consequences as well as the effectiveness of countermeasures can be assessed in growing animal easiest on growth
- Under similar conditions, breeding for maximum performance means breeding to “efficient costs” for immune function (not too much - not too little)

Questions?

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FACULTY OF VETERINARY MEDICINE
approved by EAEVE

Nutritional management of right dorsal colitis in horses: a case report

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RDC in Equids

(Andrews and Robertson, 1988; Karcher *et al.*, 1990; Simmons *et al.*, 1990; Cohen *et al.*, 1995; Bueno *et al.*, 2000)

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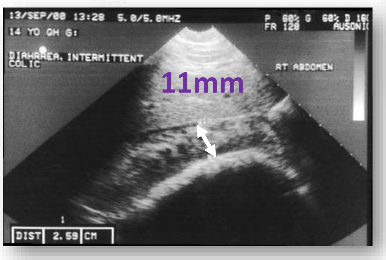
Case report

KWPN, 8y old, Mc

BCS 3/9

Estimated id. BW 630kg



(Cohen, 2002)

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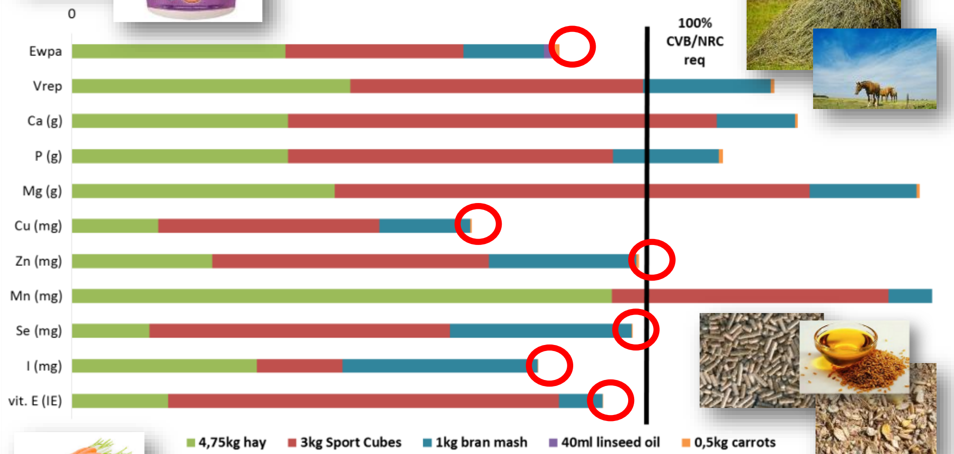
Current diet



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CF 24,5%DM
CP 11,3%DM

CFAT 4,3%DM
Sugar+starch 18,1%DM

Nutritional management of RDC

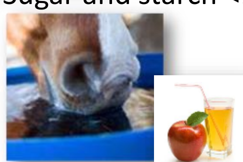
Low-bulk diet
(Cohen *et al.*, 1995)

Sugar and starch <1gr/kgBW/meal

psyllium
(Fettman, 1992; Bugaut and Bentejac, 1993; Argenzio, 1994; Fahey, 1994; Inan *et al.*, 2000, Cohen, 2010)

oil

(Schepp *et al.*, 1988; Cargile and Merritt, 1989; Henry *et al.*, 1990; McCann and Carrick, 1998)



Avoid dehydration

Multiple small meals

(Cohen, 2010)

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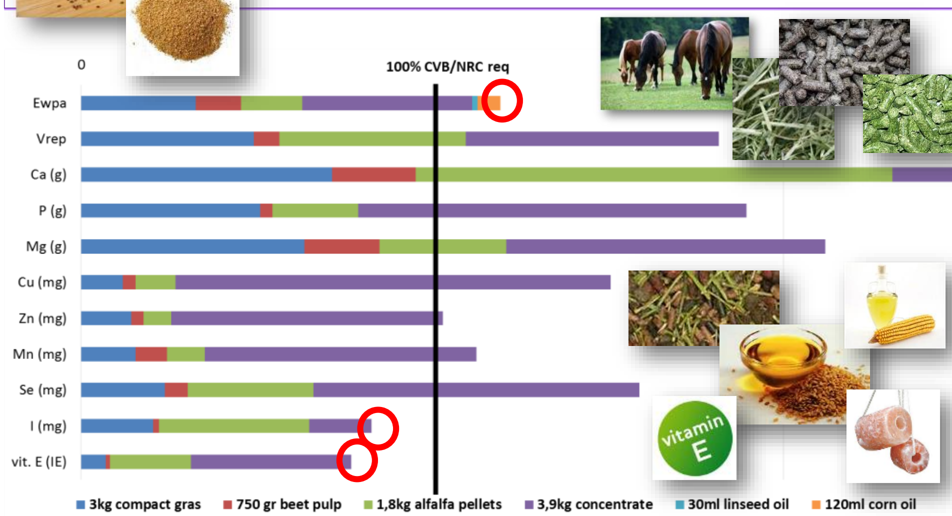
Nutritional advice



CF 30,7%DM
CP 13,7%DM

CFAT 6,4%DM
Sugar+starch 11,2%DM

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Concentrates: high fiber, low sugar and starch

Sugar and starch: 8%

11%

10,5%

12,1%

10%

17%

9,4%

x%

x%

Follow-up

One month later...

Thanks to...

Dr. Marie-Thérèse Picavet, DVM, DECEIM

Horse's owner

Thank you for your attention!

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