



Nottingham Trent
University

‘WHAT’S DIET GOT TO DO WITH IT?’

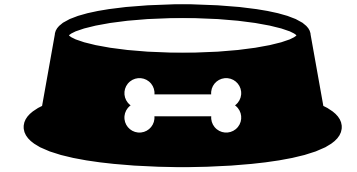
Feeding for the Future

Bernese Mountain Dog Health Symposium, 22nd September 2022

Dr Jacqueline Boyd

22/09/2022

Feeding for the Future - Overview



Can nutrition affect generational health and wellbeing?

What is the interaction between nutrition and genetics?

Does the experiences of prior generations affect subsequent generations?

What can canine enthusiasts then do practically from a nutrition and management perspective?

What does diet have to do with it.....?

Feeding for the Future



Consider nutrition
and its importance

The impact of
nutrition

Does “one size fit
all”?

Nutrition for
breeding

Nutrition through
the generations

Genetics,
genomics,
epigenetics,
nutrigenomics, the
microbiome

Where next....?!

Feeding for the Future – The aim.....



**“never discuss religion,
politics or.....canine
nutrition...!!**

Easily one of the most contentious canine topics

”



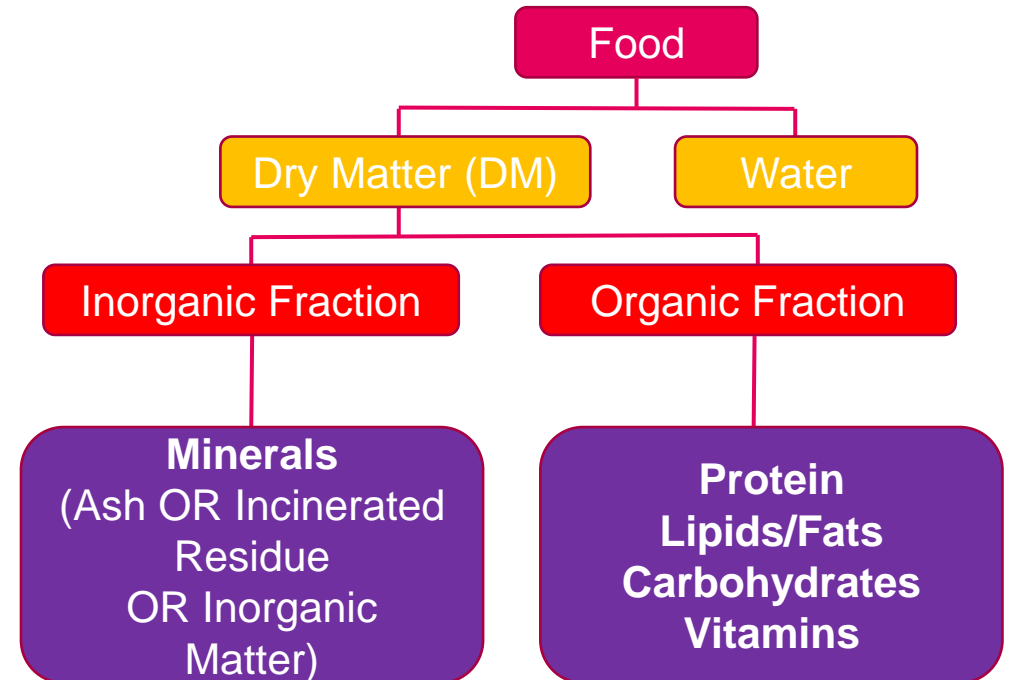
Canine Nutrition and Feeding

- Nutrition relates food to the living organism
- In simple terms, you get “out what you put in”
- Nutrition is a “controllable variable” and impacts upon;
 - Welfare/wellness/wellbeing
 - Health and disease
 - Metabolic demands
 - Activity level
 - Performance output
- But, nutrition can't cure everything and changes can be **positive, negative or even neutral**
 - Nutrition is part of a **holistic** management approach

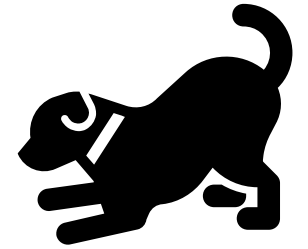


Canine Nutrition Essentials

- Dogs need nutrients.....food supplies those nutrients
 - Protein = building blocks
 - Fat = energy and key components for biological function
 - Carbohydrates = energy (also fibre for gut health!)
 - Vitamins and minerals = essential for normal metabolic functioning



Canine Nutrition Challenges



We must:

- Feed appropriately for the species/individual animal
- Understand the nutritional requirements of the species – new data continually
- Promote good husbandry/welfare/health/longevity and maximise “natural” behaviours
- Enhance productivity/performance where required
- Consider issues of supply, sustainability and waste generation
- Not be anthropomorphic – dogs are not small people!
- Appreciate and acknowledge the human-animal bond (HAB)

Canine Nutrition Challenges

Our dogs evolved as a **scavengers**

Carnivore dentition and digestive anatomy

BUT omnivore tendencies and adaptations

Many **scavenger** traits have been retained.....



Canine Nutrition Challenges

Siobhán only buys Columbo the best food. It is grain-free, single-protein, holistic, hypo-allergenic and certified organic.

“You love it, don’t you, boy?” says Siobhán.

Columbo does love the food. But he would be just as happy to eat his own sick.

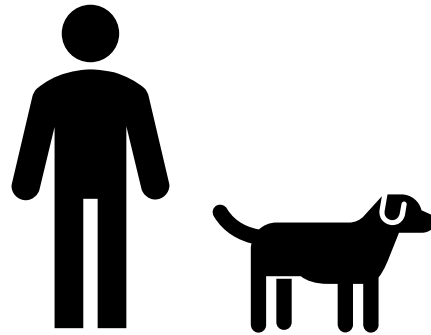


(“How it Works – The Dog”, Ladybird Books)

Canine Nutrition Challenges

The Caregiver(s)

- Budget
- Gender
- Age
- Lifestyle
- Family
- Career/Education
- Ethics/morals
- Own health
- Politics
- Living situation
- Attachment level



The Dog

- Breed/type
- Sex
- Age
- Personality
- Genetics
- Lifestyle
- “Career”
- Health
- Spay/neuter
- Living situation
- Activity level

Feeding for the Future - Breeding



- Nutrition of sire and dam should be optimal BEFORE mating and conception
 - Good nutritional plane (plus overall management – fit, not fat!)
 - Female reproduction is nutritionally demanding (pregnancy, whelping, lactation)
 - Male reproduction also needs consideration to ensure performance and conception!
 - A pregnancy covers three generations – dam, offspring, gametes
- Malnutrition (under- AND over-feeding) results in poor reproductive output

Feeding for the Future - Breeding

Received: 29 May 2019 | Revised: 4 September 2019 | Accepted: 2 October 2019

DOI: 10.1111/jpn.13236

ORIGINAL ARTICLE

Journal of Animal Physiology and Animal Nutrition WILEY

Nutrition consultation for an overweight growing Bernese Mountain Dog—A case report

Antonia Giordanella | Kerstin Gerstner  | Angela Gimmel | Annette Liesegang 

Institute of Animal Nutrition, Vetsuisse Faculty, University of Zurich, Zurich, Switzerland

Correspondence
Annette Liesegang, Institute of Animal Nutrition, Vetsuisse faculty, University of Zurich, Winterthurerstrasse 270, 8057 Zurich, Switzerland.
Email: aliese@nutrivet.uzh.ch

Abstract

In growing dogs, overweight is assimilated and attributed to a fast growth rate. Proper nutrition plays a very important role during growth as mistakes in feeding may lead to severe disease. This case report is an example for excessive weight gain during growth that, particularly in large breed dogs, may lead to skeletal disorders such as improper alignments of the limbs. If body weight gain exceeds the ideal range of the individual growth curve (by initially 4 kg in this case), fast growth may lead to growth disturbances and associated chronic diseases. These cases require a dietary adaptation. However, the success in the nutritional management of the body weight relies largely on the owner's compliance.

KEYWORDS

growing dogs, nutrition, overweight, skeletal disorders



Feeding for the Future - Breeding

Other nutrients cause issues too.....

- Protein deficiency – increased neonatal morbidity/mortality
- Excess vit A/vit D – neonatal issues; ocular defects, cleft palate, skeletal issues
- Mineral deficiency (Zn and Fe especially) – resorption, poor sperm quality, immune deficiency
- Folic acid – neural tube and developmental defects
- Ca:P ratios – essential for correct skeletal development (1.2:1 NRC)
- Energy content of the diet for large breed puppies – slow, steady growth rates preferred

Feeding for the Future - Breeding

Can Vet J. 2018 Jan; 59(1): 36–42.

PMCID: PMC5731398

PMID: [29302100](#)

Language: English | [French](#)

Dietary imbalances in a large breed puppy, leading to compression fractures, vitamin D deficiency, and suspected nutritional secondary hyperparathyroidism

[Moran Tal](#), [Jacqueline M. Parr](#), [Shawn MacKenzie](#), and [Adronie Verbrugghe](#)

▶ [Author information](#) ▶ [Copyright and License information](#) [Disclaimer](#)

Abstract

Go to:

A 6-month-old intact female giant schnauzer dog fed a nutritionally unbalanced homemade diet was evaluated because of a 1-month history of lameness and difficulty walking. Abnormalities identified on ancillary tests, in conjunction with the dog's clinical improvement following diet change, suggested a diagnosis of vitamin D deficiency and nutritional secondary hyperparathyroidism. This report underlines the importance of appropriate feeding management, especially during the vulnerable growth phase.



<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5731398/>

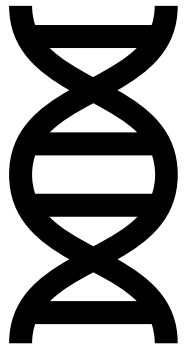
www.ntu.ac.uk

Feeding for the Future - Breeding

- Breeding is also about future generations however.....
- The link between genetics and the environment has been long known but little understood
- Human studies have demonstrated the impact of diet and intergenerational health
- The era of **NUTRIGENOMICS**
 - Essentially the interplay between nutrients, diet and gene expression
 - Personalised nutrition!
- Incorporates aspects of **EPIGENETICS**
 - Whereby there are changes in gene expression rather than changes to genes themselves.....



Feeding for the Future - Breeding



- Genetics = DNA
 - Genes are units of inheritance (“hard” inheritance)
 - Each organism has two copies of each gene, one maternal, one paternal
 - Genes (their sequence) cannot be changed
 - Mutations can affect gene function (phenotypic variants through to genetic disease)
- Genes drive the synthesis of proteins in the body
- Genetic “potential” can be supported by nutrition (e.g. body size)

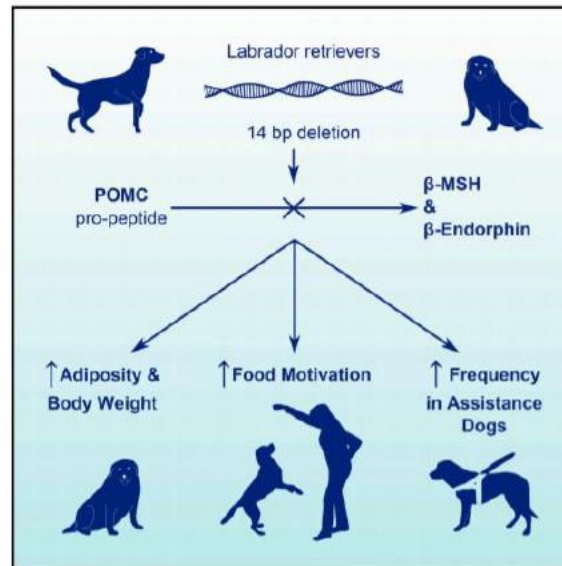
Feeding for the Future – ‘Hard Genetics’

Short Article

Cell Metabolism

A Deletion in the Canine *POMC* Gene Is Associated with Weight and Appetite in Obesity-Prone Labrador Retriever Dogs

Graphical Abstract



Authors

Eleanor Raffan, Rowena J. Dennis, Conor J. O'Donovan, ..., Kerstin Lindblad-Toh, Giles S.H. Yeo, Stephen O'Rahilly

Correspondence

er311@cam.ac.uk (E.R.), so104@medschl.cam.ac.uk (S.O.)

In Brief

Companion dogs from the obesity-prone Labrador retriever breed were found to carry a mutation in *POMC* in this study by Raffan et al. The mutation is predicted to disrupt production of the neuroactive peptides β-MSH and β-endorphin and was associated with greater weight, adiposity, and food motivation in affected dogs.

<https://doi.org/10.1016/j.cmet.2016.04.012>

www.ntu.ac.uk

Feeding for the Future - Breeding

- Genes cannot be changed in fundamental structure without mutation
- BUT gene expression CAN be altered
 - This is essentially genes being “switched on” or “switched off”
 - This is the basis of epigenetics and is reversible (“soft” inheritance)
 - **Nutrition is increasingly understood to have epigenetic effects**
 - **The microbiome is also starting to be implicated too!**

Feeding for the Future - Breeding

- **The Dutch Famine Cohort Study (1944)**
 - Indicated the role of nutrition and diet in the health of subsequent generations
 - Nutrition restriction during pregnancy led to an increased rate of metabolic disorders in offspring
 - BUT timing of nutritional restriction was important
 - During first trimester showed more incidence of metabolic issues in early adulthood of offspring
 - Obesity, high LDL cholesterol, diabetes, schizophrenia.....
 - Suggested that there is a critical period during embryonic development where nutrition can elicit certain epigenetic effects
 - Also indicated that epigenetic modifications can be passed to offspring and likely, subsequent generations
 - *Mechanisms however are unlikely to be simple.....*



www.ntu.ac.uk

Feeding for the Future



European Journal of Human Genetics (2002) 10, 682–688
© 2002 Nature Publishing Group All rights reserved 1018–4813/02 \$25.00

www.nature.com/ejhg

ARTICLE

Cardiovascular and diabetes mortality determined by nutrition during parents' and grandparents' slow growth period

G Kaati¹, LO Bygren^{*1} and S Edvinsson²

¹Department of Community Medicine and Rehabilitation, Social Medicine, Umeå University, Umeå, Sweden;

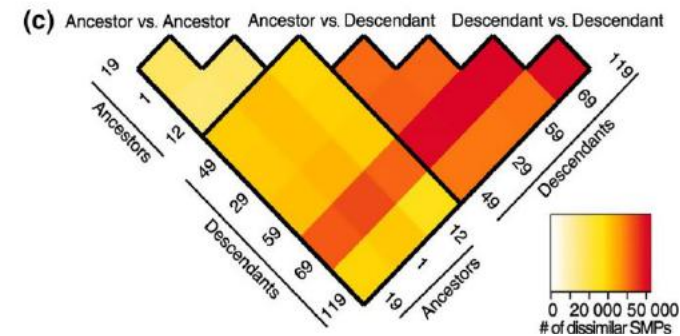
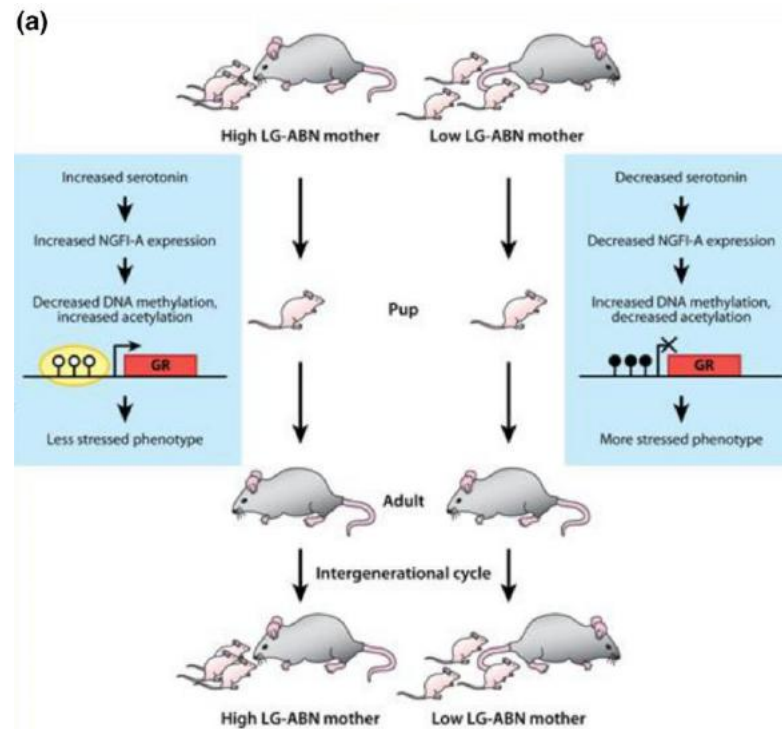
²Demographic Database, Umeå University, Umeå, Sweden

Overfeeding and overeating in families are traditions that are often transferred from generation to generation. Irrespective of these family traditions, food availability might lead to overfeeding, in its turn leading to metabolic adaptations. Apart from selection, could these adaptations to the social environment have transgenerational effects? This study will attempt to answer the following question: Can overeating during a child's slow growth period (SGP), before their prepubertal peak in growth velocity influence descendants' risk of death from cardiovascular disease and diabetes? Data were collected by following three cohorts born in 1890, 1905 and 1920 in Överkalix parish in northern Sweden up until death or 1995. The parents' or grandparents' access to food during their SGP was determined by referring to historical data on harvests and food prices, records of local community meetings and general historical facts. If food was not readily available during the father's slow growth period, then cardiovascular disease mortality of the proband was low. Diabetes mortality increased if the paternal grandfather was exposed to a surfeit of food during his slow growth period. (Odds Ratio 4.1, 95% confidence interval 1.33–12.93, $P=0.01$). Selection bias seemed to be unlikely. A nutrition-linked mechanism through the male line seems to have influenced the risk for cardiovascular and diabetes mellitus mortality.

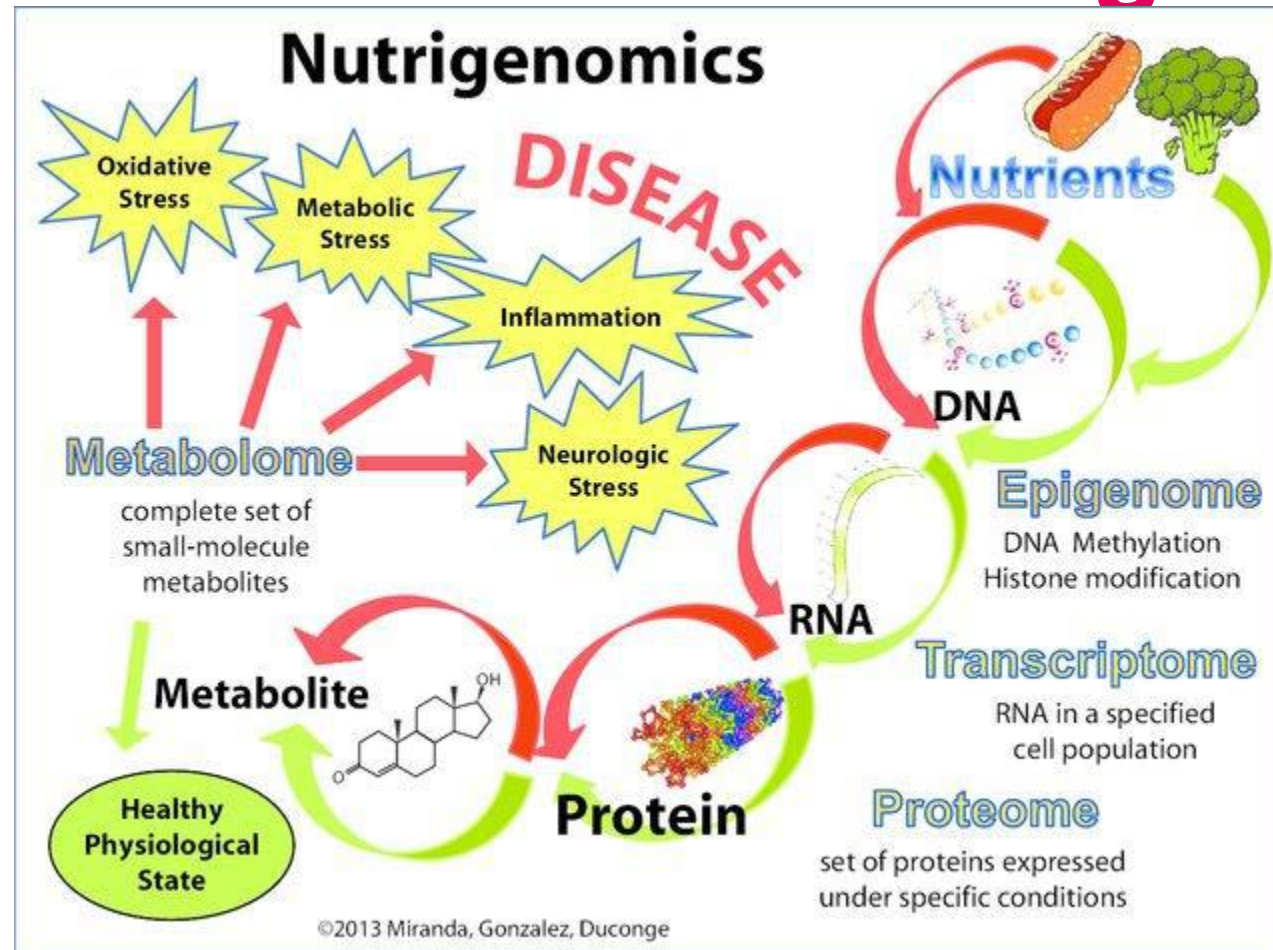
European Journal of Human Genetics (2002) 10, 682–688. doi:10.1038/sj.ejhg.5200859

Feeding for the Future - Epigenetics

- Potential effects of epigenetic changes - behaviour, coat colour, diseases, metabolic status (including obesity)



Feeding for the Future - Nutrigenomics



Feeding for the Future

- What about the **microbiome**?
- Gut microbiome = the microorganisms existing in the gastrointestinal tract
- Human studies increasingly demonstrate link between the microbiome, physical health and mental health!
- In dogs, it is also important and is [similar to the human microbiome](#)
 - Shared environment and evolution
 - [Similarities also seen in littermates and dam](#)



Disentangling factors that shape the gut microbiota in German Shepherd dogs

Asa Vilson^{1*}, Ziad Ramadan², Qinghong Li², Åke Hedhammar¹, Arleigh Reynolds², Julie Spears², Jeff Labuda², Robyn Pelker², Bengt Björkstén³, Johan Dickved⁴, Helene Hansson-Hamlin¹

1 Department of Clinical Sciences, Swedish University of Agricultural Sciences, SE Uppsala, Sweden, **2** Nestlé Purina Research, One Checkersboard Square, Saint Louis, MO, United States of America, **3** the Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden, **4** Department of Animal Nutrition and Management, Swedish University of Agricultural Sciences, SE Uppsala, Sweden

* asa.vilson@nasterunde@slu.se



Abstract

The aim of this study was to explore the development of the gut microbiota in 168 German Shepherd dogs (30 litters) from 7 weeks to 18 months of age and furthermore, to study the effect of relatedness, maternal microbiota composition and living environment in a large and well-defined population of dogs. Using 454 pyrosequencing, we assessed the effects of pre- and postnatal probiotic supplementation (*Lactobacillus johnsonii* NCC533 (*La1*)) and analysed whether administration of the probiotic strain influenced fecal microbiota composition in a placebo controlled double-blinded study. The bitches were treated with probiotics or placebo during last trimester of pregnancy and until their puppies were 8 weeks old, the puppies received the same treatment as their mothers between 3–12 weeks of age. Samples from bitches were collected at pregnancy day 42, partum, 4 weeks postpartum and 7 weeks postpartum and from puppies at the age 4 weeks, 7 weeks, 12–13 months and 15–18 months. Serum IgA, total serum IgE, fecal IgA and IgG antibody responses against canine distemper virus were analysed by ELISA in order to detect any immune stimulating effects of the probiotic strain. Analysis of the fecal microbiota composition showed that the predominant phyla were the same in 7 weeks old puppies as in pregnant and lactating bitches (Firmicutes, Fusobacteria, Bacteroidetes). Proportions among different bacteria as well as diversity varied from 7 weeks old puppies up to 15–18 months of age. Litter mates had a more similar fecal microbiota compared to unrelated dogs and 7 weeks old puppies were more similar to their mothers than to unrelated bitches at 7 weeks postpartum but not at partum. We observed a change in the relative abundance of different bacteria during lactation, and an increase in diversity from pregnancy to end of lactation. The microbial diversity was affected by living area where dogs living in big cities had higher diversity compared to dogs living at the countryside. However, we were not able to demonstrate an effect by pre and postnatal exposure to *Lactobacillus johnsonii* NCC533 (*La1*) upon the diversity or composition of the microbiota or the levels of serum IgA, total serum IgE, fecal IgA or vaccine response. Our findings provide a better understanding of the canine fecal microbiota in growing dogs as well as in pregnant and lactating bitches. This information forms a basis for further research on the connection between early gut colonization and immune function later in life.

OPEN ACCESS

Citation: Vilson A, Ramadan Z, Li Q, Hedhammar Å, Reynolds A, Spears J, et al. (2018) Disentangling factors that shape the gut microbiota in German Shepherd dogs. PLoS ONE 13(3): e0193807. <https://doi.org/10.1371/journal.pone.0193807>

Editor: Erwin G. Zoetendal, Wageningen University, NETHERLANDS

Received: February 27, 2017

Accepted: February 13, 2018

Published: March 23, 2018

Copyright: © 2018 Vilson et al. This is an open access article distributed under the terms of the [Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Data Availability Statement: Data are available at: <https://www.ncbi.nlm.nih.gov/sra/SRP132170>. The reference number of the sequence data is SRP132170 Data will be available after acceptance.

Funding: This work was supported by the Nestlé Purina PetCare (<https://www.purina.com>). The study was financed by Nestlé S.A. and several authors were employees of Nestlé S.A. when the study was conducted. The funder/employer had a role in study design, data analysis, decision to publish, and preparation of the manuscript.

Feeding for the Future – What do we know?

Lean animals live longer – observed across species

“Good” maternal and paternal nutrition benefits future generations

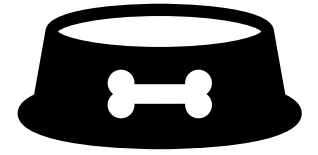
Hard inheritance (genetics) due to selection, can result in population changes (evolution) – be careful what you select for!

Epigenetic effects are passed through generations

“Lifestyle” and environment (including aspects such as stress and nutrition) interact with genetic inheritance via positive and negative epigenetic effects

The microbiome is involved too - healthy microbiome, healthy individual, and we can “feed the microbiome”!

Feeding for the Future - Review

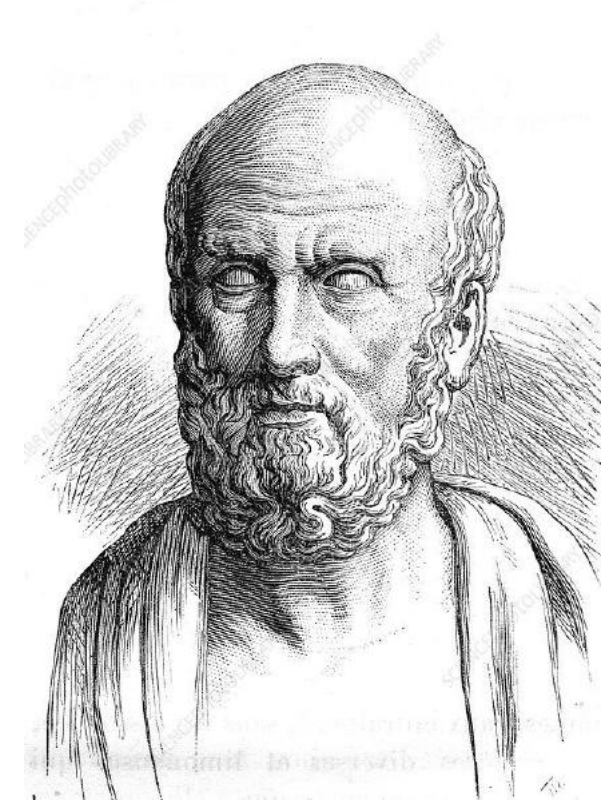


- Nutrition is part of holistic management of our dogs
- Nutrition impacts on health, welfare, longevity, and subsequent generations
- **One size rarely fits all** – requires a combination of both dog AND human factors!
- Good nutrition can support good breeding – sire, dam and puppies!
- Nutrition of one generation can affect subsequent generations
- The interplay between genetics and the environment (including nutrition) is important
- Likely that science will continue to demonstrate the intergenerational effects of nutrition.....

Feeding for the Future

**“Let food be thy medicine
and medicine be thy food”**

Hippocrates



A photograph of four dogs running through a lush green field. The dogs are of various breeds, including what appear to be spaniels. The background shows a line of trees under a clear sky. The text 'Questions?' is overlaid on the right side of the image.

Questions?

jacqueline.boyd@ntu.ac.uk

<https://www.facebook.com/drjacquelineboyd>

Reading and Resources

- Giordanella, A., Gerstner, K., Gimmel, A., & Liesegang, A. (2021). Nutrition consultation for an overweight growing Bernese Mountain Dog-A case report. *Journal of animal physiology and animal nutrition*, 105 Suppl 2, 124–128. <https://doi.org/10.1111/jpn.13236>
- Mack, J. K., & Kienzle, E. (2016). Fehlversorgungen in „BARF“-Futterplänen für einen Wurf Berner-Sennenhund-Welpen. Ein Fallbericht [Inadequate nutrient supply in "BARF" feeding plans for a litter of Bernese Mountain Dog-puppies. A case report]. *Tierärztliche Praxis. Ausgabe K, Kleintiere/Heimtiere*, 44(5), 341–347. <https://doi.org/10.15654/TPK-151091>
- <https://www.nytimes.com/2018/01/31/science/dutch-famine-genes.html>
- <https://theconversation.com/five-ways-to-help-your-dog-live-a-longer-healthier-life-166306>