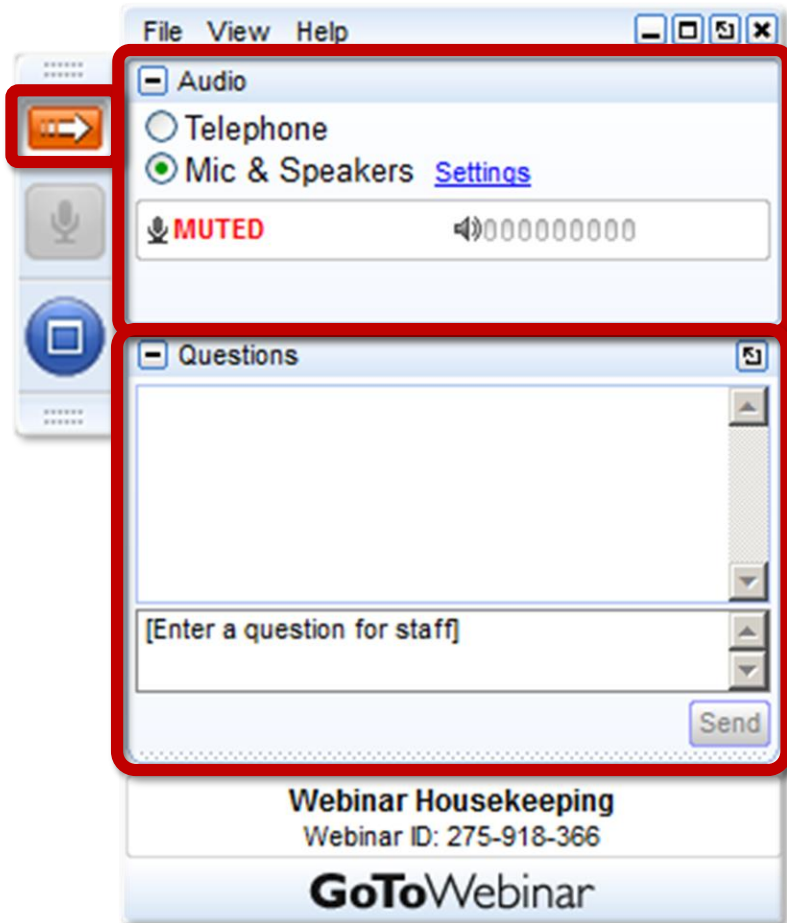


# The Power of Forage: The Importance of Feeding the Gut Microbiome in Horses



“Nutrition is the key to success”



## Your Participation

Open and close your control panel

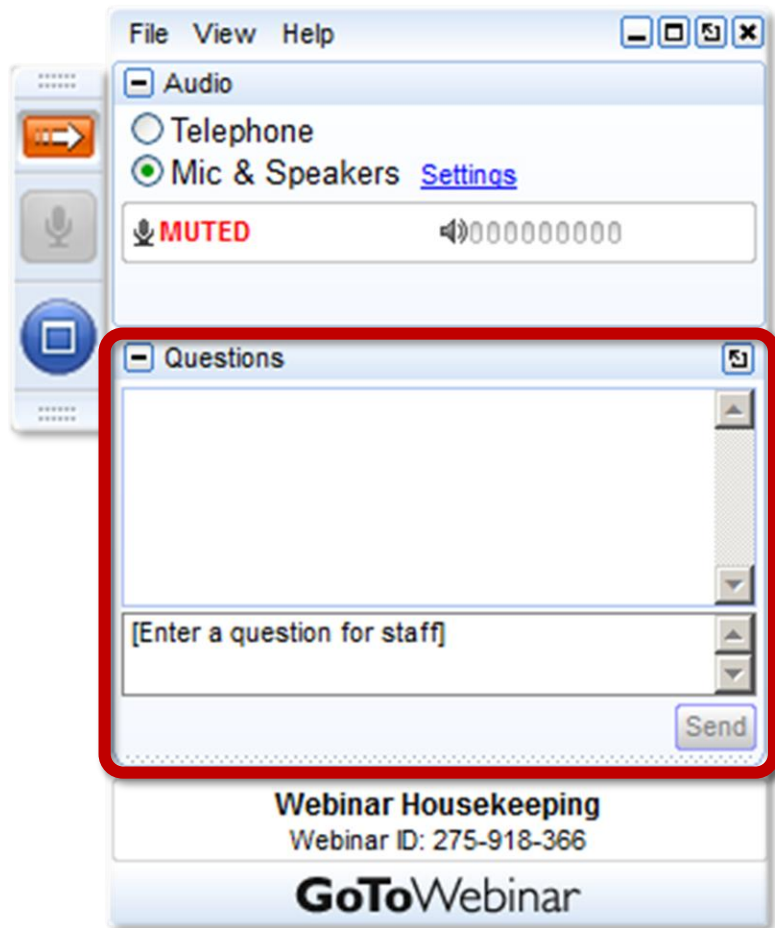
Join audio:

- Choose **Mic & Speakers** to use VoIP
- Choose **Telephone** and dial using the information provided

Submit questions and comments via the Questions panel

**Note:** Today's presentation is being recorded and will be provided within 48 hours.

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## Your Participation

- Please continue to submit your text questions and comments using the Questions panel

For more information, please contact [kstarr@standleeforage.com](mailto:kstarr@standleeforage.com).

**Note:** Today's presentation is being recorded and will be provided within 48 hours.



# YOUR HORSE'S GUT MICROBIOME

"Nutrition is the key to success"

## The Importance of Your Horse's Gut Microbiome

**What is a microbiome?** A microbiome is the community of micro-organisms living together in a particular habitat. The equine gut microbiome refers to all of the microbes in the hindgut, which act as another organ that's crucial for health.

What does the microbiome do?	What does the microbiome impact?	What effects the microbiome?	Feed management practices that benefit the microbiome
<ul style="list-style-type: none"><li>Harvests nutrients &amp; energy from the diet</li><li>Resists the colonization of pathogens</li><li>Develops the immune system</li><li>Detoxifies toxic compounds in the host</li></ul>	<ul style="list-style-type: none"><li>Immune function</li><li>Inflammation</li><li>Obesity</li><li>Metabolic Disorders</li><li>Behavior</li><li>Diarrhea</li><li>Colic</li></ul>	<ul style="list-style-type: none"><li>Lifestyle</li><li>Environment</li><li>Dietary patterns</li><li>Gastrointestinal distress</li><li>Dietary change</li><li>Hindgut Acidity</li></ul>	<ul style="list-style-type: none"><li>Feed forage regularly</li><li>Feed high quality forage</li><li>Feed several sources of forage</li><li>Feed clean forage</li></ul>

**Veterinary Contact Information**

Name: \_\_\_\_\_  
Email: \_\_\_\_\_  
Phone: \_\_\_\_\_

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Download under Infographics at:  
<https://standleeforage.com/nutrition/nutritional-resources>

# NUTRITIONAL RESOURCES



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[standleeforage.com](http://standleeforage.com)

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## NUTRITIONAL RESOURCES

Standlee Premium Western Forage® creates and maintains a wealth of nutritional resources to help you maintain the nutrition of your horses. You can find those resources here.

### Nutritional Webinars

- ▶ How to Decrease Your Horse's Risk of Colic with Nutrition Management ([Watch Video Recording Now](#))
- ▶ Winter Feeding ([Watch Video Recording Now](#))
- ▶ Gastric Ulcers in Horses ([Watch Video Recording Now](#))
- ▶ Metabolic Disease Prevention and Management ([Watch Video Recording Now](#))
- ▶ What Do I Need to Know About Raising Chicks? ([Watch Video Recording Now](#))
- ▶ When Quality Hay Is In Short Supply, What Can I Feed My Horse? ([Watch Video Recording Now](#))
- ▶ Beet Pulp – What Is It and Why Do Horses Need It? ([Watch Video Recording Now](#))



# The Power of Forage: The Importance of Feeding the Gut Microbiome in Horses

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**DR. TANIA CUBITT**  
**PERFORMANCE HORSE NUTRITION**



# OUTLINE

“Nutrition is the key to success”

- Digestion
- Gut Microbiome
  - Obesity
  - Immune function
  - Inflammation
  - Behavior
- Management





# Digestion



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# BACKGROUND

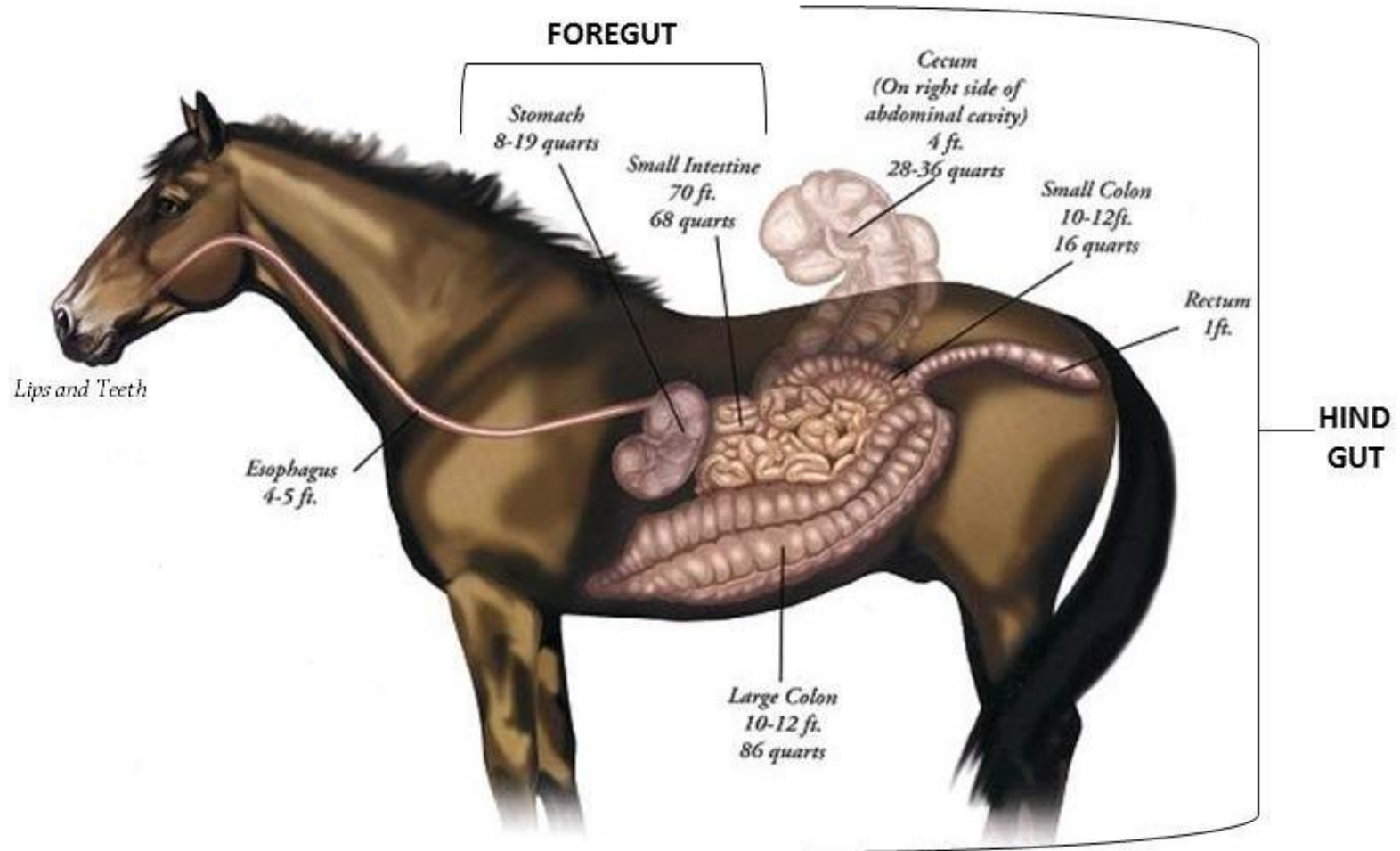
“Nutrition is the key to success”

- Grazing non-ruminant herbivore
  - Hindgut fermenter capable of utilizing a wide range of plant species (Costa et al., 2012)
- Hindgut fermenters contain a complex microbial digestion uniquely adapted to:
  - Grazing on high-fiber, low-energy fodder (Dougal et al., 2012)
  - Degrade and ferment to short chain fatty acids that in turn can be absorbed and utilized as energy sources (Blackmore et al., 2013)



# EQUINE DIGESTIVE TRACT

“Nutrition is the key to success”



# FORAGE AMOUNT

“Nutrition is the key to success”

- **Absolute Minimum** = 1% of B.W.  
1000 lb horse = 10 lbs forage (DM)
- **Weight Loss** = 1.2% of B.W. 1000 lb horse = 12 lbs forage (DM)
- **Recommended Minimum** = 1.5% of B.W. 1000 lb horse = 15 lbs forage (DM)
- **Normal Forage Intake** = 1.8 to 2.5% of B.W. (DM)
- **Maximum Intake** = 3 to 3.5% of B.W. (DM)





# QUESTIONS?

“Nutrition is the key to success”

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- We know the numbers
- We know the horse needs fiber

## BUT WHY?

- We know gut health can effect many functions in the horse

## BUT HOW?



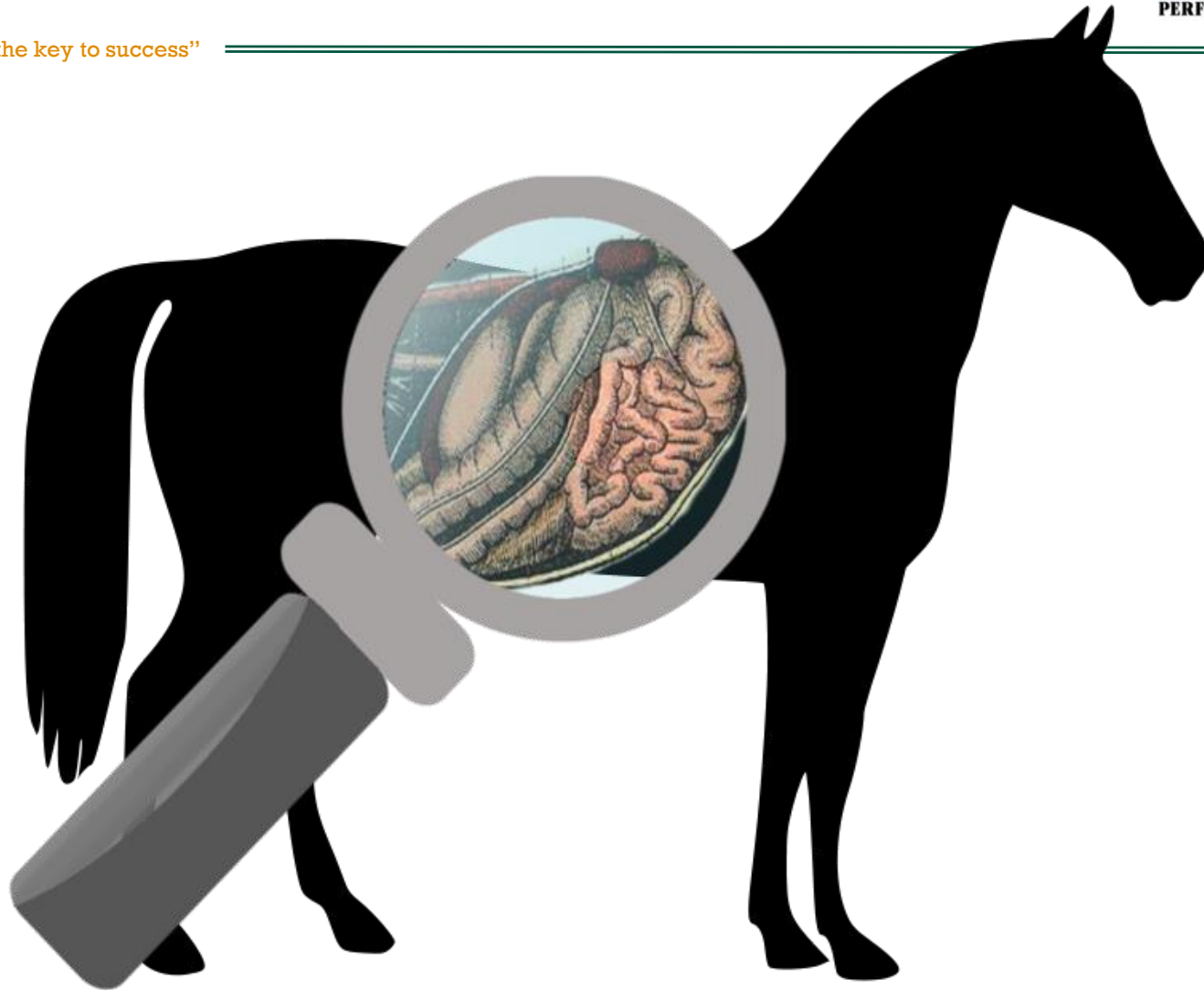
# Gut Microbiome



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# CLOSER LOOK

“Nutrition is the key to success”





# MICROBIOME

“Nutrition is the key to success”

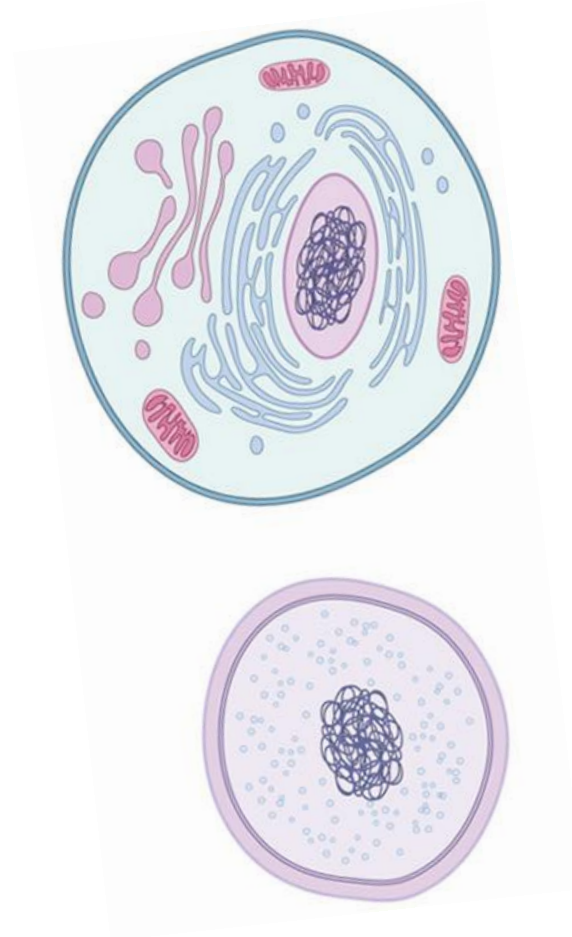
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- A microbiome is the community of micro-organisms living together in a particular habitat. Humans, animals and plants have their own unique microbiomes.
- The equine gut microbiome refers to all of the microbes in hindgut, which act as another organ that's crucial for health.
- Gut microbiome plays important roles in:
  - Harvesting nutrients & extracting energy from the diet
  - Resisting the colonization of pathogens
  - Developing the immune system
  - Detoxifying toxic compounds in the host

# MICROBIOME

“Nutrition is the key to success”

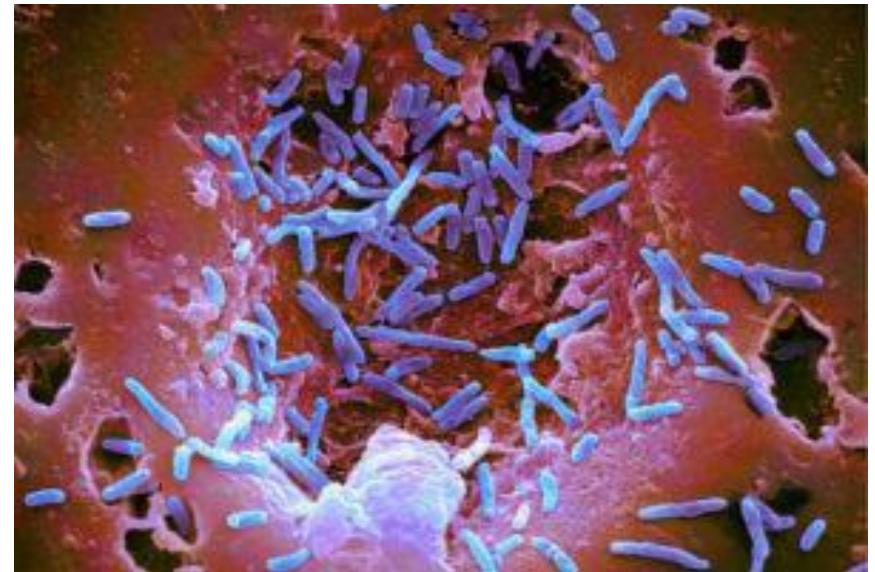
- Consists of:
  - Bacteria
  - Fungi (yeast)
  - Protozoa
  - Viruses
  - Archaea
- Microbes outnumber the cells in our body by a factor of about 10 to 1



# MICROBIOME

“Nutrition is the key to success”

- The gut microbiome can be affected by external factors such as:
  - Lifestyle
  - Environment
  - Dietary patterns
  - Gastrointestinal disease
  - Dietary change
  - Fermentative acidosis
  - Laminitis
  - Colic






MENU ▾

## SCIENTIFIC REPORTS

Article | [OPEN](#) | Published: 14 November 2017

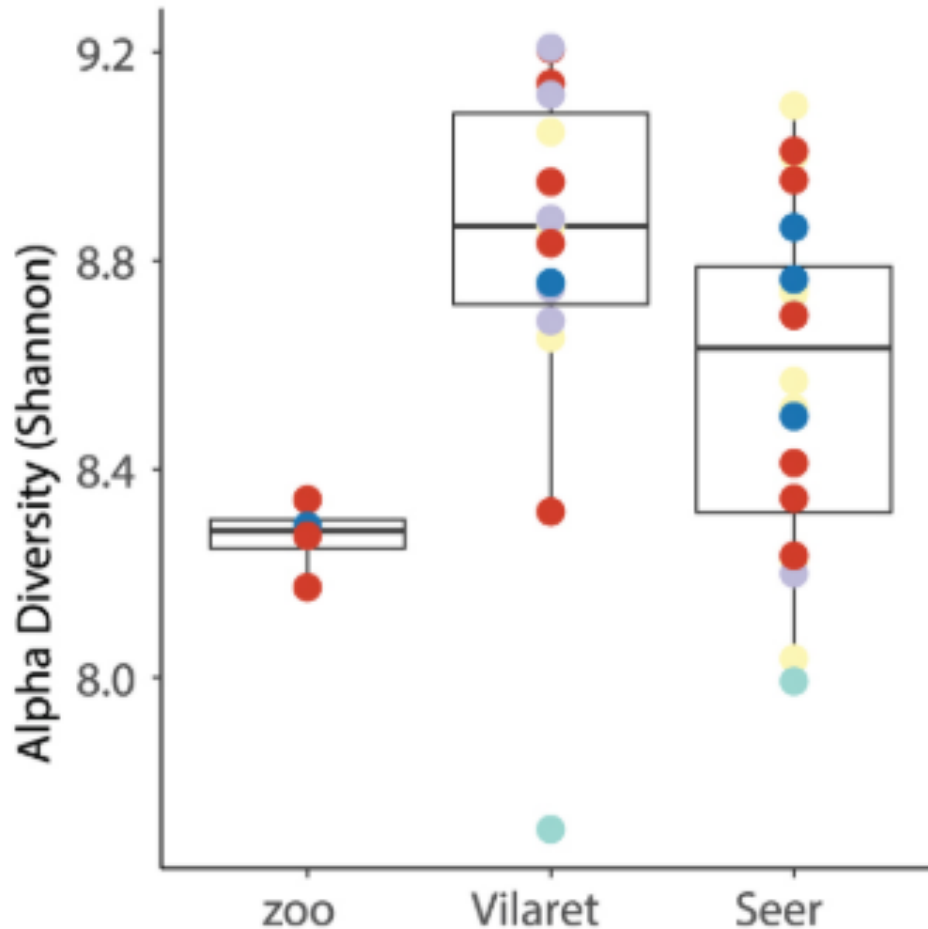
# Evaluating the impact of domestication and captivity on the horse gut microbiome

Jessica L. Metcalf, Se Jin Song, James T. Morton, Sophie Weiss, Andaine Seguin-Orlando, Frédéric Joly, Claudia Feh, Pierre Taberlet, Eric Coissac, Amnon Amir, Eske Willerslev, Rob Knight, Valerie McKenzie & Ludovic Orlando 

*Scientific Reports* **7**, Article number: 15497 (2017) | [Download Citation](#) ↓

# DOMESTICATION

“Nutrition is the key to success”



Gut microbial diversity based on birth place and domestication:

- Zoo (domesticated)
- Vilaret (wild reserve in France not domesticated)
- Seer (wild reserve in Mongolia not domesticated)

*Significantly stunted microbial diversity when born in a zoo*

## Article

Asian-Australasian Journal of Animal Sciences (AJAS) 2016; 29(9): 1345-1352.

Published online: December 1, 2015

DOI: <https://doi.org/10.5713/ajas.15.0587>

# Comparison of Fecal Microbiota of Mongolian and Thoroughbred Horses by High-throughput Sequencing of the V4 Region of the 16S rRNA Gene

Yiping Zhao, Bei Li, Dongyi Bai, Jinlong Huang, Wunierfu Shiraigo, Lihua Yang, Qinan Zhao, Xiujuan Ren, Jing Wu, Wuyundalai Bao, Manglai Dugarjaviin \*



# LIFESTYLE DIFFERENCES

“Nutrition is the key to success”

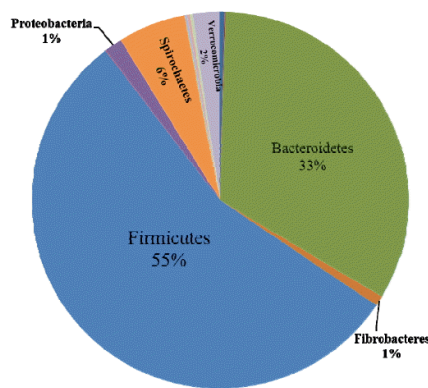
- Mongolian horses vs. Thoroughbred
- All housed in Mongolia - 2 different farms
- Mongolian horses roamed and grazed prairies
- Thoroughbreds fed typical hay and grain rations housed in stalls



# LIFESTYLE DIFFERENCES

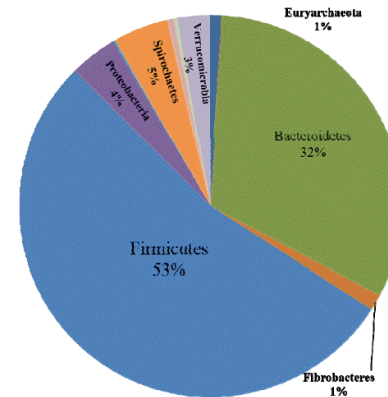
“Nutrition is the key to success”

Mongolian  
Phylum level



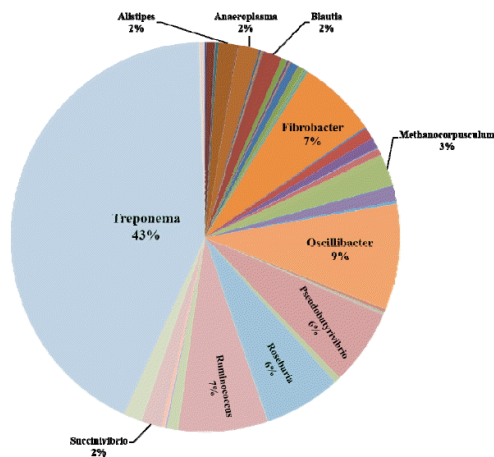
(A)

Thoroughbred  
Phylum level



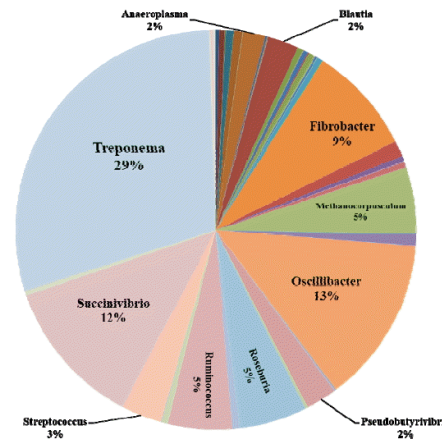
(B)

Mongolian  
Genus level



(C)

Thoroughbred  
Genus level

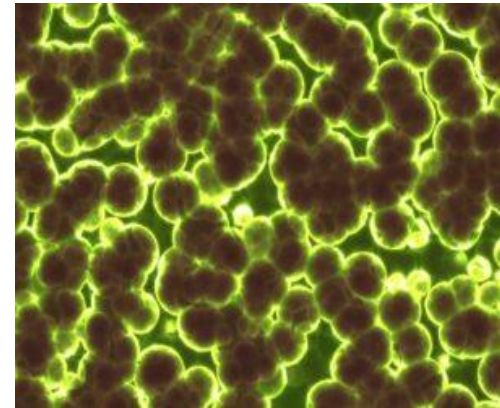


(D)

# LIFESTYLE DIFFERENCES

“Nutrition is the key to success”

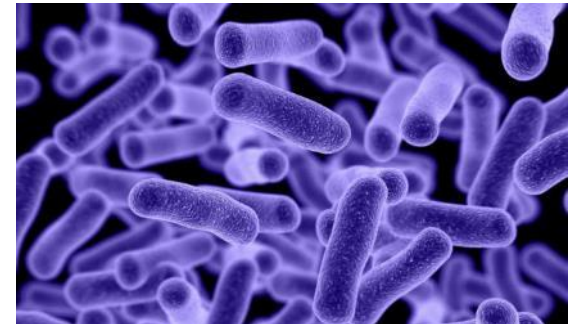
- Previous studies in horses reported:
  - Firmicutes as the predominant taxa (39.5% to 72.6%)
  - Firmicutes are the main bacterial phylum, comprising over 250 genera, including Lactobacillus, Streptococcus, Mycoplasma, and Clostridium which are able to produce several short chain fatty acids (SCFAs) like butyrate



# LIFESTYLE DIFFERENCES

“Nutrition is the key to success”

- Previous studies in horses reported:
  - Bacteroidetes (2<sup>nd</sup> to Firmicutes) (8.9% to 21.3%) in healthy horses populations Costa et al. (2012)
  - Bacteroidetes are gram-negative bacteria that ferment polysaccharides and otherwise indigestible carbohydrates and produce short-chain fatty acids (SCFAs) that have many beneficial effects in the gut





# LIFESTYLE DIFFERENCES



“Nutrition is the key to success”

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Current study reported the same predominance

## However

- Proteobacteria was significantly different in two breeds
  - (1% and 4%, Mongolian horses and Thoroughbred horses respectively)
  - Proteobacteria included many pathogenic bacteria, such as *salmonella*, *V. cholera*, *Helicobacter pylori*, etc.
- *Streptococcus* was 3% for Thoroughbred horses and less than 1% for Mongolian horses
  - *Streptococcus* also included pathogenic bacteria (e.g. *Streptococcus pneumoniae*, *Streptococcus pyogenes*, *Streptococcus agalactiae*)

## Link?

- Thoroughbred horses more susceptible to diseases than Mongolian horses?



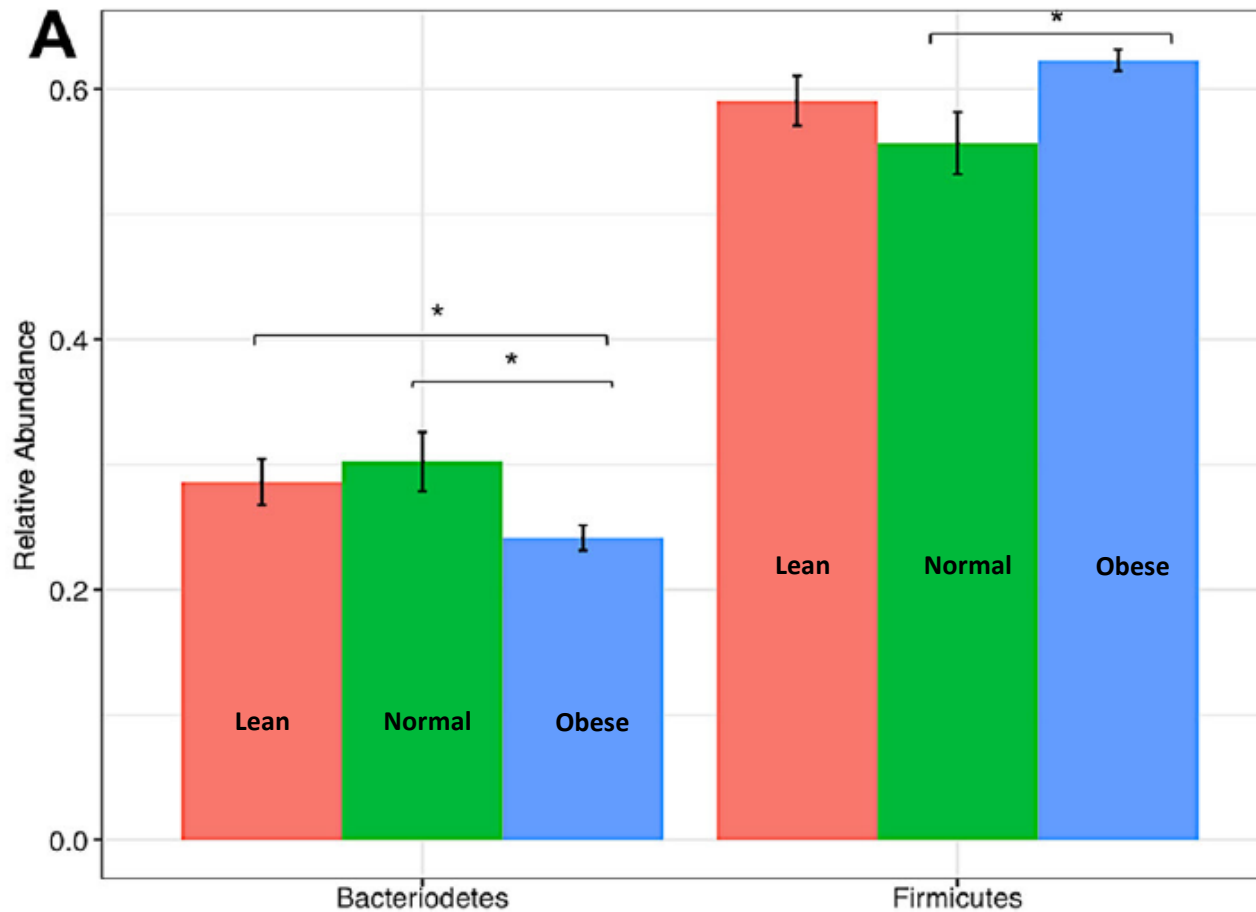
# Microbiome and Blood Analyte Differences Point to Community and Metabolic Signatures in Lean and Obese Horses

Amy S. Biddle<sup>1\*</sup>, Jean-Francois Tomb<sup>2</sup> and Zirui Fan<sup>2</sup>

<sup>1</sup> Department of Animal and Food Science, University of Delaware, Newark, DE, United States, <sup>2</sup> Department of Computer and Information Sciences, University of Delaware, Newark, DE, United States

# OBESEITY

“Nutrition is the key to success”



Similar to humans  
– decreased  
*Bacteroidetes* &  
increased  
*Firmicutes* in  
obese horses

# OBESITY

“Nutrition is the key to success”

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- Human obesity has been associated with reduced proportions of *Bacteroidetes*, and correspondingly increased abundances of *Firmicutes* in fecal samples (Ley et al., 2006)
- Human obesity is associated with a reduction in insulin sensitivity (Kahn and Flier, 2000), and in turn, a reduced insulin sensitivity has been associated with decreased microbial richness (Le Chatelier et al., 2013)



“Nutrition is the key to success”



## Journal of Equine Veterinary Science

Volume 76, May 2019, Pages 40-41



# Microbiome effects on metabolic efficiencies in easy and hard keepers

A.C.B. Johnson\*, A.S. Biddle

# Poll Question

“Nutrition is the key to success”

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# METABOLIC STATUS

“Nutrition is the key to success”

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- Hard Keeper (HK)
- Easy Keeper (EK)
- Medium Keeper (MK)
- HK contained the least bacterial diversity followed by EK then MK respectively
- HK –less lactic acid producing bacteria, less Amino Acid utilizing bacteria
- MK are the most efficient at nutrient digestion and host absorption
- Reduced bacterial diversity in HK leads to insufficient nutrient levels to support a healthy microbiome and maintain horse condition

[PLoS One](#). 2014; 9(2): e87424.

PMCID: PMC3913607

Published online 2014 Feb 4. doi: [10.1371/journal.pone.0087424](https://doi.org/10.1371/journal.pone.0087424)

PMID: [24504261](https://pubmed.ncbi.nlm.nih.gov/24504261/)

## Characterisation of the Faecal Bacterial Community in Adult and Elderly Horses Fed a High Fibre, High Oil or High Starch Diet Using 454 Pyrosequencing

[Kirsty Dougal](#),<sup>1</sup> [Gabriel de la Fuente](#),<sup>1</sup> [Patricia A. Harris](#),<sup>2</sup> [Susan E. Girdwood](#),<sup>1</sup> [Eric Pinloche](#),<sup>1</sup>  
[Raymond J. Geor](#),<sup>3</sup> [Brian D. Nielsen](#),<sup>3</sup> [Harold C. Schott, II](#),<sup>3</sup> [Sarah Elzinga](#),<sup>3</sup> and [C. Jamie Newbold](#)<sup>1, \*</sup>



# AGE/DIET

“Nutrition is the key to success”

- 17 horses (2 different groups - Adult vs. Elderly)
  - 8 in the 5-12 year range
  - 9 in the 19-28 year range
- 3 different diets
  - Hay (NSC – 11%; Fat – 4%)
  - Hay + CHO (NSC - 42%; Fat – 5%)
  - Hay + Fat (NSC – 13%; Fat – 8.5%)



# AGE/DIET

“Nutrition is the key to success”

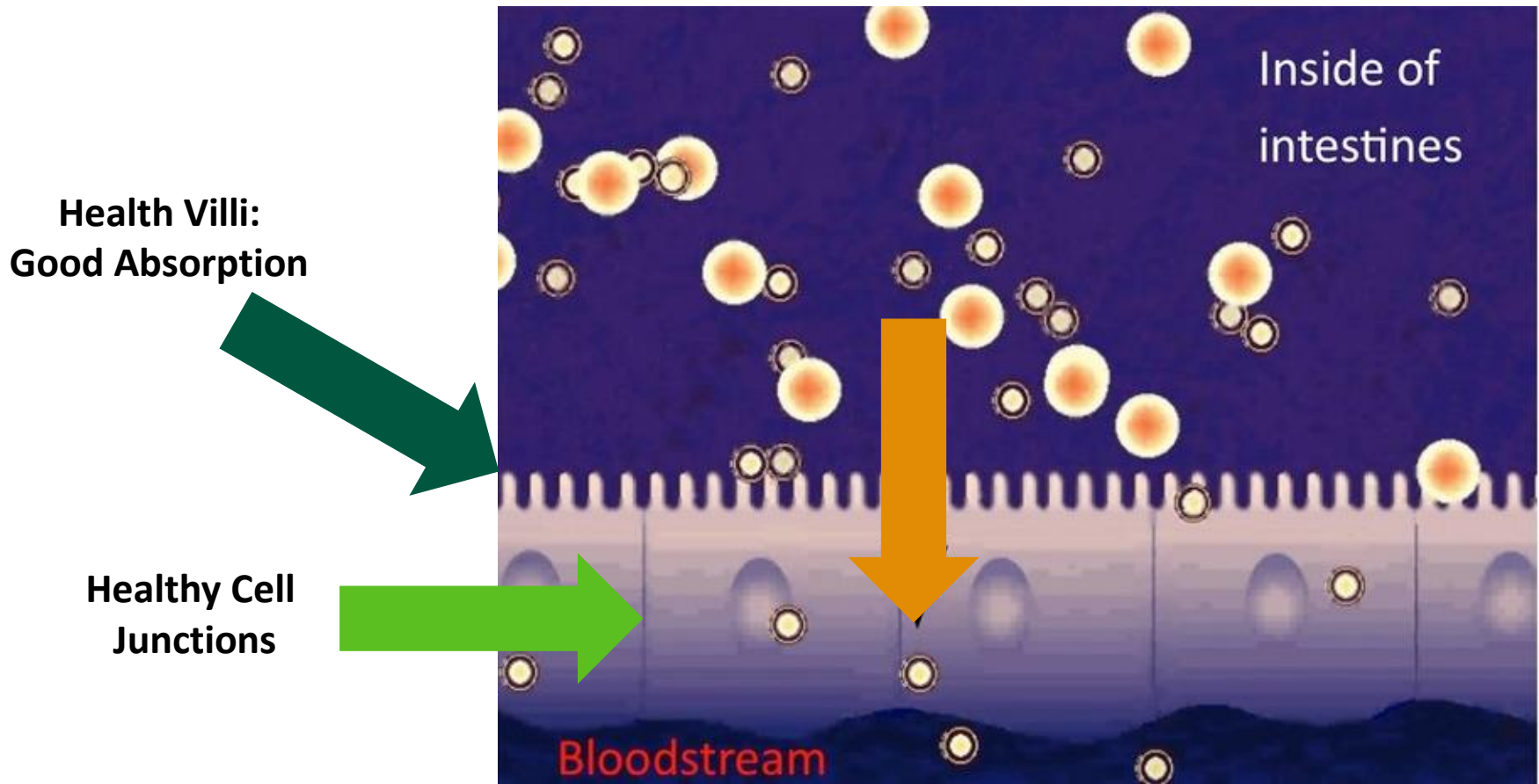
- Core Community -
  - HAY diet 15.9%
  - OIL diet 10.3%
  - CHO 5.4%
- *Lachnospiraceae* being the most abundant in the core community
  - *Lachnospiraceae* are known butyrate producers and butyrate is known to have a protective function on colonocytes in the gut wall
- Fecal microbiome significantly reduced in elderly horses (*perhaps due to reduced dentition/fiber digestion? Or is this a result?*)



# HEALTHY GUT

“Nutrition is the key to success”

Small, properly digested food particles are absorbed - everything else kept out



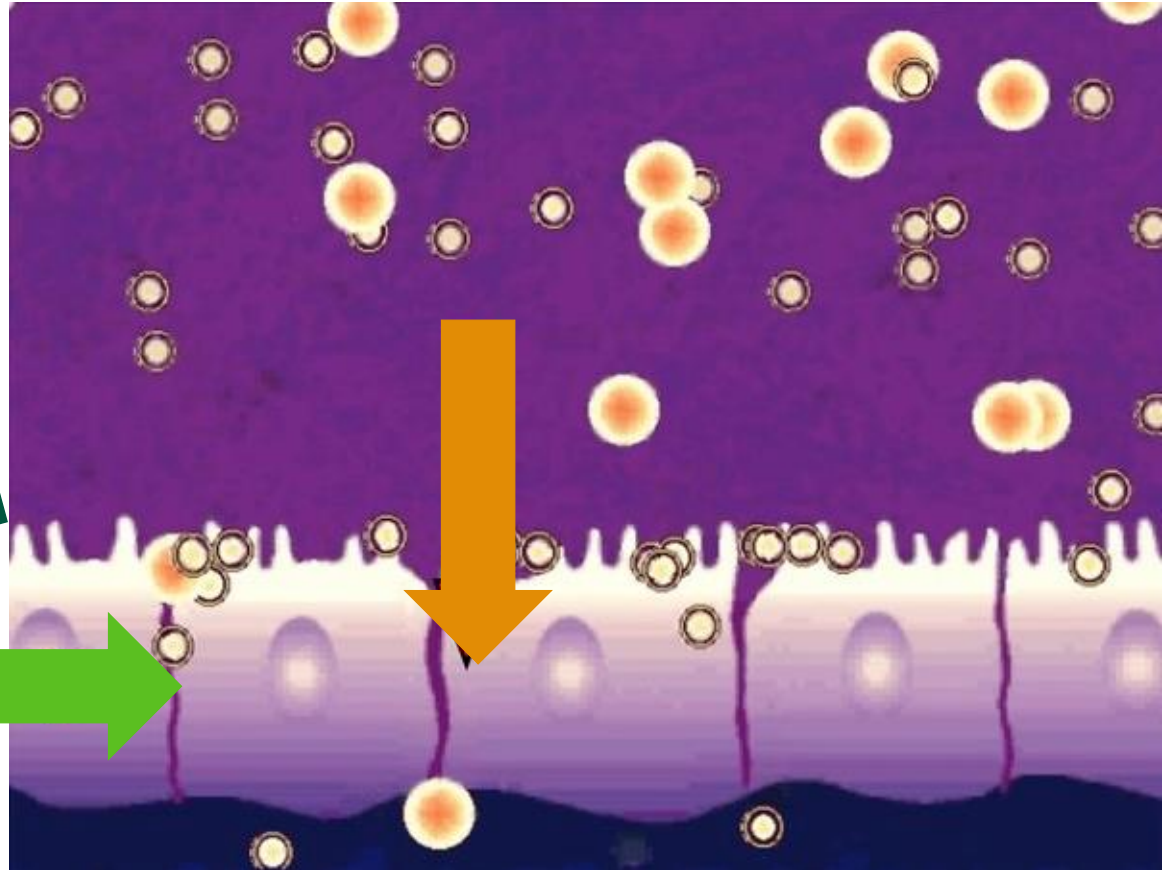
# LEAKY GUT

“Nutrition is the key to success”

Large food particles and bacterial debris leak through the damaged intestinal barrier

Damage Villi:  
Poor Absorption

Damaged Cell  
Junctions





# Poll Question

“Nutrition is the key to success”

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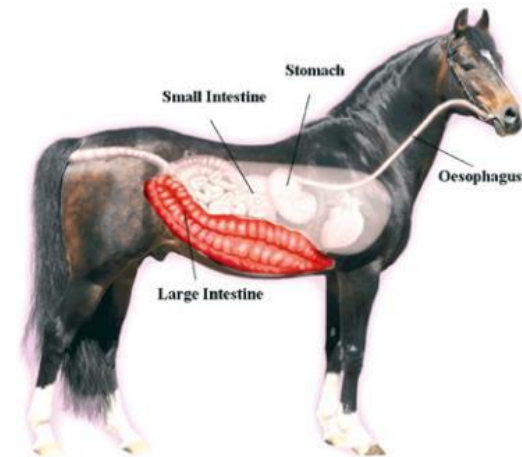


# Comparison of the Fecal Microbiota of Healthy Horses and Horses with Colitis by High Throughput Sequencing of the V3-V5 Region of the 16S rRNA Gene

Marcio C. Costa<sup>1\*</sup>, Luis G. Arroyo<sup>2</sup>, Emma Allen-Vercoe<sup>3</sup>, Henry R. Stämpfli<sup>2</sup>, Peter T. Kim<sup>4</sup>, Amy Sturgeon<sup>1</sup>, J. Scott Weese<sup>1</sup>

<sup>1</sup> Department of Pathobiology, Ontario Veterinary College, University of Guelph, Guelph, Ontario, Canada, <sup>2</sup> Department of Clinical Studies, Ontario Veterinary College, University of Guelph, Guelph, Ontario, Canada, <sup>3</sup> Department of Molecular and Cellular Biology, College of Biological Sciences, University of Guelph, Guelph, Ontario, Canada, <sup>4</sup> Department of Mathematics and Statistics, College of Physical and Engineering Science, University of Guelph, Guelph, Ontario, Canada

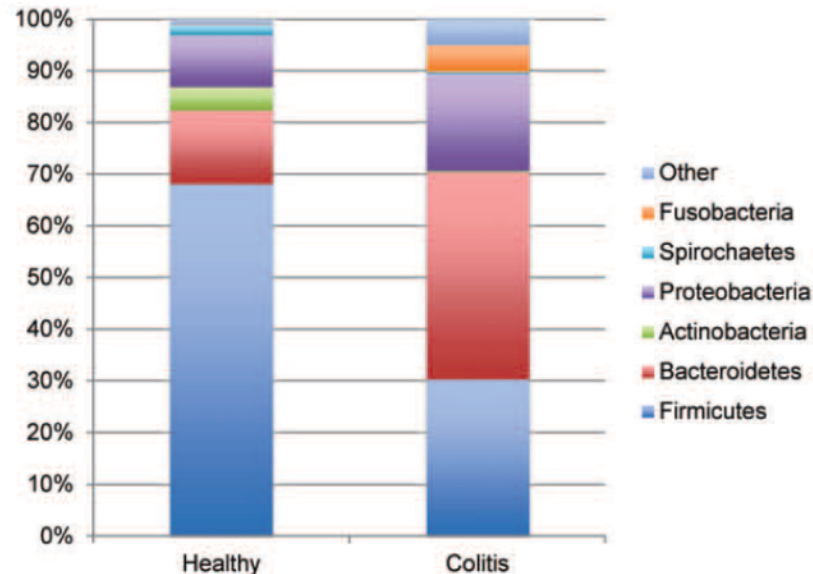
- 16 horses
- 6 healthy
- 10 colitis
- Fecal samples



# COLITIS

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- **Phylum: "Firmicutes"**
  - **Order: Clostridiales**
    - **Domain: Bacteria**
      - **Family: Lachnospiraceae**



- Clostridiales, members of the Lachnospiraceae family, were the most abundant bacteria shared between healthy horses
- Previous study showed Lachnospiraceae highest in horses eating high forage diets

“Nutrition is the key to success”

Journal of Equine Veterinary Science 44 (2016) 9–16



Contents lists available at [ScienceDirect](#)

## Journal of Equine Veterinary Science

journal homepage: [www.j-evs.com](http://www.j-evs.com)



Original Research

### Comparison of the Fecal Microbiota in Horses With Equine Metabolic Syndrome and Metabolically Normal Controls Fed a Similar All-Forage Diet



Sarah E. Elzinga<sup>a</sup>, J. Scott Weese<sup>b</sup>, Amanda A. Adams<sup>a,\*</sup>

<sup>a</sup>Department of Veterinary Science, M.H. Gluck Equine Research Center, University of Kentucky, Lexington KY

<sup>b</sup>Ontario Veterinary College, University of Guelph, Ontario, CA

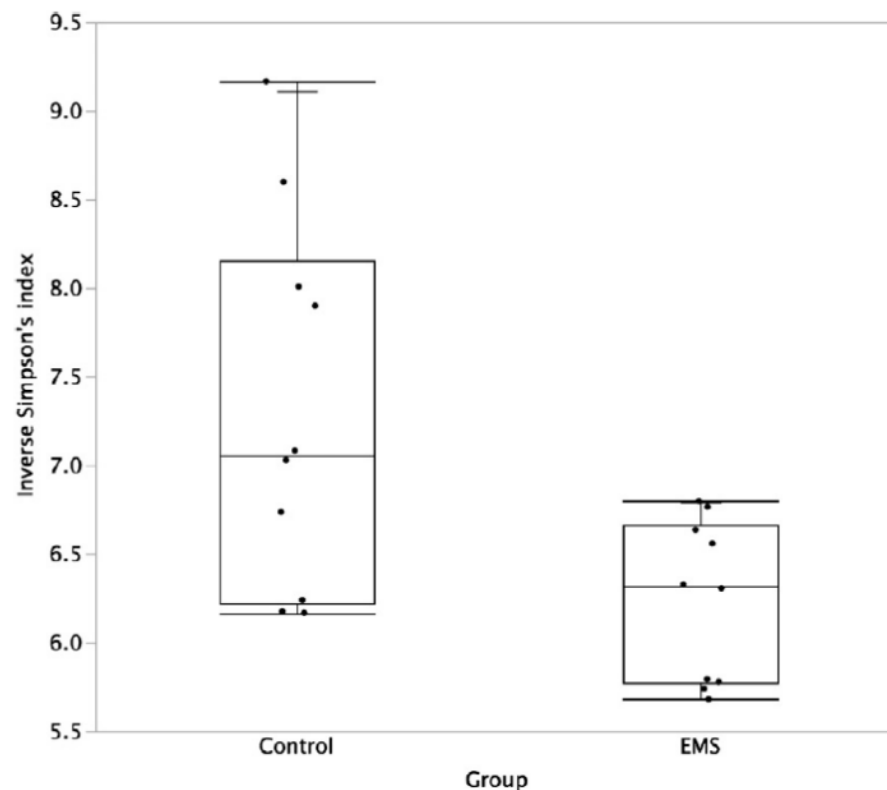
“Nutrition is the key to success”

- 20 horses
- 10 with EMS
- 10 non EMS control
- Forage only diet

Characterization of phenotypic measures in equine metabolic syndrome (EMS) versus non-EMS control horses.

Group	BCS	CNS	Basal Insulin (μIU/mL)	Post Oral Sugar Insulin (μIU/mL)
EMS	7.13 ± 0.15	3.57 ± 0.27	33.85 ± 2.66	63.26 ± 5.29
Control	5.85 ± 0.23	1.95 ± 0.18	13.03 ± 1.46	26.11 ± 3.77
P value	<.001	<.001	<.001	<.001

Average body condition score (BCS) and cresty neck score (CNS), and basal insulin and insulin 60 minutes after oral sugar administration in n = 10 EMS and n = 10 non-EMS control horses. Results are represented as the mean plus or minus the standard error of the mean.



**Fig. 1.** Intestinal microbiota diversity in equine metabolic syndrome (EMS) versus non-EMS control horses. Intestinal microbiota diversity as represented by an inverse Simpson’s index in n = 10 EMS and n = 10 non-EMS control horses.



RESEARCH ARTICLE

Open Access

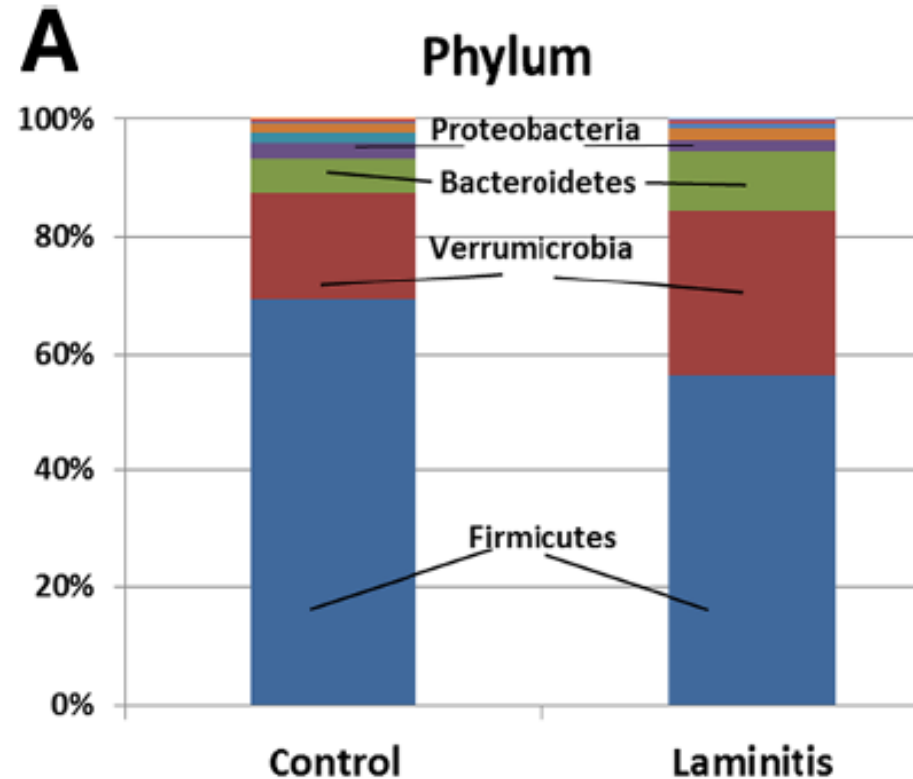
# Pyrosequencing of 16S rRNA genes in fecal samples reveals high diversity of hindgut microflora in horses and potential links to chronic laminitis

Samantha M Steelman<sup>1</sup>, Bhanu P Chowdhary<sup>1</sup>, Scot Dowd<sup>2</sup>, Jan Suchodolski<sup>3</sup> and Jan E Janečka<sup>1\*</sup>

# LAMINITIS

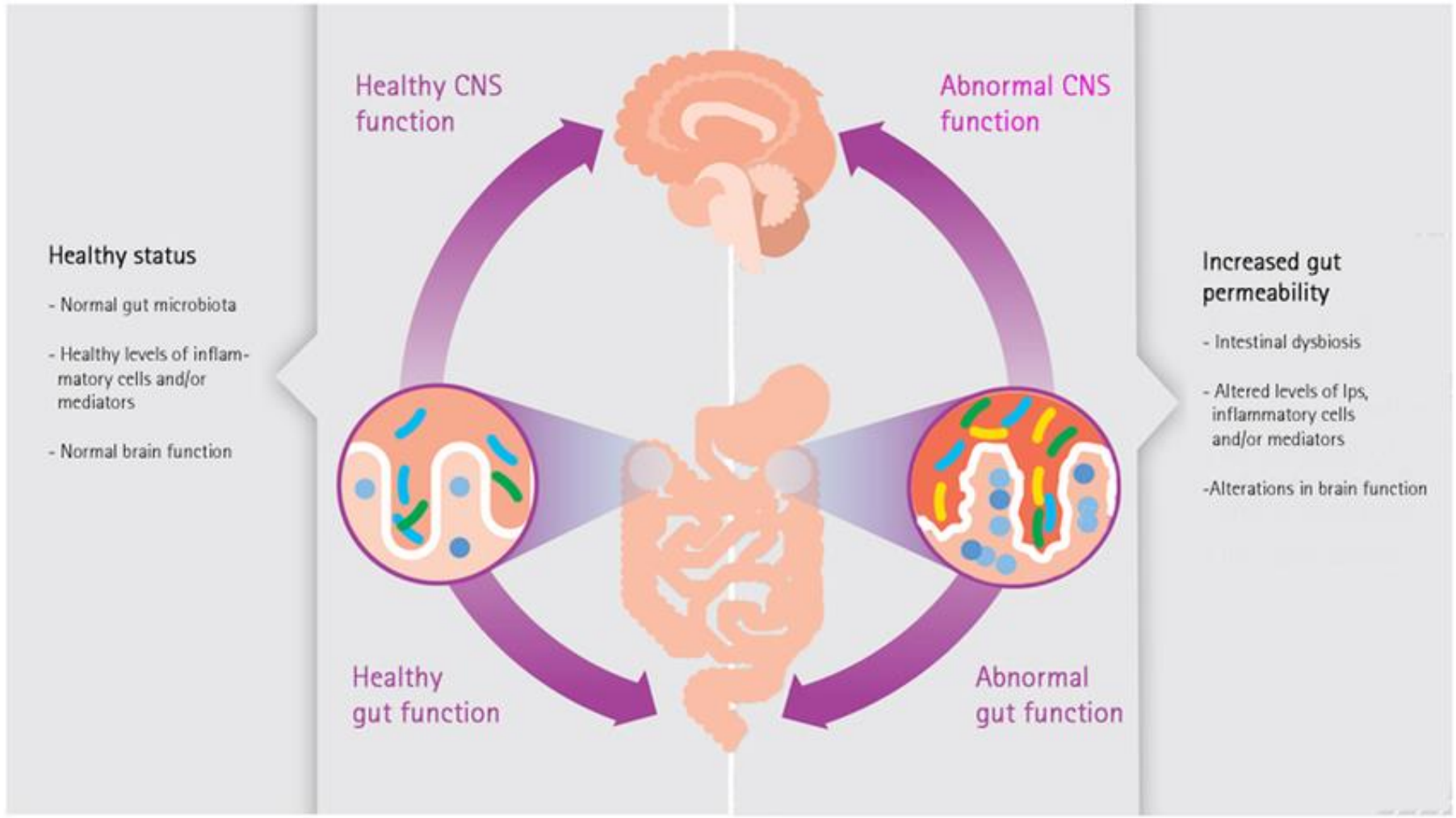
“Nutrition is the key to success”

- 18 horses
  - 10 normal
  - 8 laminitis
- Results
  - Less Firmicutes in Laminitic horses



# GUT - BRAIN AXIS (BEHAVIOR)

“Nutrition is the key to success”



# Management



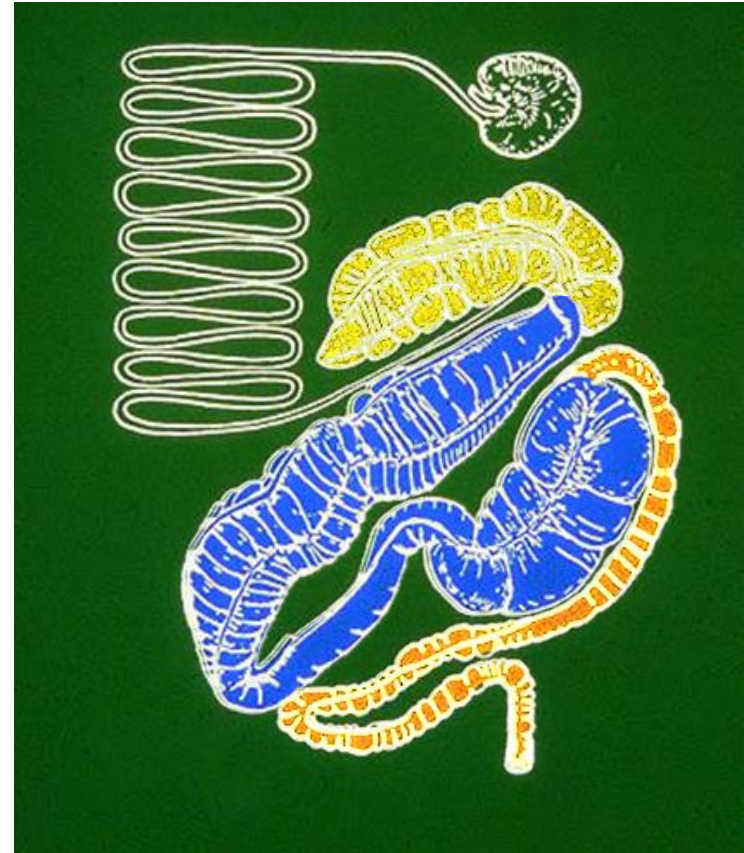
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# MANAGEMENT

“Nutrition is the key to success”

- Focus on feeding the “Microbiome”
- Feeding strategies that:
  - Promote a healthy “microbiome”
  - Discourage pathogenic bacteria
- Gut microbiome is the link between nutrition and health





# FORAGE AMOUNT REMINDER

“Nutrition is the key to success”

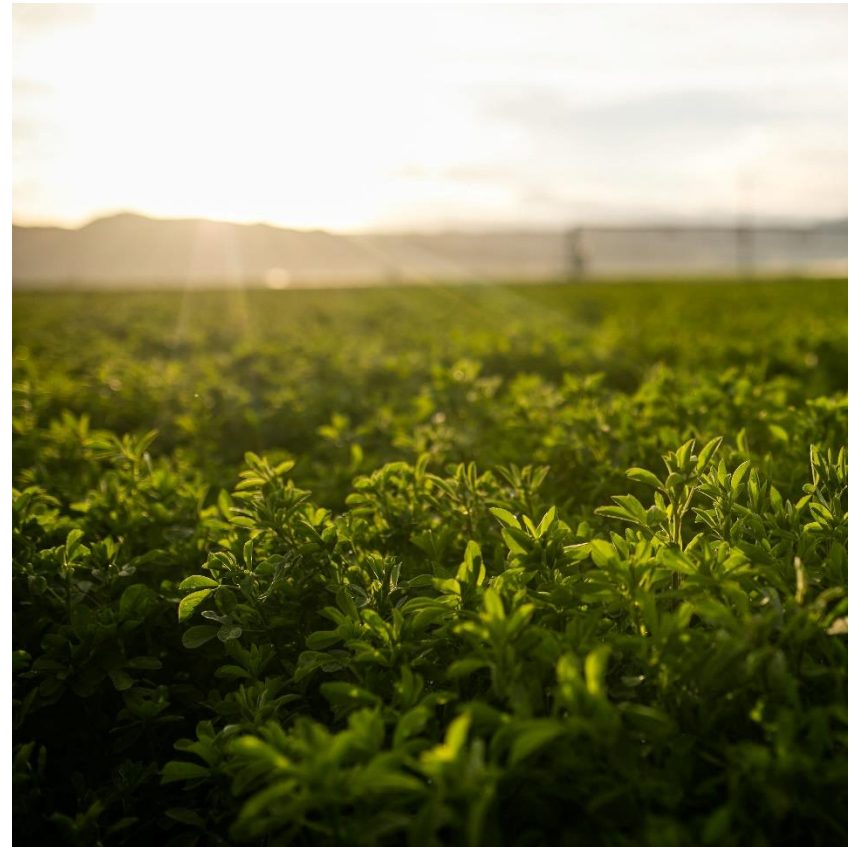
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- **Maximum Intake** = 3 to 3.5% of B.W. (DM)



# SUMMARY

“Nutrition is the key to success”

- High quality forage
- Consistently provided
- Feeding management practices that favor the microbiome
- Research ongoing





# Q & A Session



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# Thank you for joining us!

**For follow-up questions, please contact our customer relations:**

1-800-398-0819

[customerservice@standleeforage.com](mailto:customerservice@standleeforage.com)

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[standleeforage.com](http://standleeforage.com)

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