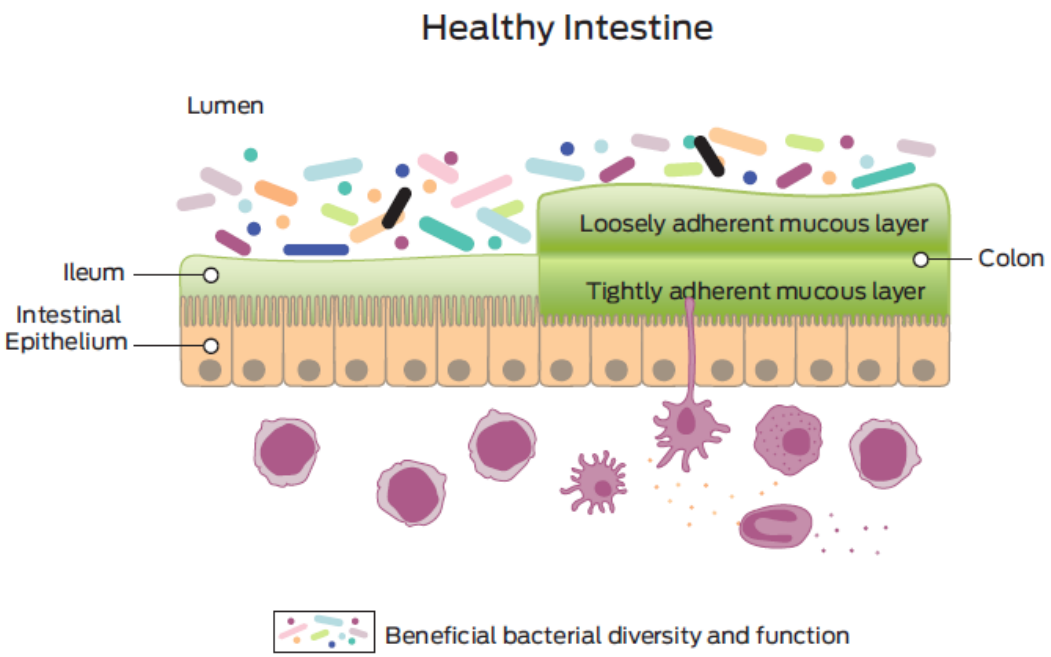
Purina® PRO PLAN® Symposium 2026

Navigating Microbiota Dynamics Applicable to Pet Nutrition

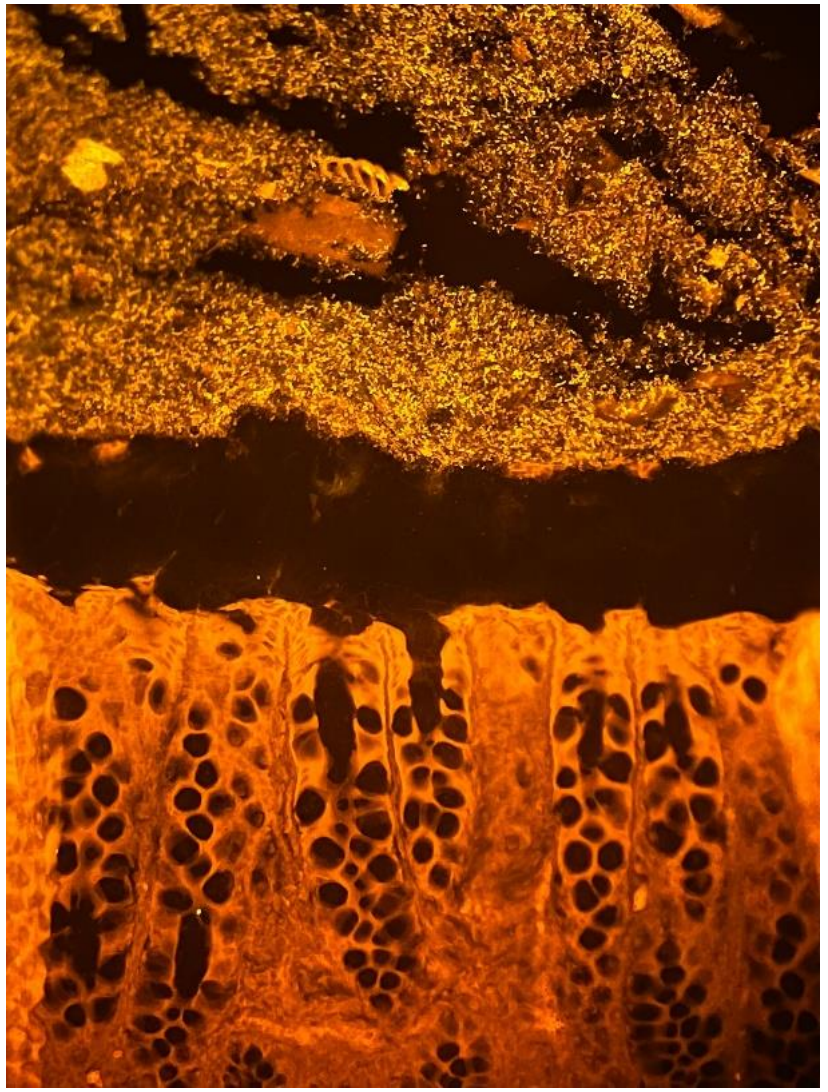
Connecting the Dots: The Use of Biomarkers for better understanding of Gut Health and Disease

Jan S. Suchodolski

HEALTHY INTESTINE



Suchodolski JS - Assessing and Managing the Gut Microbiome in Canine and Feline Practice.
In "Purina Institute - Canine and Feline Clinical Nutrition Handbook, 2023 edition"



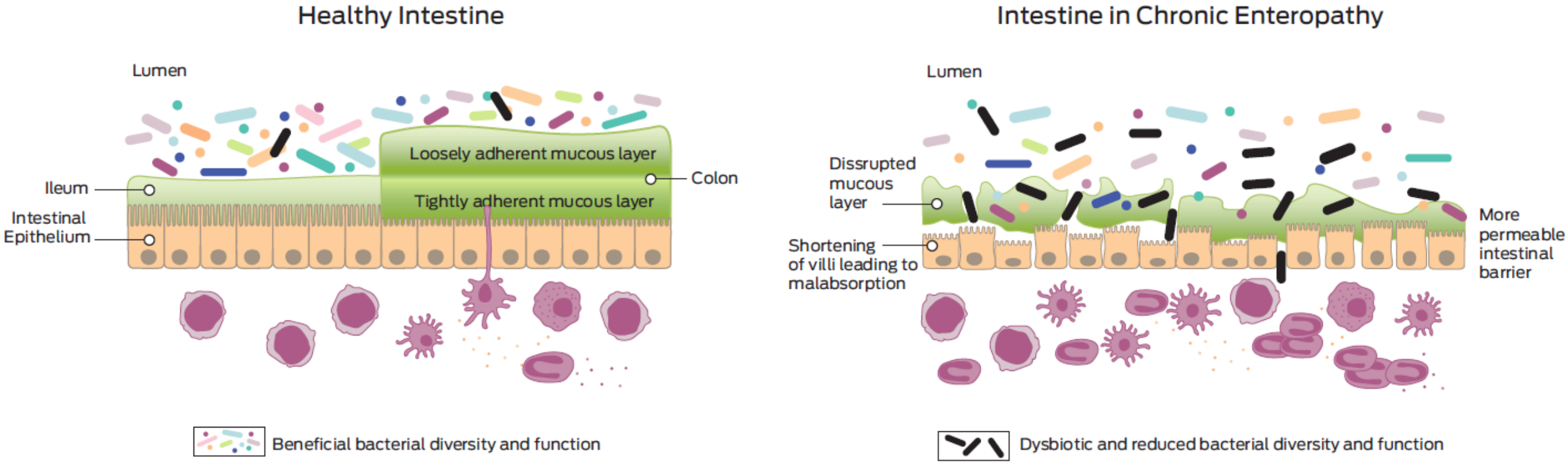
Live bacteria (what we see as feces)

Mucus layer

Epithelium

Courtesy: Dr. Chi-Hsuan Sung, GI LAB, TAMU

Gradient of changes: CE is a heterogenous syndrome of variable underlying pathologies

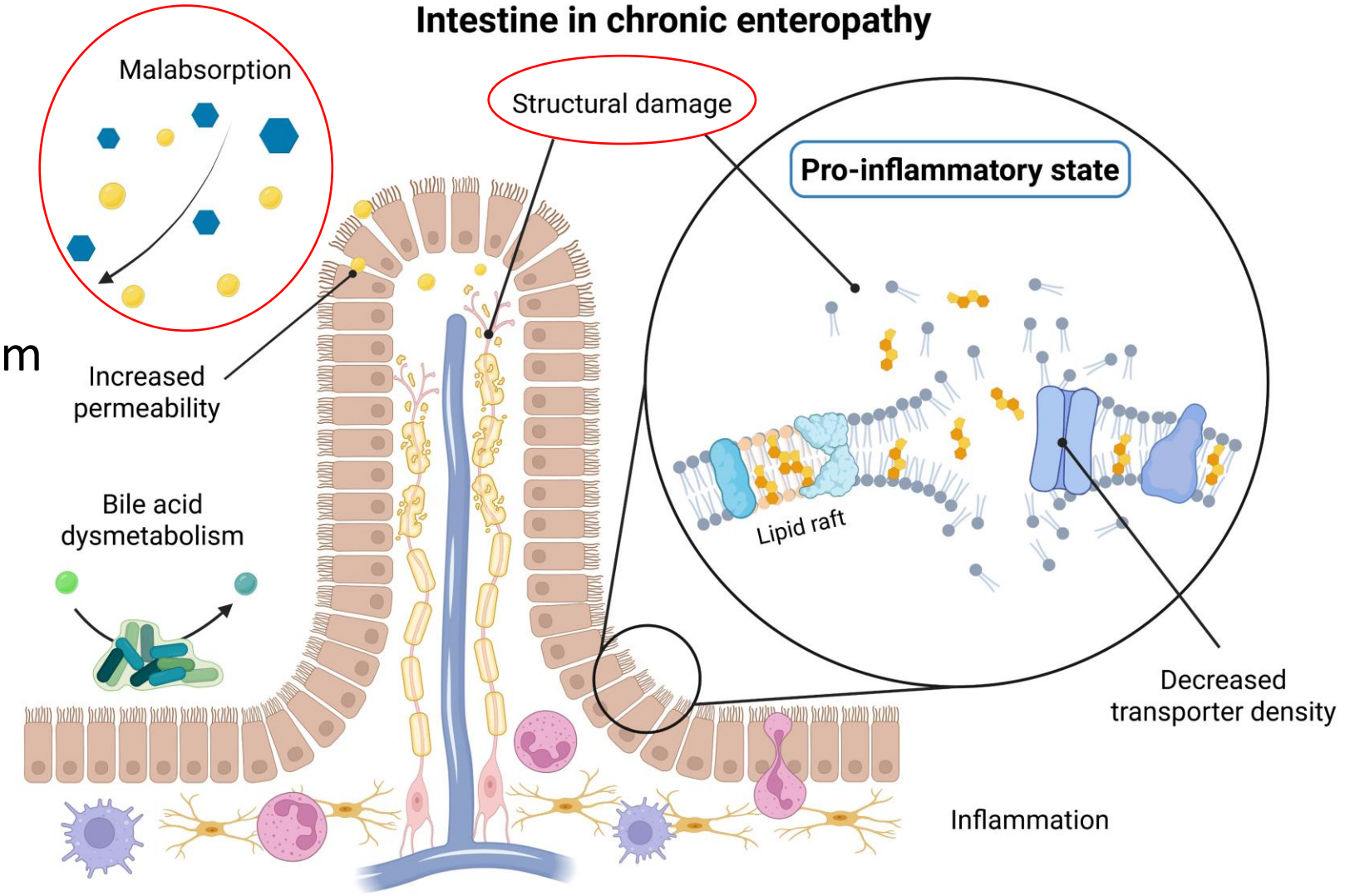


Suchodolski JS - Assessing and Managing the Gut Microbiome in Canine and Feline Practice.
In “Purina Institute - Canine and Feline Clinical Nutrition Handbook, 2023 edition”

Underlying pathophysiology of chronic enteropathy

A subset of animals has

- Dysbiosis
- Bile acid and lipid dysmetabolism
- Carbohydrate malabsorption
- Inflammation
- Mucosal damage



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Underlying pathophysiology of chronic enteropathy

A subset of animals has

- Dysbiosis
- Bile acid and lipid dysmetabolism
- Carbohydrate malabsorption
- Inflammation
- Mucosal damage

Differences in severity and duration between acute and chronic enteropathies

Acute – quick recovery

Chronic – only in subsets of animals and typically longer lasting or chronically persistent

Cell Reports Medicine Open access

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ARTICLE | ONLINE NOW, 101263

Characterizing the pre-clinical phase of inflammatory bowel disease

Marie Vibeke Vestergaard • Kristine H. Allin • Gry J. Poulsen • James C. Lee [5] • Tine Jess [5, 6] •

Show footnotes

Open Access • Published: November 07, 2023 • DOI: https://doi.org/10.1016/j.xcrm.2023.101263

Highlights

- Early diagnosis of IBD enables timely interventions and improved clinical outcomes
- A pre-clinical phase of IBD is well recognized but poorly understood
- Biological changes occur up to 8 years before CD diagnosis and 3 years before UC diagnosis
- The ability of these changes to predict future IBD is modest

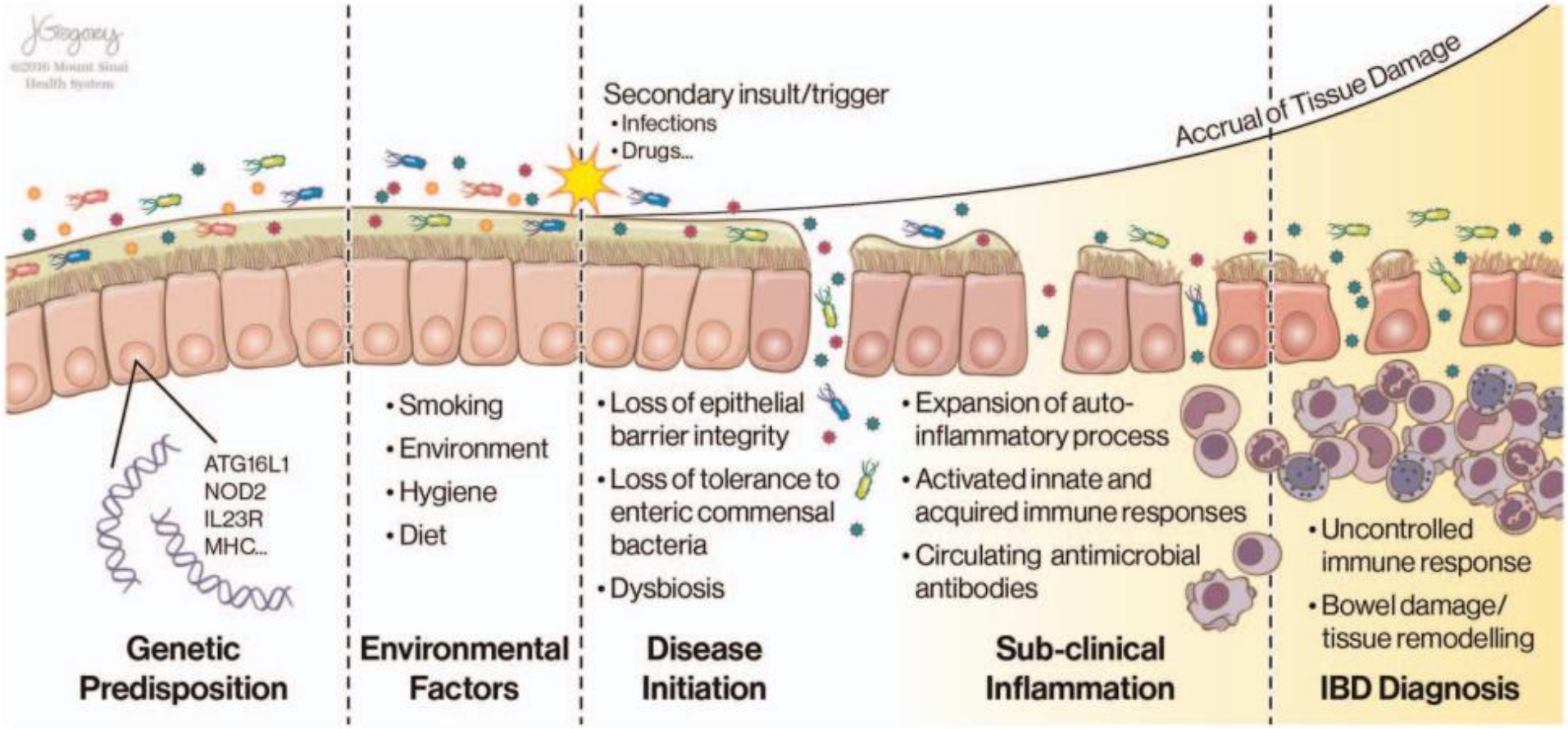
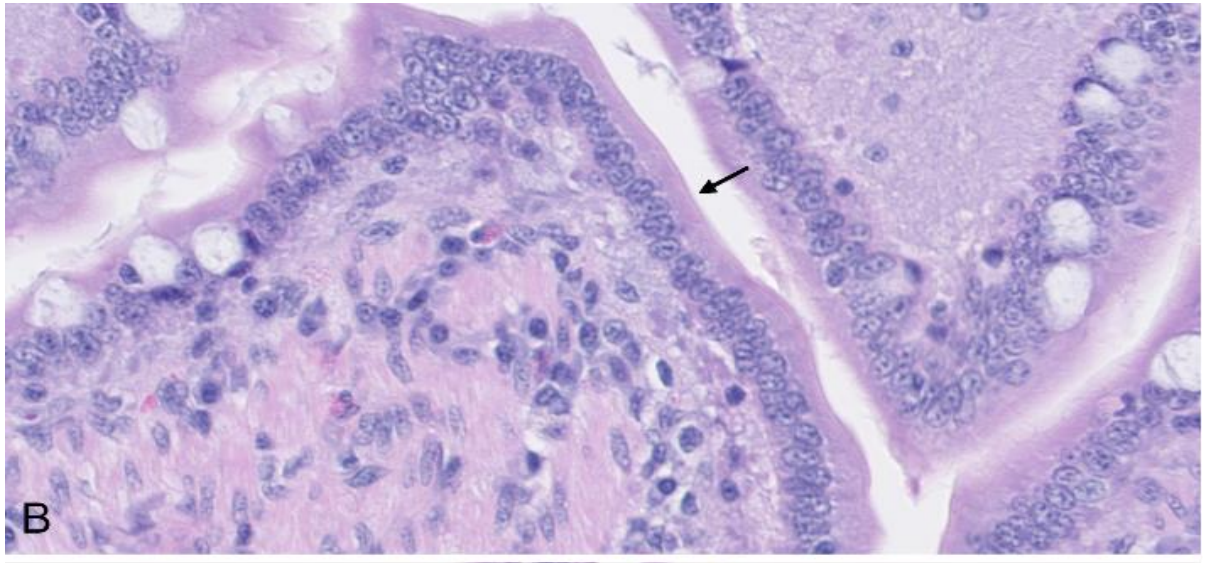


Figure 1 Proposed model of IBD pathogenesis and progression from preclinical to clinical disease.

Torres J, *et al*. *Gut* July 2016 Vol 65 No 7

Histology of normal small intestine

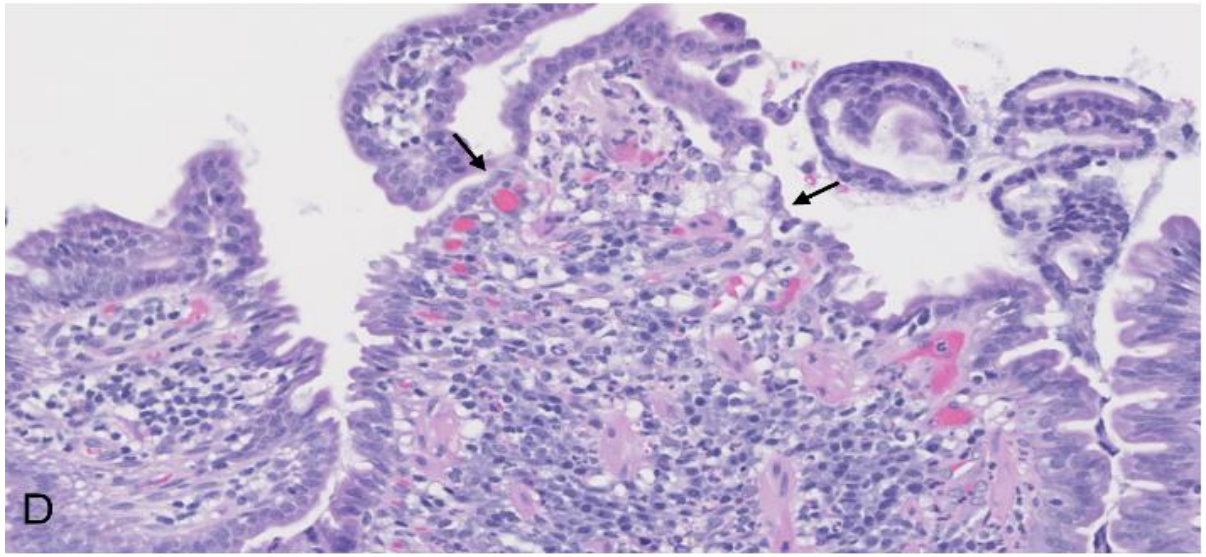
Dr. Paula Giaretta, DVM, PhD, DACVP



Normal villus is lined by tall columnar epithelial cells with a prominent brush border (arrow)

Histology of normal small intestine

Dr. Paula Giaretta, DVM, PhD, DACVP



Epithelial cells in CE are attenuated and cuboidal with indistinct brush border (arrow)

CE showing villous blunting and fusion
Lamina propria contains numerous neutrophils, plasma cells, and eosinophils

Fecal lipid markers

Arachidonic acid:

- Pro-inflammatory properties (precursor of prostaglandin)
- Released during enterocyte shedding (component of cell membranes)

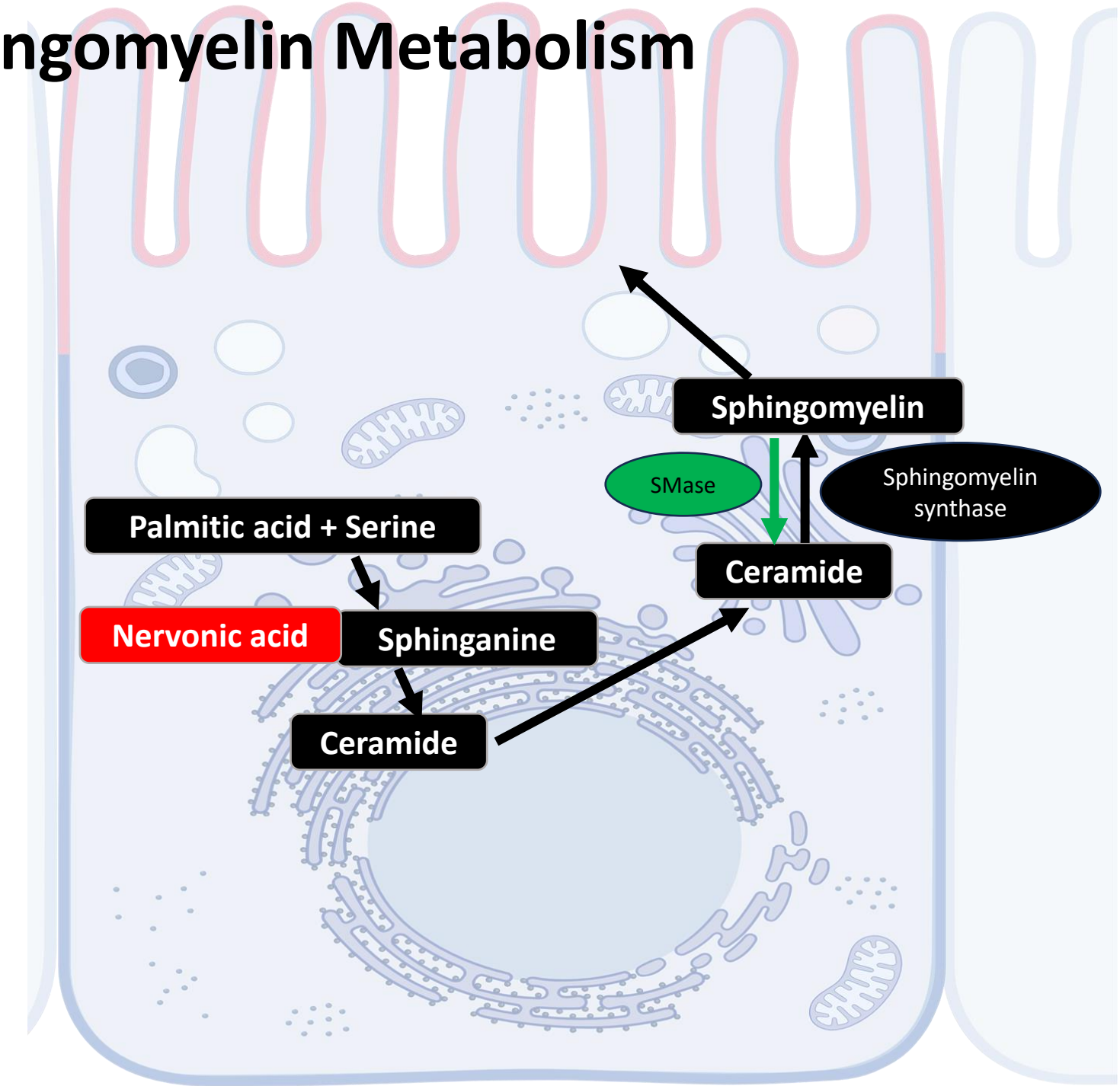
Cholesterol:

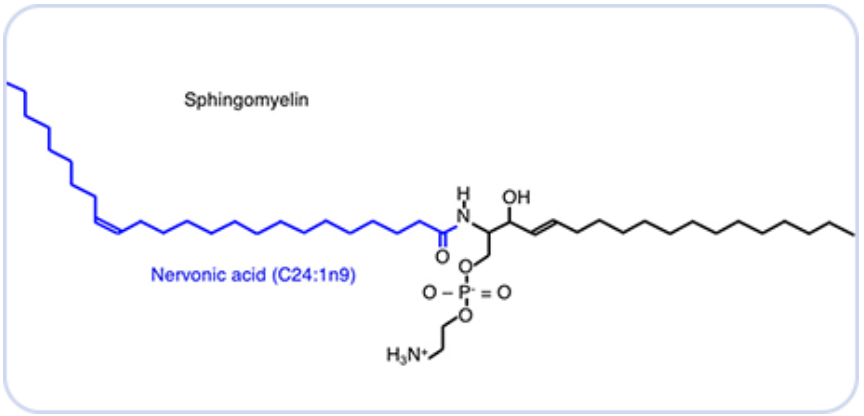
- Released during enterocyte shedding (main component of cell membranes)

Nervonic acid:

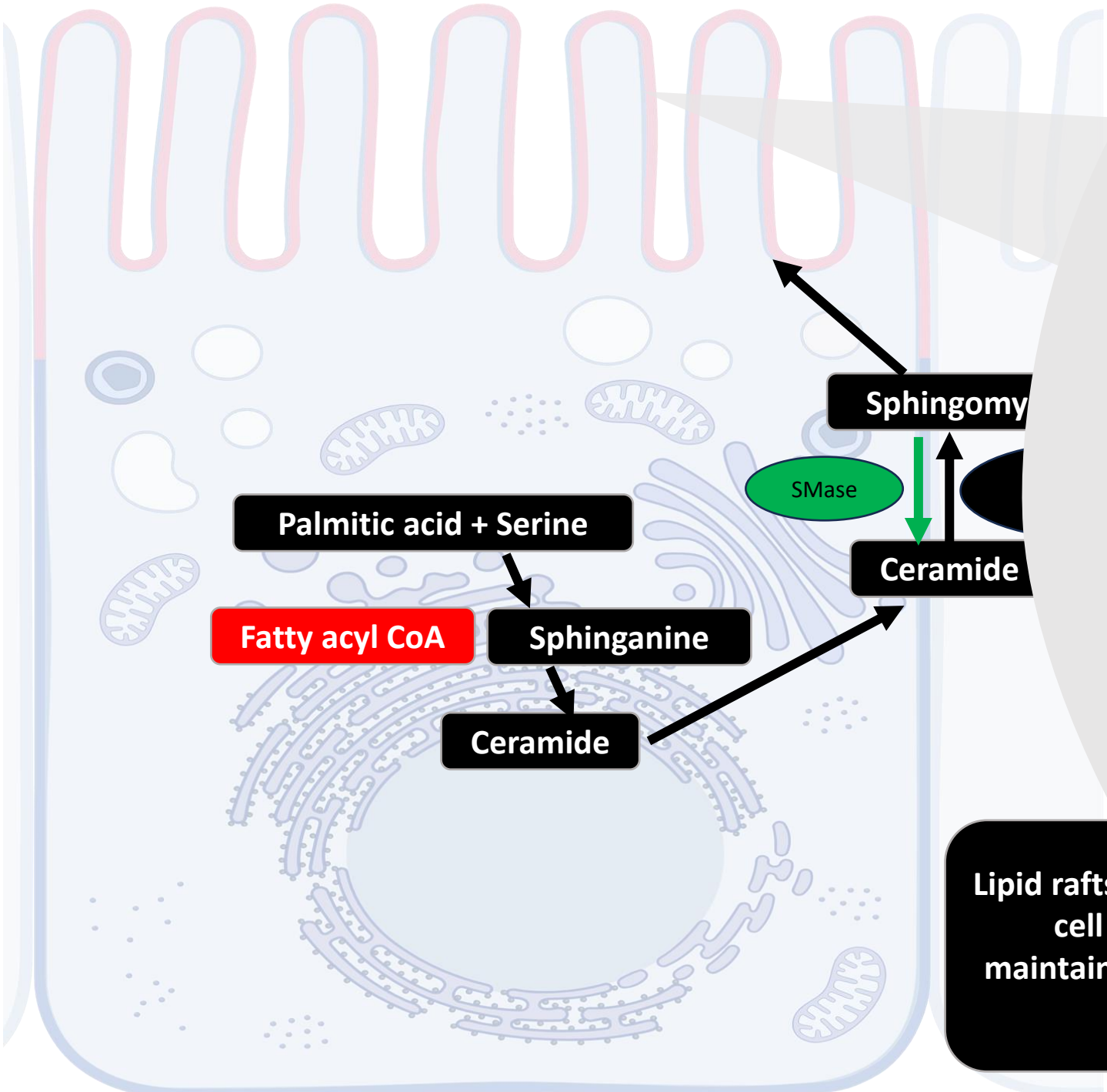
- Released during enterocyte shedding (component of lipid rafts in cell membranes)
- Abundant in myelin sheaths of peripheral nerve fibers (deep mucosal damage)

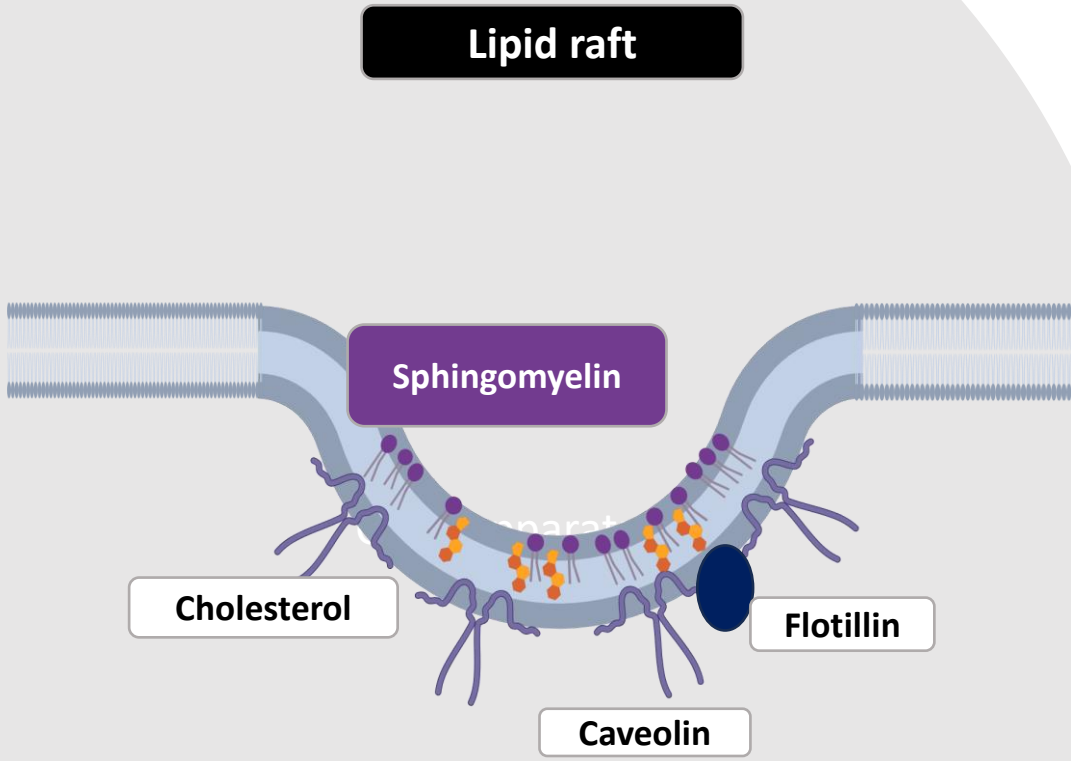
Sphingomyelin Metabolism





SMase: Sphingomyelinase





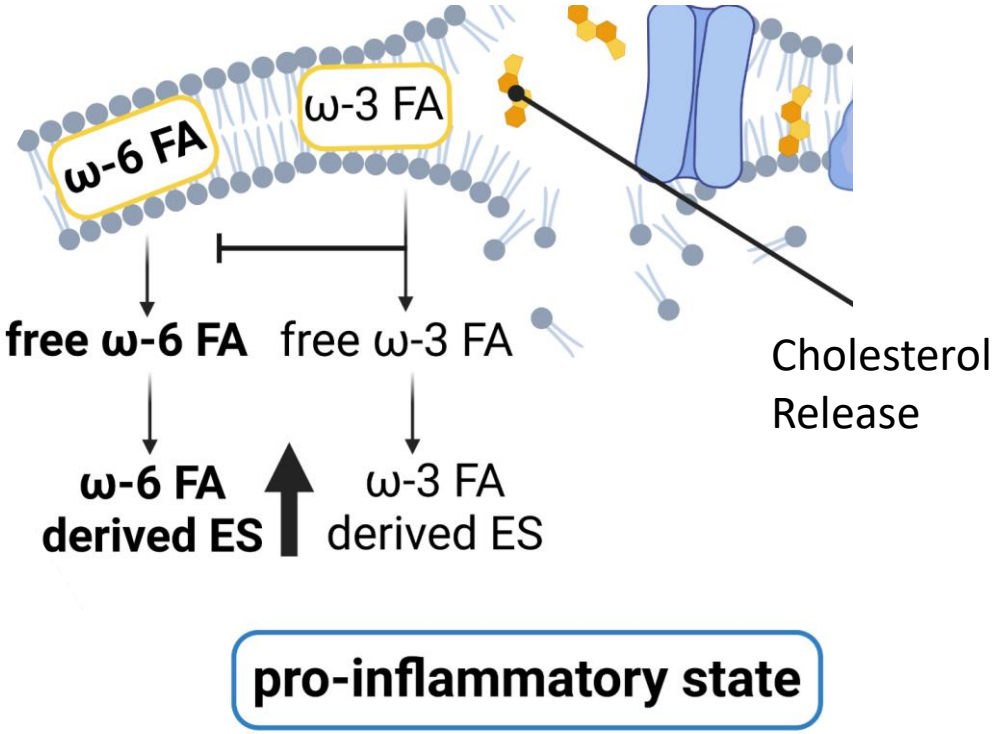
Lipid rafts are cholesterol- and sphingolipid-rich microdomains in cell membranes that organize signaling molecules and maintaining the integrity of the intestinal barrier and lymphatic function.

Long-chain fatty acids (LCFA) and sterols

Previous studies have shown some fecal LCFA and sterols to be potential GI biomarkers

Increased fecal arachidonic acid, nervonic acid, and cholesterol

- Dogs with CIE, PLE, AHDS
- Cats with CE
- Horses with Infectious colitis
- Humans with IBD



Increased risk for developing CE in dogs

Research | Open access | Published: 11 March 2022

Parvovirus enteritis and other risk factors associated with persistent gastrointestinal signs in dogs later in life: a retrospective cohort study

Kanae Sato-Takada, Anne M. Flemming, Maarten J. Voordouw & Anthony P. Carr

BMC Veterinary Research **18**, Article number: 96 (2022) | Cite this article

4372 Accesses | **6** Citations | **2** Altmetric | Metrics

Parvovirus vs control: 57% vs 25%

RESEARCH ARTICLE

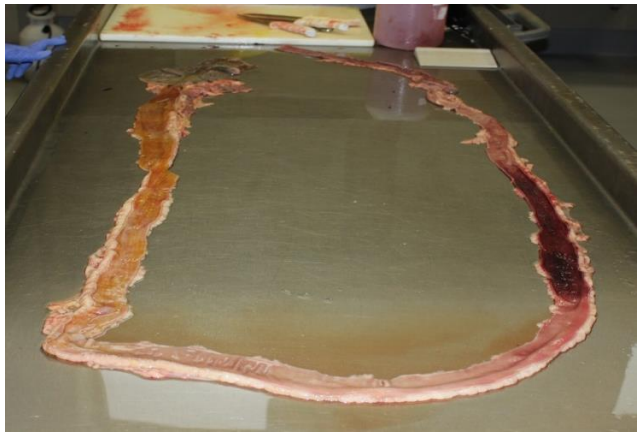
Long-term effects of canine parvovirus infection in dogs

Elena Kilian[1]*, Jan S. Suchodolski[2], Katrin Hartmann[1], Ralf S. Mueller[1], Gerhard Wess[1], Stefan Unterer[1]

1 Clinic of Small Animal Medicine, Centre for Clinical Veterinary Medicine, LMU Munich, Munich, Germany, **2** Gastrointestinal Laboratory, Department of Small Animal Clinical Sciences, Texas A&M University, College Station, Texas, United States of America

* elena.kilian@gmx.de

Parvovirus vs control: 42% vs 12%



ACVIM JOURNAL OF VETERINARY INTERNAL MEDICINE Open Access

STANDARD ARTICLE | Open Access

Frequency of signs of chronic gastrointestinal disease in dogs after an episode of acute hemorrhagic diarrhea

Elisabeth Skotnitzki, Jan S. Suchodolski, Kathrin Busch, Melanie Werner, Yury Zablotski, Bianca D. Ballhausen, Felix Neuerer, Stefan Unterer

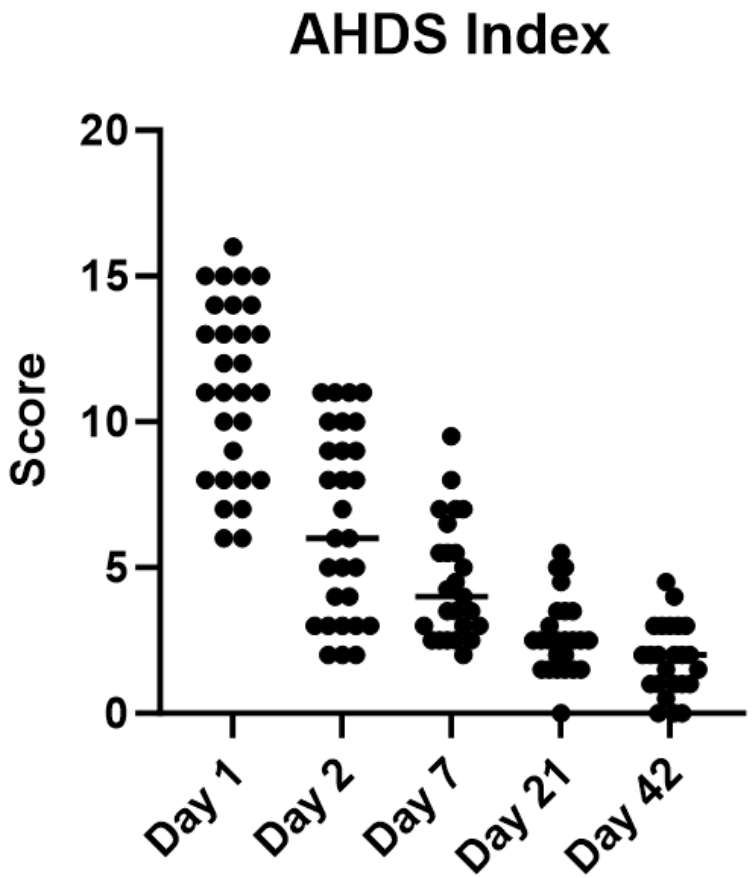
First published: 10 December 2021 | https://doi.org/10.1111/jvim.16312 | Citations: 3

AHDS vs control: 28% vs 13%

Comparative Study > J Am Vet Med Assoc. 2024 Aug 2;262(12):1657-1665.
doi: 10.2460/javma.24.03.0153. Print 2024 Dec 1.

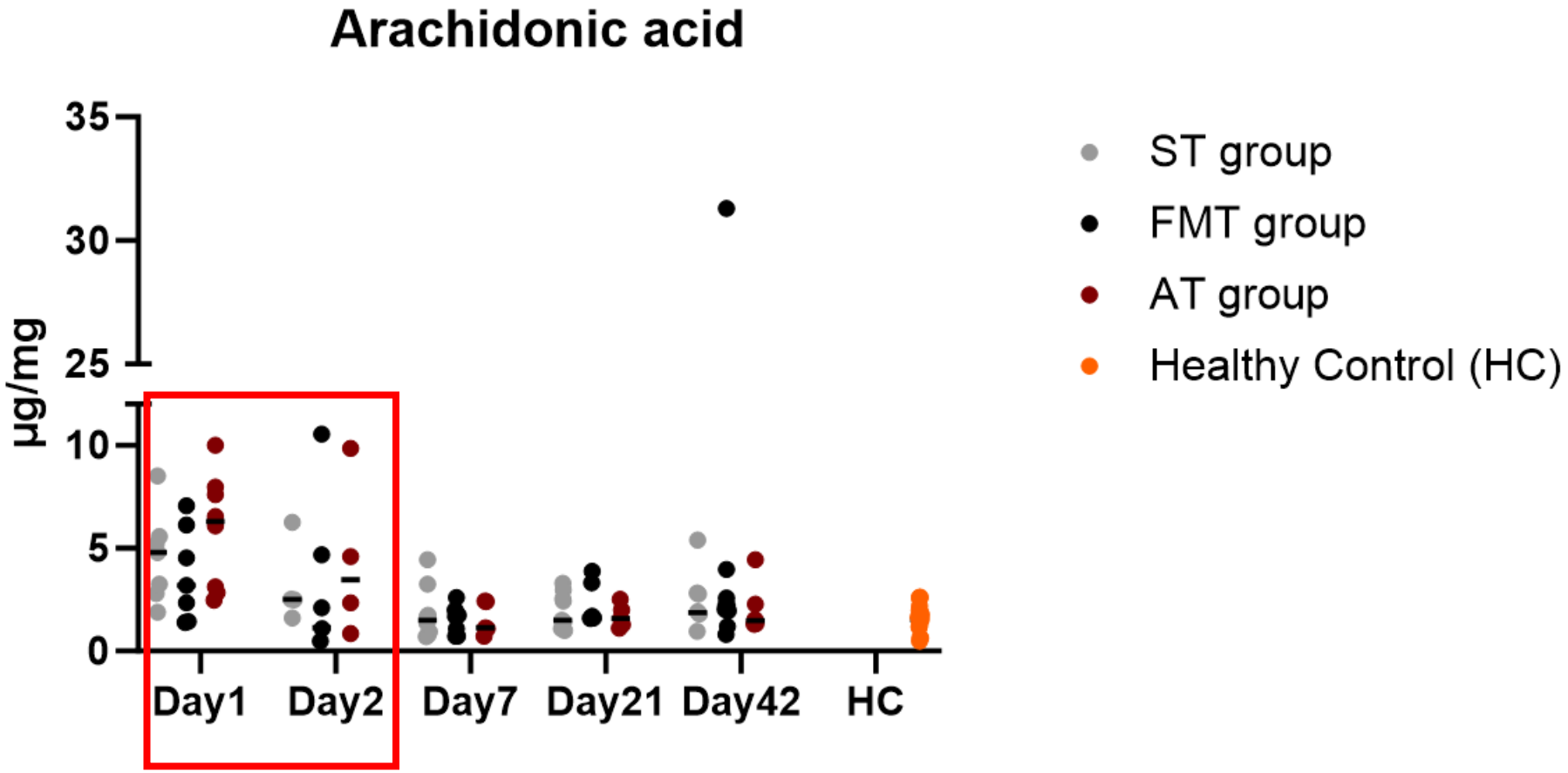
Comparing treatment effects on dogs with acute hemorrhagic diarrhea syndrome: fecal microbiota transplantation, symptomatic therapy, or antibiotic treatment

Andrea Reisinger [1], Helene Stübing [1], Jan S Suchodolski [2], Rachel Pilla [2], Stefan Unterer [3], Kathrin Busch [1]



Busch K et al, ECVIM 2024

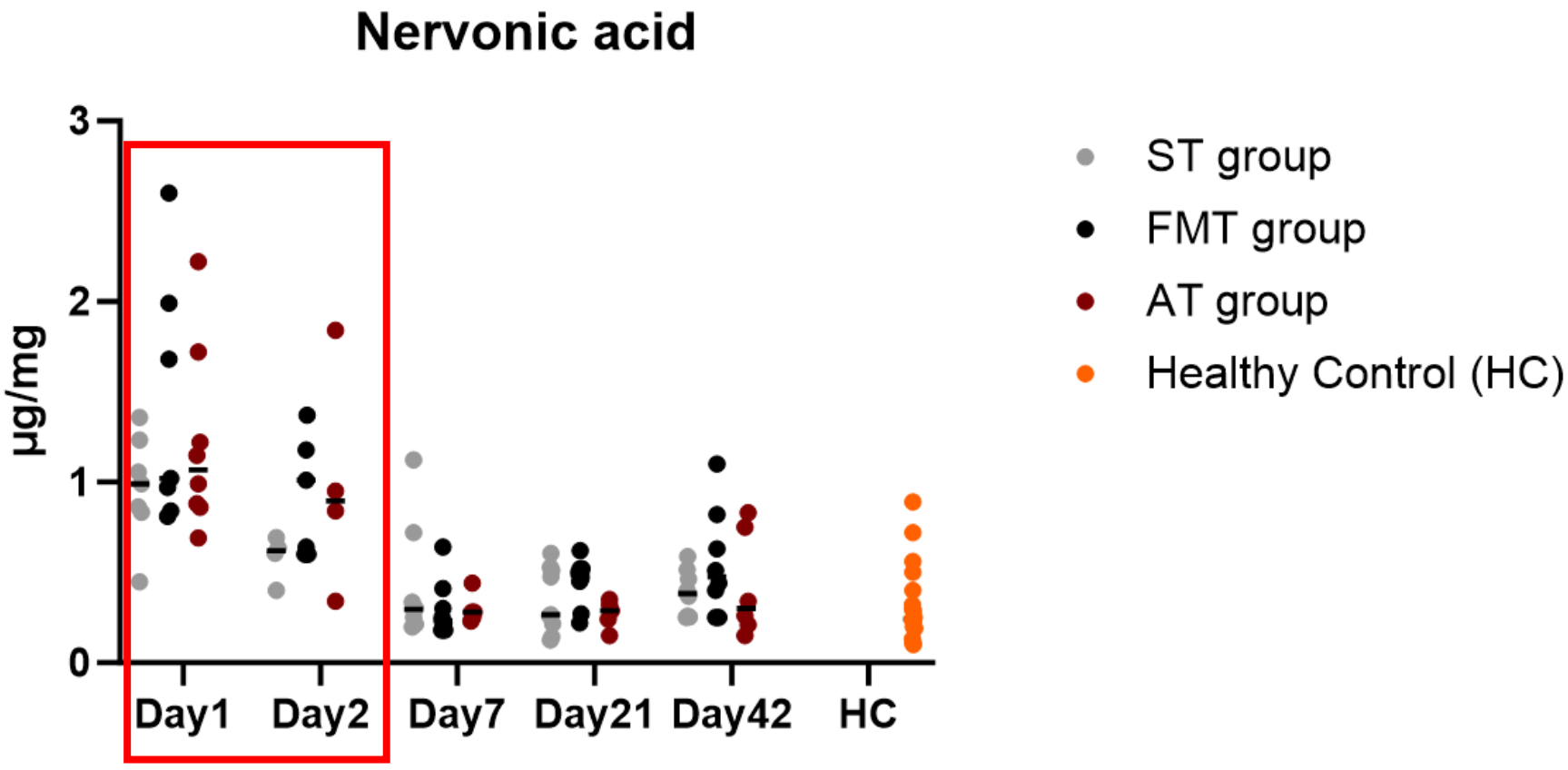
AHDS – rapid recovery



ST: Symptomatic Treatment , FMT: Fecal Microbiota Transplant, AT: Antibiotic Treatment

HC: Healthy Control

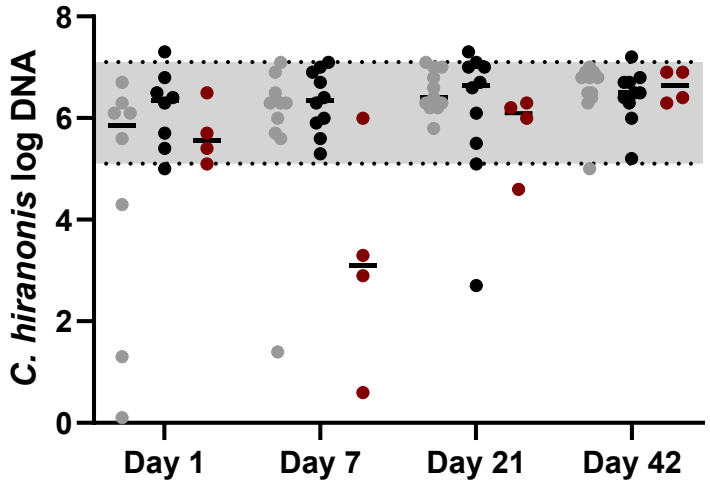
AHDS – rapid recovery



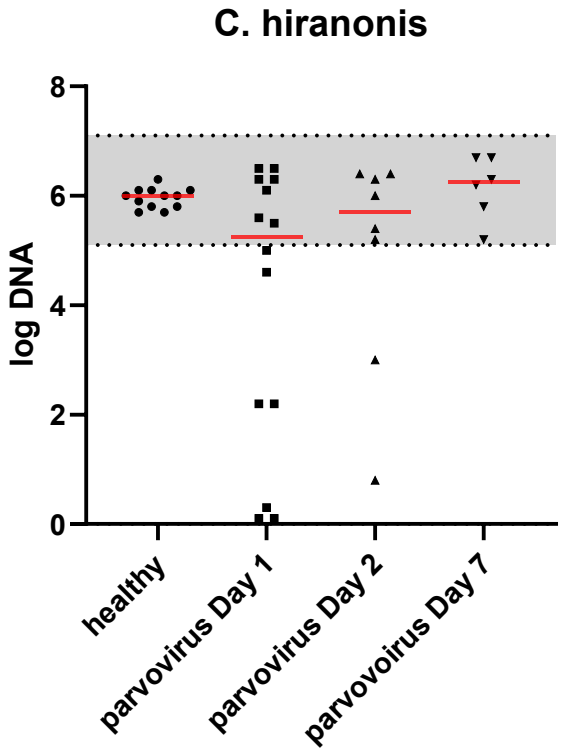
ST: Symptomatic Treatment , FMT: Fecal Microbiota Transplant, AT: Antibiotic Treatment

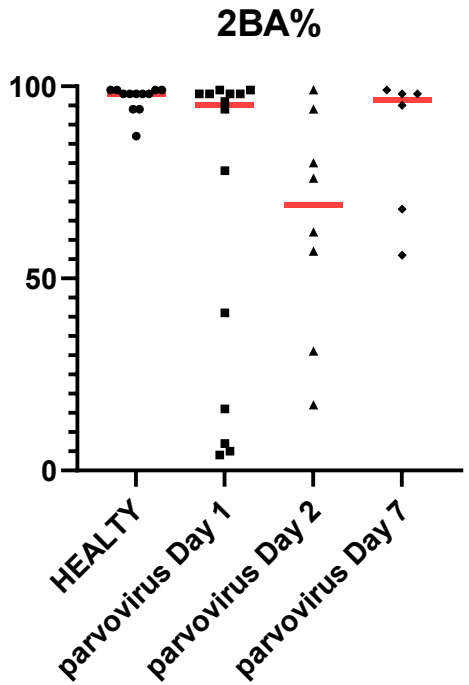
HC: Healthy Control

AHDS and Parvovirosis – despite severe acute intestinal injury, bile acid converting P. hiranonis remains or recovers rapidly



- symptomatic treatment
- FMT group
- antibiotic group

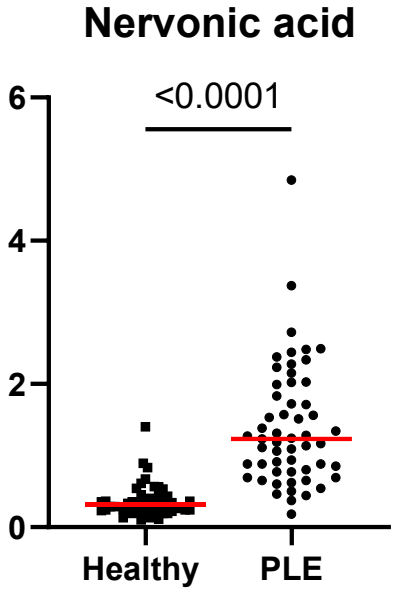




Chronic enteropathies:

- **Subset of dogs has chronically increased LCFA**

Protein losing enteropathy (PLE)

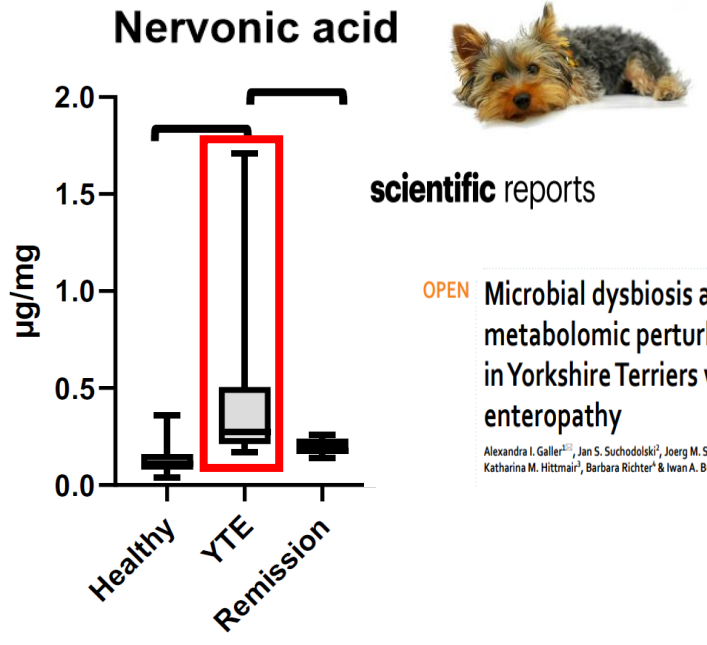


Front. Microbiol., 10 October 2024
Sec. Systems Microbiology
Volume 15 - 2024 | https://doi.org/10.3389/fmicb.2024.1433175

Dysbiosis index and fecal concentrations sterols, long-chain fatty acids and unconjugated bile acids in dogs with inflammatory protein-losing enteropathy

Federica Cagnasso [1*] Jan S. Suchodolski [2] Antonio Borrelli

Yorkshire Terrier Enteropathy (YTE)



scientific reports

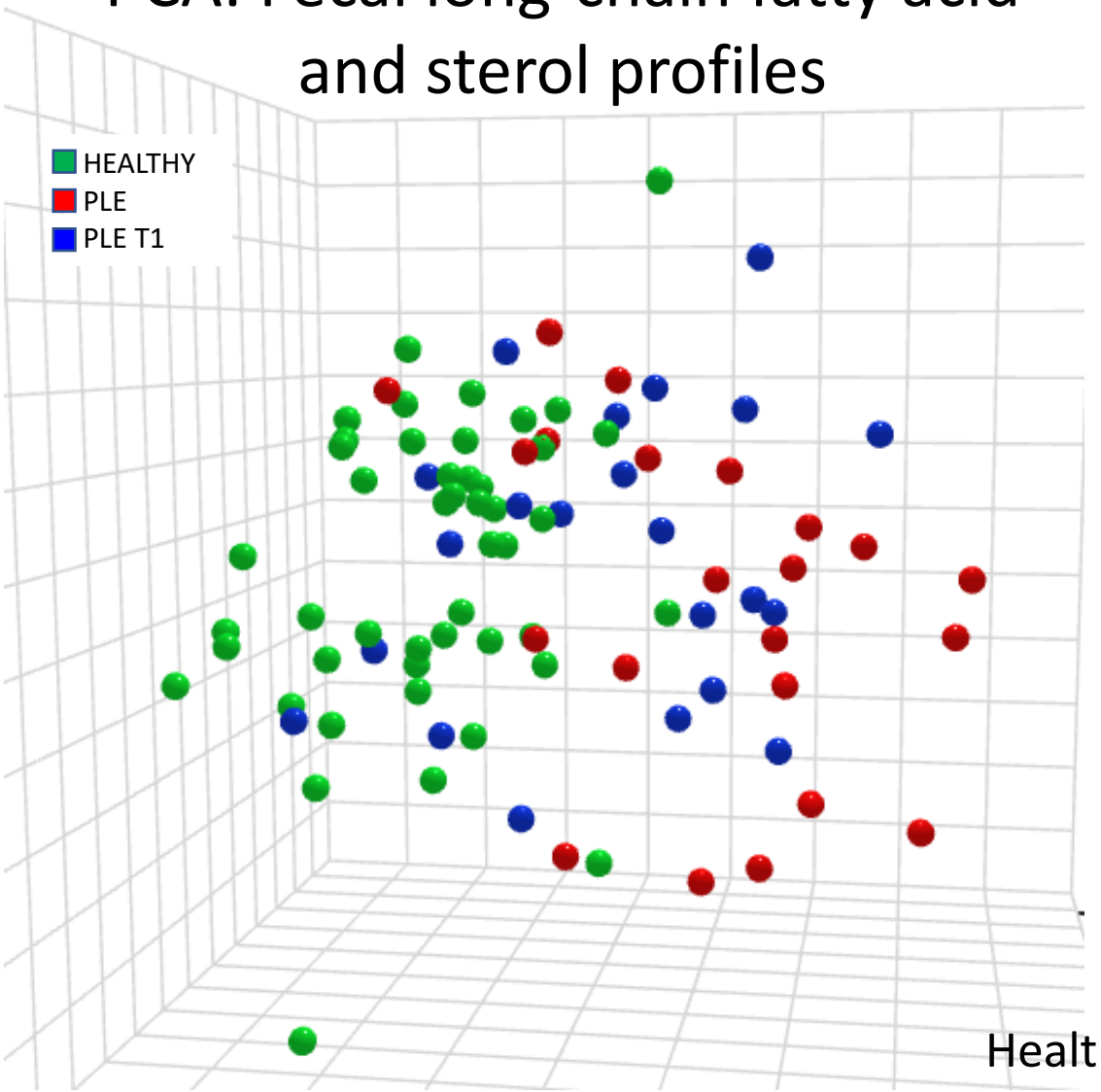
OPEN Microbial dysbiosis and fecal metabolomic perturbations in Yorkshire Terriers with chronic enteropathy

Alexandra I. Galler[1*], Jan S. Suchodolski[2], Joerg M. Steiner[2], Chi-Hsuan Sung[2], Katharina M. Hittmair[3], Barbara Richter[4] & Iwan A. Burgener[1]

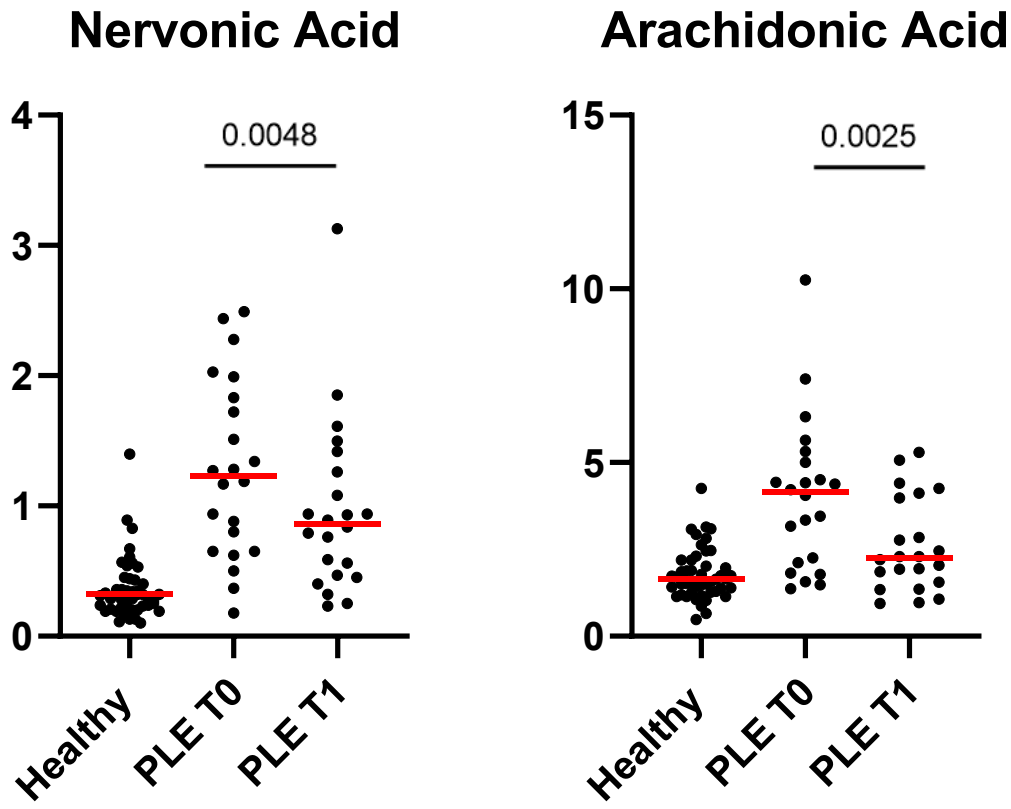
Protein losing enteropathy (PLE)

Short term follow-up – 1 month

PCA: Fecal long-chain fatty acid and sterol profiles



Long-chain fatty acids



Healthy: healthy control; PLE T0: baseline; PLE T1: 1 month follow-up

Journal of Veterinary Internal Medicine

STANDARD ARTICLE | Open Access

Pre-clinical enteropathy in healthy soft-coated wheaten terriers

Correction(s) for this article

M. Katherine Tolbert, Jewels Darrow, Louise Grubb, Stuart Fitzgerald, Rebecca Bergee, Josh Price, Marcos Mariano, Michael Hong, Chi-Hsuan Sung, Tracy Hill, Joerg M. Steiner, Jan S. Suchodolski

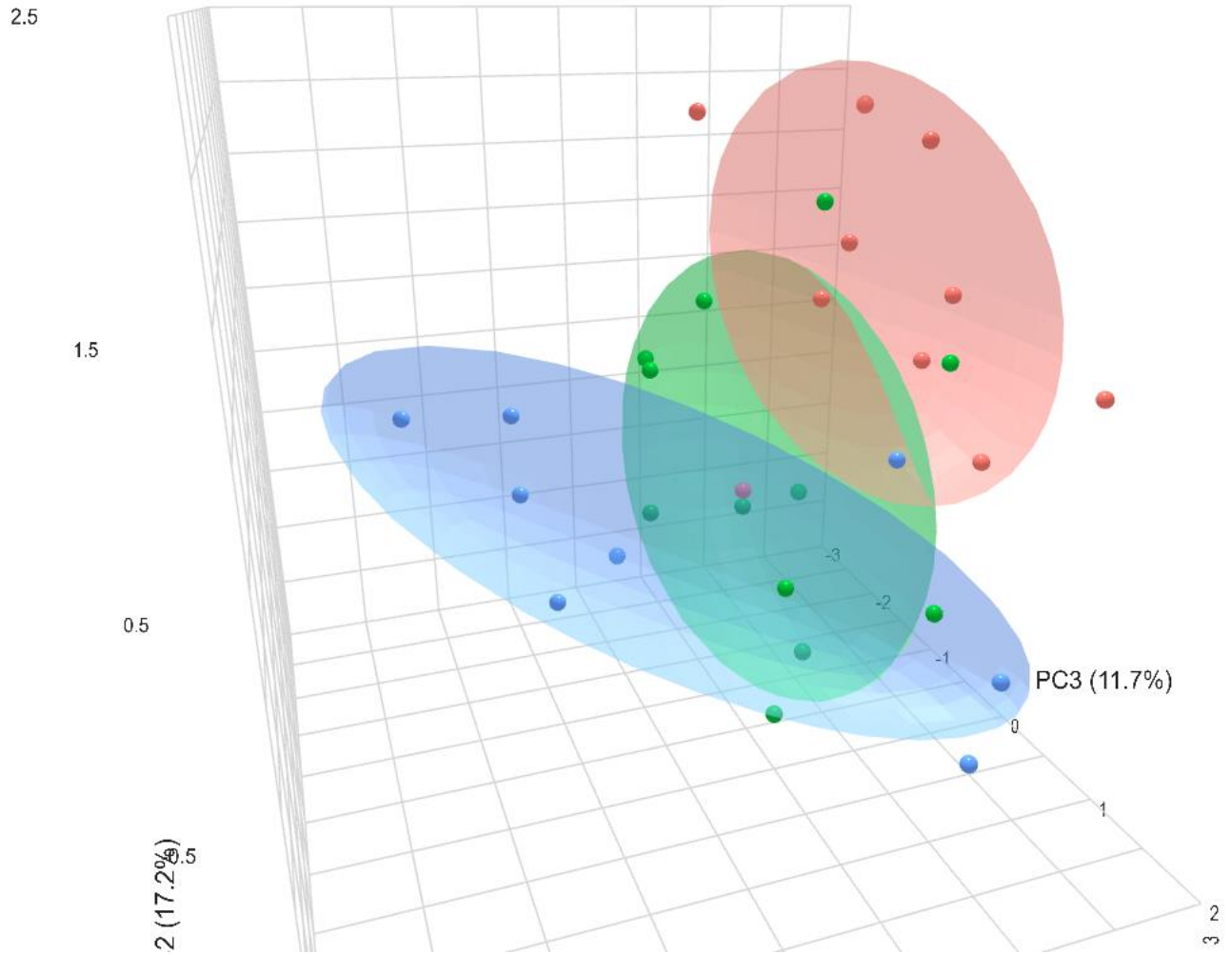
First published: 19 February 2025 | https://doi.org/10.1111/jvim.17293 | VIEW METRICS

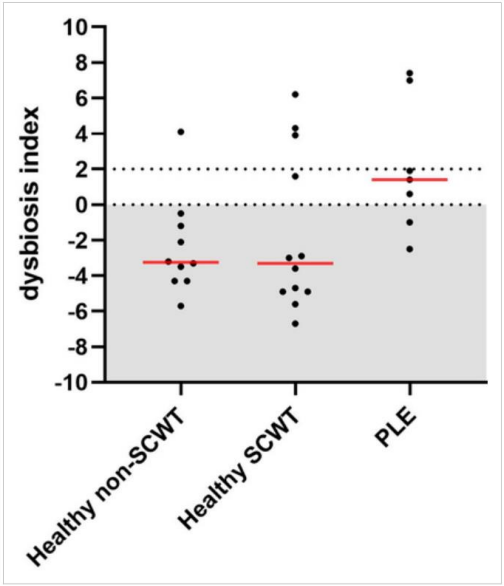
Soft-coated wheaten terriers (SCWTs):

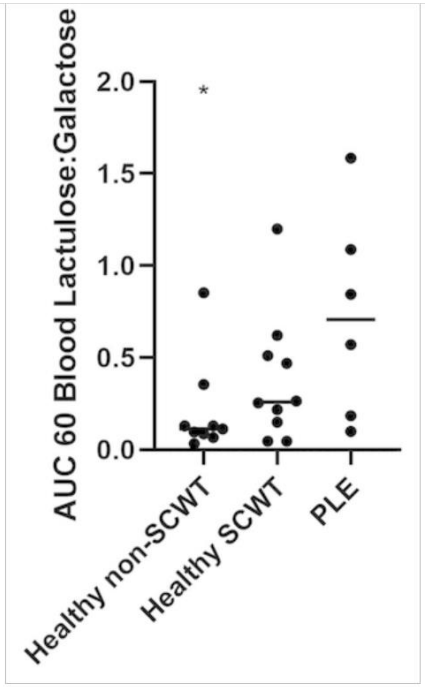
- Predisposed to develop PLE

Protein losing enteropathy (PLE)

PCA: Fecal long-chain fatty acid and sterol profiles







Blue: healthy control group (non-SCWTs); Green: healthy SCWTs; Red: PLE dogs

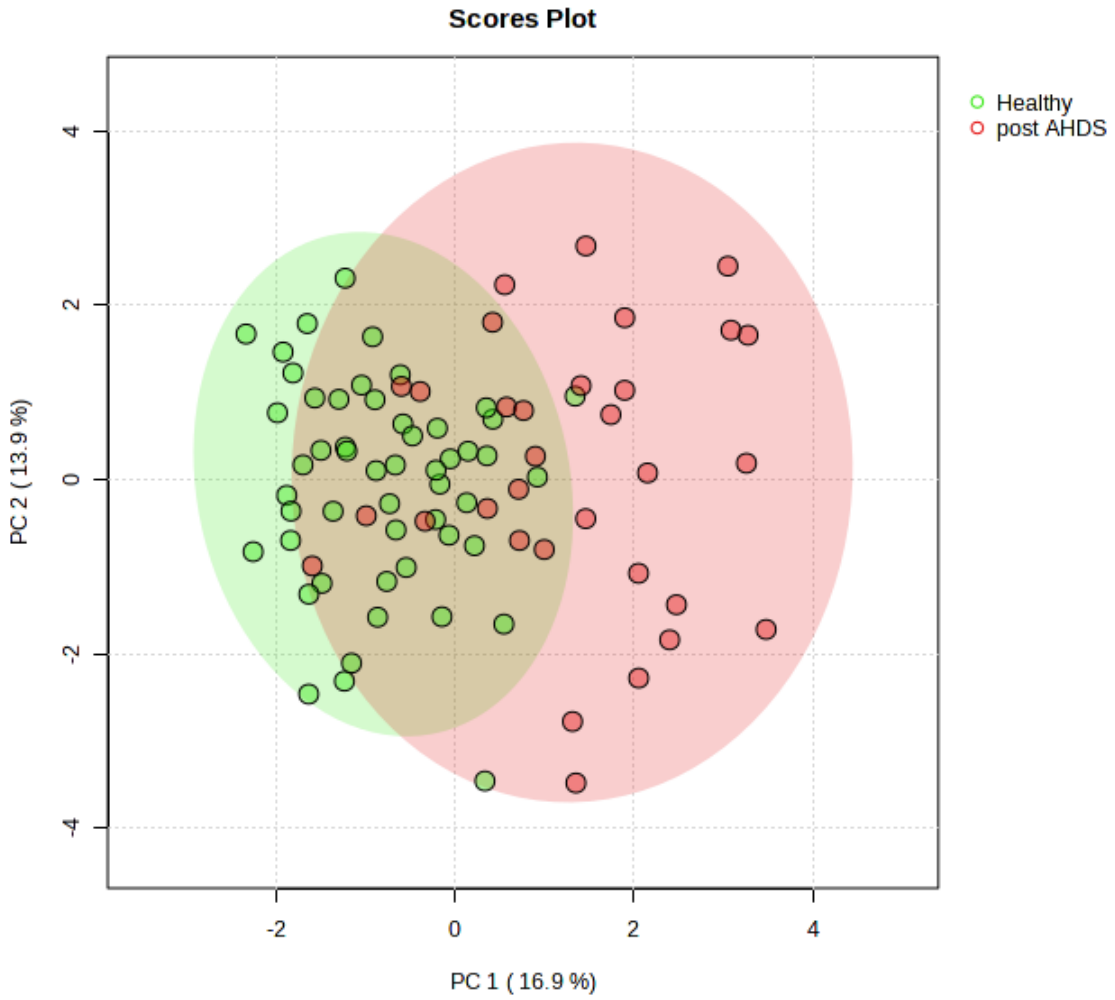
Influence of a past acute hemorrhagic diarrhea syndrome (AHDS) in domestic dogs on gastrointestinal health and fecal long chain fatty acids and sterols

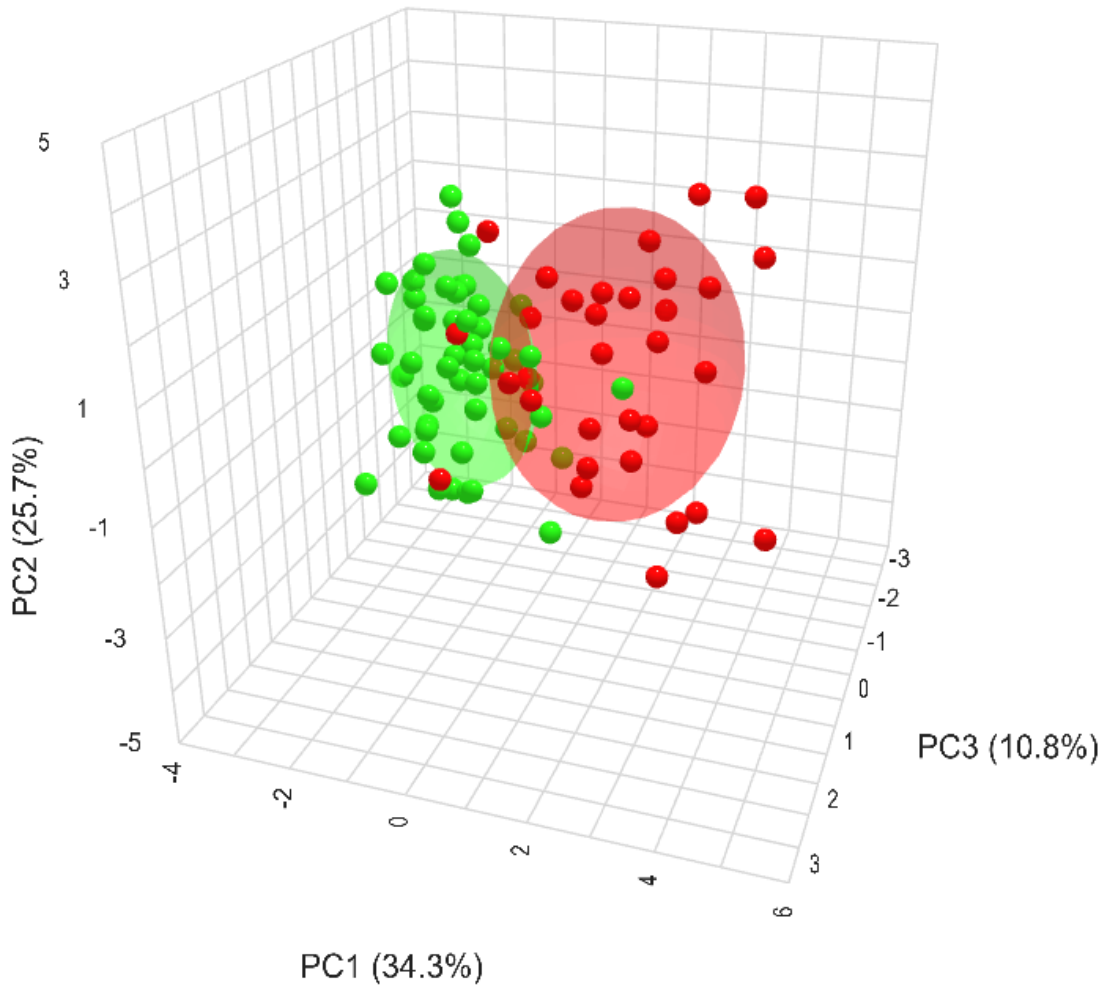
Lilly Baum, Teresa Schmidt, Jan Suchodolski, Kathrin Busch

Kleintierklinik der LMU München

Results – Metabolites (LCFAs, Sterols)

Kleintierklinik der LMU München





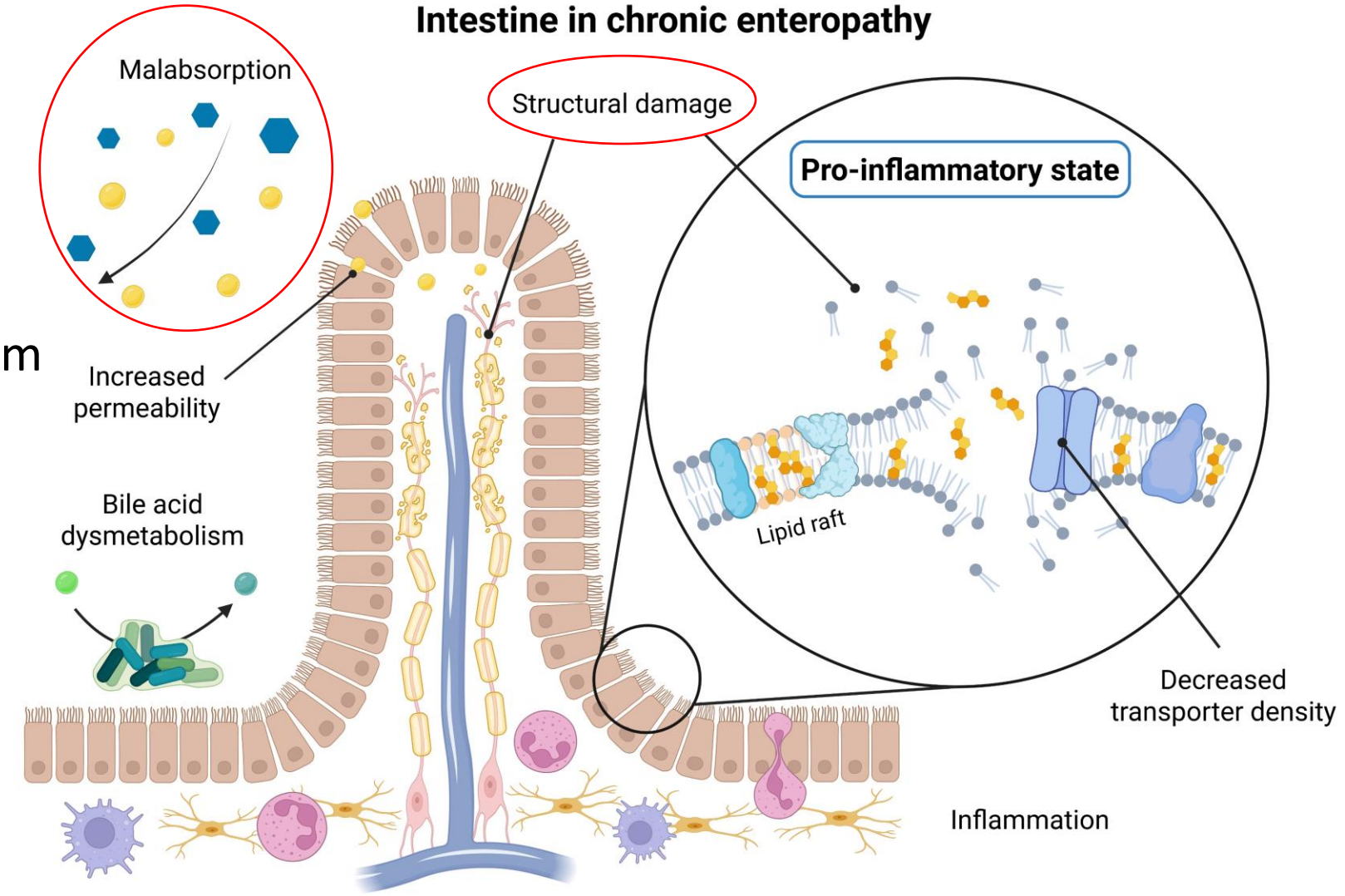
Clear clustering between groups: median 3 years after AHDS episode

Healthy dogs
Post AHDS dogs

Underlying pathophysiology of chronic enteropathy

A subset of animals has

- Dysbiosis
- Bile acid and lipid dysmetabolism
- Carbohydrate malabsorption
- Inflammation
- Mucosal damage



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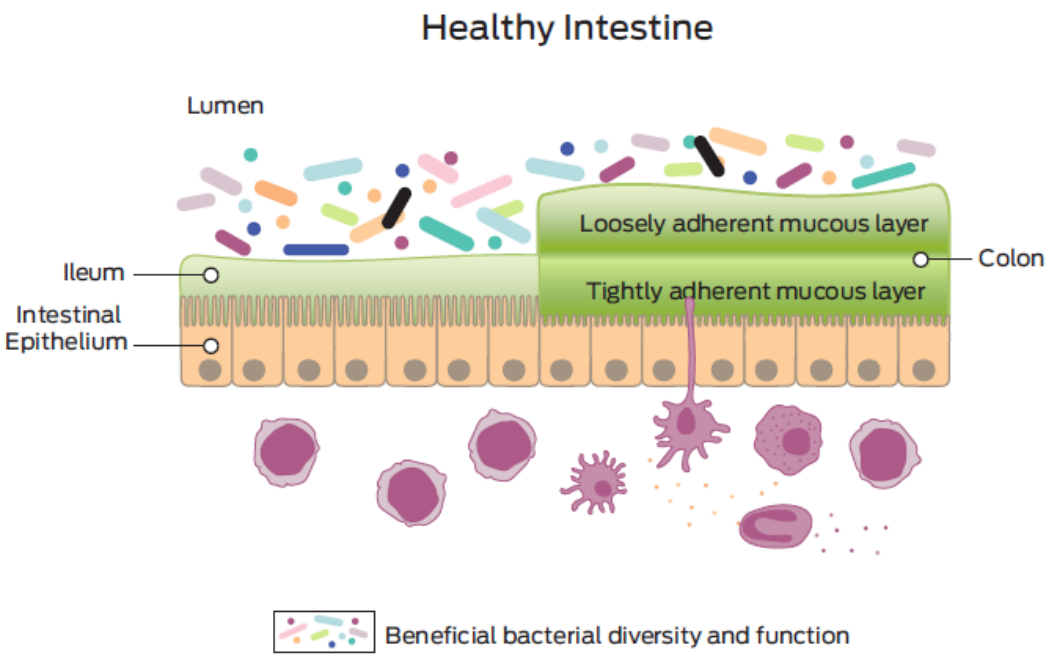
HEALTHY INTESTINE



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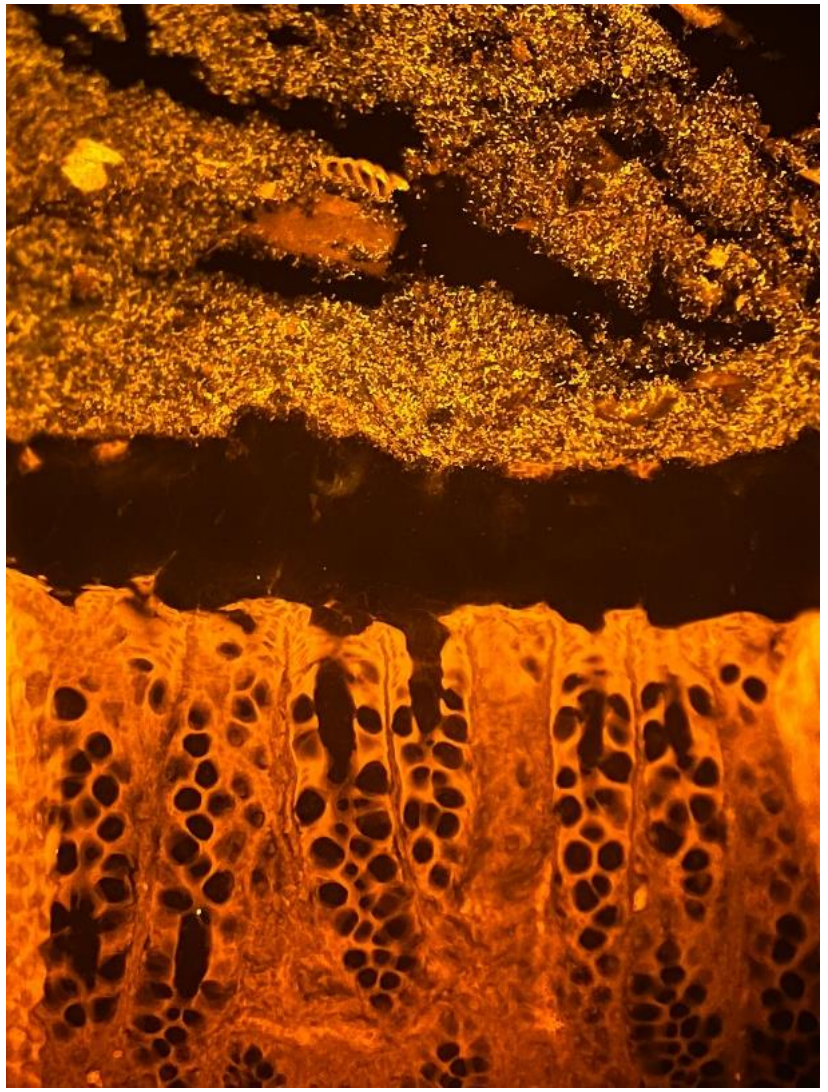
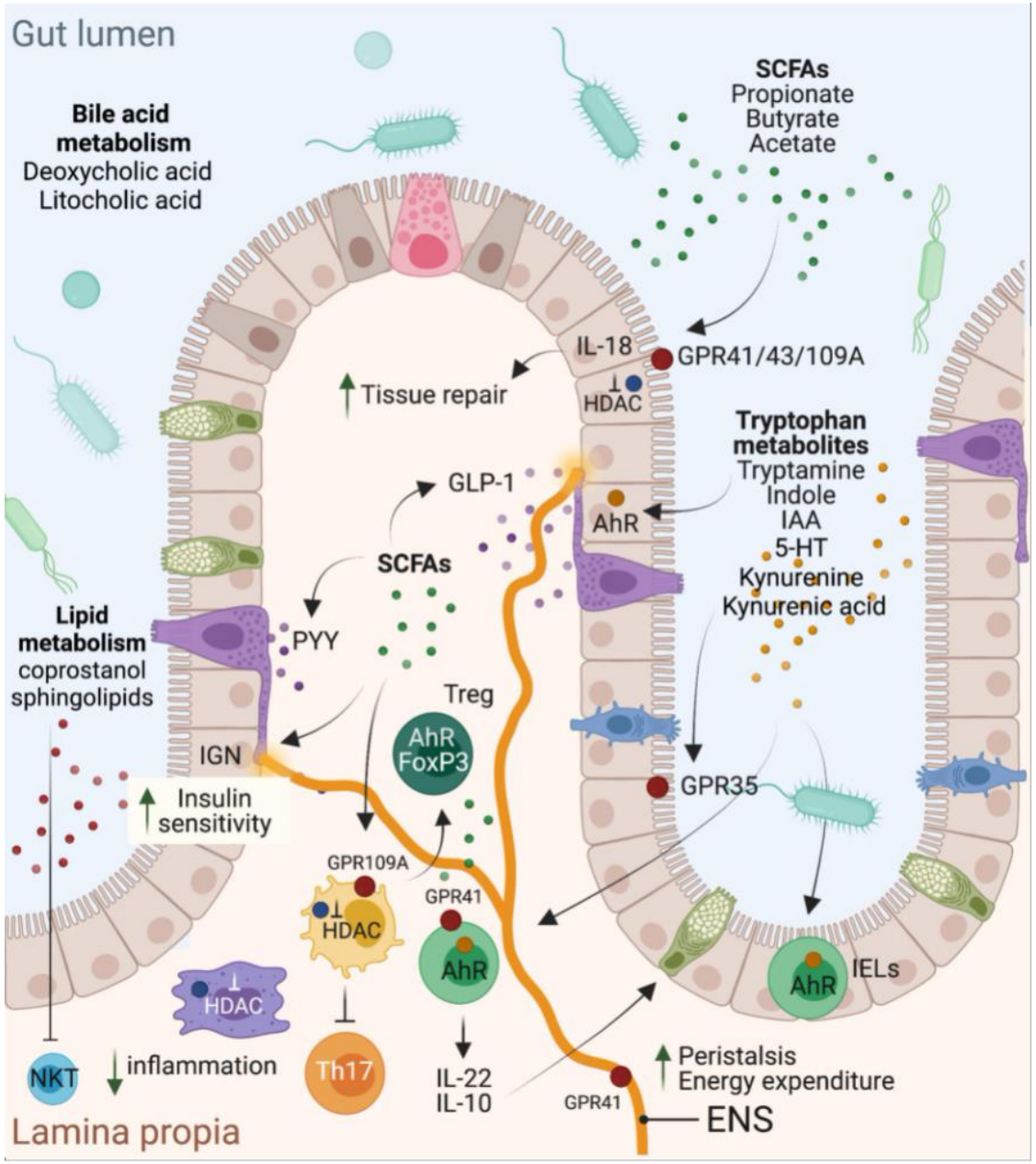


Live bacteria (what we see as feces)

Mucus layer

Epithelium

Courtesy: Dr. Chi-Hsuan Sung, GI LAB, TAMU



Next Generation Microbiome Research: Identification of Keystone Species in the Metabolic Regulation of Host-Gut Microbiota Interplay

Héloïse Tudela[1,2], Sandrine P. Claus[1*] and Maya Saleh[2,3*]

Short-chain fatty acids (SCFA)

- produced from dietary fiber
- signal through G-receptors
  - IL-18 production which is required for intestinal epithelial integrity
  - anti-inflammatory

Important bacterial keystone species: **Faecalibacterium**

Pharmacological Research
Volume 104, February 2016, Pages 9-21

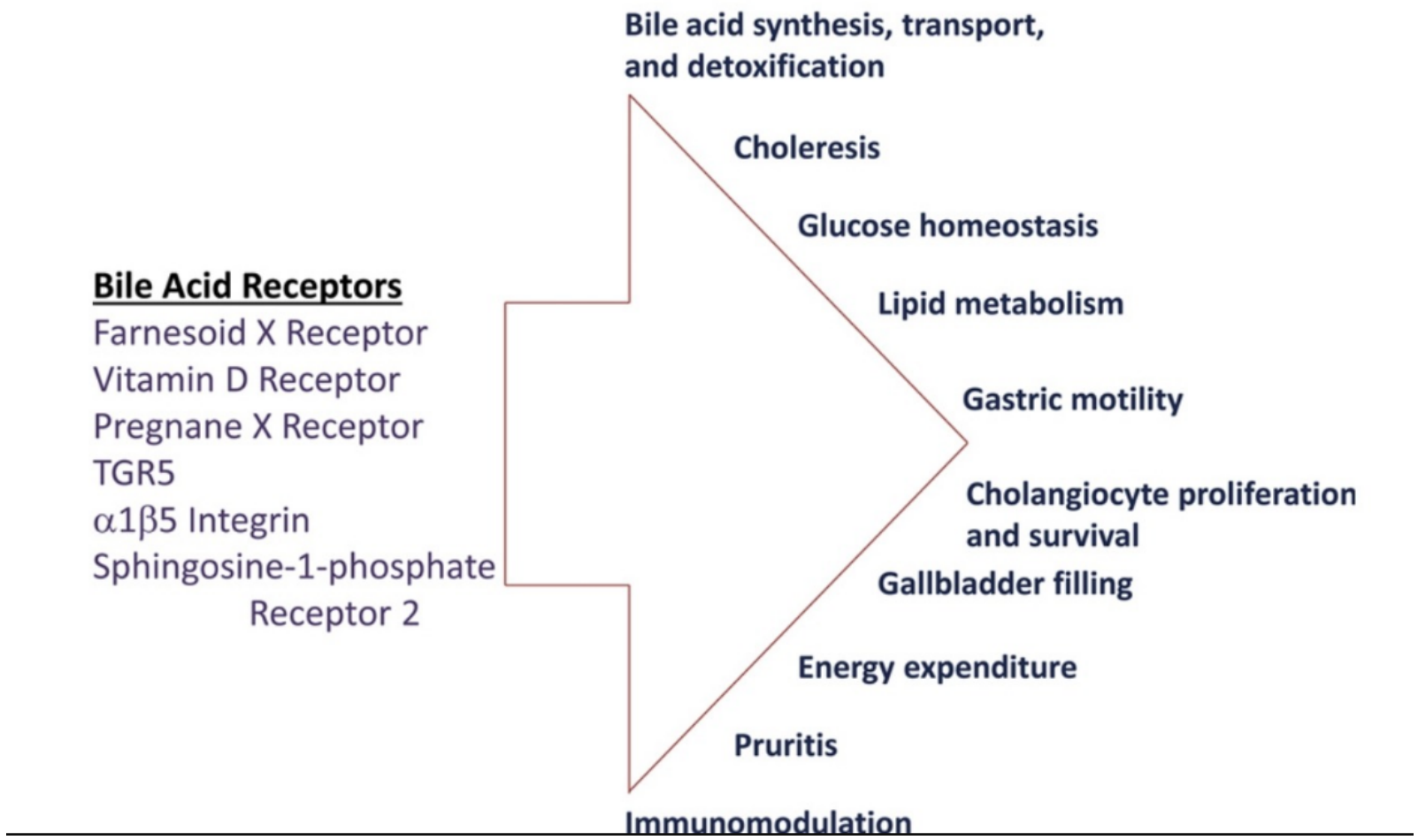
Invited review

Pharmacology of bile acid receptors: Evolution of bile acids from simple detergents to complex signaling molecules

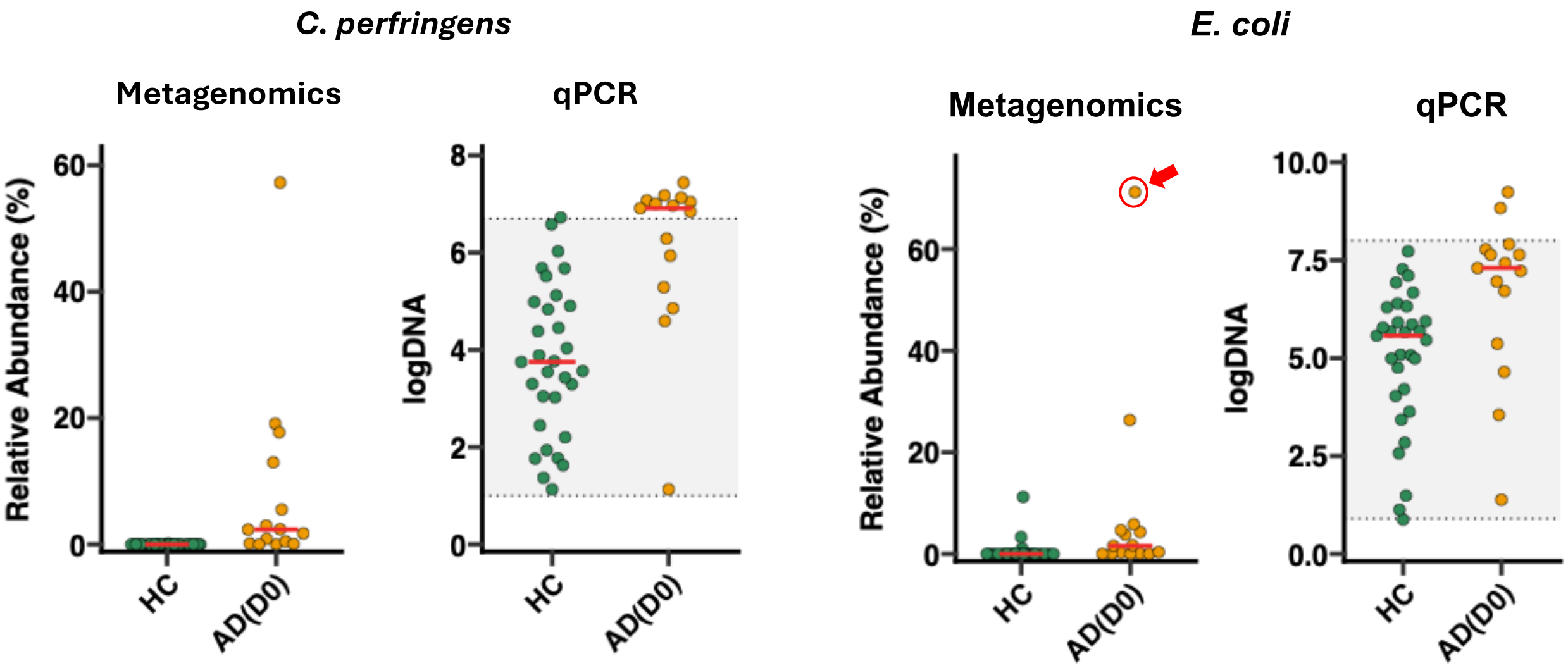
Bryan L. Copple[a,*], Tiangang Li[b]

- primary bile acids from liver are converted to secondary bile acids by microbiota

- ***Peptoacetobacter (Clostridium) hiranonis*** is main bile acid converter in dogs and cats

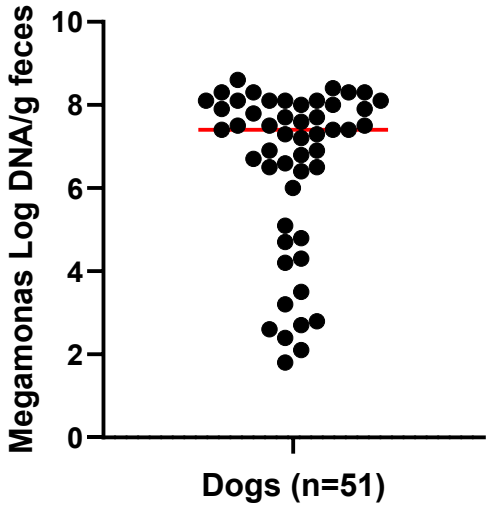


Sequencing vs qPCR

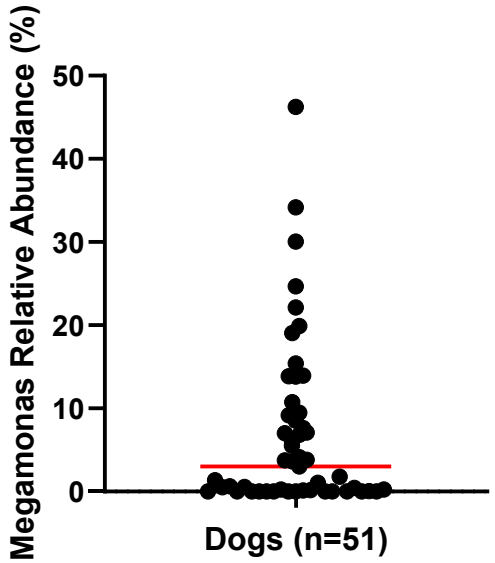


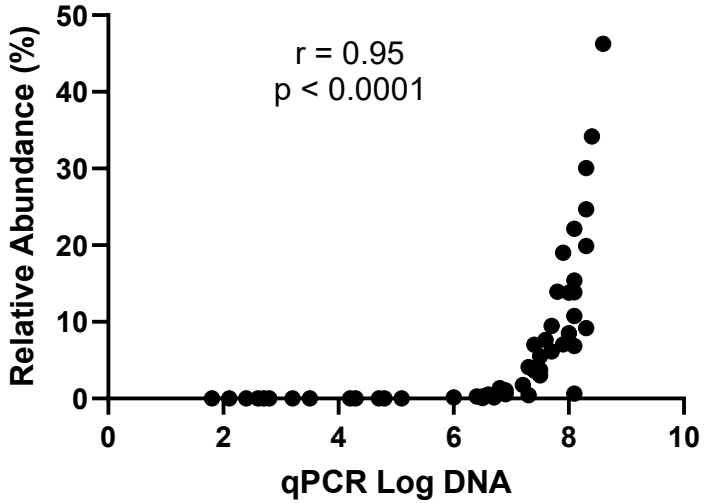
Megamonas

qPCR

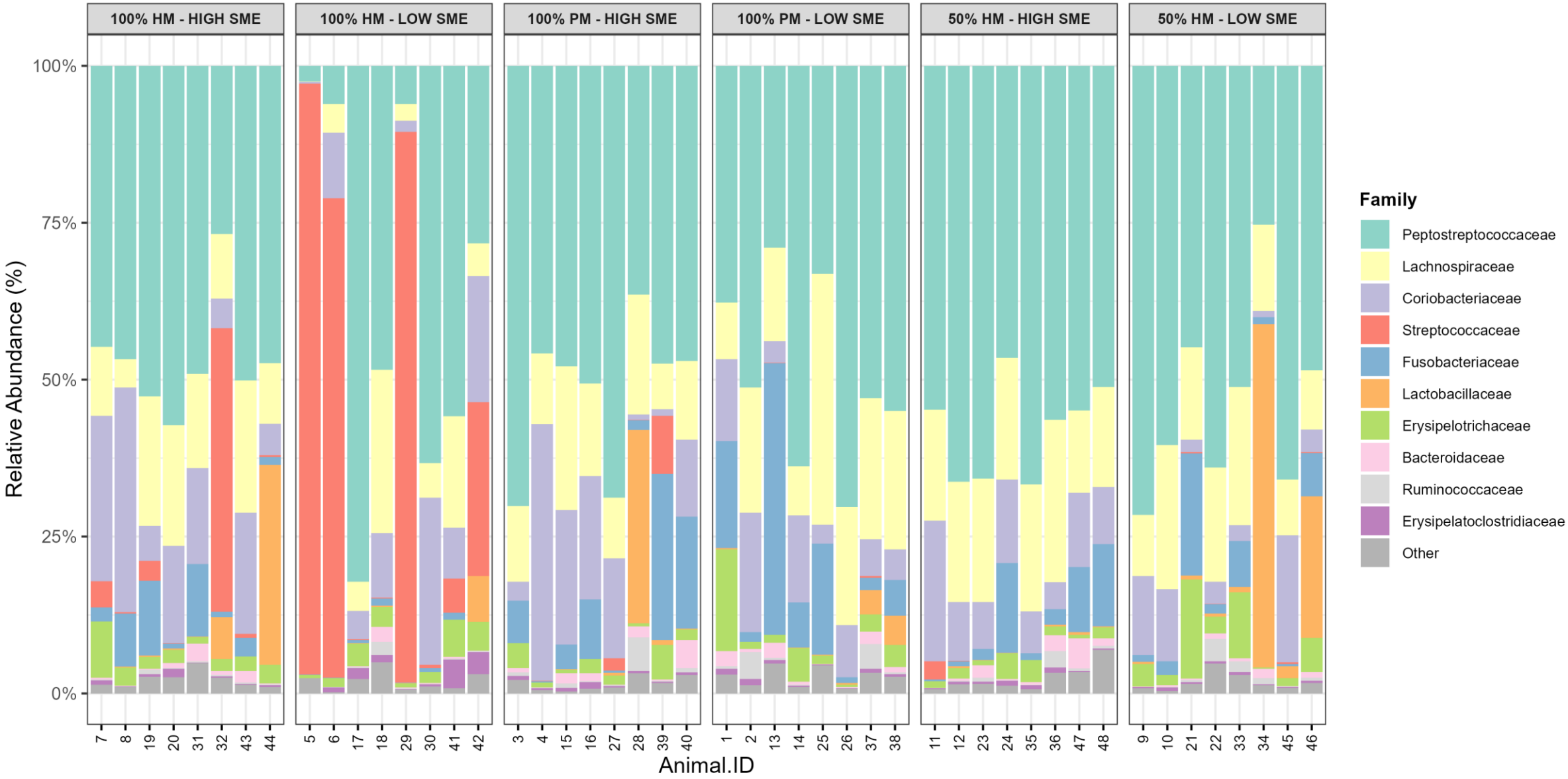


Sequencing



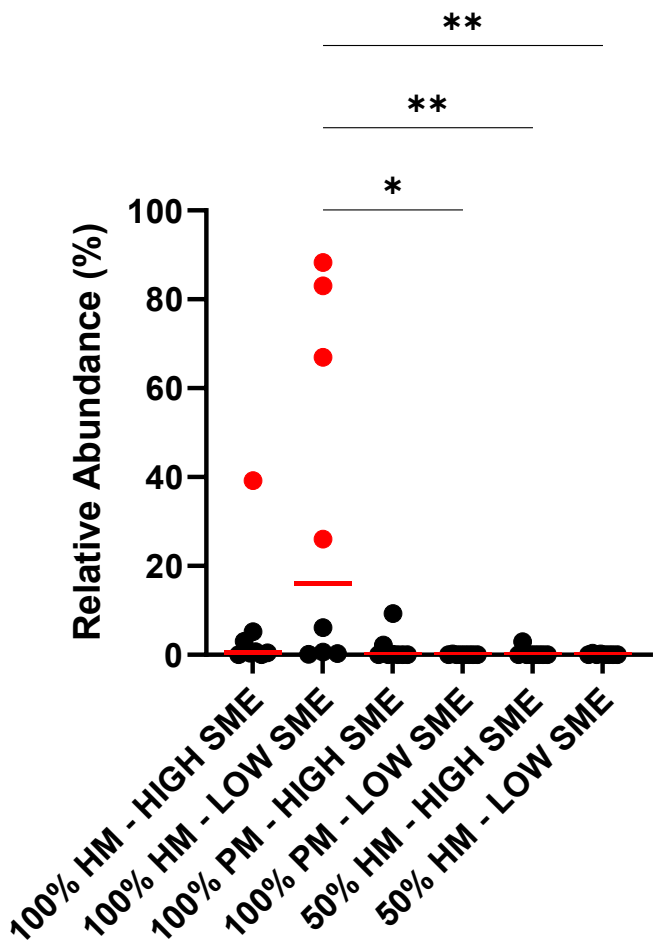


Taxa Summary – Family



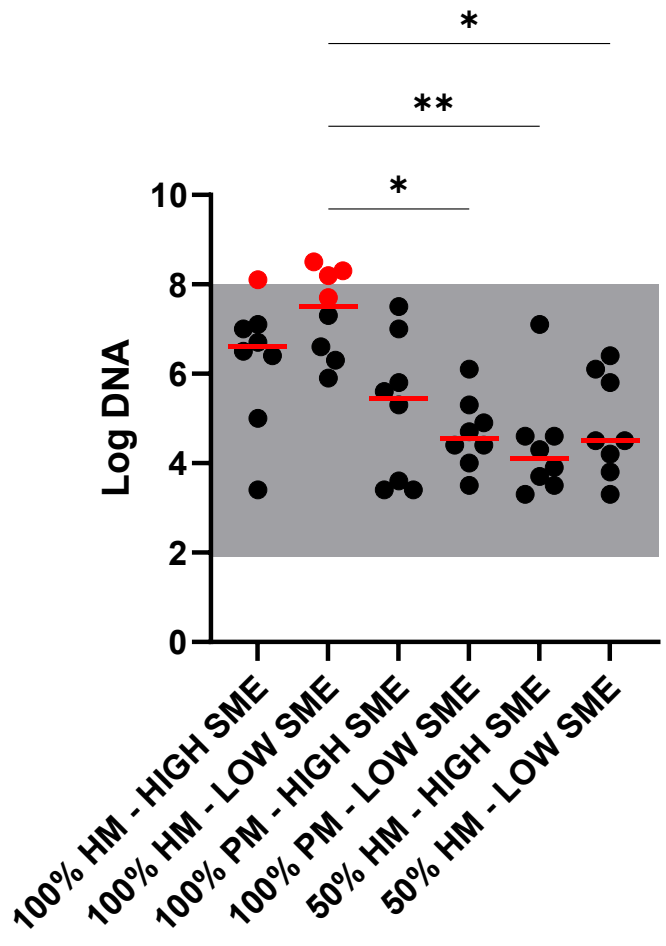
Sequencing

Streptococcus



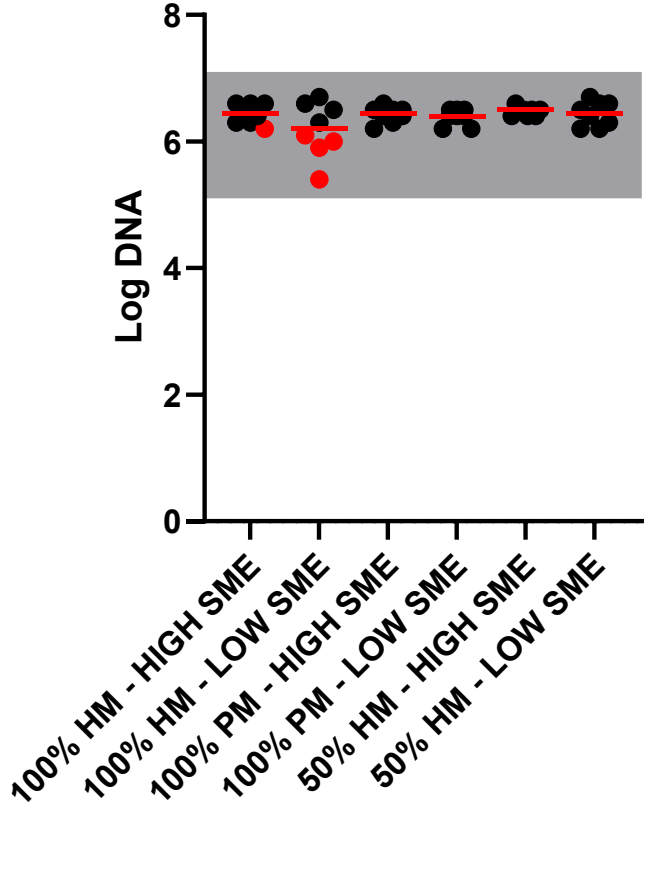
qPCR

Streptococcus



qPCR

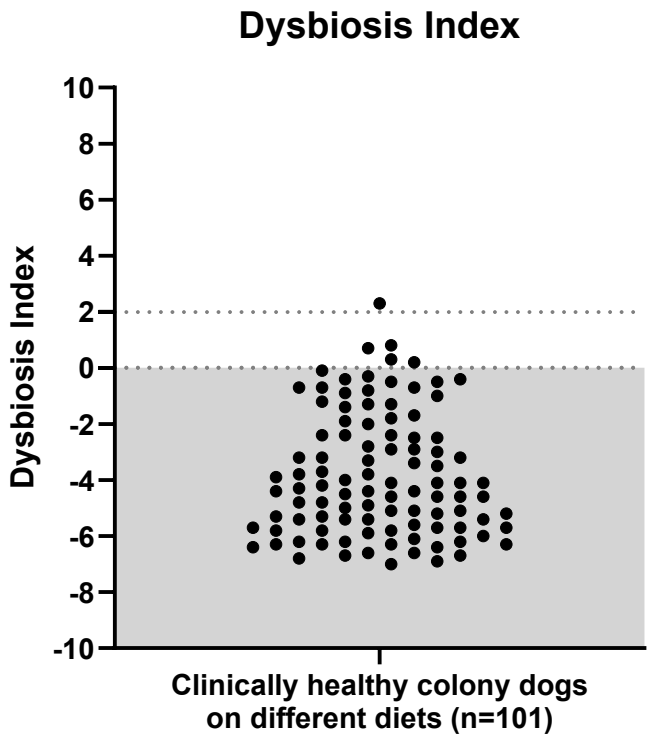
Peptacetobacter hiranonis

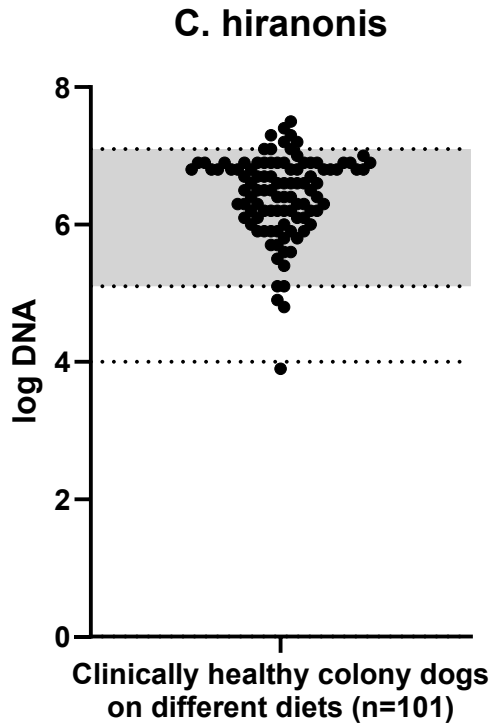


Effects of diet type on the core fecal bacterial taxa and the dysbiosis index of healthy adult dogs

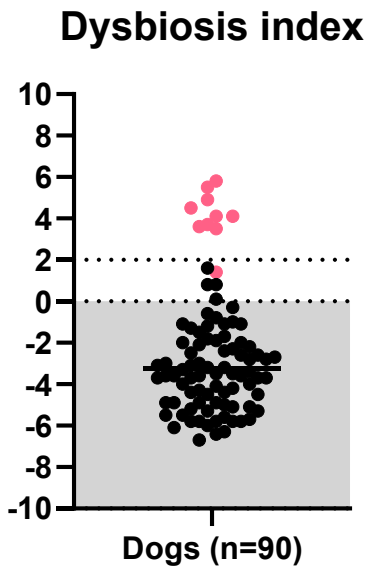
Patrícia M. Oba[1], Leah J. Roberts[1], Elizabeth L. Geary[1], Jan S. Suchodolski[2], Kelly S. Swanson[1*]

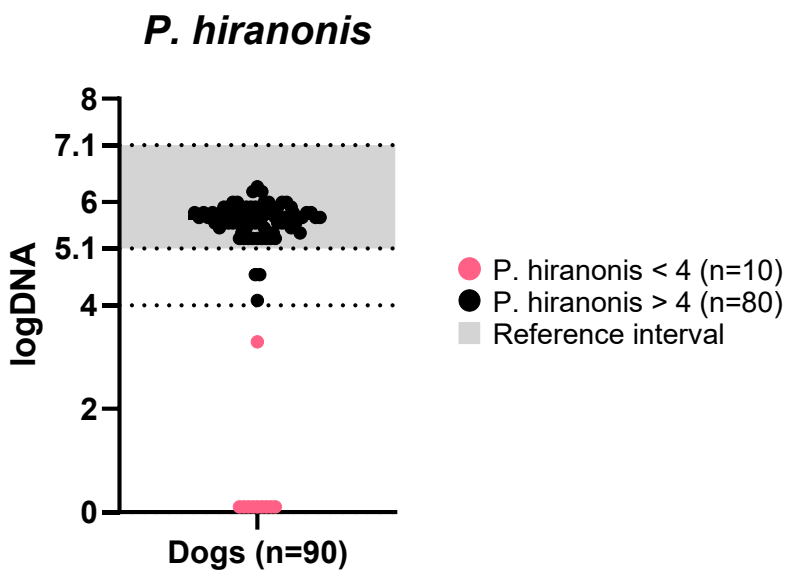
[1]University of Illinois at Urbana-Champaign, United States, [2]Department of Small Animal Clinical Sciences, College of Veterinary Medicine & Biomedical Sciences, Texas A&M University, United States

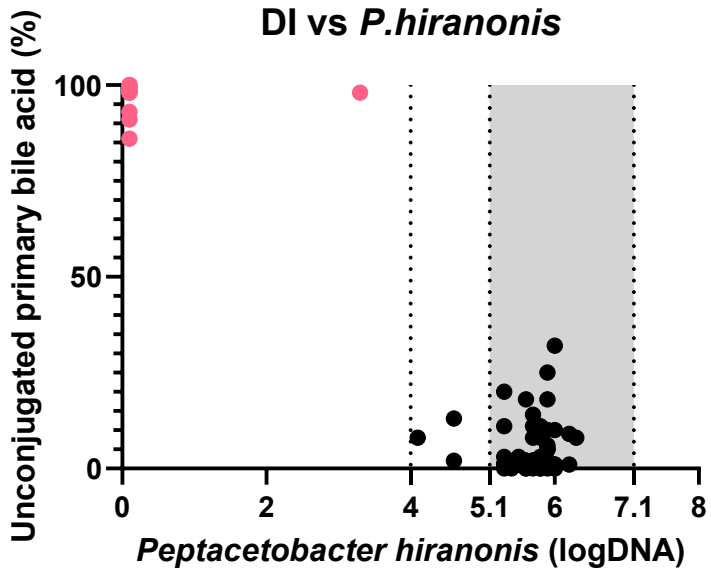


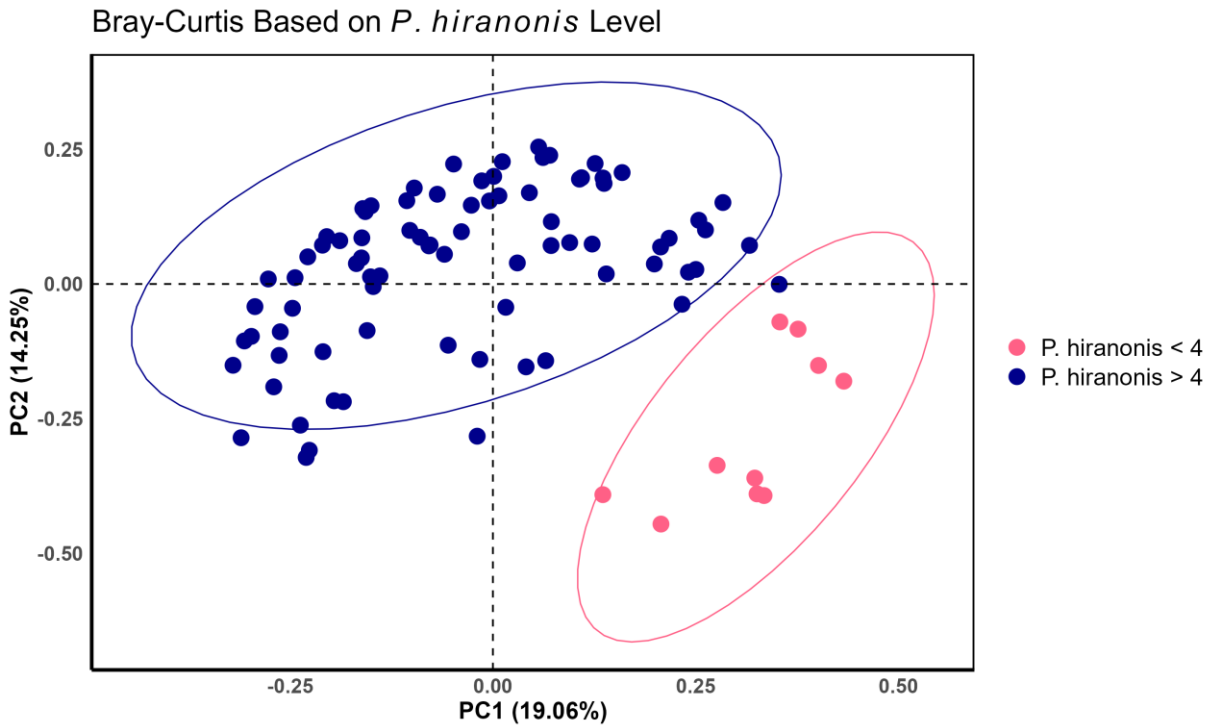


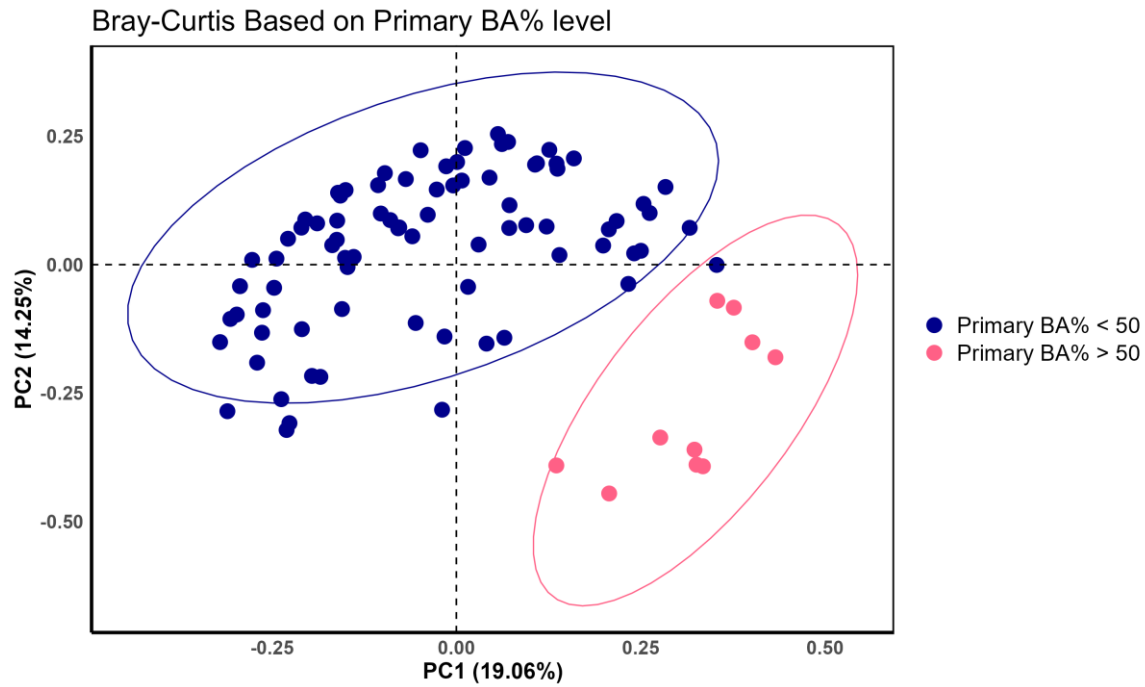
Clinically healthy pet dogs



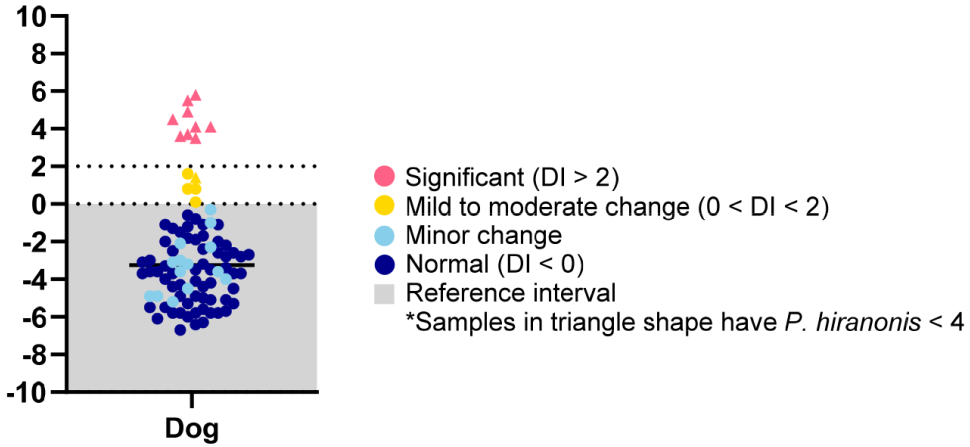




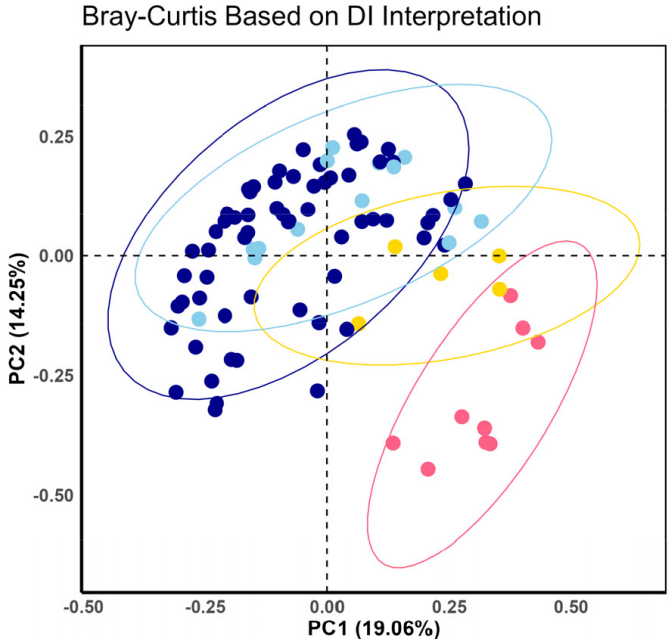

Bray-Curtis Based on P. hiranonis Level
0.25
0.00
-0.25
-0.50
PC2 (14.25%)
-0.25
0.00
0.25
0.50
PC1 (19.06%)
P. hiranonis < 4
P. hiranonis > 4


Bray-Curtis Based on Primary BA% level
0.25
0.00
-0.25
-0.50
PC2 (14.25%)
-0.25
0.00
0.25
0.50
PC1 (19.06%)
Primary BA% < 50
Primary BA% > 50

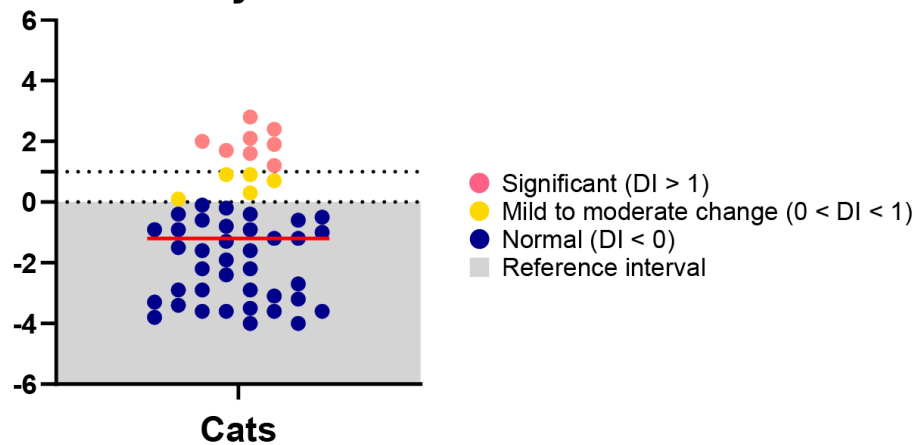
A **Canine Dysbiosis Index**



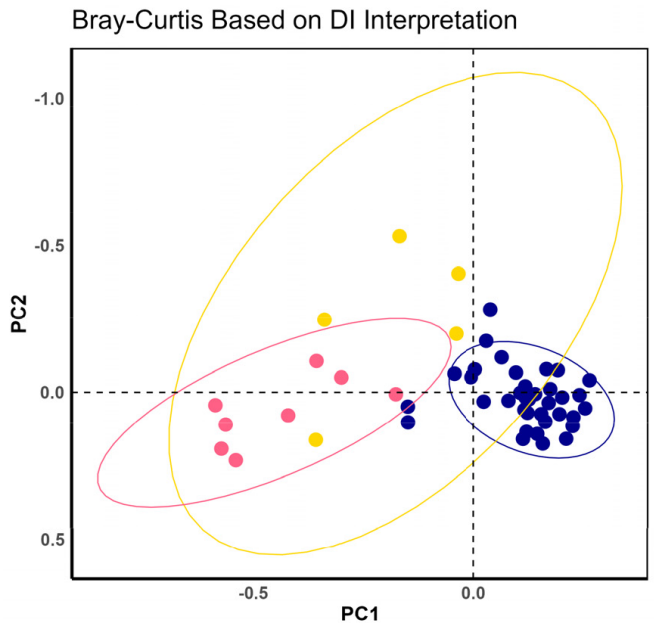
B



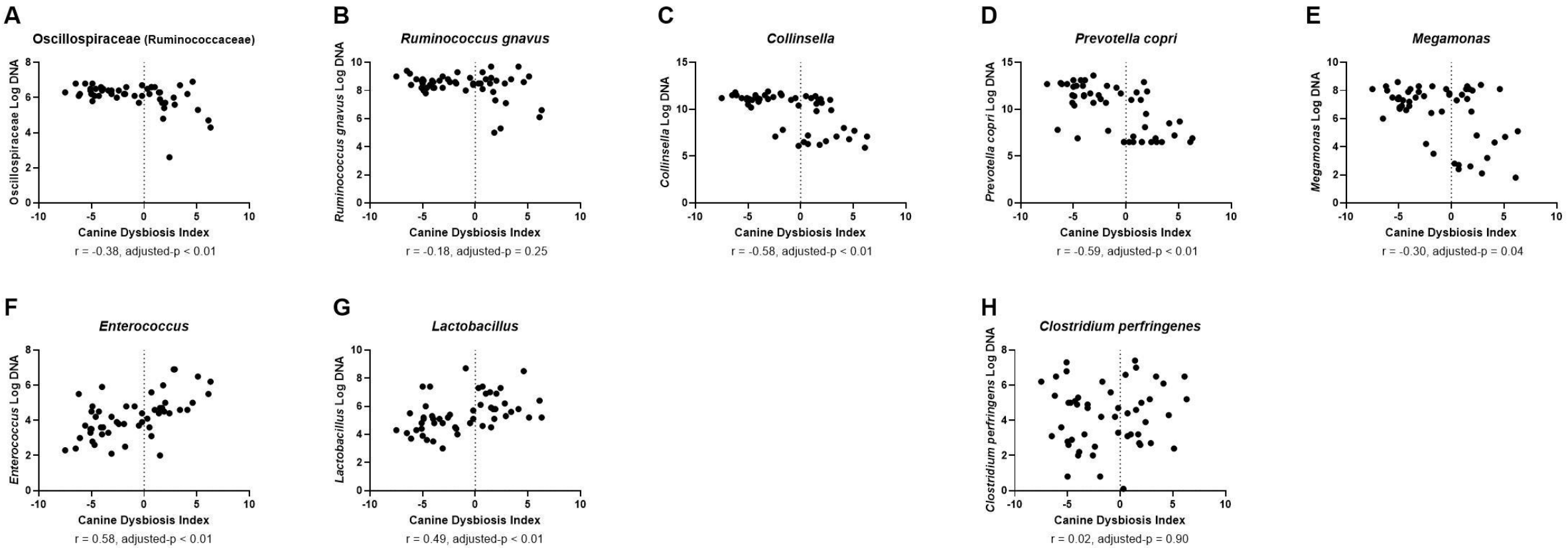
C **Feline Dysbiosis Index**



D



Many other core bacteria are also altered once Dysbiosis Index Increases



THE LANCET
Gastroenterology & Hepatology

Broad spectrum antibiotics

- 23,982 new patients with IBD
- 117,827 matched controls
- 28,732 siblings

After adjusting for risk factors, OR in patients who had used antibiotics versus those who had never used antibiotics was

- 1·74 (1·64–1·85) for Ulcerative colitis
- 2·27 (2·06–2·49) for Crohn's disease

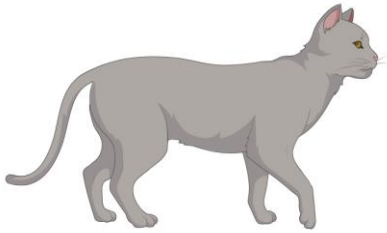
Effects of Metronidazole on the Fecal Microbiota, Fecal Metabolites, and Serum Metabolites of Healthy Adult Cats

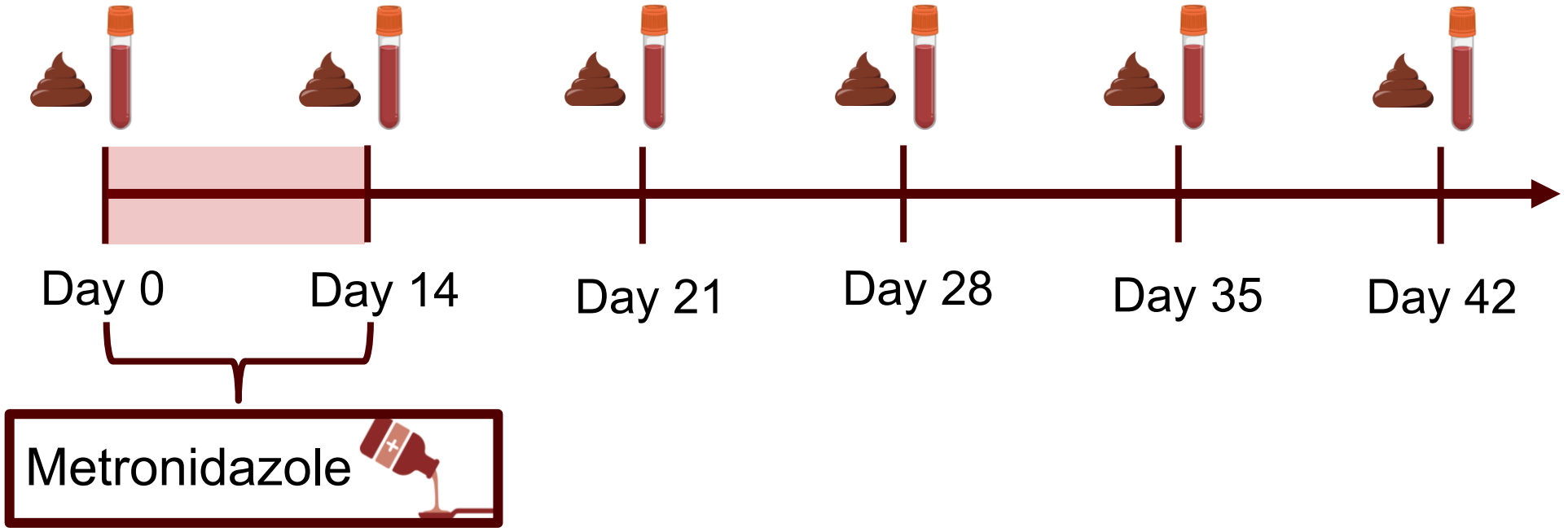
by **Sara E. Martini** [1], **Teresa Schmidt** [2], **Wenyi Huang** [2], **Amanda B. Blake** [2], **João P. Cavasin** [2], **Jan S. Suchodolski** [2,*] and **Kelly S. Swanson** [1,3,4,*]

[1] Department of Animal Sciences, University of Illinois Urbana-Champaign, Urbana, IL 61801, USA
[2] Gastrointestinal Laboratory, Department of Small Animal Clinical Sciences, Texas A&M University, College Station, TX 77843, USA
[3] Division of Nutritional Sciences, University of Illinois Urbana-Champaign, Urbana, IL 61801, USA
[4] Department of Veterinary Clinical Medicine, University of Illinois Urbana-Champaign, Urbana, IL 61801, USA
[*] Authors to whom correspondence should be addressed.

Pets **2025**, *2*(2), 19; **https://doi.org/10.3390/pets2020019**

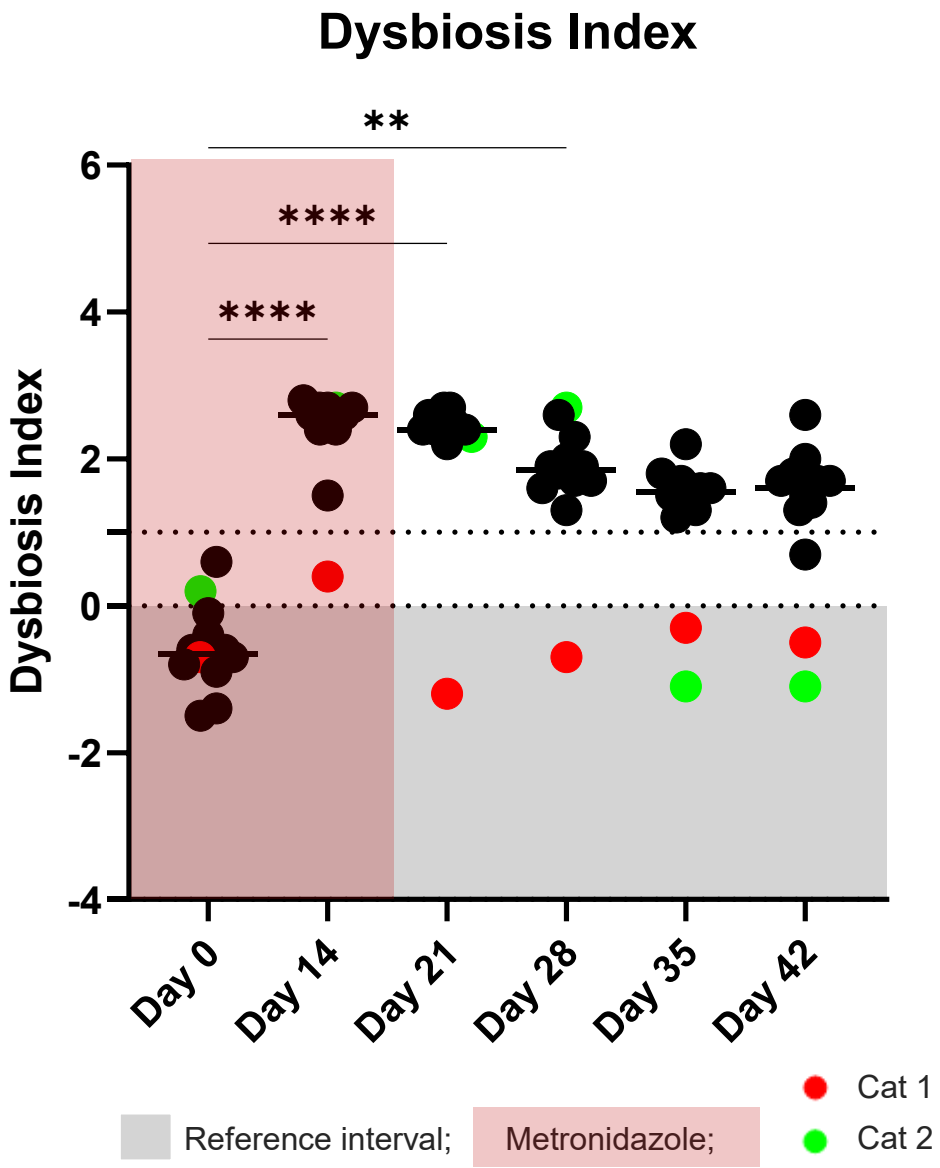
12 healthy domestic short-hair cats
4.7 (mean) ± 0.4 (SD) years
4 males / 8 females (all neutered)
Standardized diet

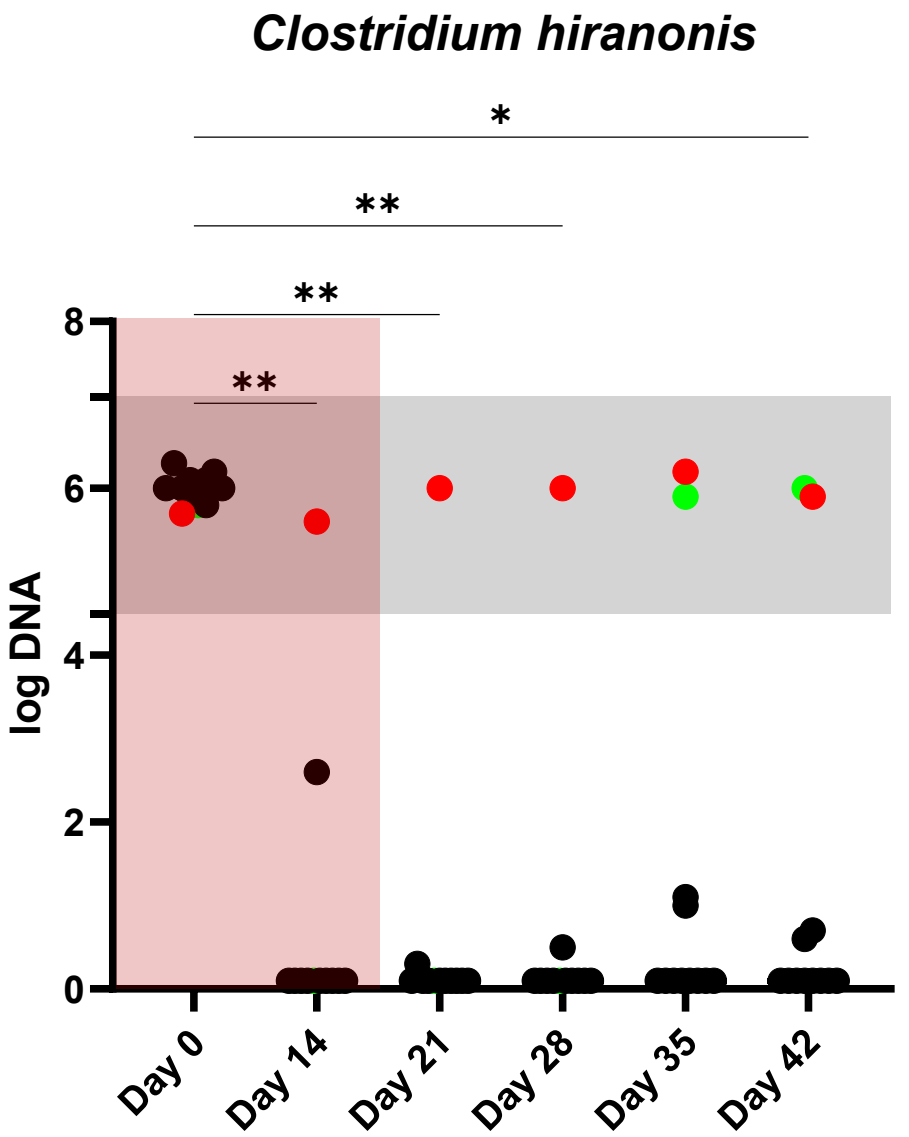




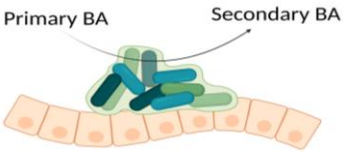
Increase

Depletion in 10/12 cats

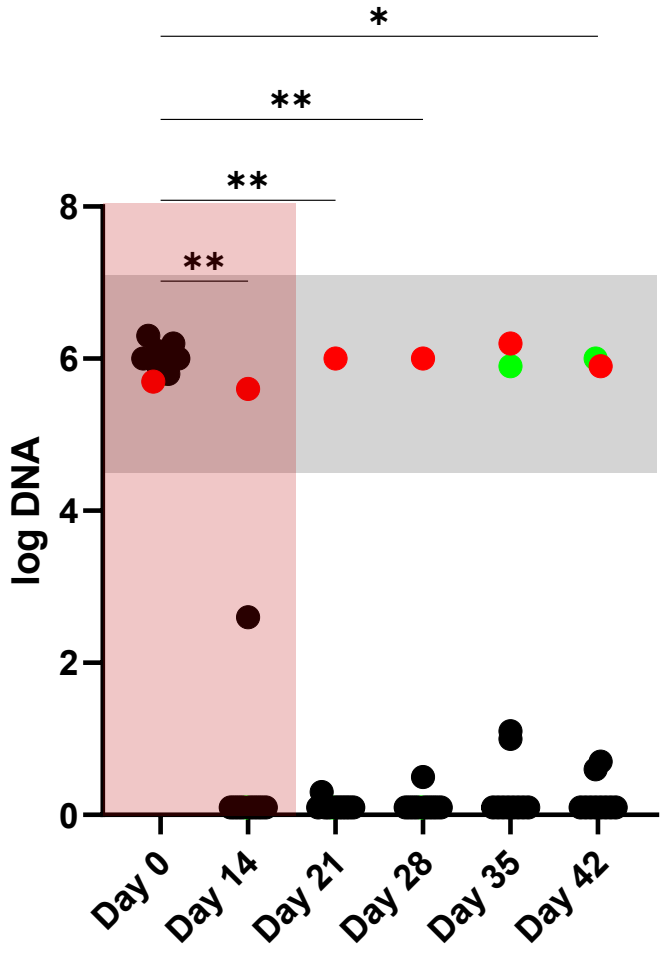




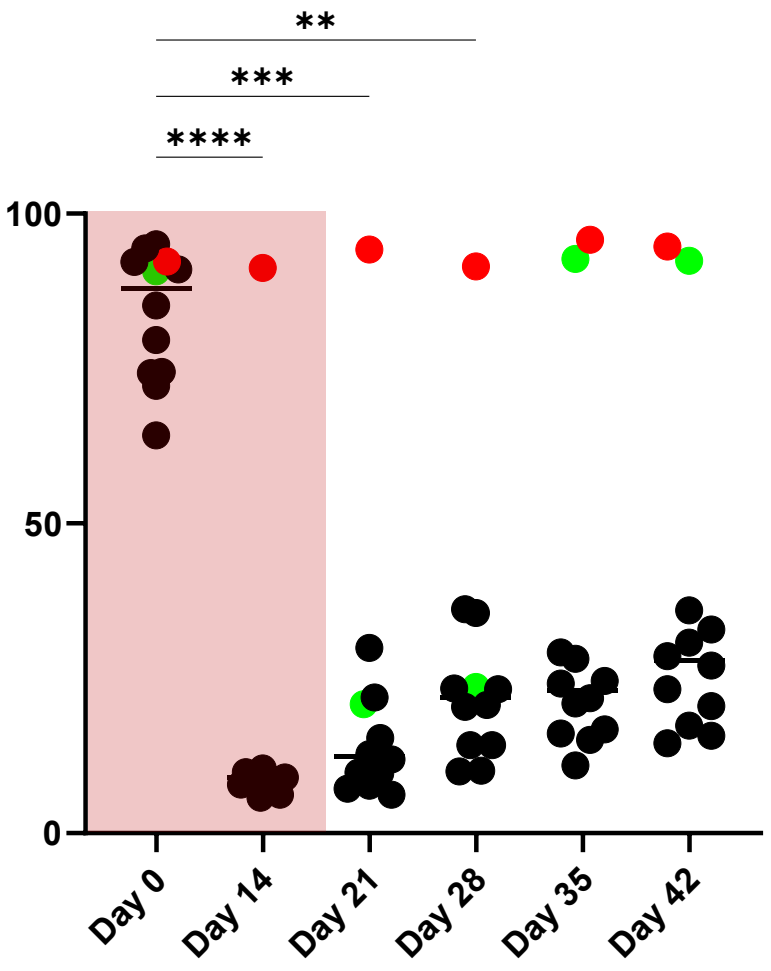
Bile acids



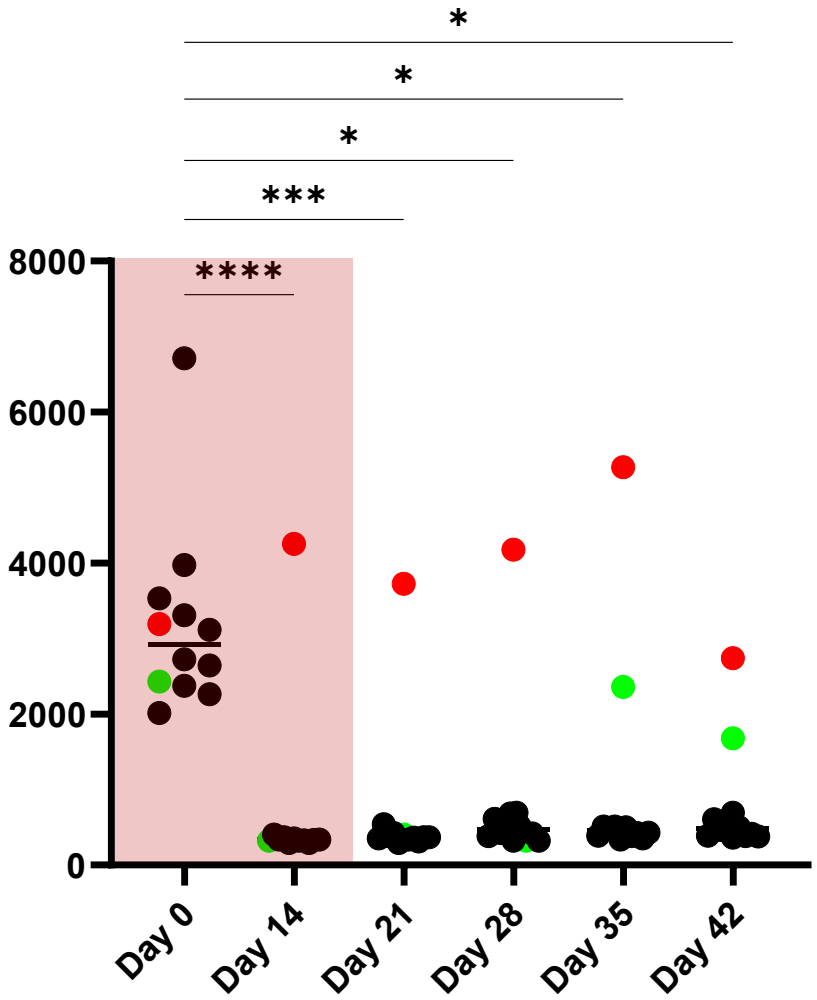
Clostridium hiranonis



Secondary BA (% Total)



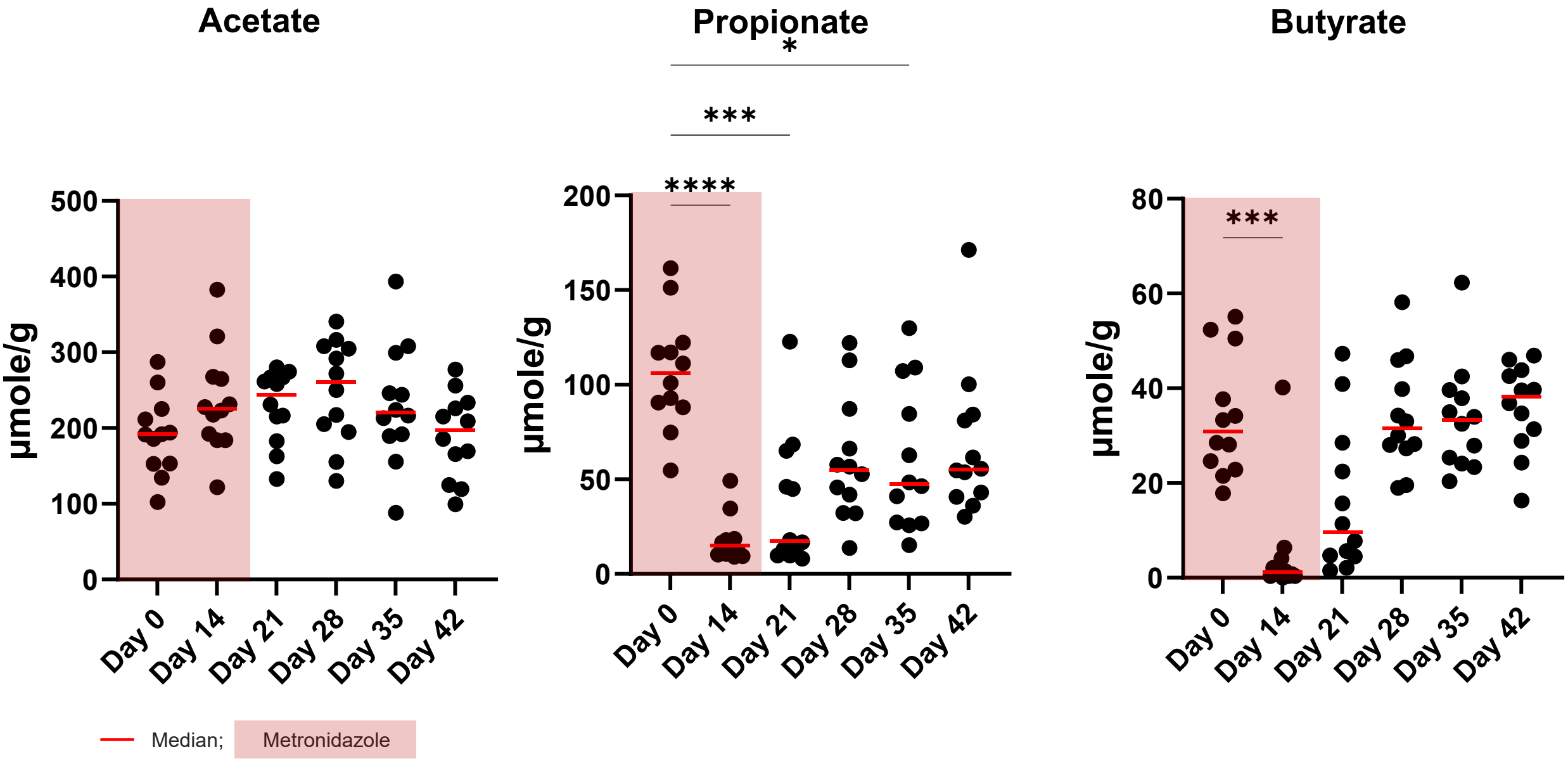
Total secondary bile acids



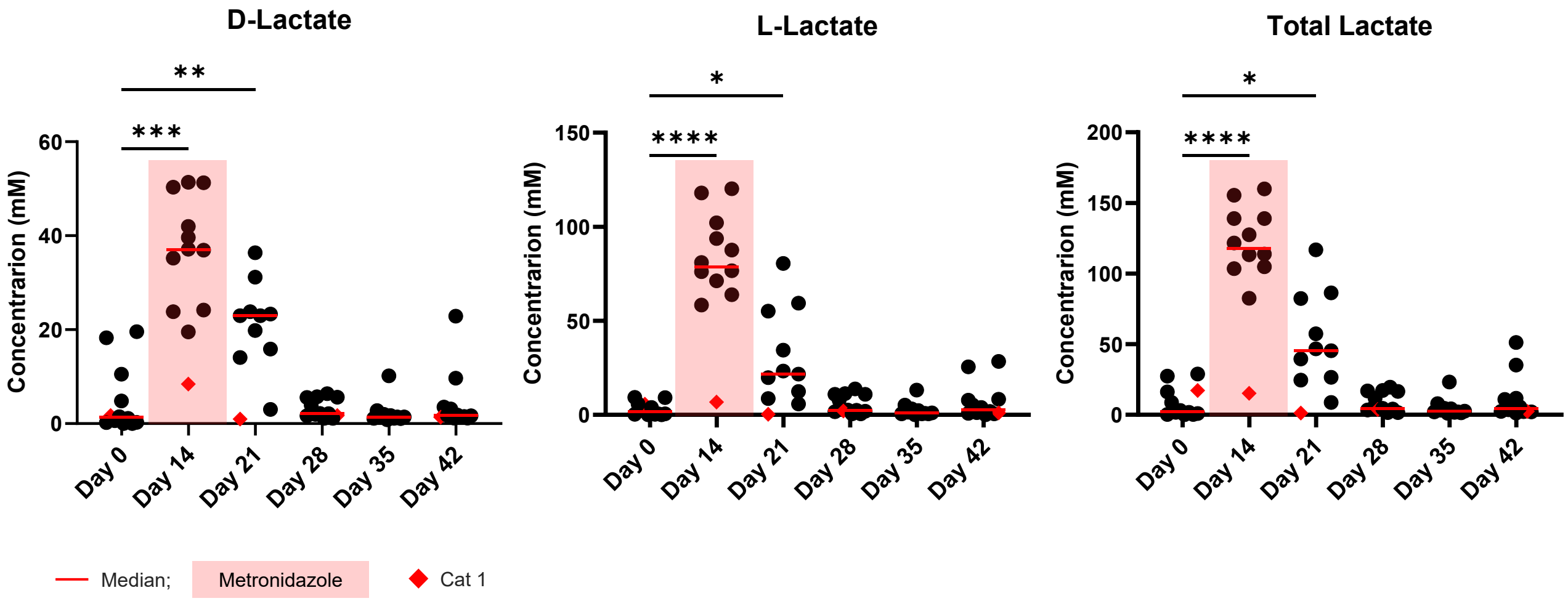
Reference interval; Metronidazole;

Cat 1
Cat 2

SCFAs


Acetate
Propionate
Butyrate
*
***
****
***
µmole/g
0
100
200
300
400
500
50
150
20
40
60
80
Day 0
Day 14
Day 21
Day 28
Day 35
Day 42
Median;
Metronidazole

Fecal Lactate



Shifted microbiome and metabolome only in a subset of canine chronic enteropathy (CE)

Fecal/ intestinal microbiota

Evaluation of mucosal bacteria and histopathology, clinical disease activity and expression of Toll-like receptors in German shepherd dogs with chronic enteropathies

K. Allenspach [a,*], A. House [a], K. Smith [c], F.M. McNeill [a], A. Hendricks [a], J. Elson-Riggins [a] A. Riddle [a], J.M. Steiner [b], D. Werling [c], O.A. Garden [a], B. Catchpole [c], J.S. Suchodolski [b]

Domestic Animals–Original Article

Bacterial Biogeography of the Colon in Dogs With Chronic Inflammatory Enteropathy

Veterinary Pathology
2020, Vol. 57(2) 258-265

DOI: 10.1177/0300985819891259
journals.sagepub.com/home/vet

Paula R. Giaretta[1], Jan S. Suchodolski[2], Albert E. Jergens[3], Jörg M. Steiner[2], Jonathan A. Lidbury[2], Audrey K. Cook[4], Mohsen Hanifeh[5], Thomas Spillmann[5], Susanne Kilpinen[5], Pernilla Syrjä[6] and Raquel R. Rech[1]

Fecal/ serum metabolome

Alteration of the fecal microbiota and serum metabolite profiles in dogs with idiopathic inflammatory bowel disease

Yasushi Minamoto, Cristiane C Otoni, Samantha M Steelman, Olga Büyükleblebici, Jörg M Steiner, Albert E Jergens & Jan S Suchodolski

animals

MDPI

Article

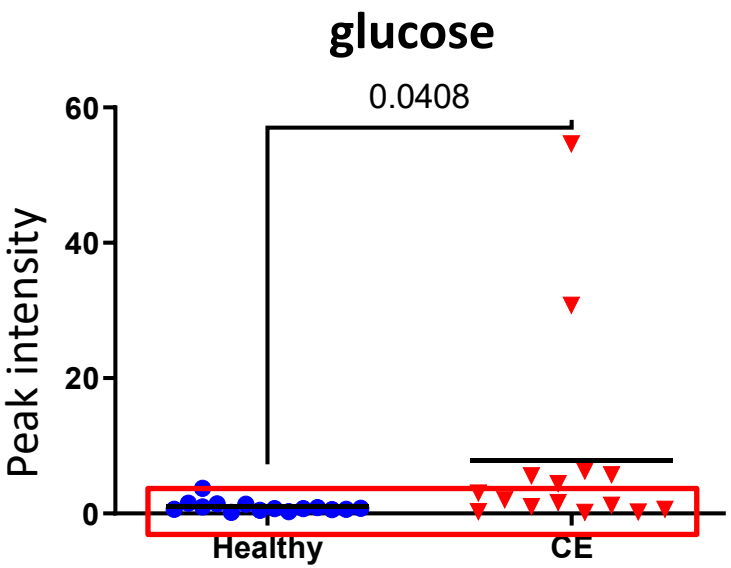
Long-Term Recovery of the Fecal Microbiome and Metabolome of Dogs with Steroid-Responsive Enteropathy

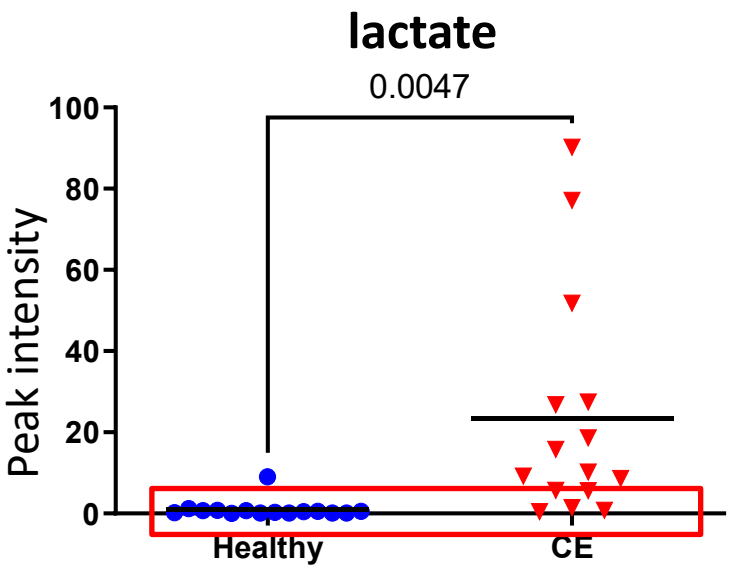
Rachel Pilla [1,*], Blake C Guard [1], Amanda B Blake [1], Mark Ackermann [2], Craig Webb [3], Steve Hill [4,5], Jonathan A Lidbury [1], Jörg M Steiner [1], Albert E. Jergens [6] and Jan S Suchodolski [1]

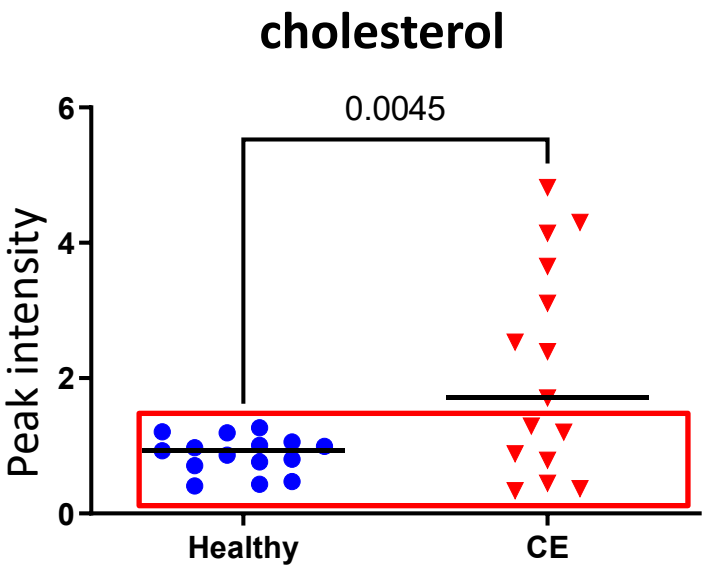
Sample type	Biomarker	Abnormal %	Reference
Serum	Albumin	21%	Allenspach et al., 2008
		45%	Jablonski et al., 2017
	Cobalamin	19%	Allenspach et al., 2008
		36%	Berghoff et al., 2013
		62%	Toresson et al., 2023
Feces	Dysbiosis index	50%	Vecchiato et al., 2025
		57%	Galler et al., 2022
		80%	Minamoto et al., 2019
	Calprotectin	50%	Otoni et al., 2018

ABNORMAL INTESTINAL FUNCTION IN A SUBSET OF DOGS WITH CE

- Carbohydrate metabolism
  - Glycolysis
  - Pentose phosphate pathway
- Lipid metabolism
- Amino acid metabolism
  - Aromatic amino acid
  - Redox homeostasis



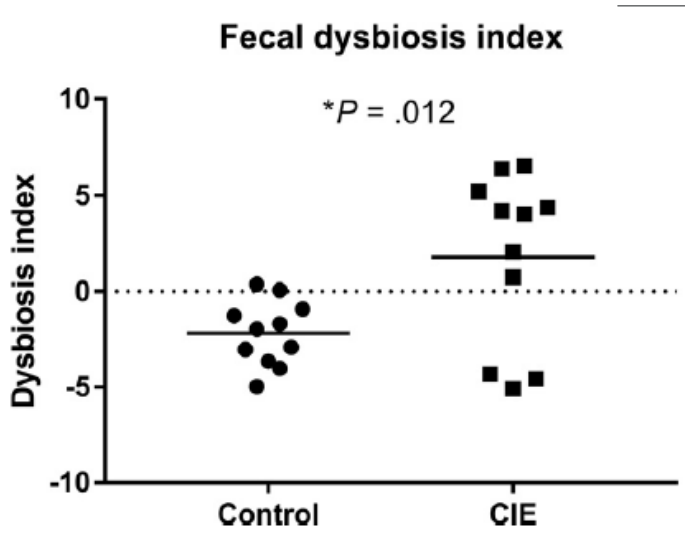




Honneffer JB, Texas A&M University dissertation 2015

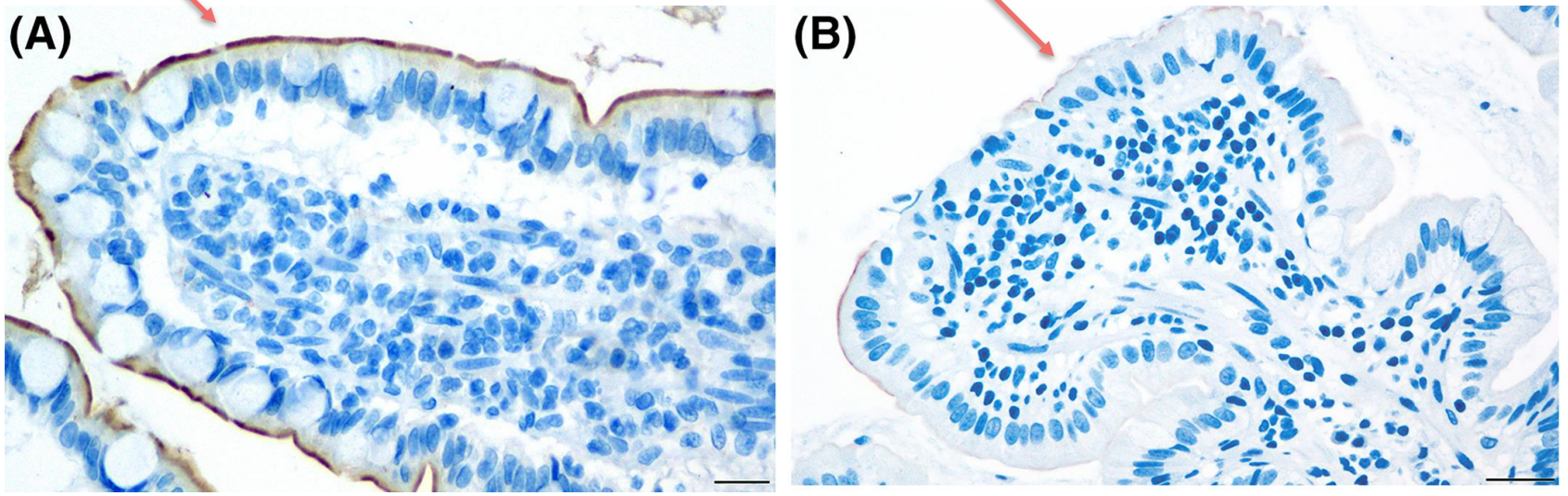
Comparison of intestinal expression of the apical sodium-dependent bile acid transporter between dogs with and without chronic inflammatory enteropathy

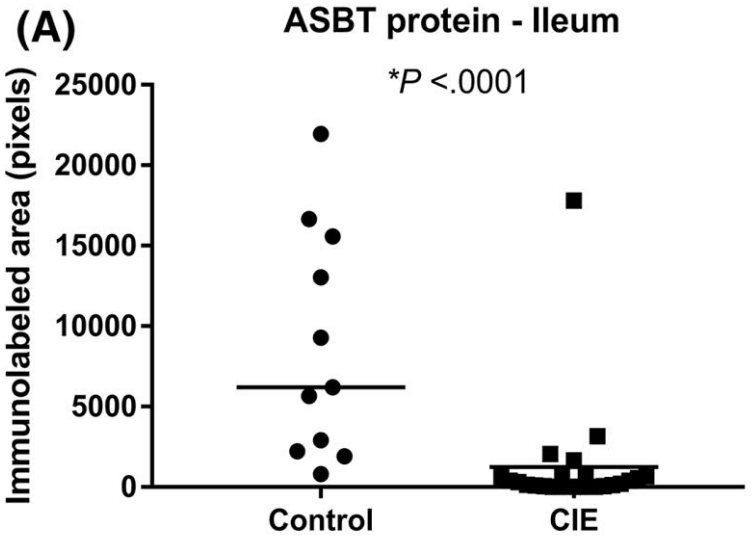
Paula R. Giaretta[1] | Raquel R. Rech[1] | Blake C. Guard[2] | Amanda B. Blake[2] | Anna K. Blick[1] | Jörg M. Steiner[1,2] | Jonathan A. Lidbury[2] | Audrey K. Cook[3] | Mohsen Hanifeh[4] | Thomas Spillmann[4] | Susanne Kilpinen[4] | Pernilla Syrjä[5] | Jan S. Suchodolski[2]



Healthy dog

Dogs with CE





Journal of Veterinary Internal Medicine

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Small Animal Internal Medicine Genetics

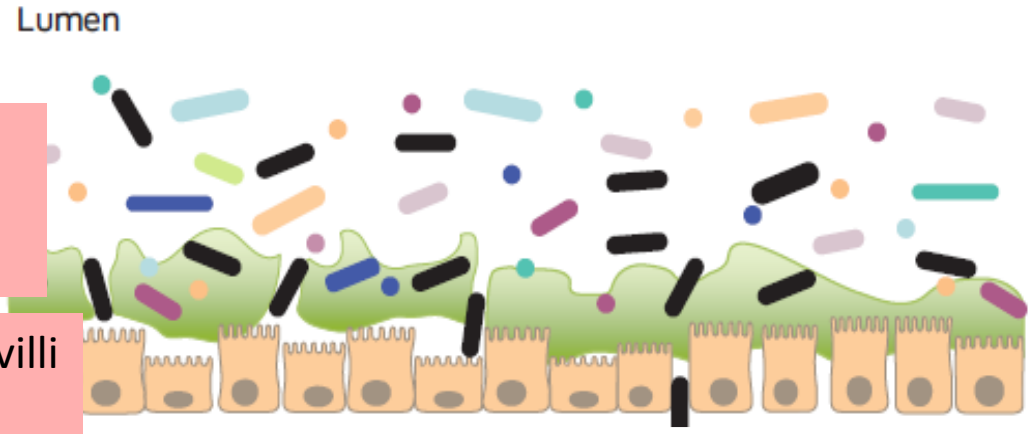
Microbial Gene Profiling and Targeted Metabolomics in Fecal Samples of Dogs With Chronic Enteropathy With or Without Increased Dysbiosis Index

Chih-Chun Chen[1] | Rachel Pilla[1] | Linda Toresson[1,2] | Chi-Hsuan Sung[1] | Amanda B. Blake[1] | Bruna Correa Lopes[1] | Jonathan Turck[1] | Albert E. Jergens[3] | Stacie C. Summers[4] | Stefan Unterer[5] | Patricia Eri Ishii[1,6] | Paula R. Giaretta[1] | M. Katherine Tolbert[1] | Jan S. Suchodolski[1]

Hypothesis: malabsorption is a major pathway in CE

glucose

Intestine in chronic enteropathy



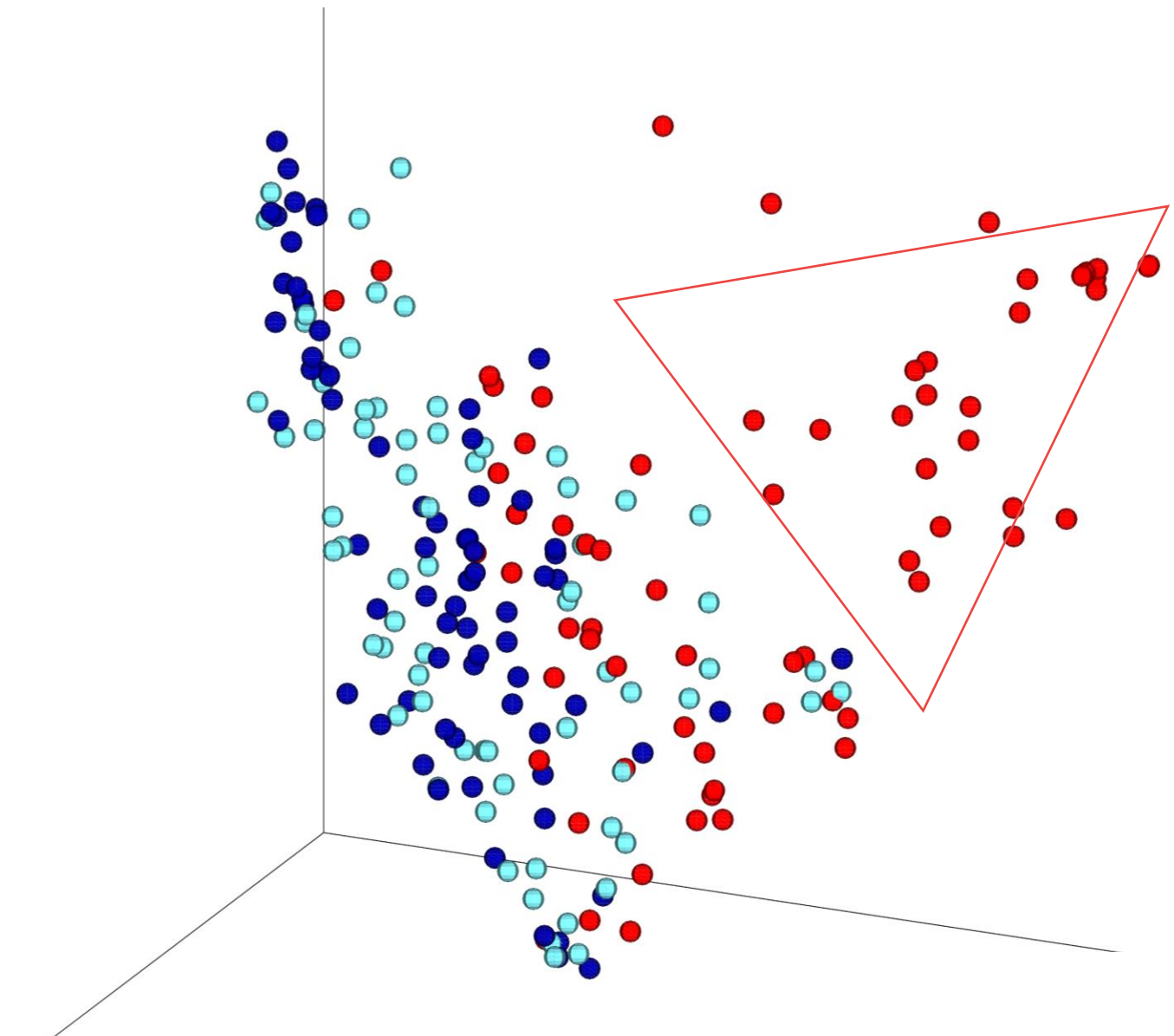
Disrupted mucous layer

Shortening villi leading to malabsorption

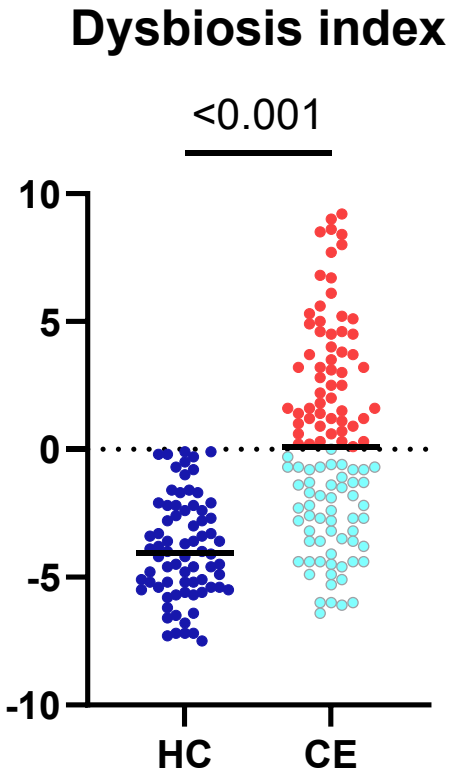
More permeable intestine barrier

gas

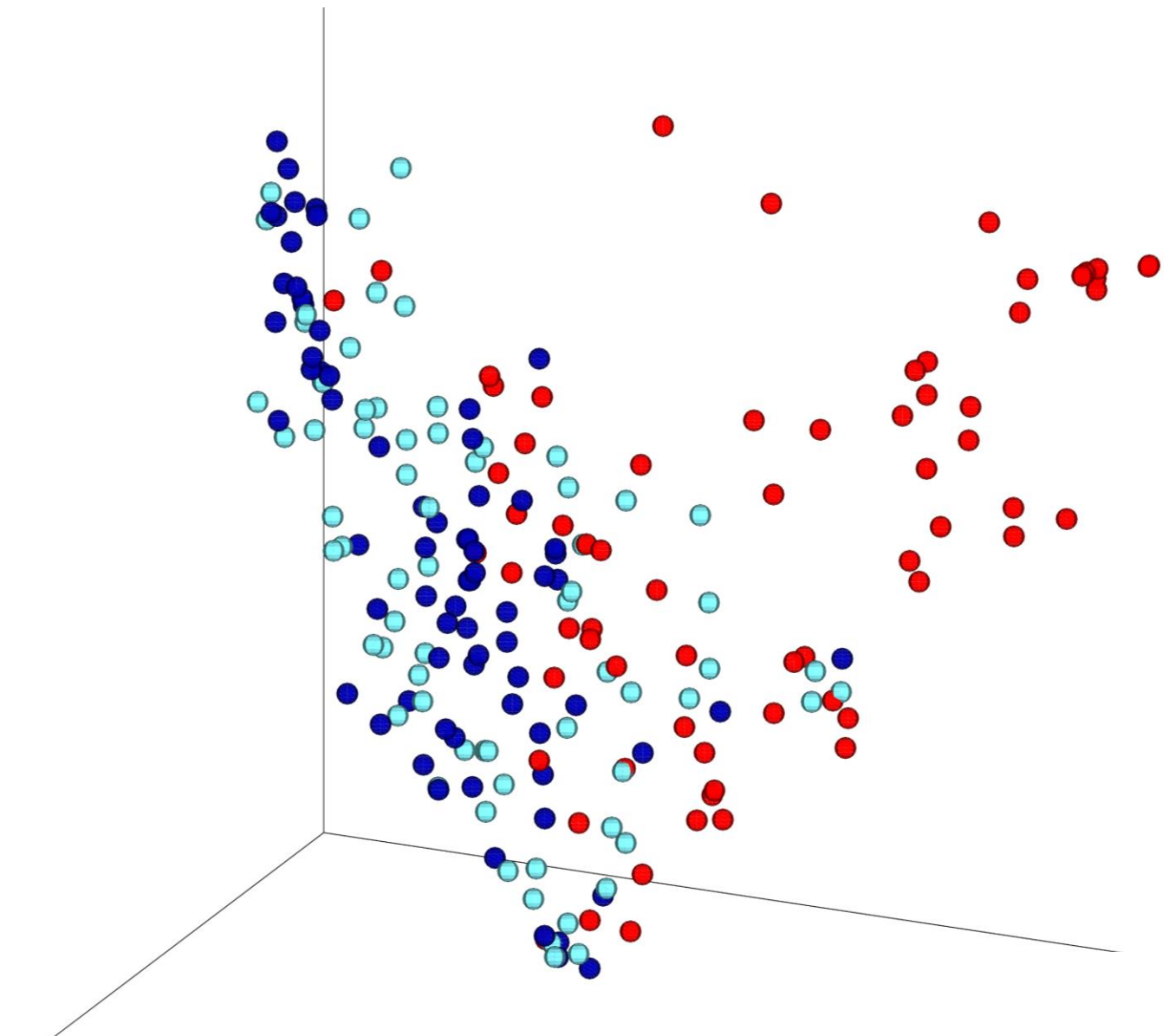
Fecal microbial composition (shotgun sequencing)



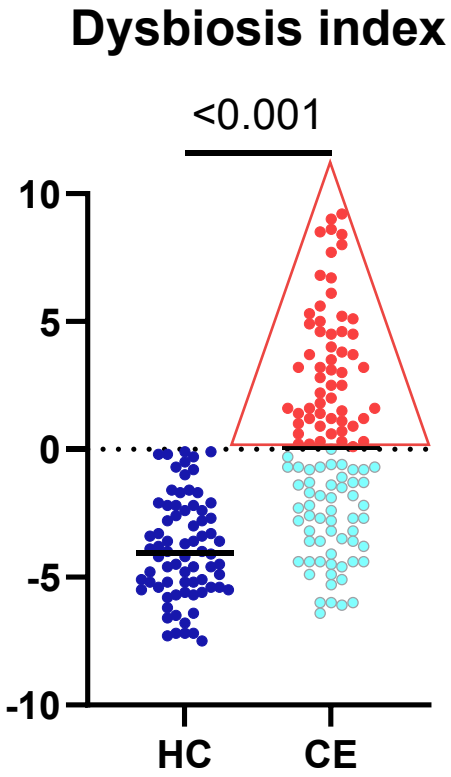
- HC
- Dogs with CE
  - normal dysbiosis index
  - increased dysbiosis index



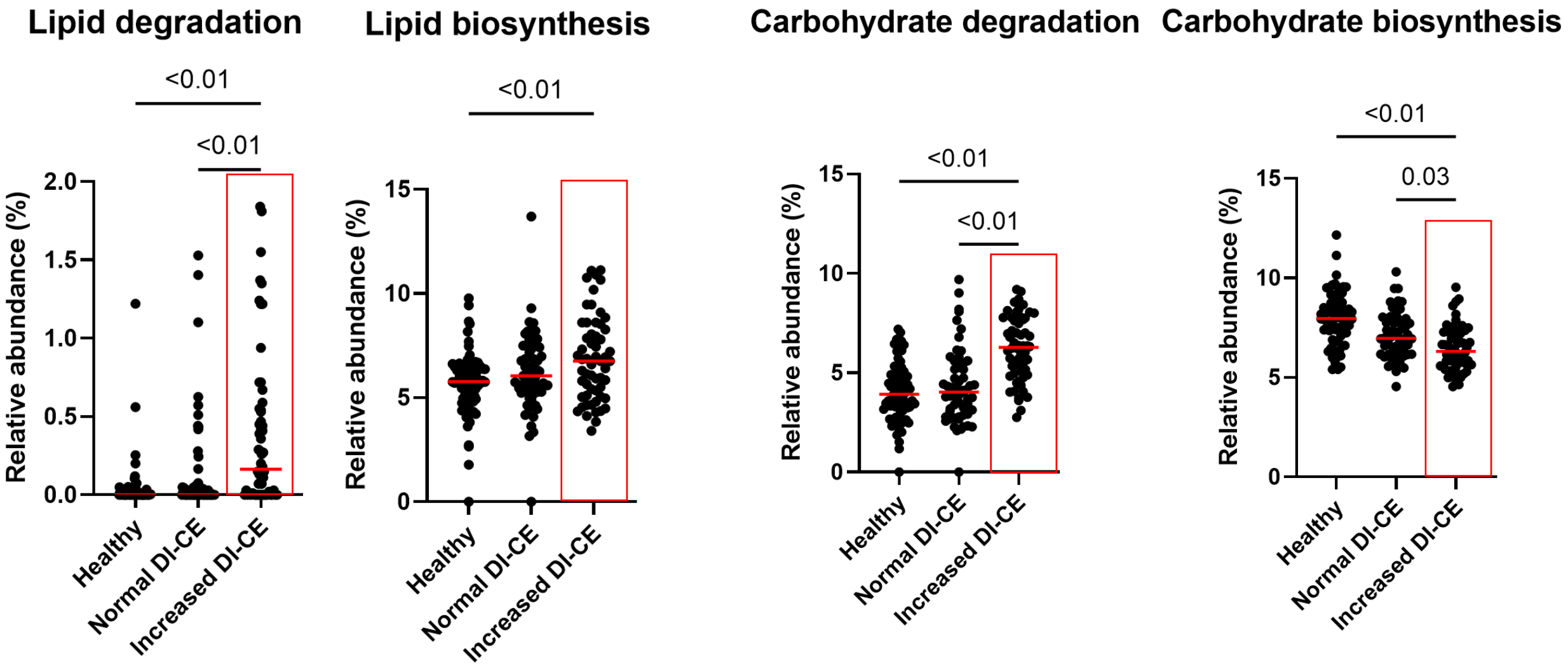
Fecal microbial composition (shotgun sequencing)



- HC
- Dogs with CE
  - normal dysbiosis index
  - increased dysbiosis index



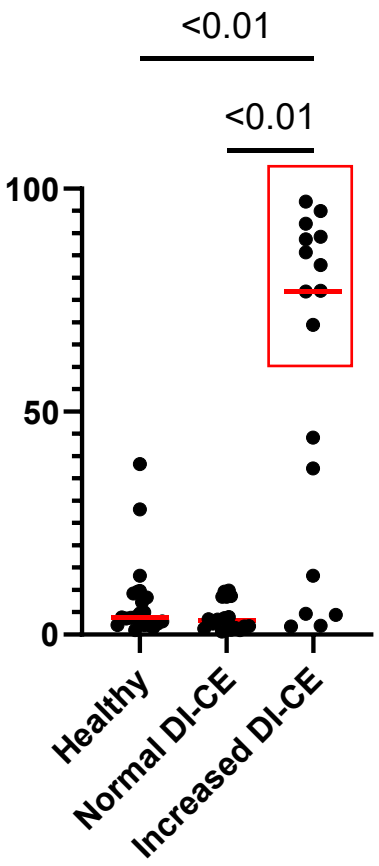
Abnormal microbial metabolism



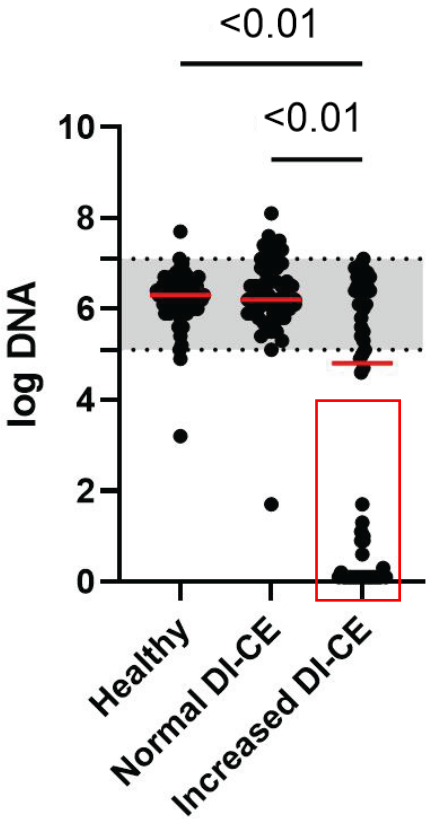
Abnormal bile acid metabolism

Main bile acid convertor

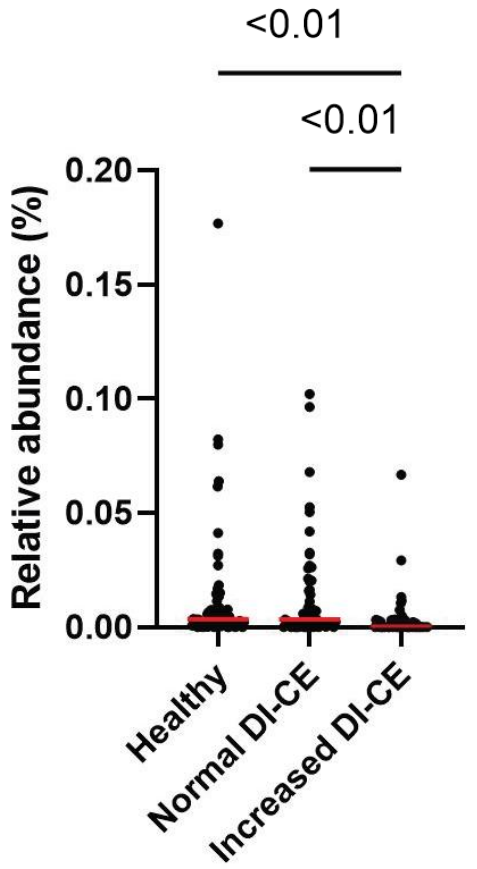
Primary bile acid %



P. hiranonis - qPCR



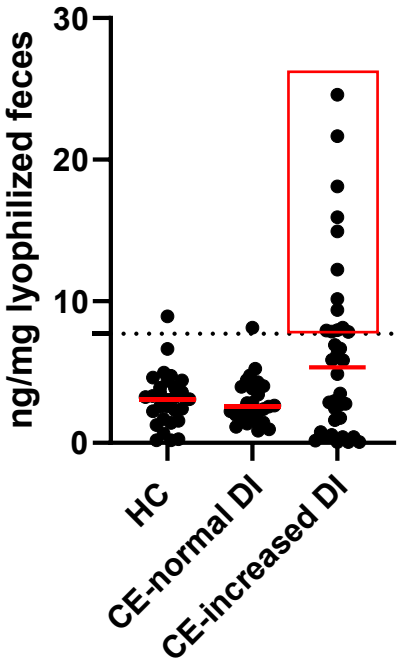
P. hiranonis - sequencing



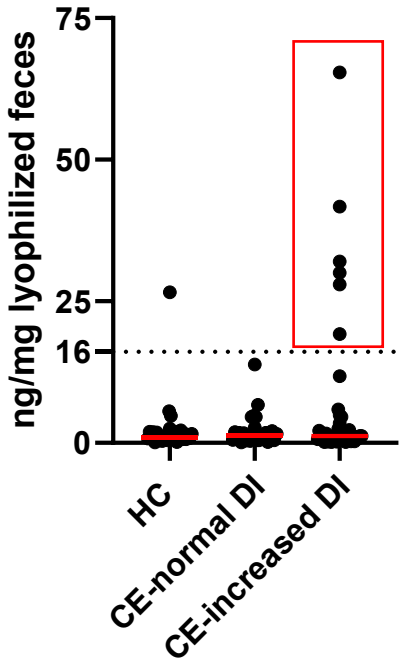
Abnormal carbohydrate metabolism

Transporter dependent

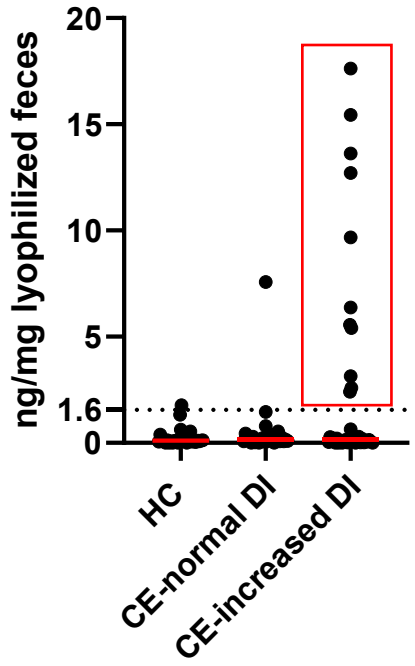
Glucose



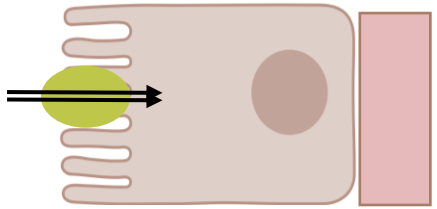
Galactose+Mannose

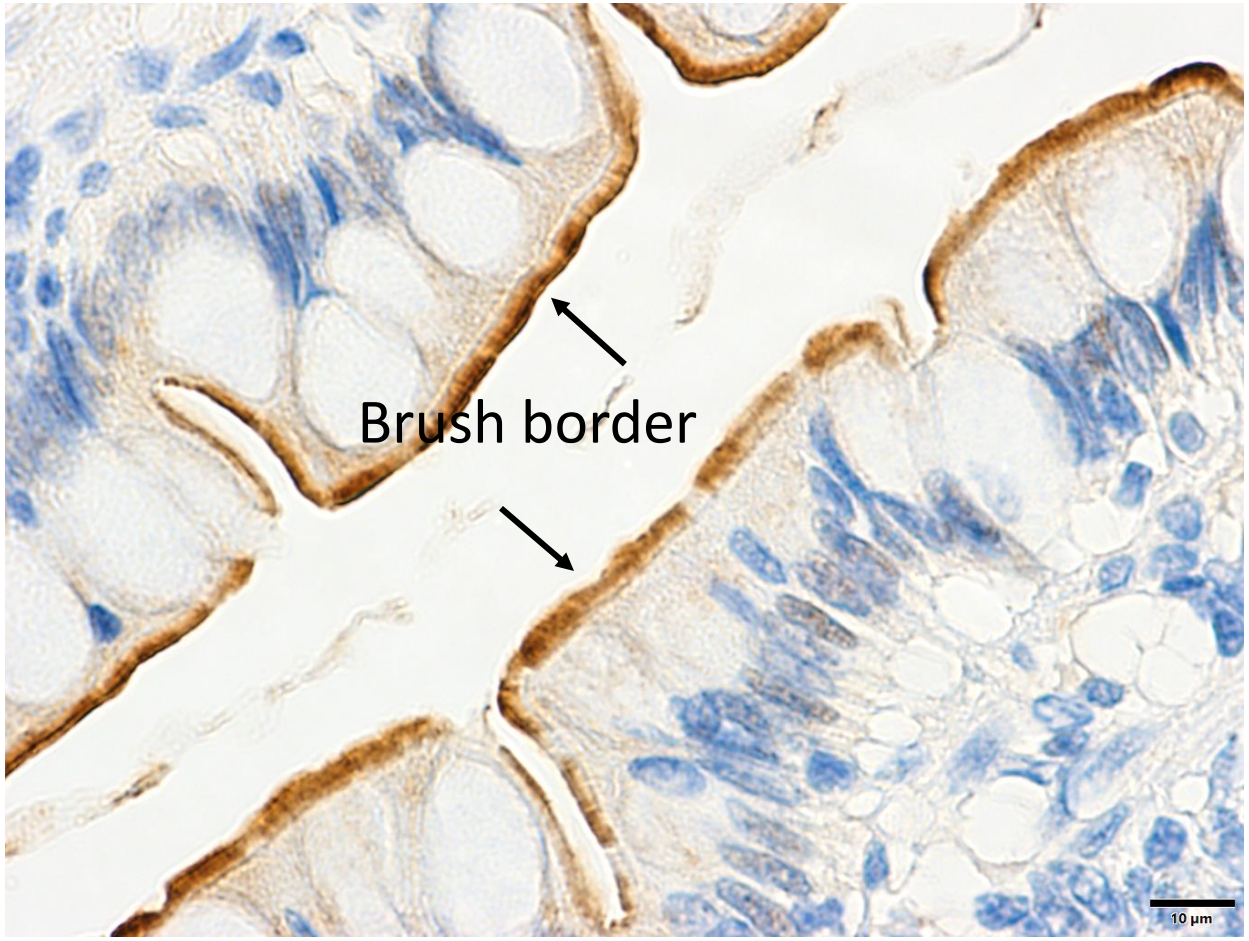


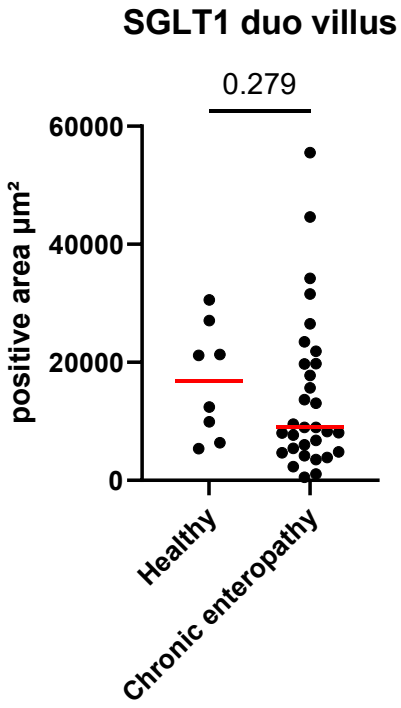
Fructose

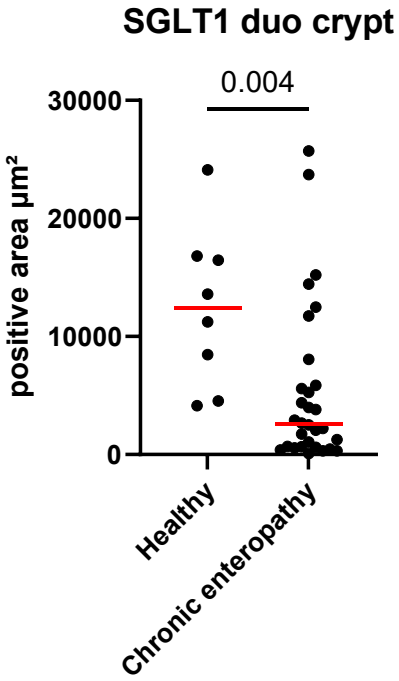


IHC: SGLT1 (glucose transporter)

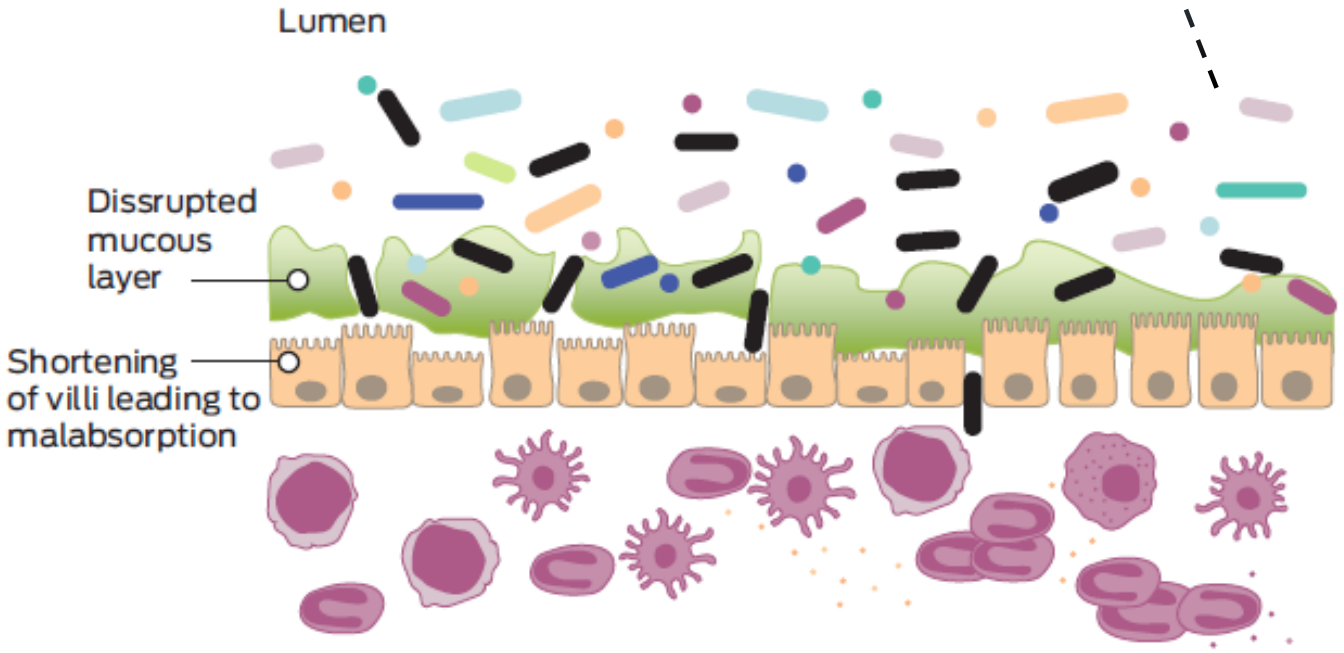








A subset of dogs with chronic enteropathy



Dysbiosis

Bile acid dysmetabolism

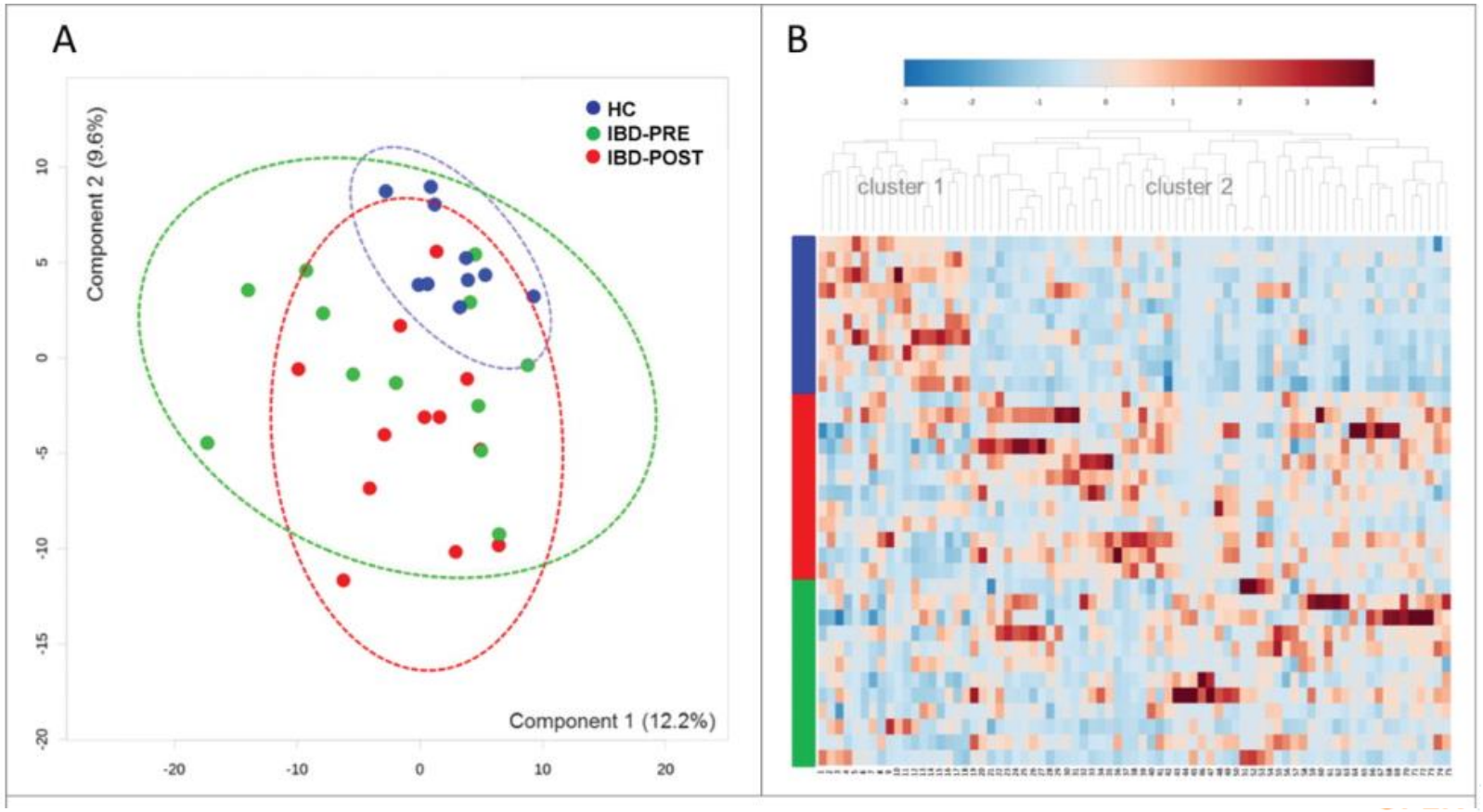
Lipid perturbation

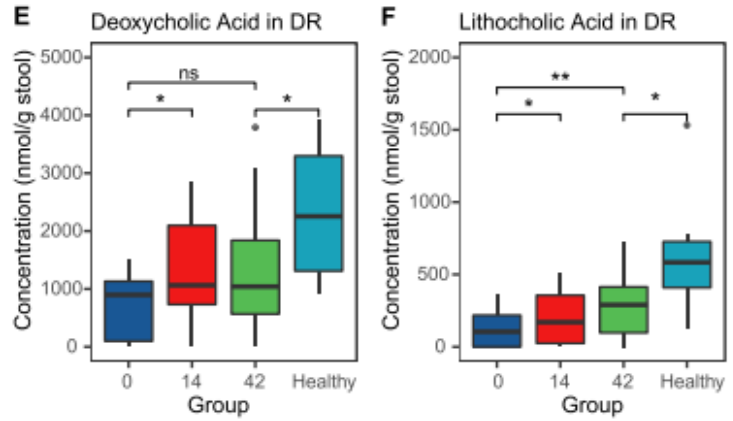
Carbohydrate malabsorption

Inflammation

Increased Dysbiosis Index is associated with more severe functional changes in intestine

Despite CLINICAL remission – most abnormalities persist, indicating persistent underlying pathology in chronic enteropathy





RESEARCH PAPER

Alteration of the fecal microbiota and serum metabolite profiles in dogs with idiopathic inflammatory bowel disease

Yasushi Minamoto, Cristiane C Otoni, Samantha M Steelman, Olga Büyükleblebici, Jörg M Steiner, Albert E Jergens & Jan S Suchodolski

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Pages 33-47 | Received 01 May 2014, Accepted 02 Dec 2014, Published online: 07 Jan 2015

RESEARCH Open Access

Diet-induced remission in chronic enteropathy is associated with altered microbial community structure and synthesis of secondary bile acids

Shuai Wang[1], Rene Martins[2], Megan C. Sullivan[1], Elliot S. Friedman[3], Ana M. Misic[1], Ayah El-Fahmawi[1], Elaine Cristina Pereira De Martinis[4], Kevin O'Brien[1], Ying Chen[1], Charles Bradley[1], Grace Zhang[1], Alexander S. F. Berry[1,5], Christopher A. Hunter[1], Robert N. Baldassano[5], Mark P. Rondeau[2] and Daniel P. Beiting[1]*

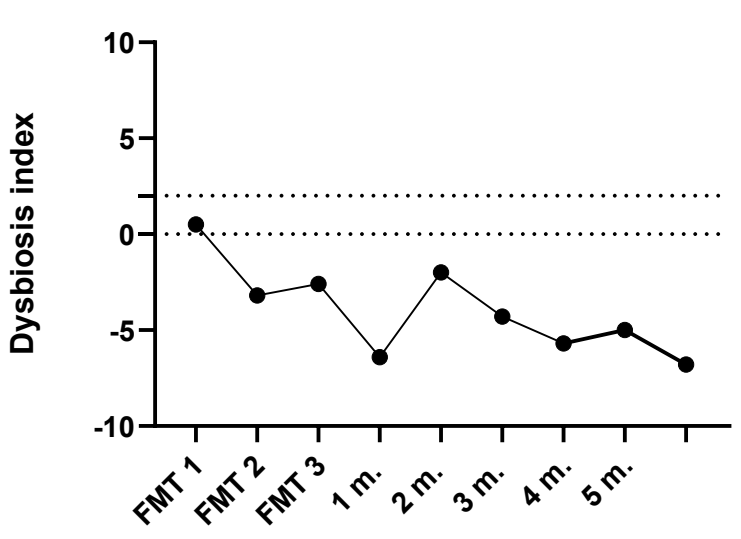
Microbial dysbiosis and fecal metabolomic perturbations in Yorkshire Terriers with chronic enteropathy

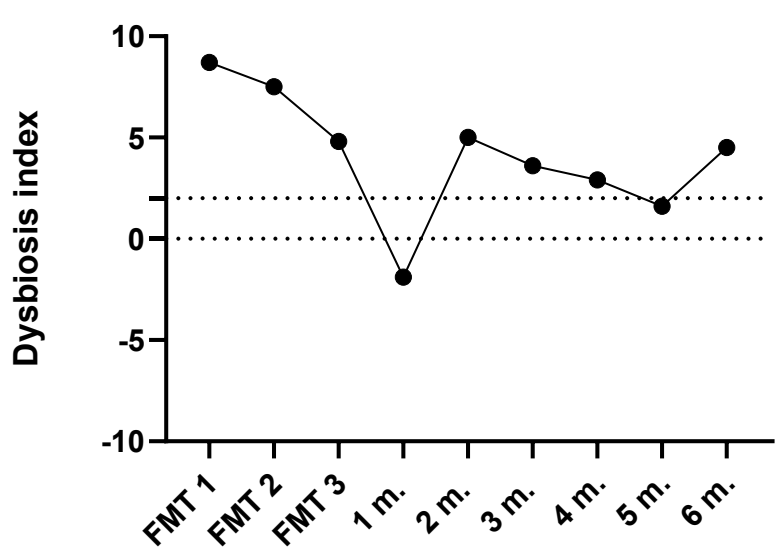
Alexandra I. Galler[1], Jan S. Suchodolski[2], Joerg M. Steiner[2], Chi-Hsuan Sung[2], Katharina M. Hittmair[3], Barbara Richter[4] & Iwan A. Burgener[1]

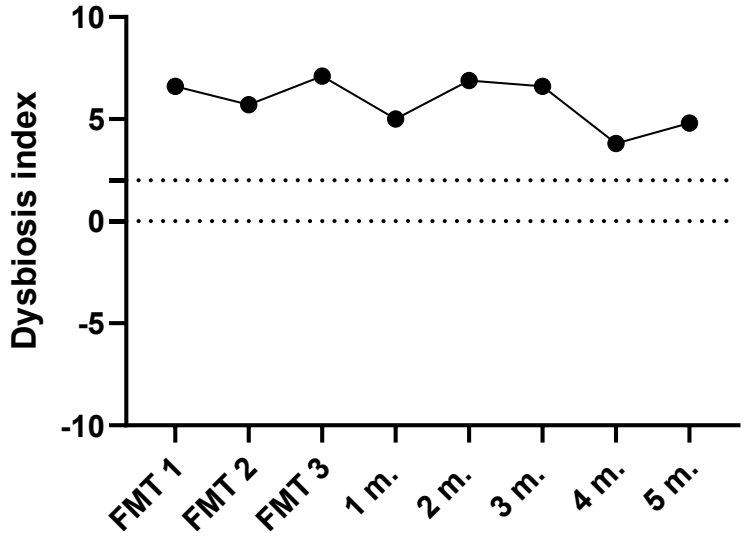
Combined data at baseline from 3 different FMT studies using the same FMT protocol

- Long lasting responders: 85% had DI < 2
- Short-term responders: 70% had DI > 2

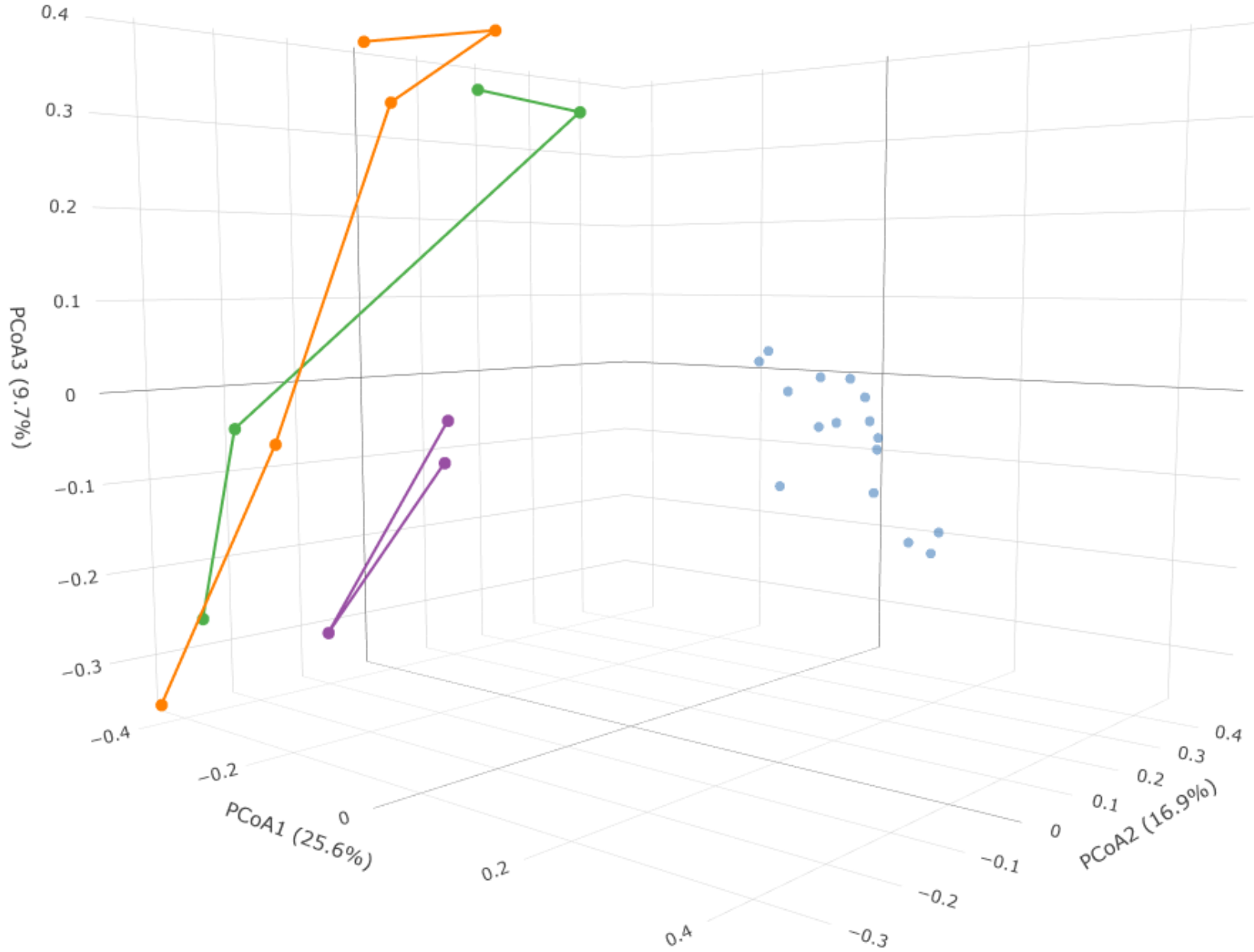
Toresson et al, 2023 and 2025
Vecciato et al, 2025







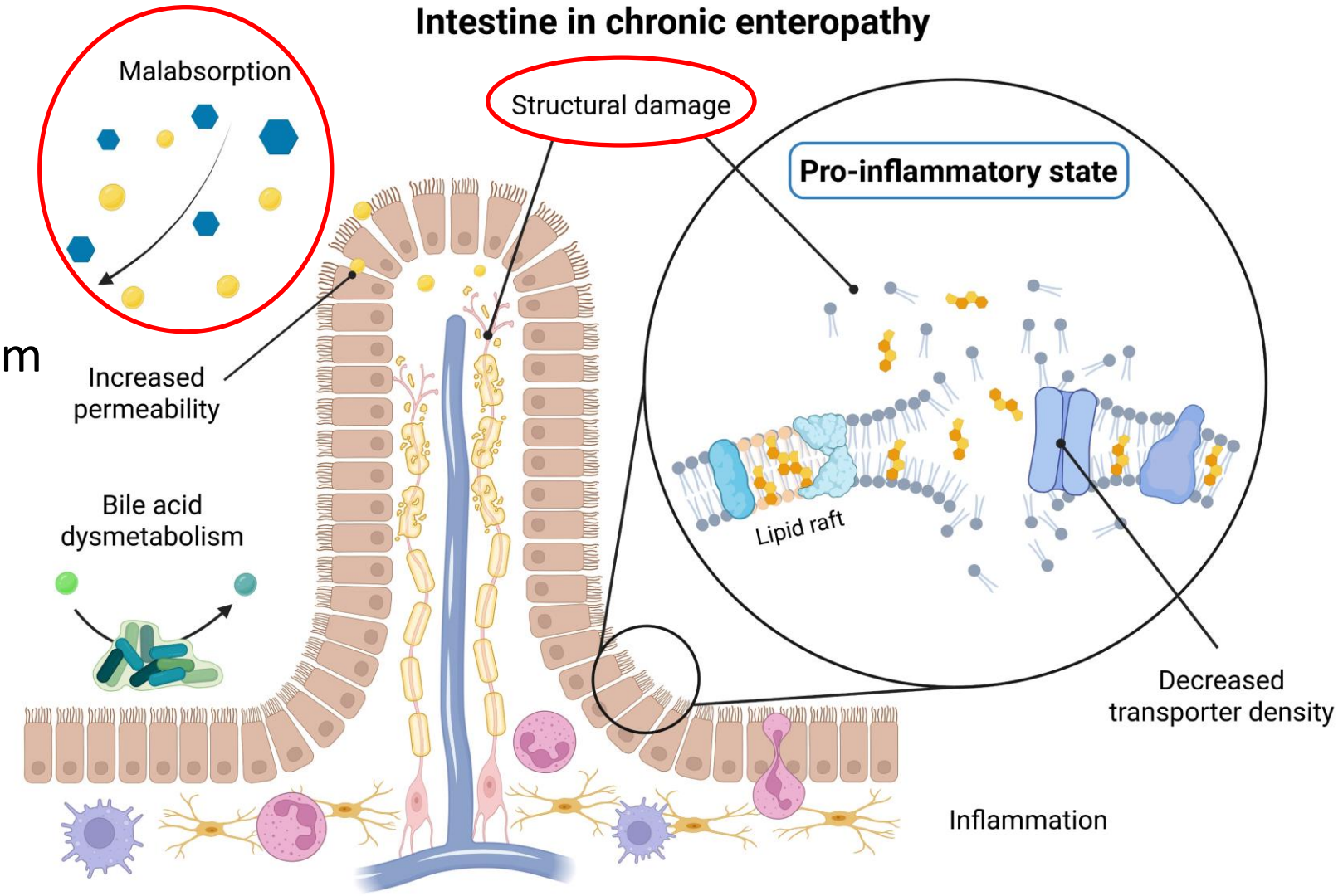
Suchodolski JS, Toresson L. Microbiome Modulation in Veterinary Medicine: From Diet to Fecal Microbiota Transplantation. Vet Clin N Am Small Animal Pract, 2026


0.4
0.3
0.2
0.1
0
−0.1
−0.2
−0.3
PCoA3 (9.7%)
−0.4
−0.2
0
0.2
0.4
PCoA1 (25.6%)
0.4
0.3
0.2
0.1
0
−0.1
−0.2
−0.3
PCoA2 (16.9%)

Underlying pathophysiology of chronic enteropathy

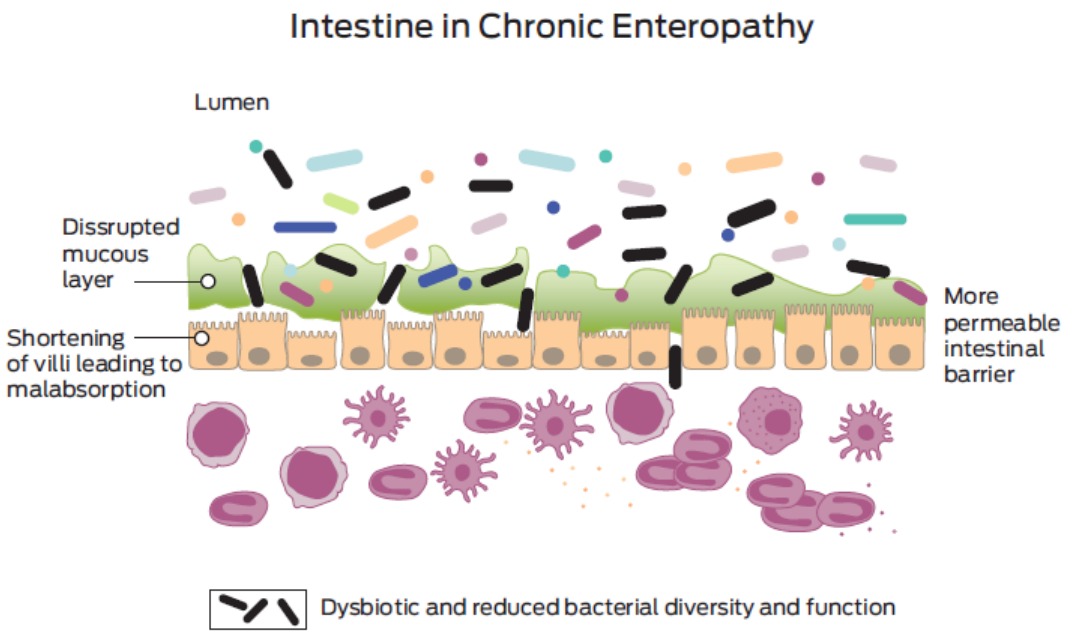
A subset of animals has

- Dysbiosis
- Bile acid and lipid dysmetabolism
- Carbohydrate malabsorption
- Inflammation
- Mucosal damage



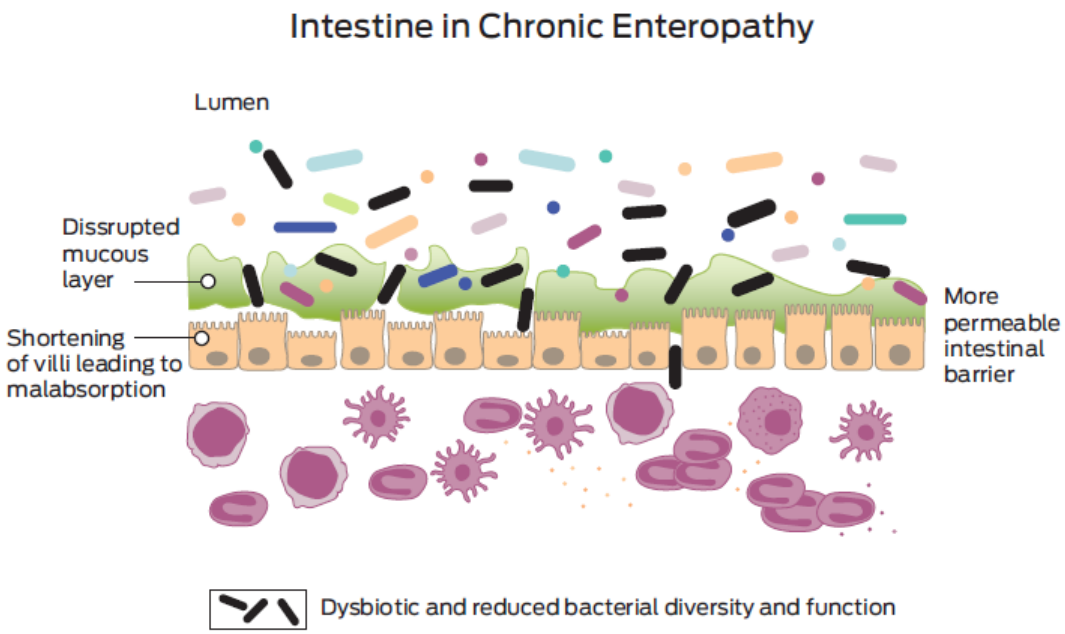
Created with BioRender.com

Summary



- established CIE is more than an immune-mediated disease
- heterogenous syndrome
  - various overlapping pathologies, which differ in extend between patients
- a subset of patients has
  - increased dysbiosis index
  - increased markers of inflammation
  - malabsorption
  - abnormal intestinal permeability
- acute vs chronic enteritis
  - rapid recovery of function in acute
  - persistent dysfunction in chronic

Summary



- need to subclassify and treat these underlying pathologies
- need for multimodal therapy approaches to treat underlying dysfunction
- stage intestinal disease – persistent changes will require long-term management

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Thank you!

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