MS Oral Competition

Effects of Non-Nutritive Sweeteners on Intestinal Morphology and Systemic Immunity in Weaned Pigs

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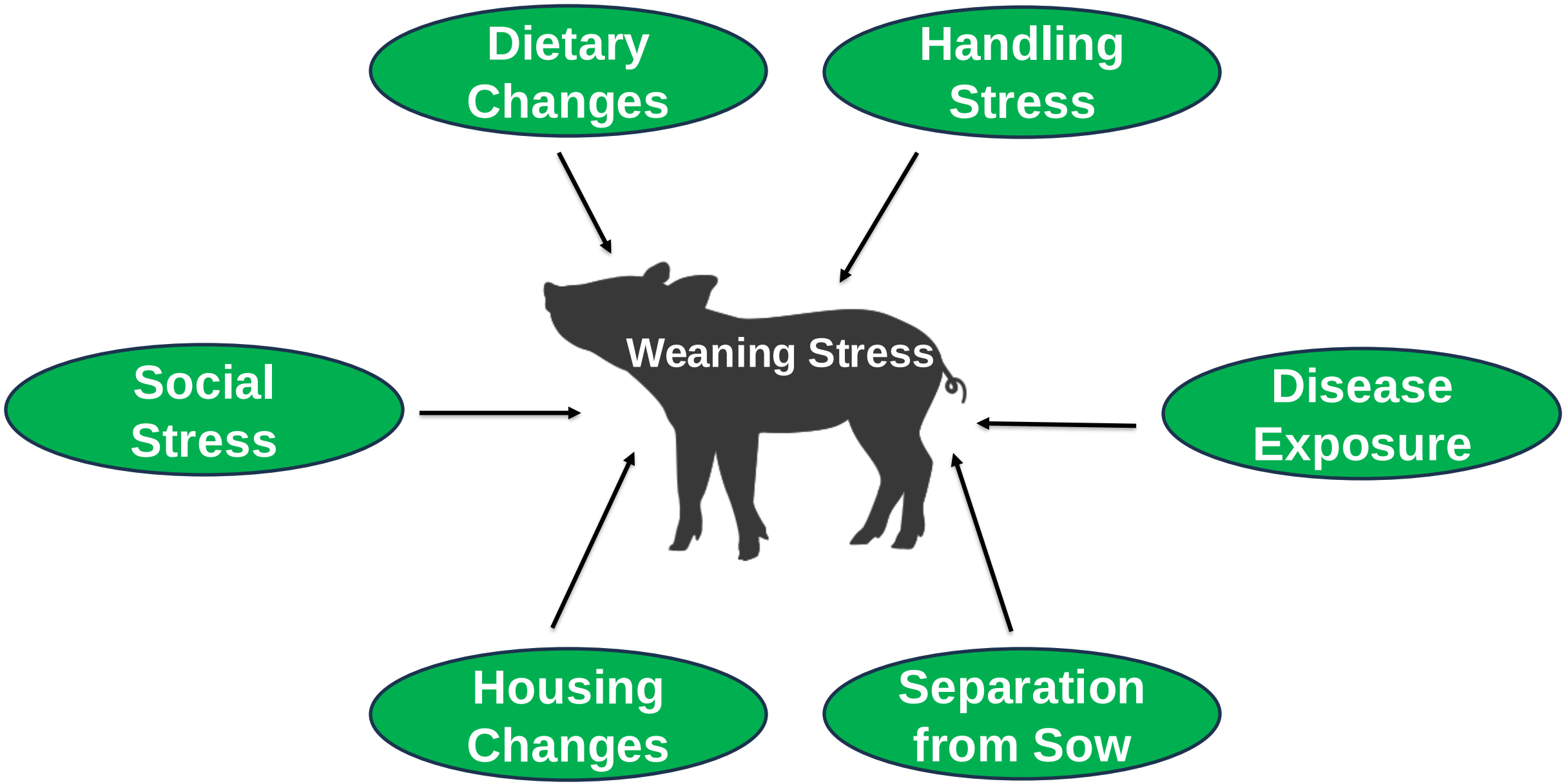
Outline

- Introduction
  - Weaning Stress & Challenges
  - Non-Nutritive Sweeteners
- Objective & Hypothesis
- Results & Conclusions
- Future Directions


Dietary Changes
Handling Stress
Social Stress
Weaning Stress
Disease Exposure
Housing Changes
Separation from Sow

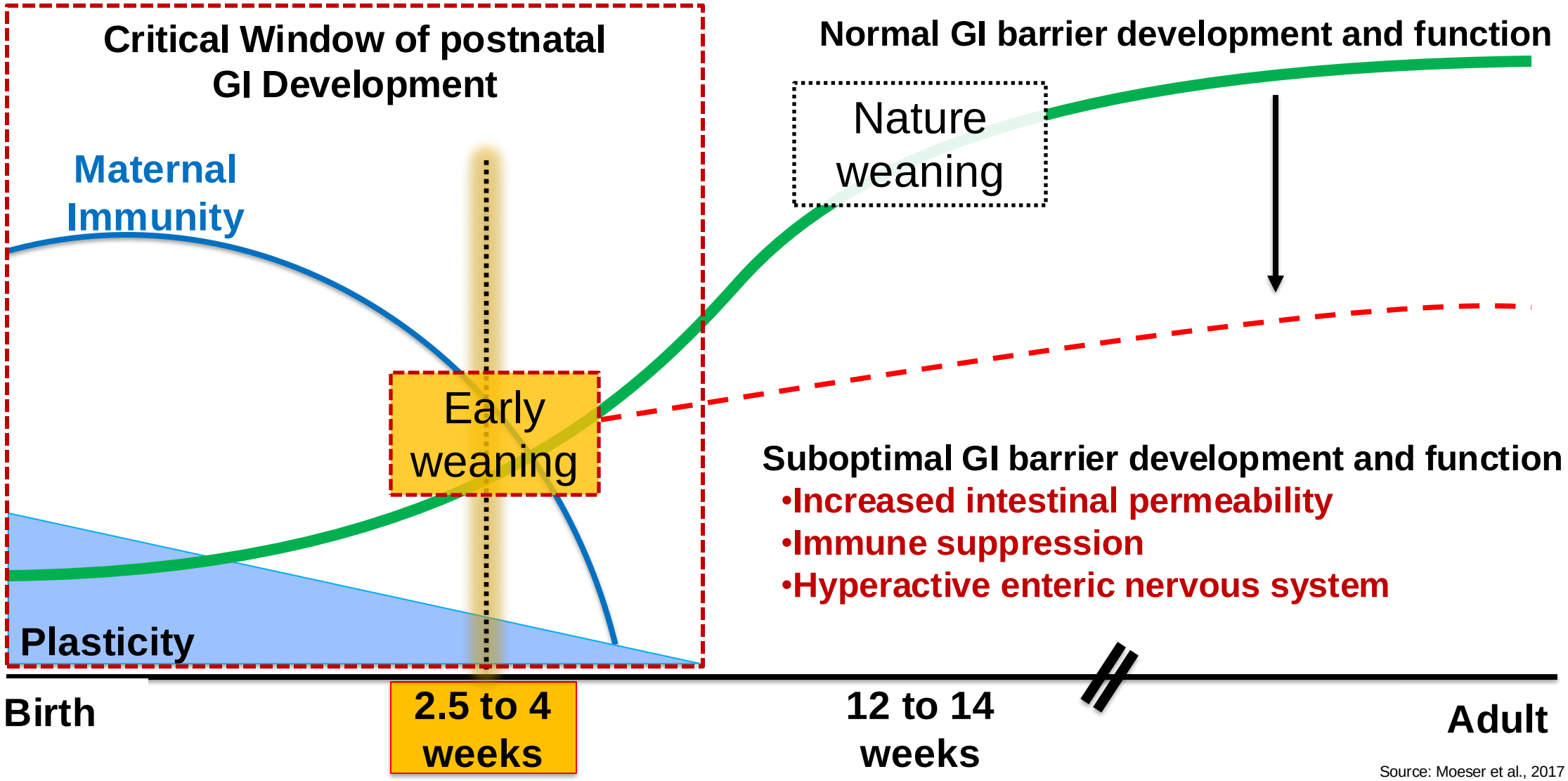
Post-weaning Diarrhea

↓ Growth/Feed Intake

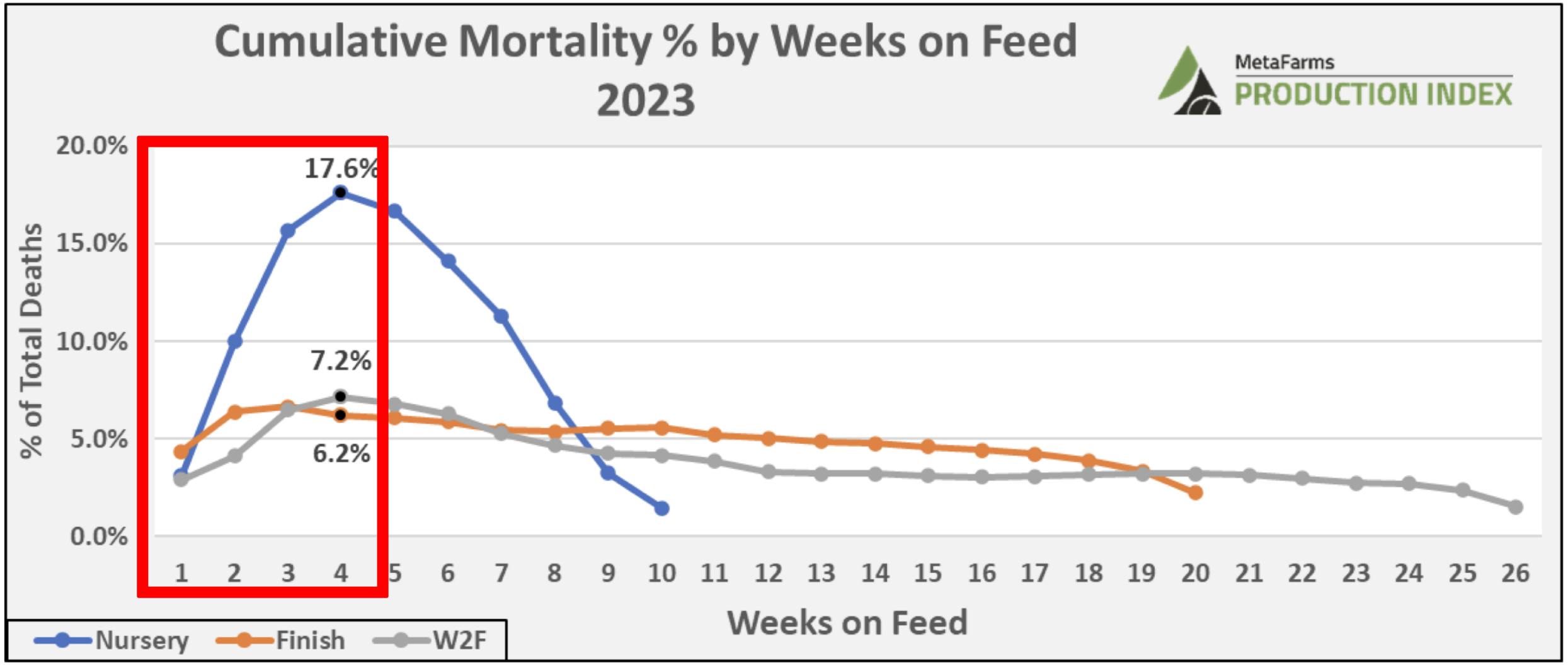
↓ Immune Responses

Development of the Intestinal Tract

Gastrointestinal (GI) tract development during weaning

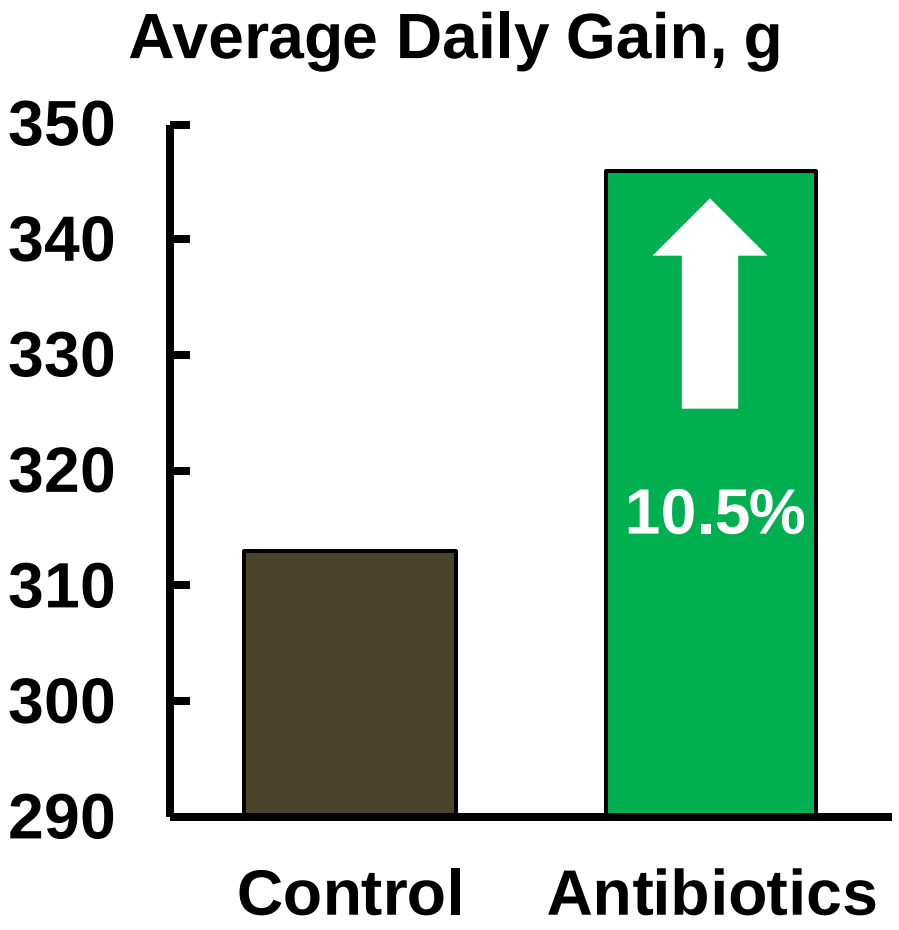


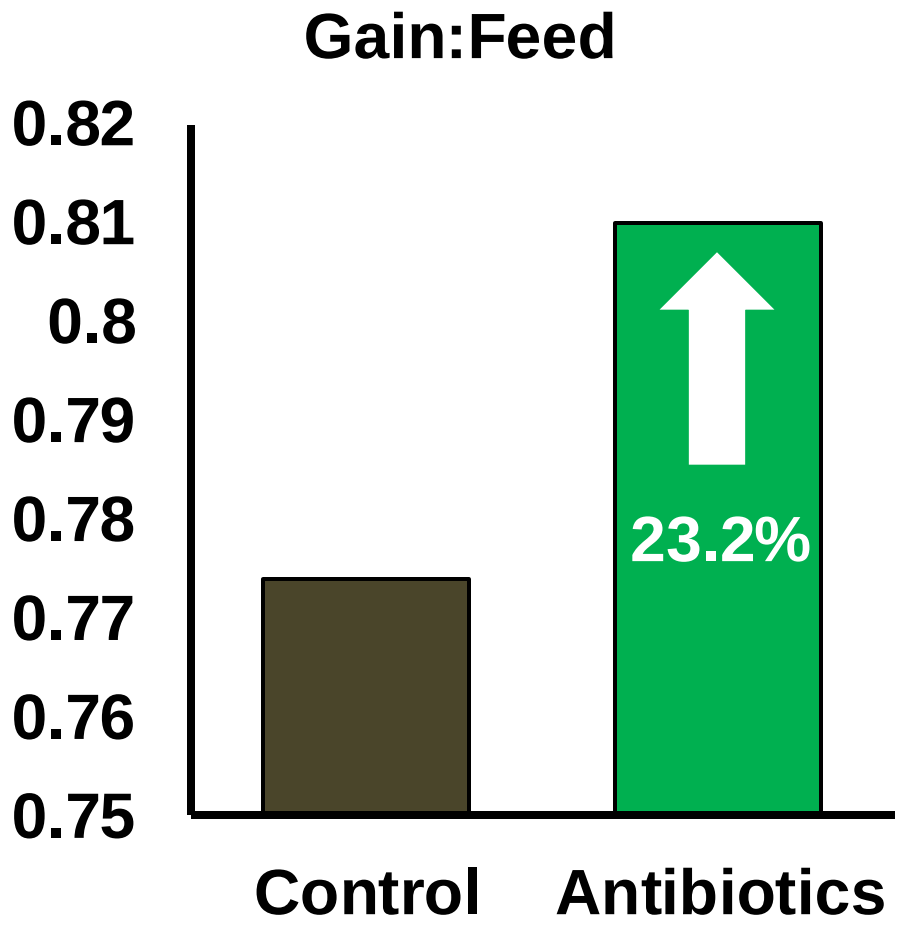
Source: Moeser et al., 2017



Nursery mortality rates reach peak percentages within the first 4 weeks post-weaning (National Pork Board, 2023)

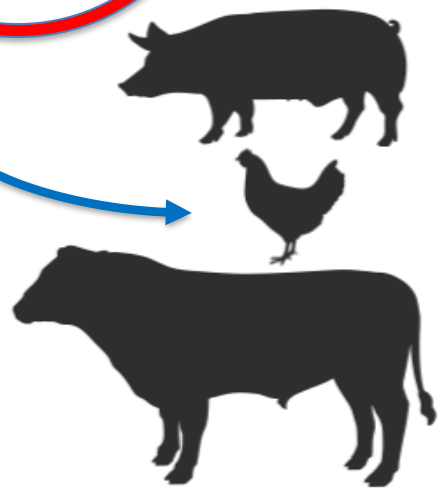
In-Feed Antibiotics During Post-Weaning (28-days)





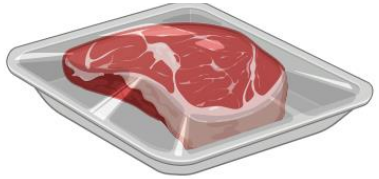
Keagan et al., 2005

Restrictions on In-Feed Antibiotics



Development of antibiotic resistance bacteria in farm animals

Fertilizer or water contaminated with resistant bacteria on crops



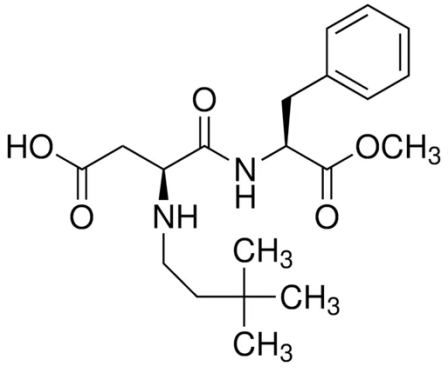
Meat products can transfer antibiotic-resistant bacteria

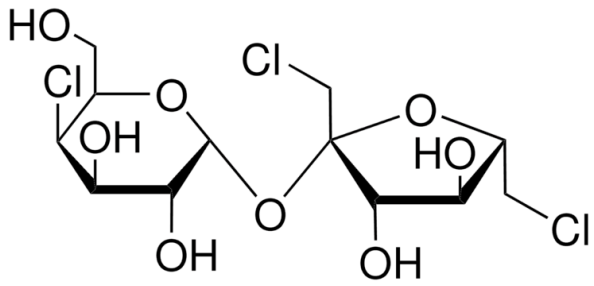
Contaminated products can transfer antibiotic-resistant bacteria to humans

Potential Alternative: Non-Nutritive Sweeteners

- **Artificial Sweeteners, Sugar Substitutes, High Intensity Sweeteners**
- **Minimal caloric value and 10 to 1000 times sweeter than sucrose** (Carocho et al., 2017)
- **Potential benefits in pigs:**
  - ↑ **Feed Intake** (Lee et al., 2019; Zhang et al., 2020)
  - ↑ **Growth Performance** (Wang et al., 2014; Zhu et al., 2016;)
  - **Modulated Immune Response & Reduction of Diarrhea** (Wang et al., 2014; Lie et al., 2022; Xiong et al., 2022)

Non-Nutritive Sweeteners: Neotame & Sucralose





Feed Preference	Feed Intake	Average Daily Gain	Other
↑	↑	↑	**Sucralose:** ↑ T1R2-T1R3 receptor activation ↑ Expression and activity of intestinal SGLT1

(Zhu et al., 2016; Lee et al., 2019 Zhang et al., 2020; Glaser et al., 2000; Daly et al., 2021)

Non-Nutritive Sweetener Preliminary Data

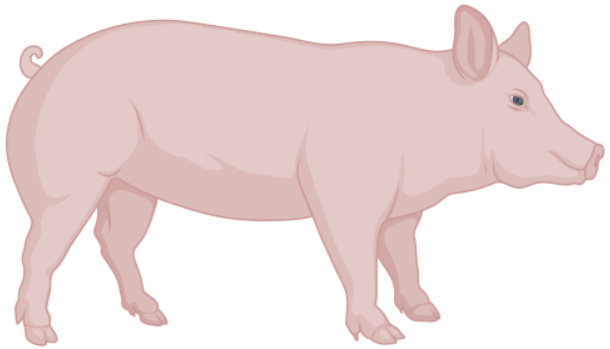
Growth Performance & Frequency of Diarrhea

Preliminary Data: Non-Nutritive Sweeteners

	Body Weight	Average Daily Gain	Average Daily Feed Intake	Frequency of Diarrhea
Sucralose	↑	↑	↑	↓
Neotame	↑	↑	↑	↓
Carbadox	↑	↑	↑	↓

(Jansen et al., 2024)

Objective



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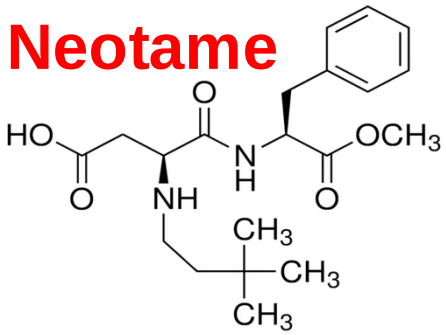
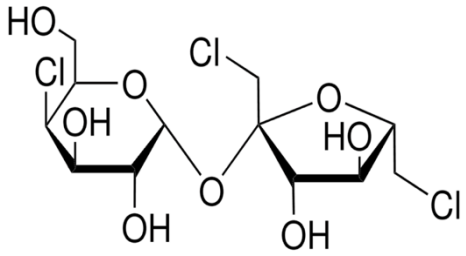
Neotame



Sucralose



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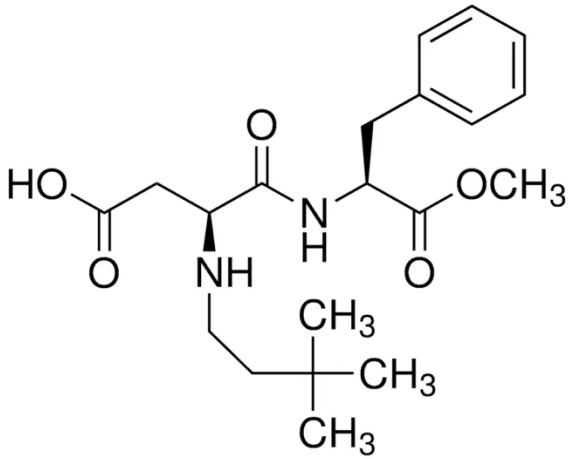
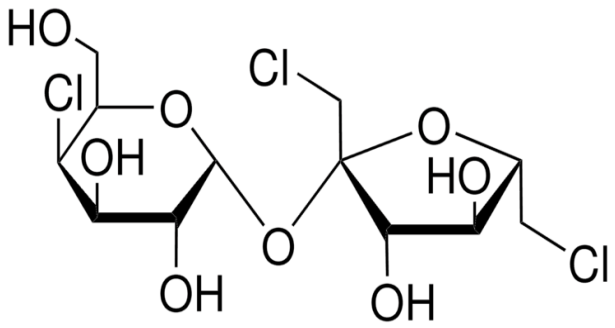
Investigate the effects of non-nutritive sweeteners, sucralose and neotame, on small intestinal development and inflammatory responses

Hypothesis

We hypothesize that these sweeteners will positively influence small intestinal morphology and systemic immunity furthering our understanding of the underlying mechanisms



Neotame



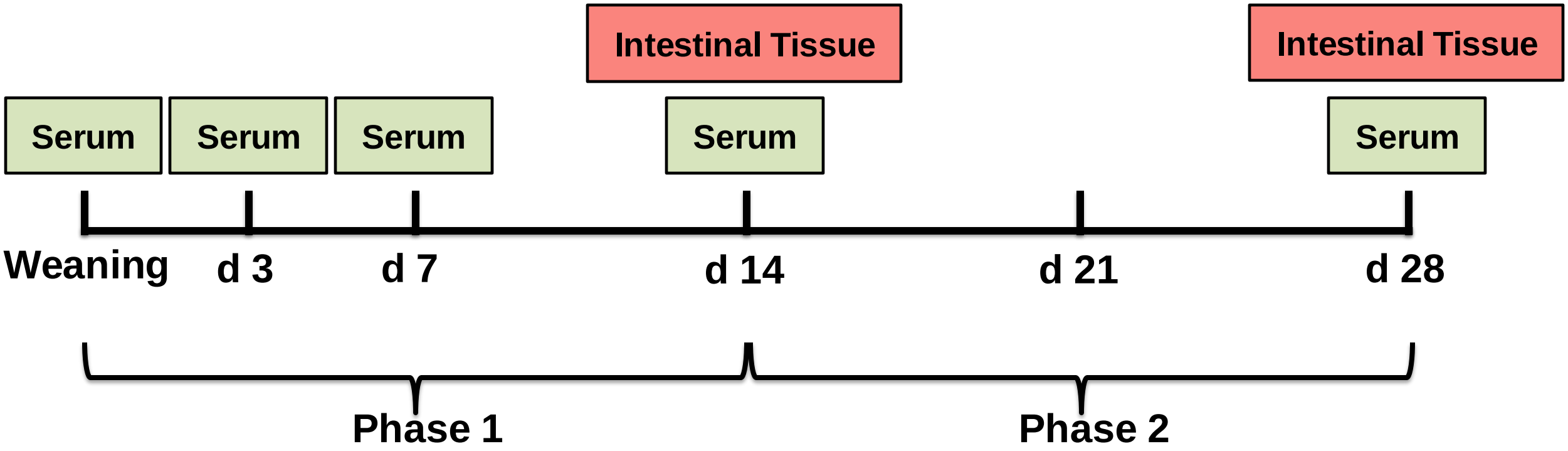
Sucralose

Experimental Design & Treatments

- **Randomized Complete Block Design (Blocks: BW and Sex)**
- **288 Weanling Pigs (6 pigs/pen, 4 treatments)**
  - **Average Body Weight: 6.21 ± 0.45 kg**
  - **Weaning Age: 21 ± 1 days old**
- **28-day Feeding Program**

Nursery basal diet as control (CON)
CON + 150 mg/kg of Sucralose (SCL)
CON + 30 mg/kg of Neotame (NEO)
CON + 50 mg/kg of Carbadox (CBX)

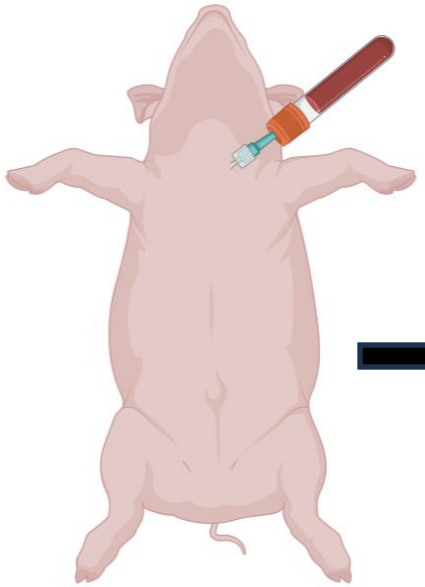
Experimental Timeline



Statistical Analysis

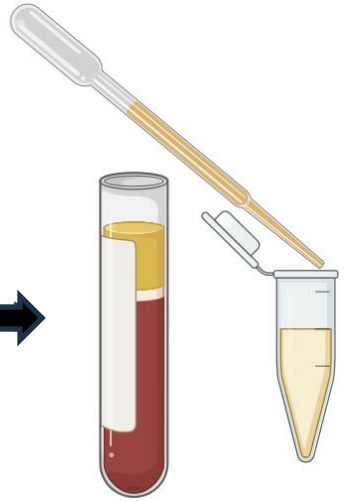
- **Statistical Model:**
  - **Response Variable:** $Y_{ijk} = \mu + D_i + B_{jk} + \epsilon_{ijk}$
  - **Experimental Unit: Pen**
  - **Fixed effect: Diet**
  - **Random Effect: Block (body weight & sex)**
- **All data were analyzed by ANOVA using the PROC MIXED of SAS**
- **Significance at $P \leq 0.05$ and tendency at $0.05 < P \leq 0.10$**

Sample Collection: Serum

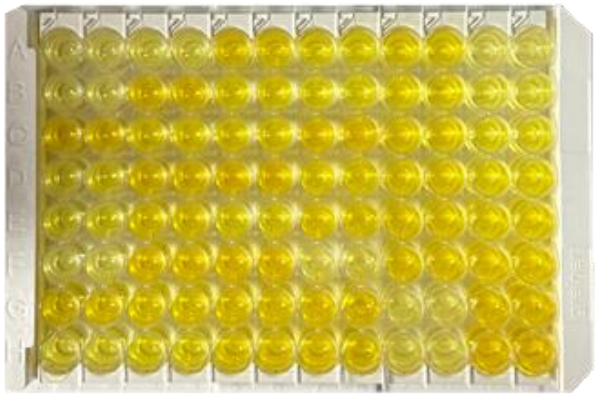


Whole Blood Collection (6 pigs/treatment)

Centrifuge

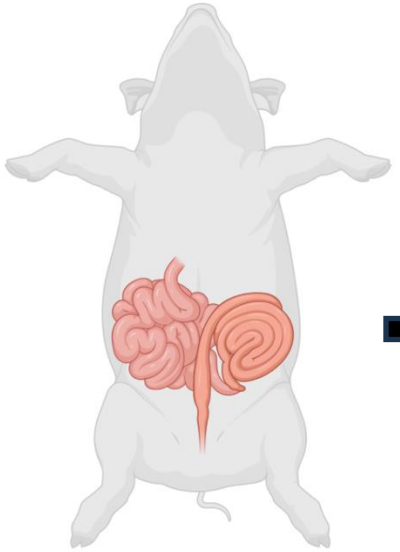


Serum Isolation

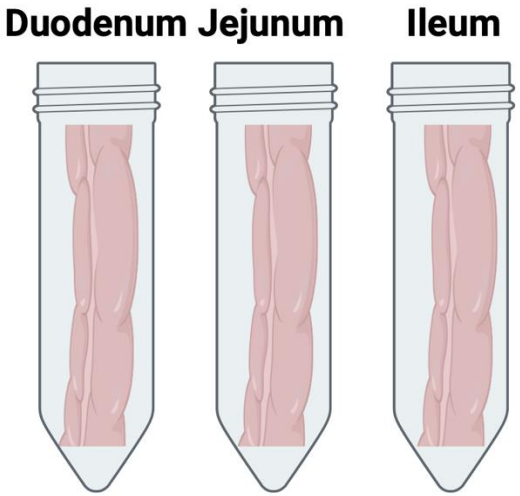


ELISA

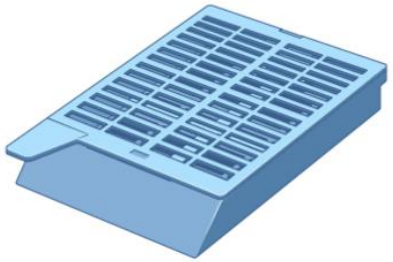
Sample Collection: Small Intestine Tissue



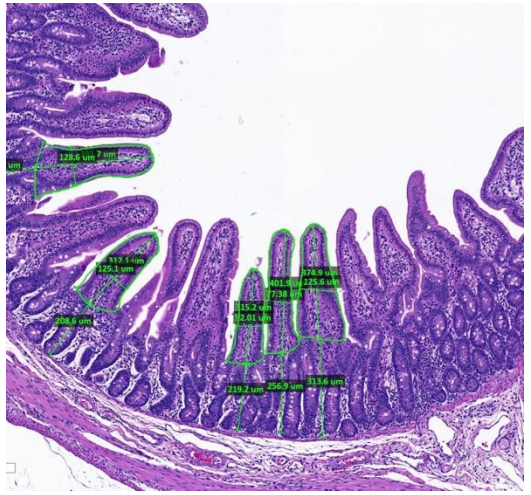
Euthanasia
(6 pig/treatment/day)



Tissue Collection



Embedding in Paraffin



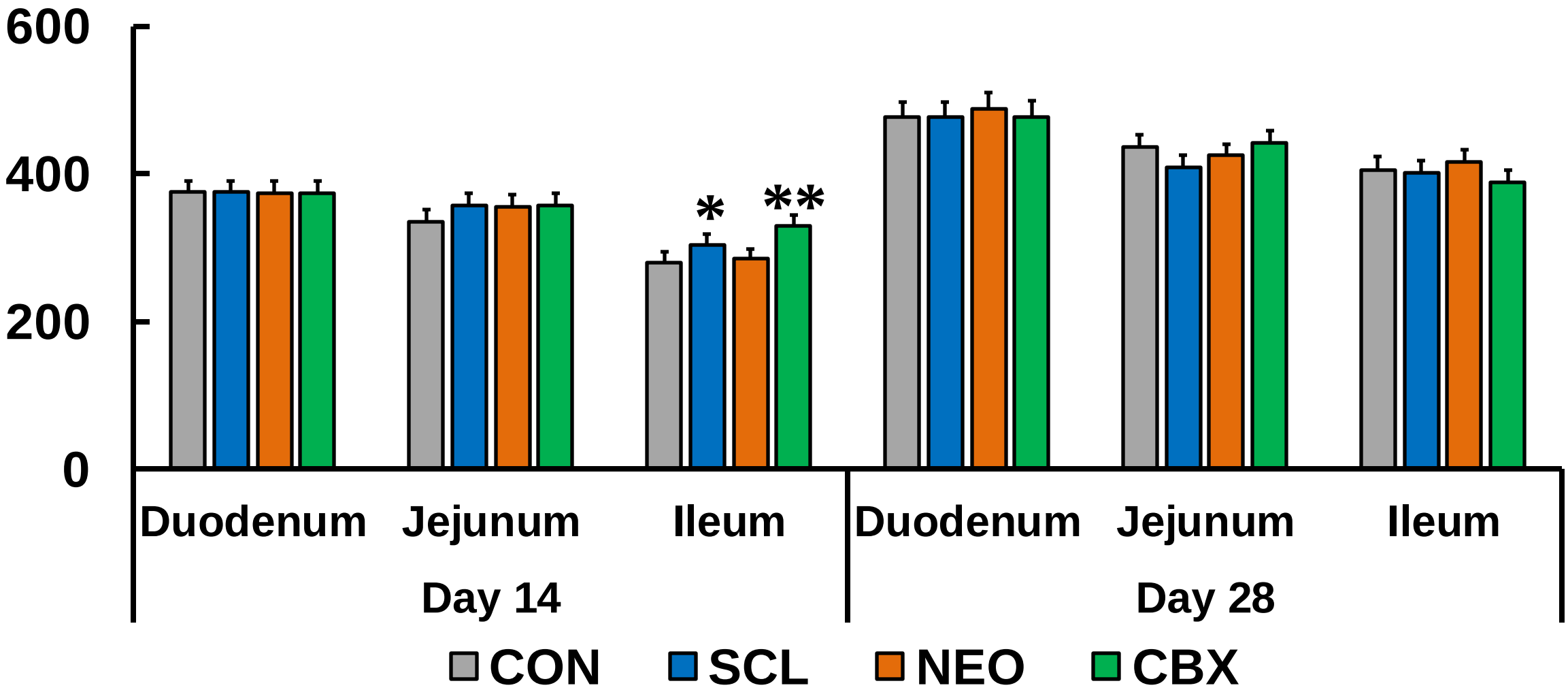
Staining with H&E and Scanning

Non-Nutritive Sweetener

Intestinal Morphology Results

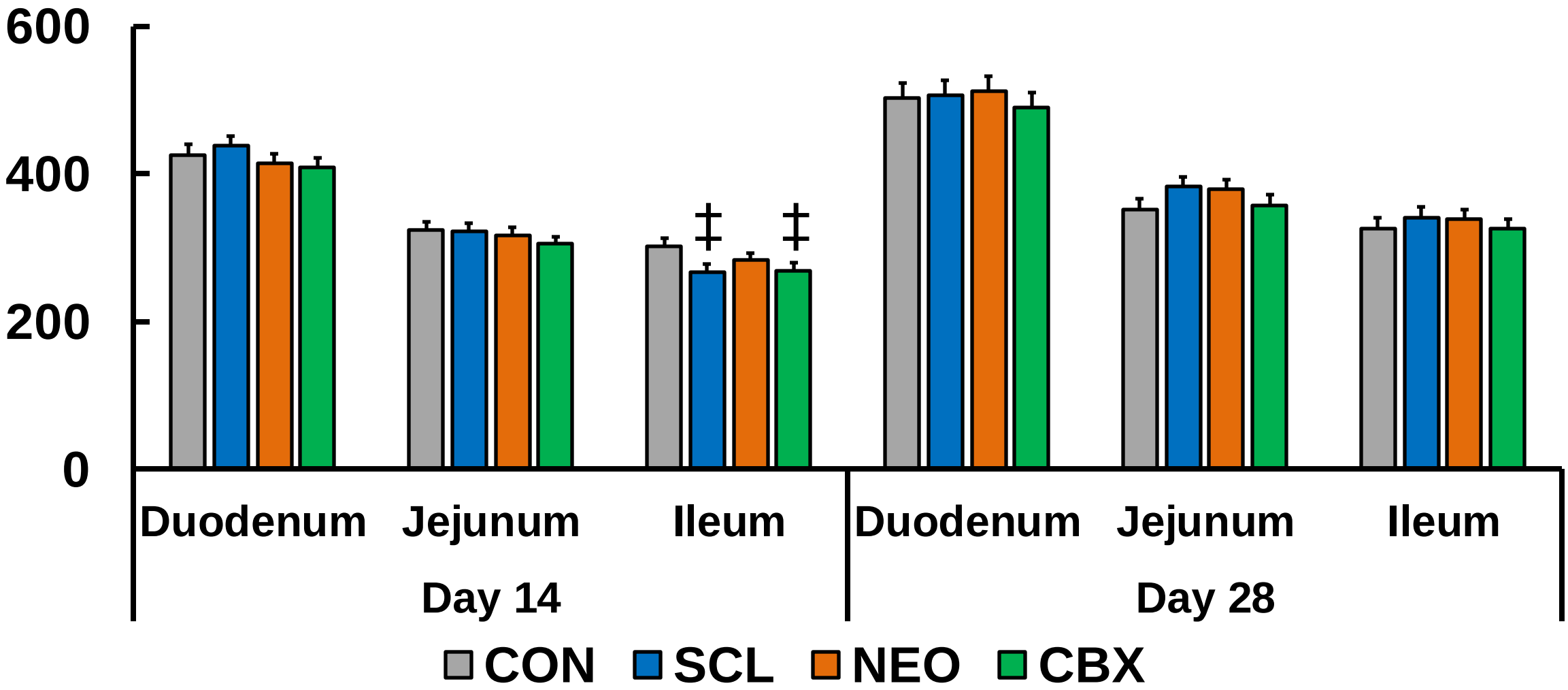
* Tended to increase
** Significant increase

Villi Height, µm



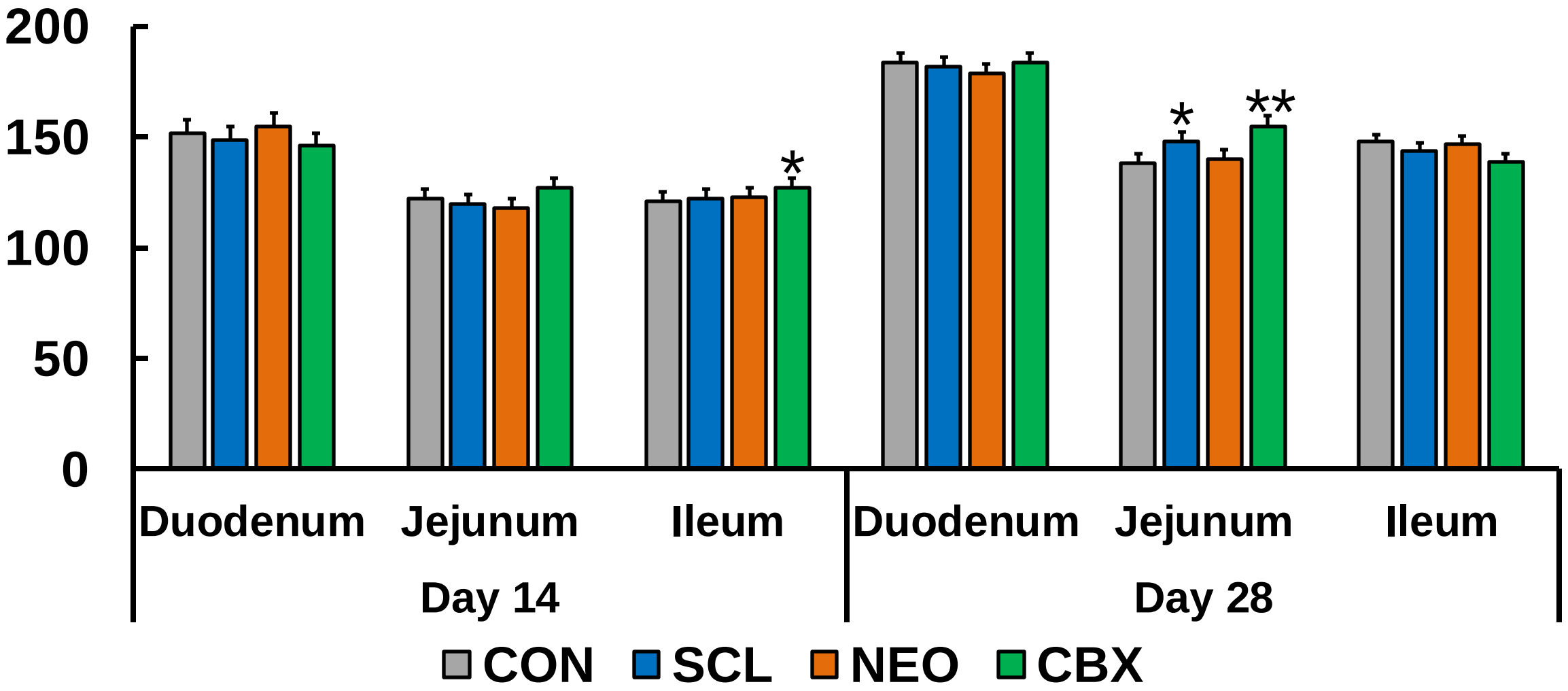
† Tended to decrease
‡ Significant decrease

Crypt Depth, µm



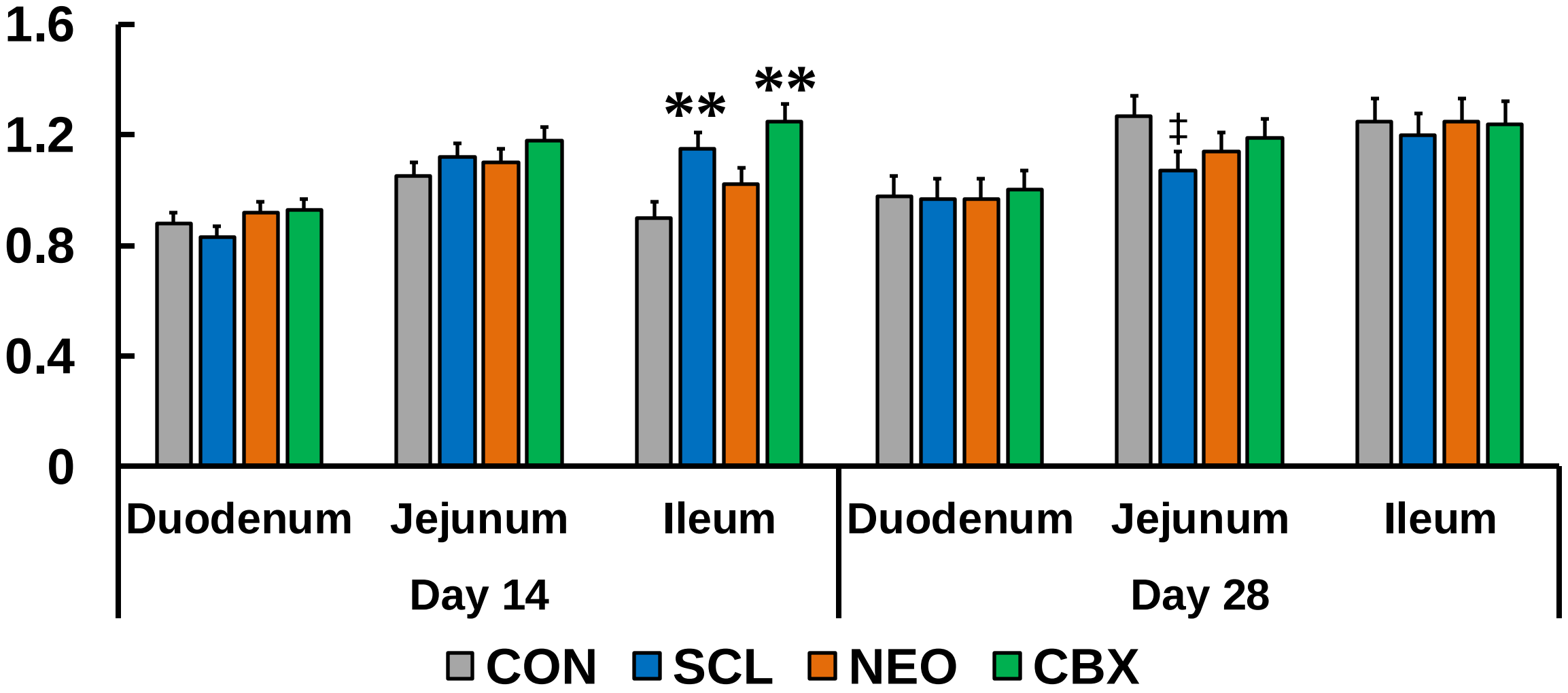
* Tended to increase
** Significant increase

Villi Width, µm



* Tended to increase
** Significant increase
‡ Significant decrease

Villi Height:Crypt Depth



Non-Nutritive Sweetener

ELISA Results

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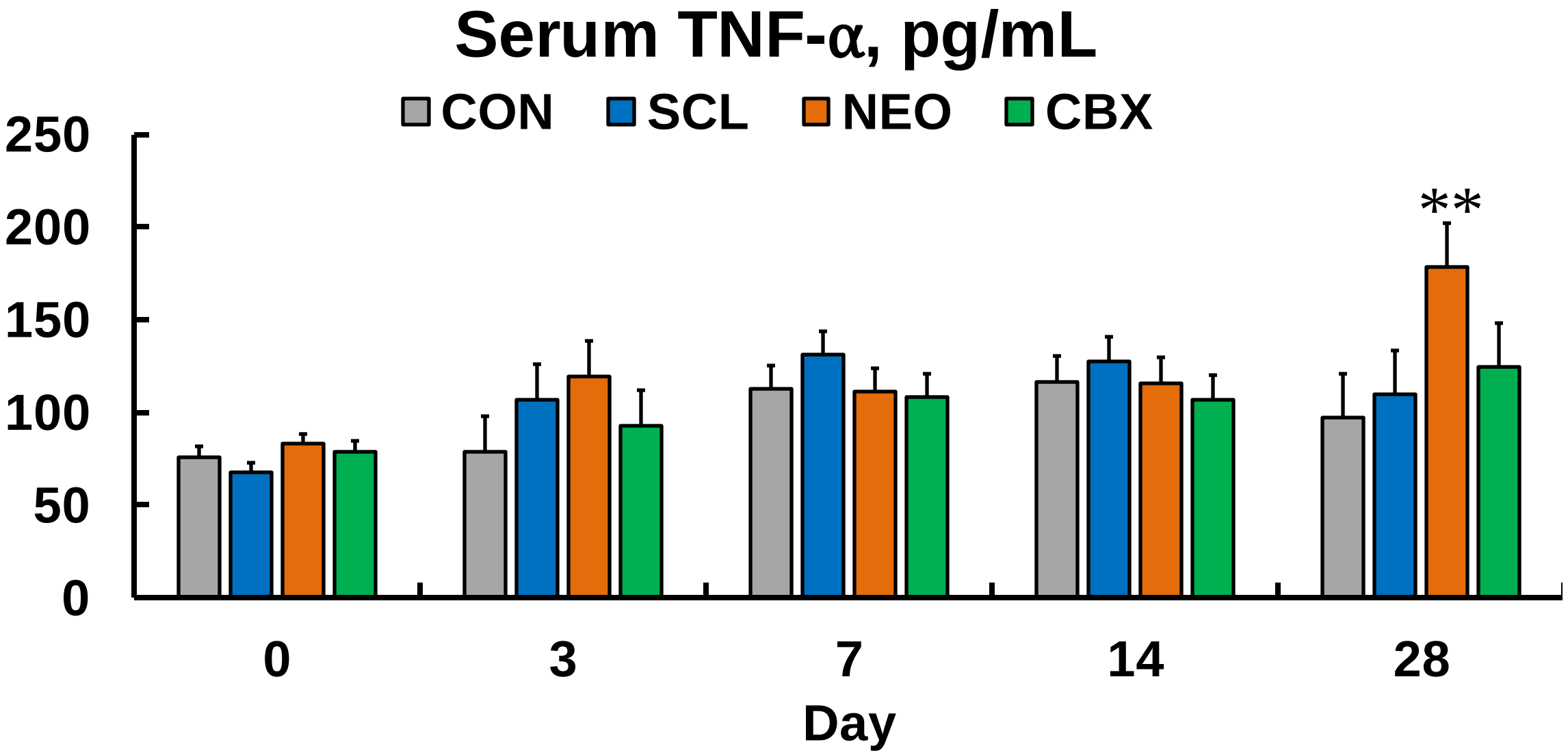
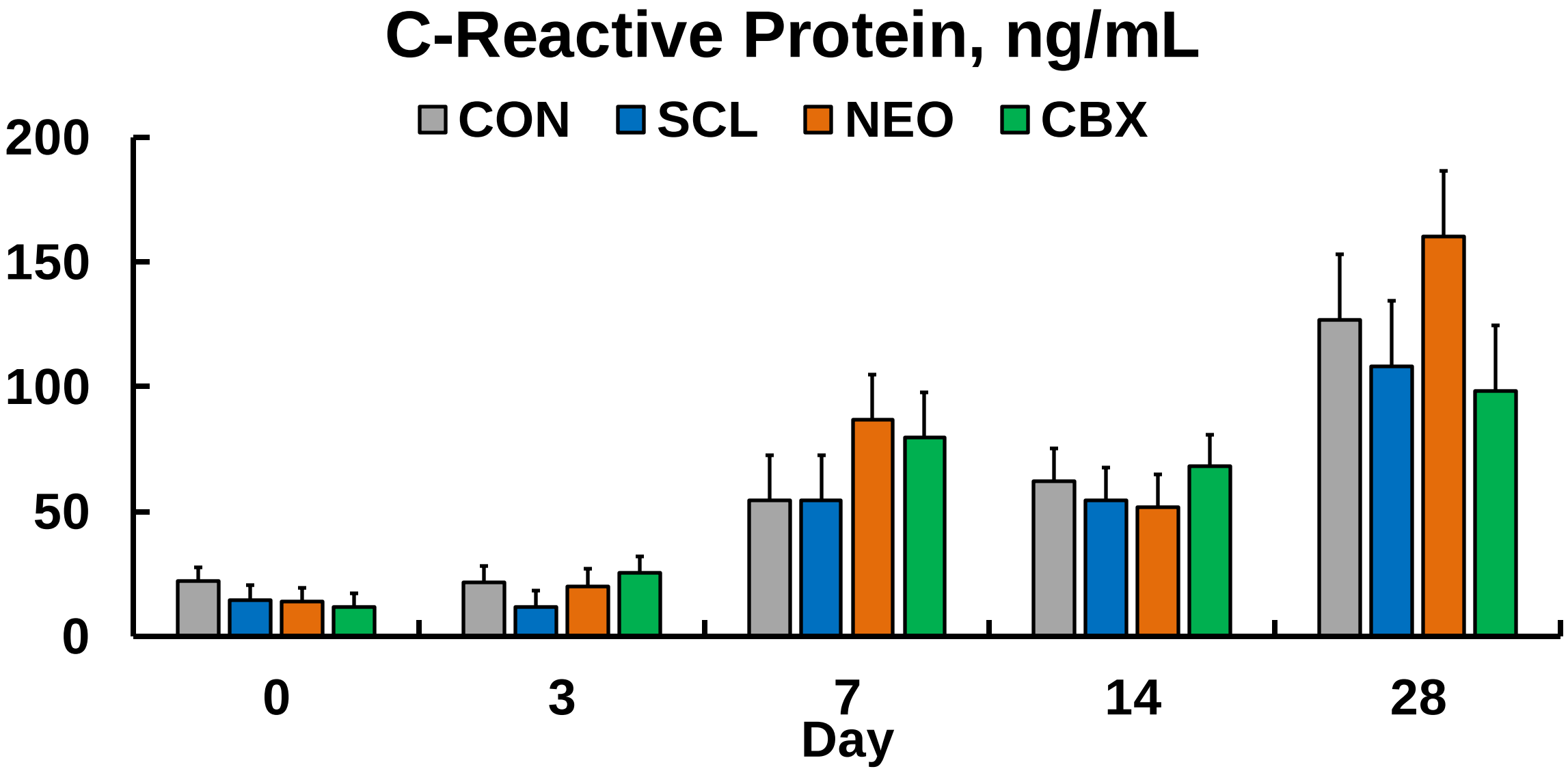
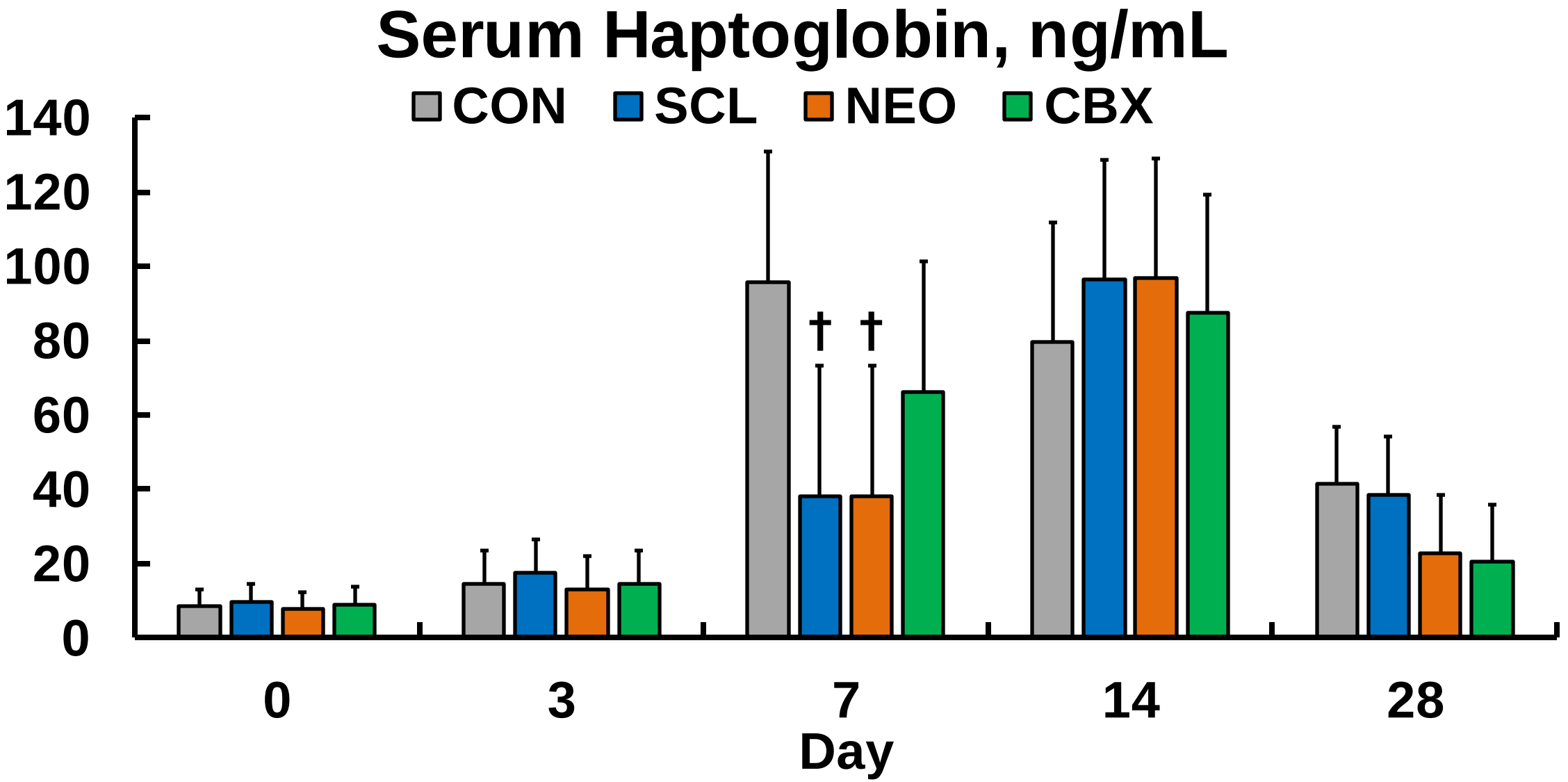
** Significant increase

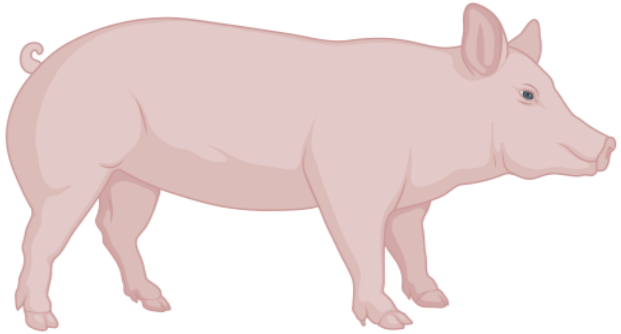



C-Reactive Protein, ng/mL
CON
SCL
NEO
CBX
200
150
100
50
0
0
3
7
14
28
Day

† Tended to decrease
‡ Significant decrease



Summary: During the First 2-Weeks Post-Weaning…



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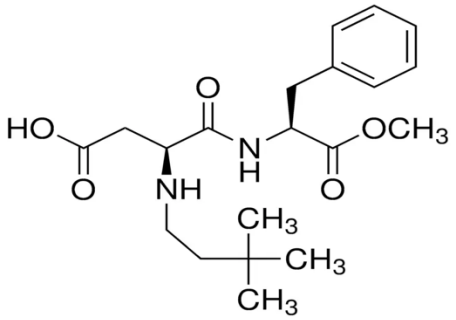
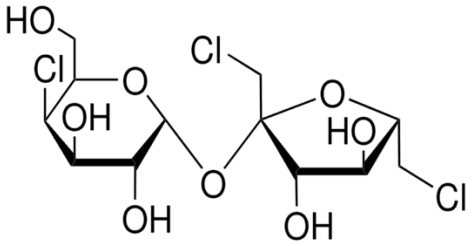
Neotame



Sucralose



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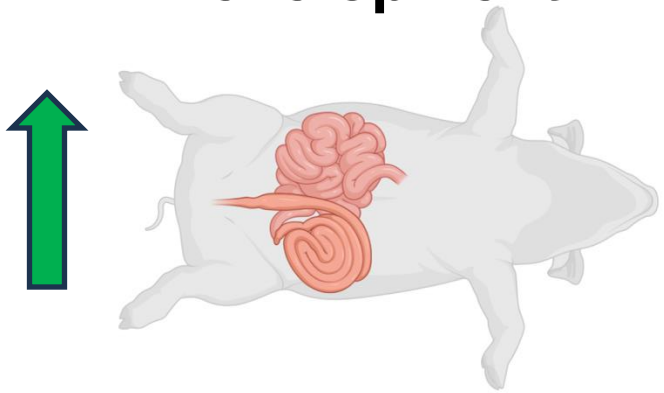
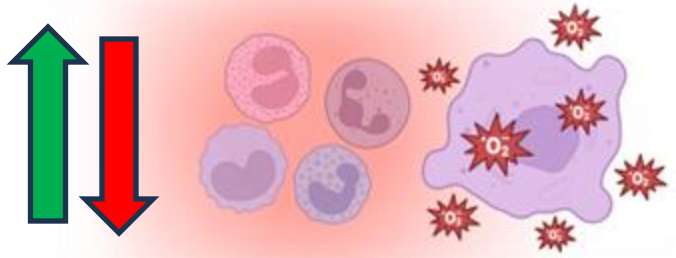
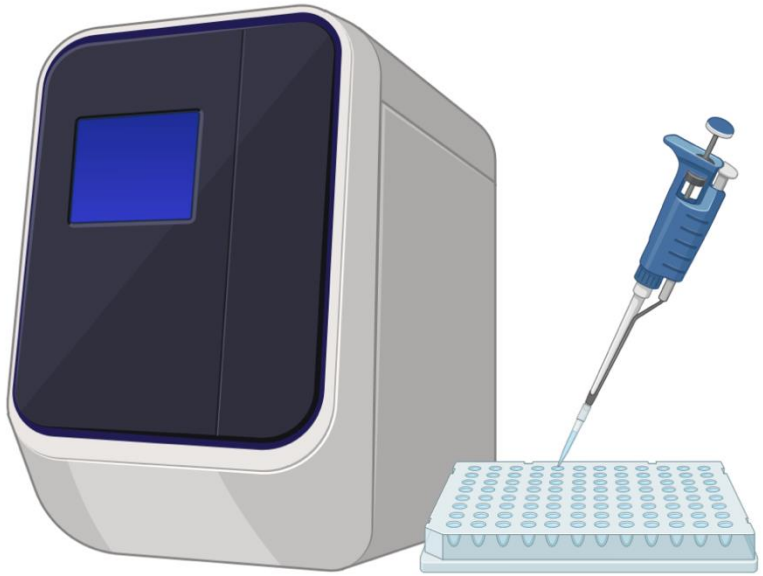
Small Intestinal Development



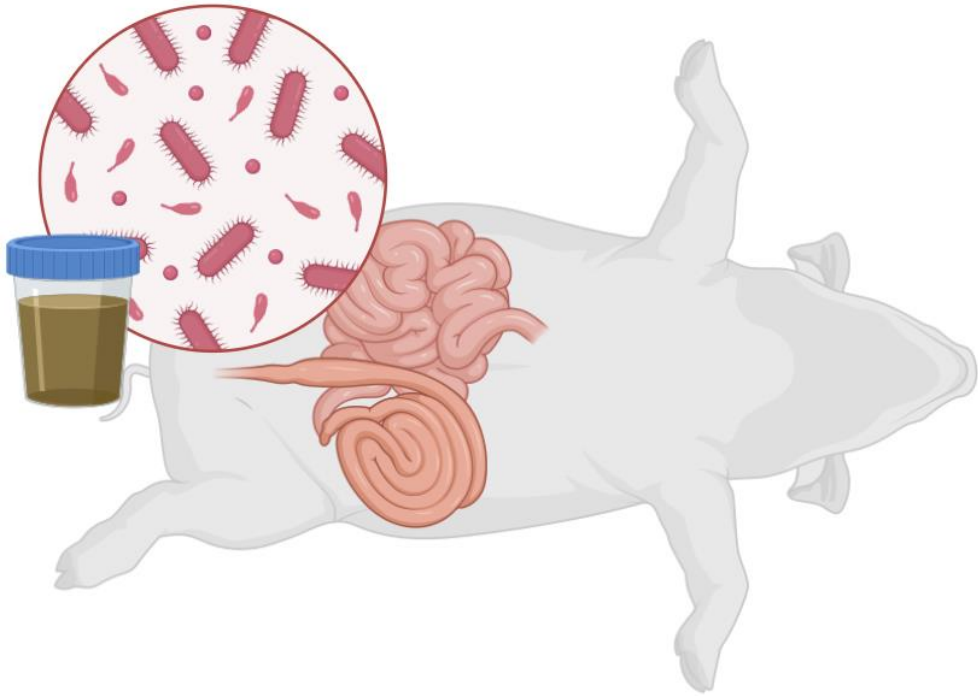
Stress Response



On-Going Research



Gene Expression of the Jejunal and Ileal Mucosa



Analysis of the Gut Microbiota

Acknowledgement

MSU Animal Nutrition, Health, and Physiology Laboratory
East Lansing, MI

Thank you for your attention!