

Young Scholar Award Talk | June 2022

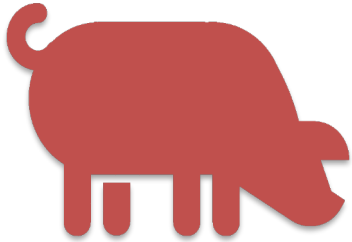
Supplementation of Oligosaccharide-based Polymer Enhanced Growth and Disease Resistance of Weaned Pigs by Modulating Intestinal Integrity and Systemic Immunity

Kwangwook Kim, PhD

**Department of Animal Science
University of California, Davis**



Outline



**Challenges in
swine industry**

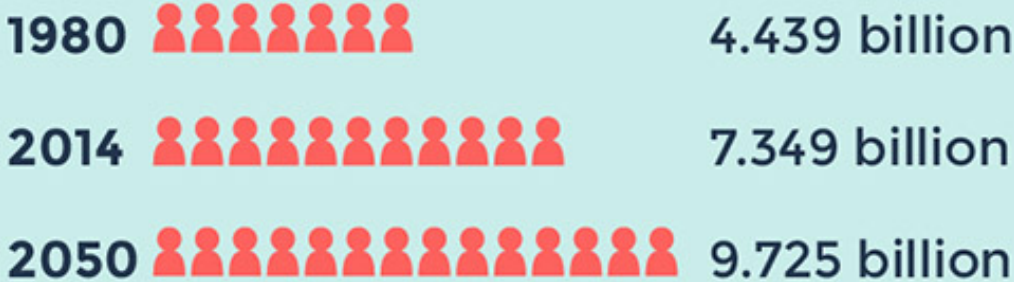


**In-feed antibiotics &
potential alternative
methods**



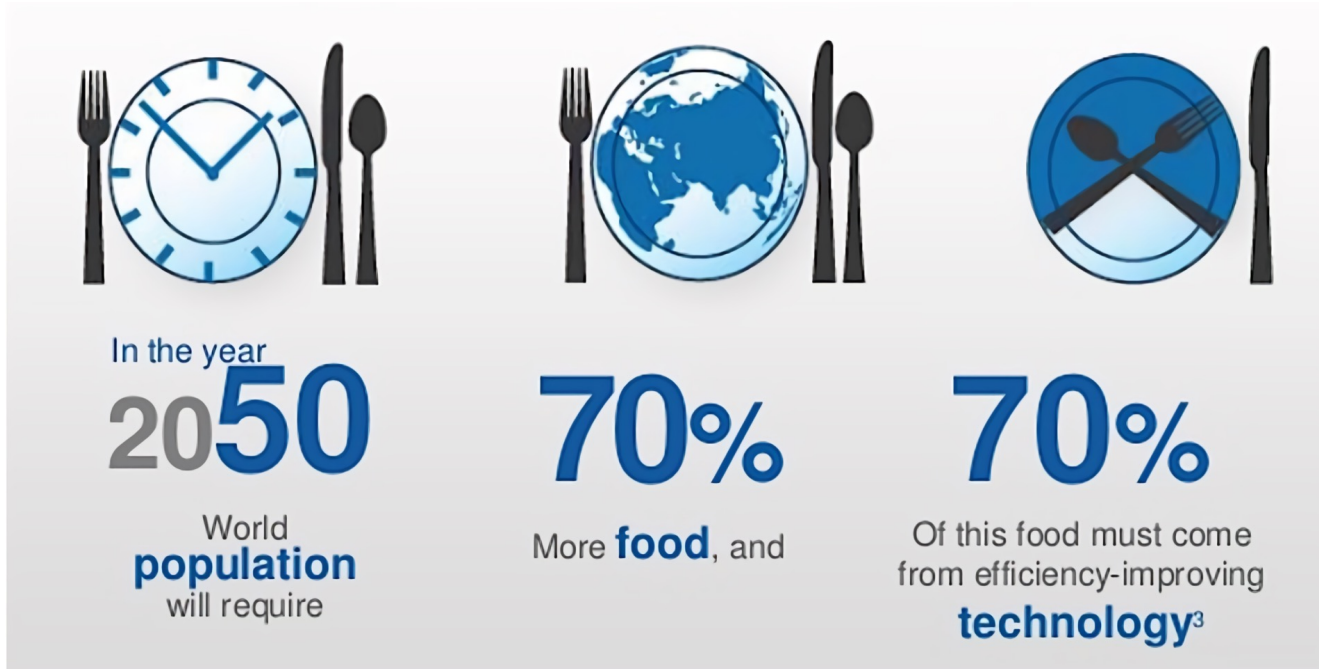
**Research findings
& implications**

Global population growth: Feeding the world in 2050



Source: United Nations, Department of Economics and Social Affairs, Population Division (2014). World Urbanization Prospects: The 2014 Revision, custom data acquired via website

Can we meet the rising global food demand?



Source: World Agriculture: Towards 2015/2030. Summary Report (<https://www.fao.org/3/y3557e/y3557e.pdf>)

5 challenges that will influence food production towards 2050



**Increase food
production
per acre**



**Climate
change**



**Farmland
limitation**



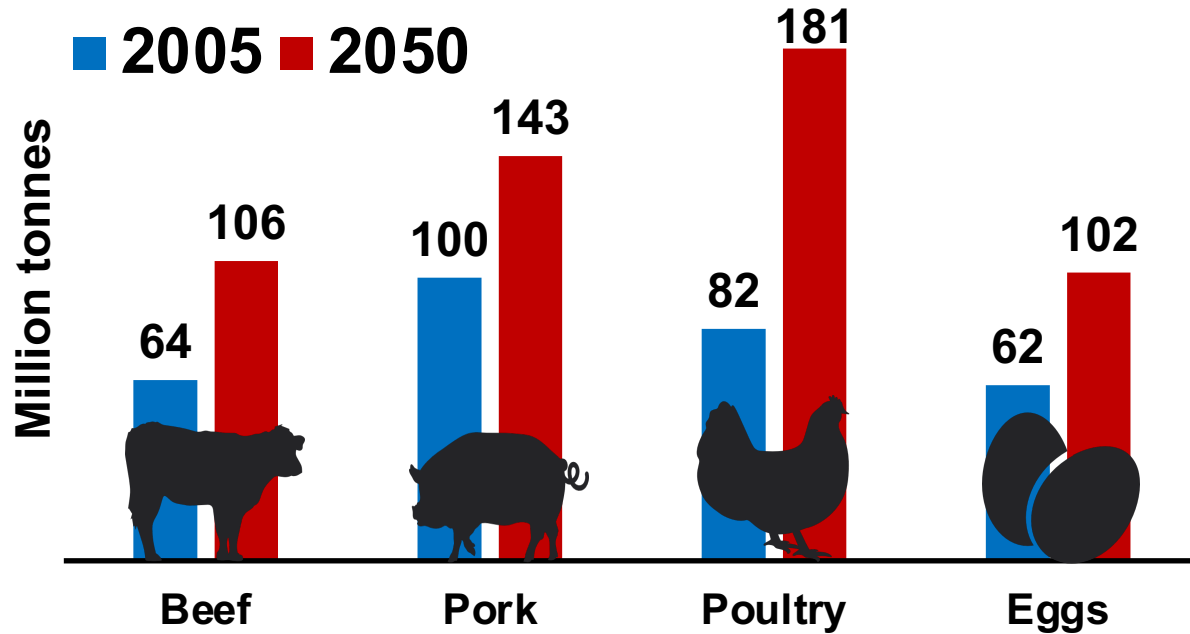
**Improving
food quality**



**Natural
resources**

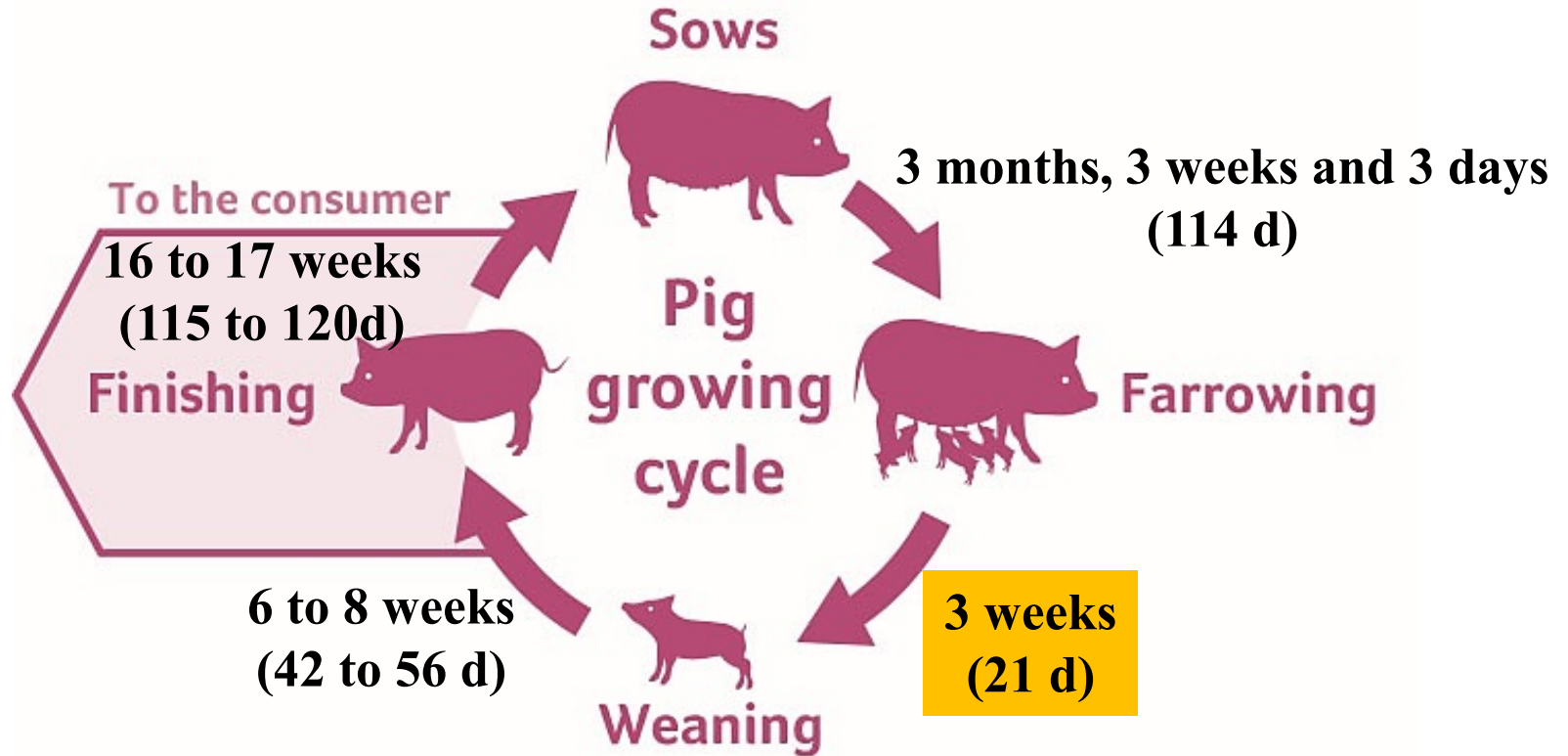
Source: www.agrocares.com/en/news/5-challenges-food-production

Growth in global protein demand



Source: Food and Agriculture Organization of the United Nations, ESA Working Paper No. 12-03, p. 131

Life cycle of a market pig

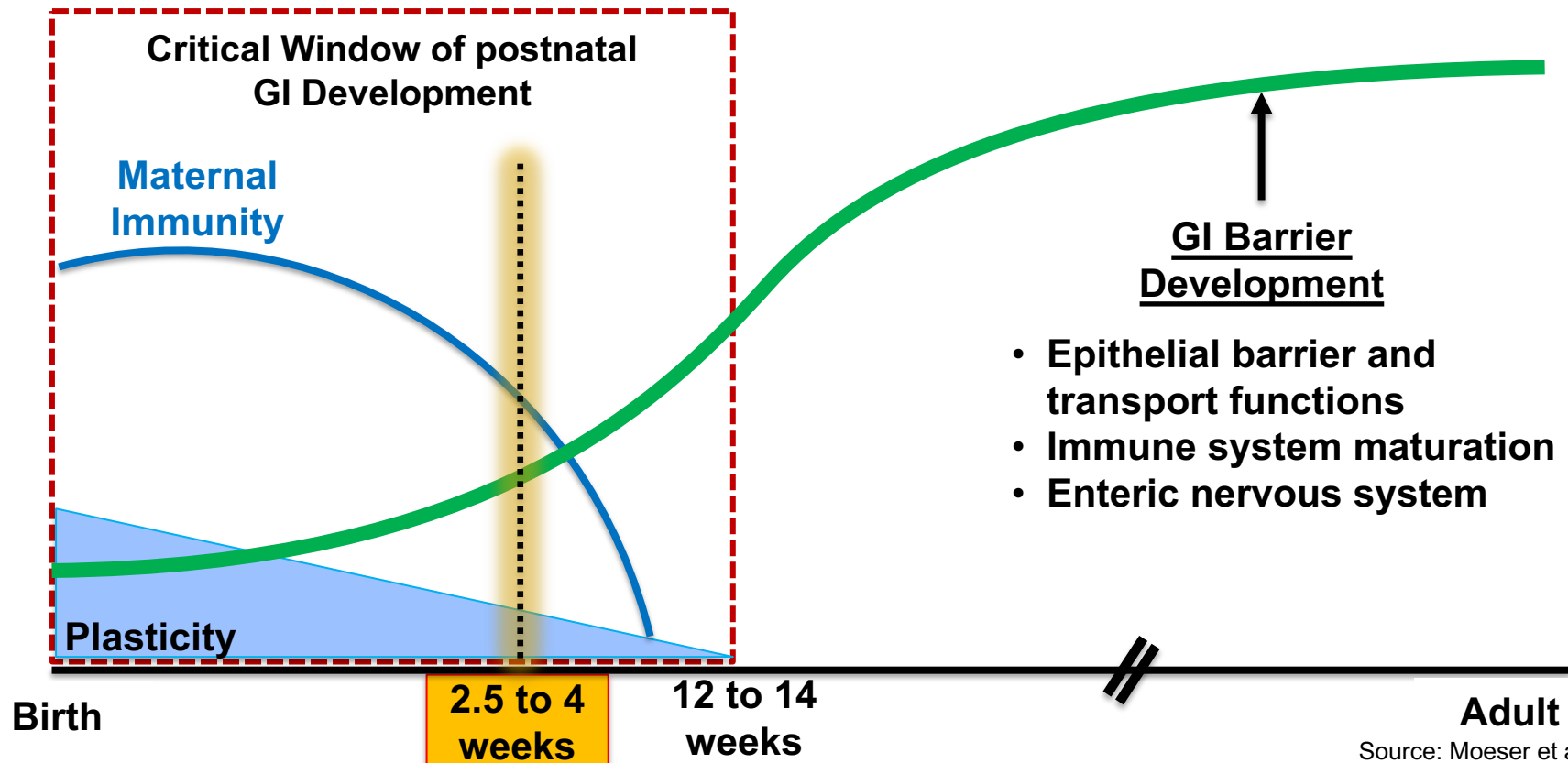


Weaning stress

- Environmental changes
- Transportation stress
- Abrupt transition of diet
- Increase the risk of exposure to disease



Gastrointestinal (GI) tract development during weaning



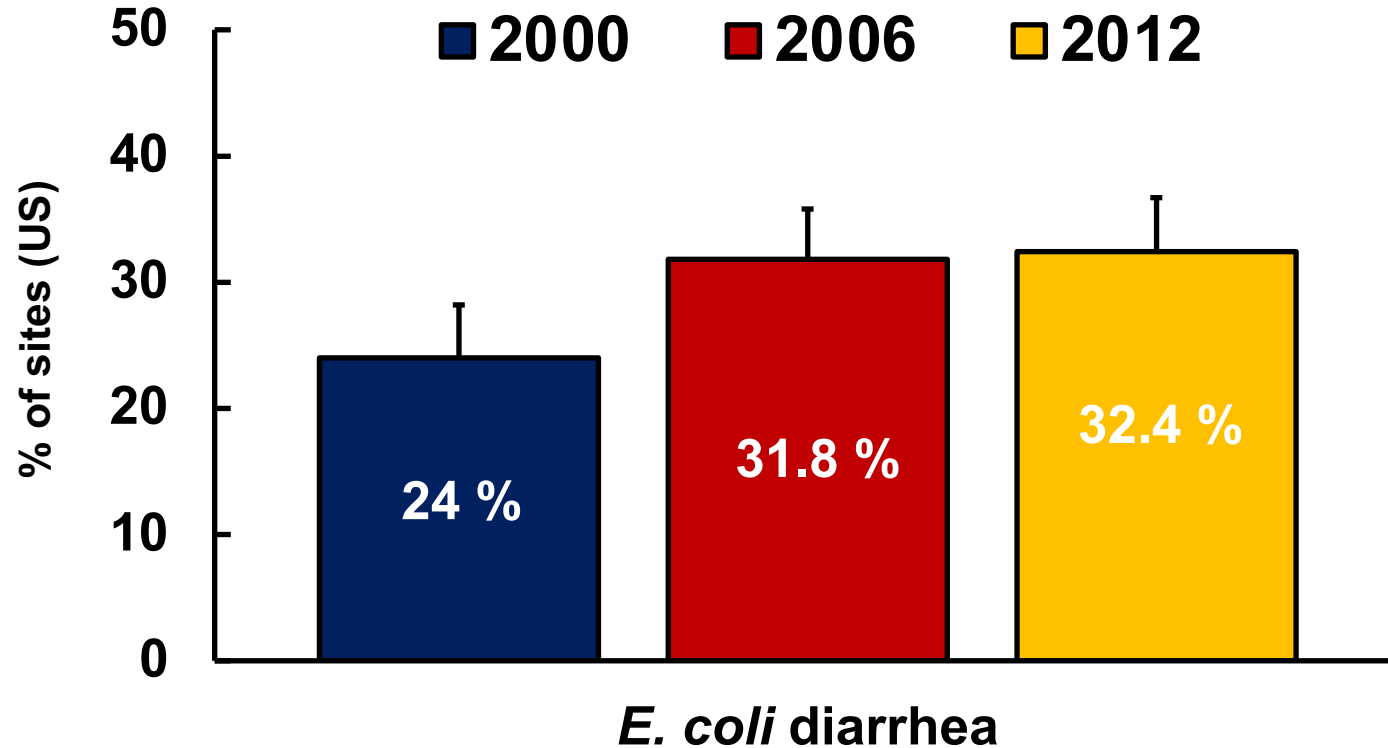
Source: Moeser et al., 2017

Post-weaning diarrhea in pigs

- One of the most serious threats for the swine industry
- Usually associated with proliferation of enterotoxigenic *E. coli* (ETEC)
 - ✓ F4 (K88)
 - ✓ F18

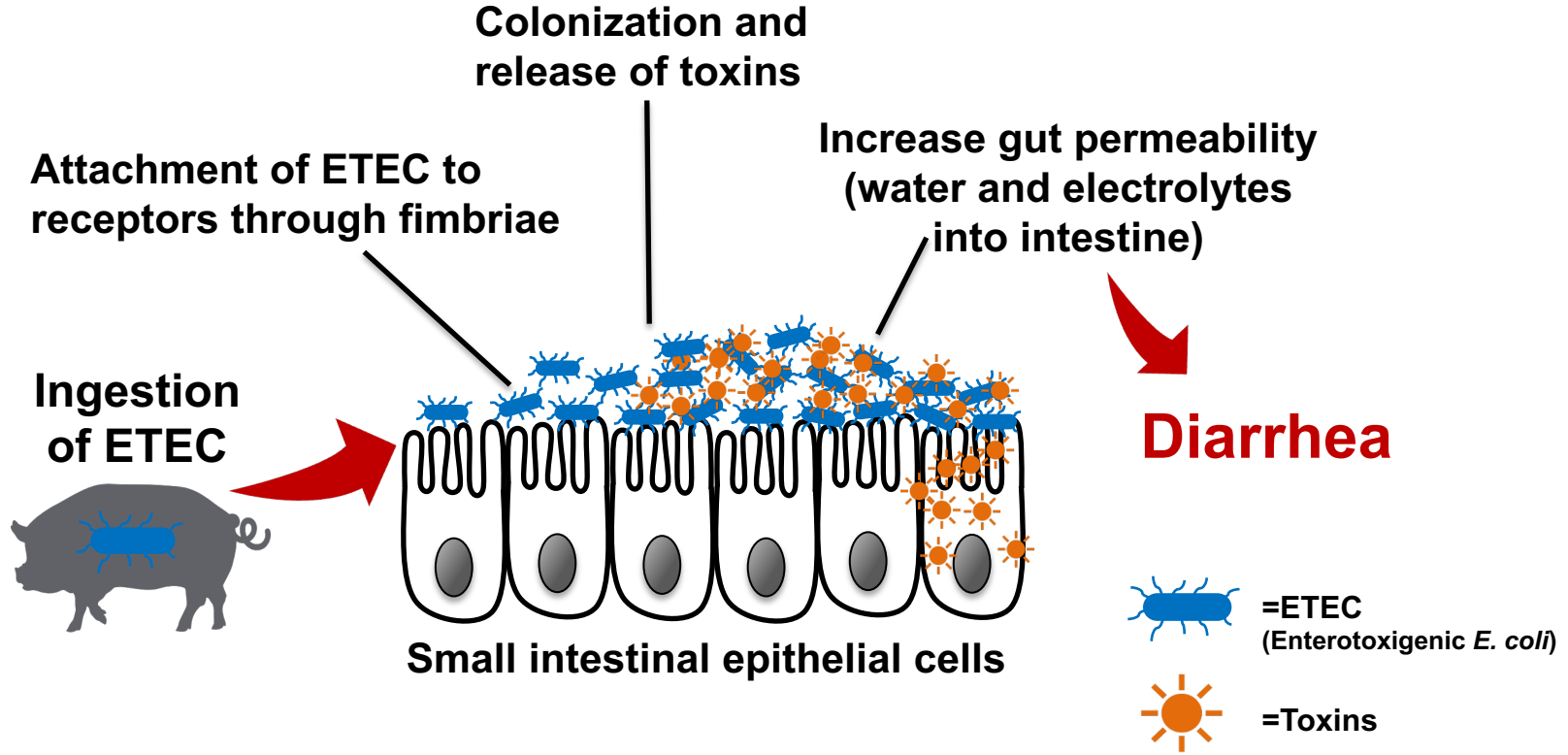


Post-weaning ETEC diarrhea morbidity

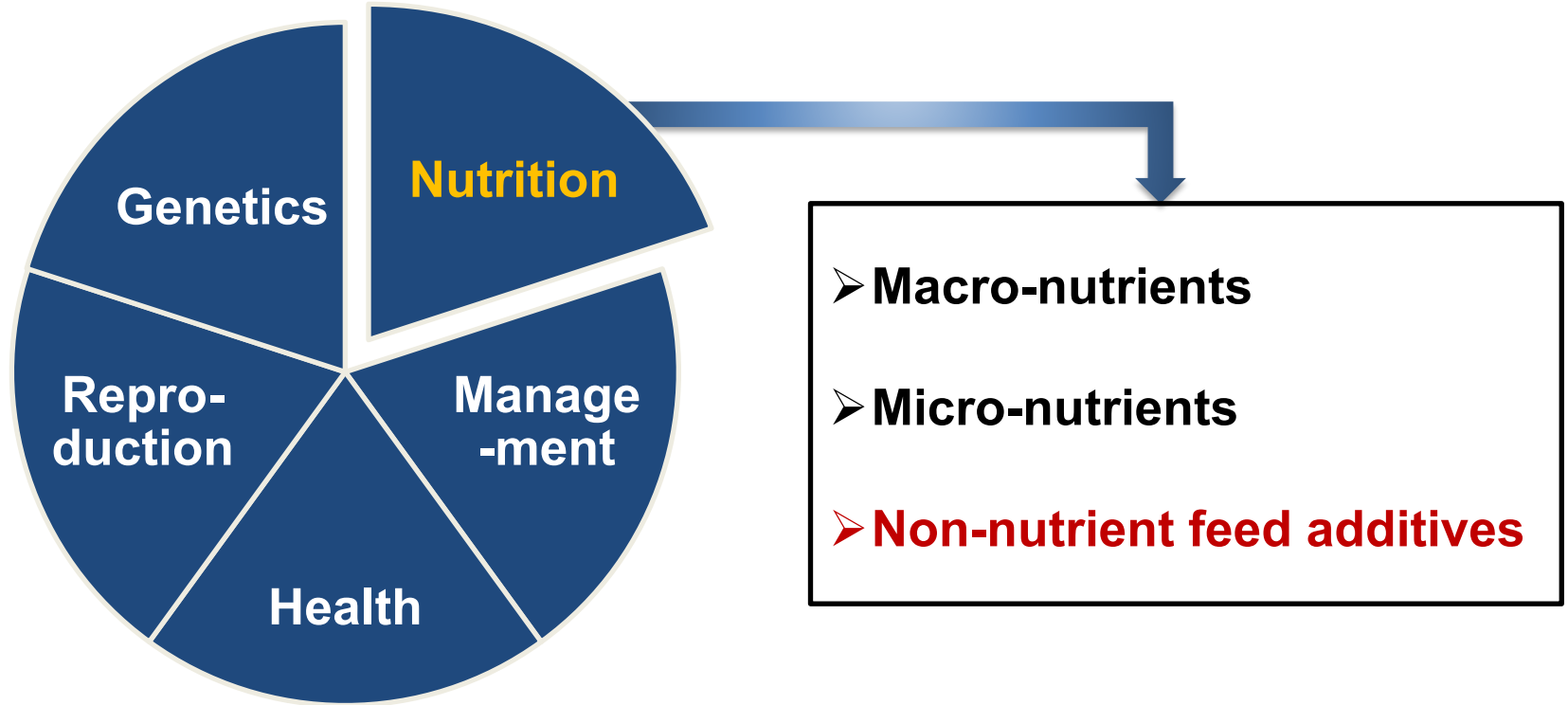


Source: USDA, Swine 2012 Part III: Changes in the U.S. Swine Industry, 1995–2012

ETEC pathogenesis



Swine (Livestock) production technologies

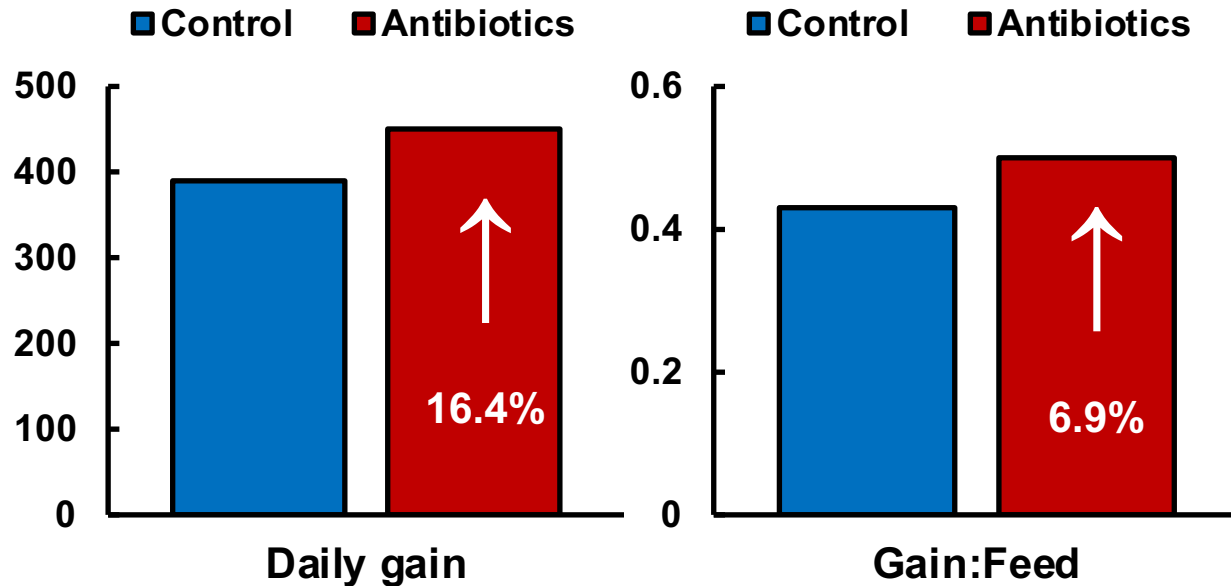


Antibiotics use in livestock

Efficacy of antibiotics as growth promoters for weaned pigs (7-25 kg)

➤ Antimicrobial substances active against bacteria

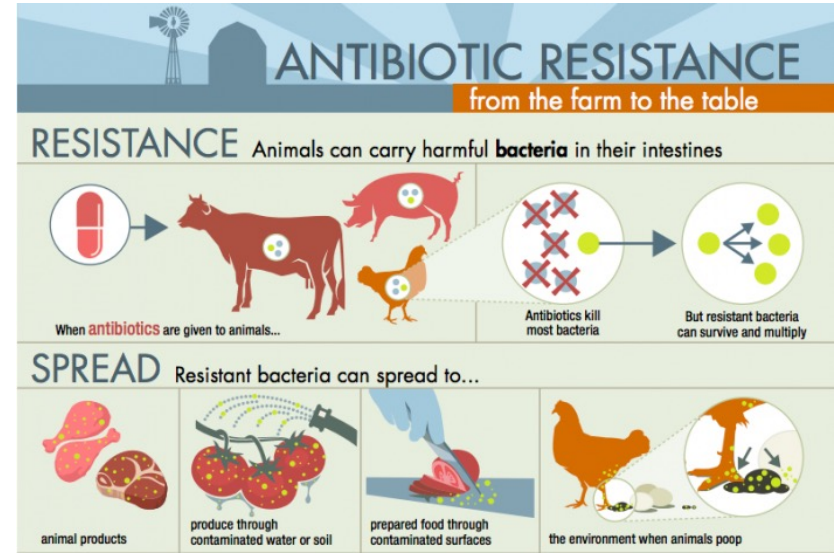
- Disease prevention
- Disease treatment
- Growth promotion



Source: Zimmerman, 1986

Antibiotics as growth promoter in animal diets poses risk

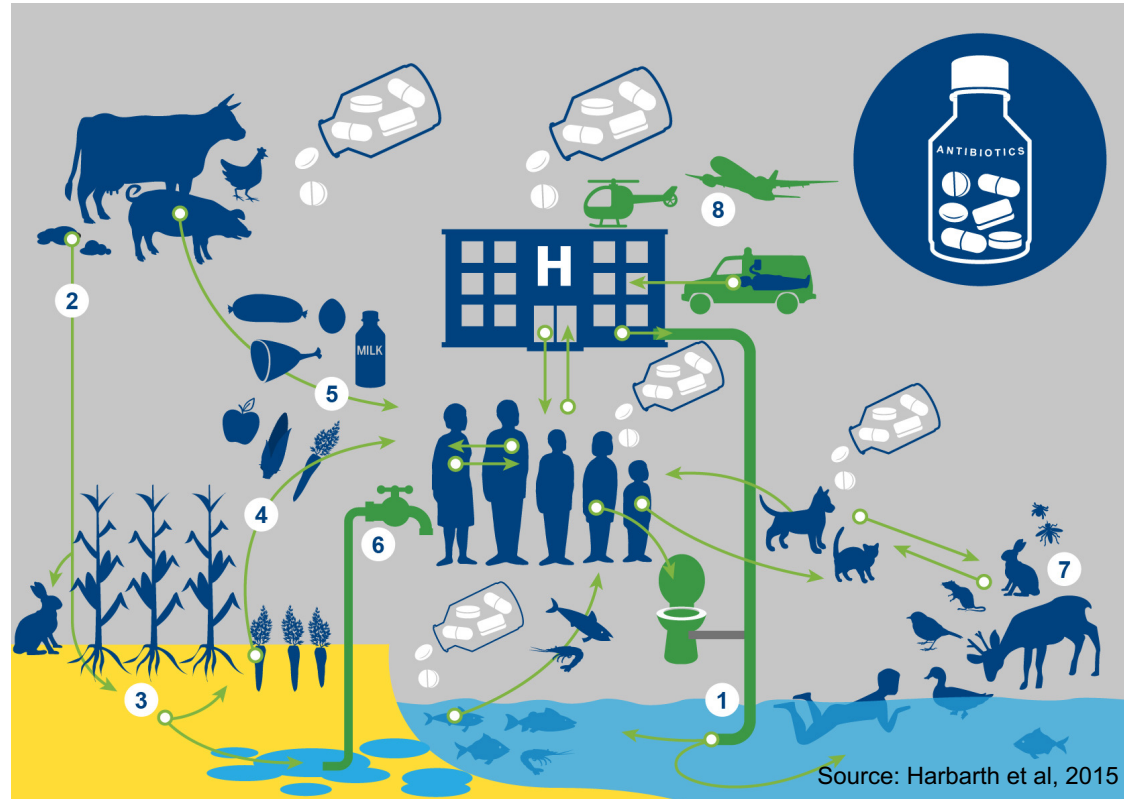
- Emergence of antibiotic resistance
- Banned in the European Union since 2006
- Also restricted in the United States since 2017



Source: <https://fairfarmsnow.org>

Trace levels of antibiotics: A global health hazard

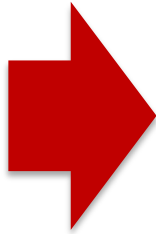
- Manure
- Surface water
- Soil
- Air
- Dust
- Farm environment



Source: Harbarth et al, 2015

Adverse effects of trace levels of antibiotics

- Toxicity
- Mutagenicity
- Carcinogenicity
- Hypersensitivity
- Antibiotic resistance

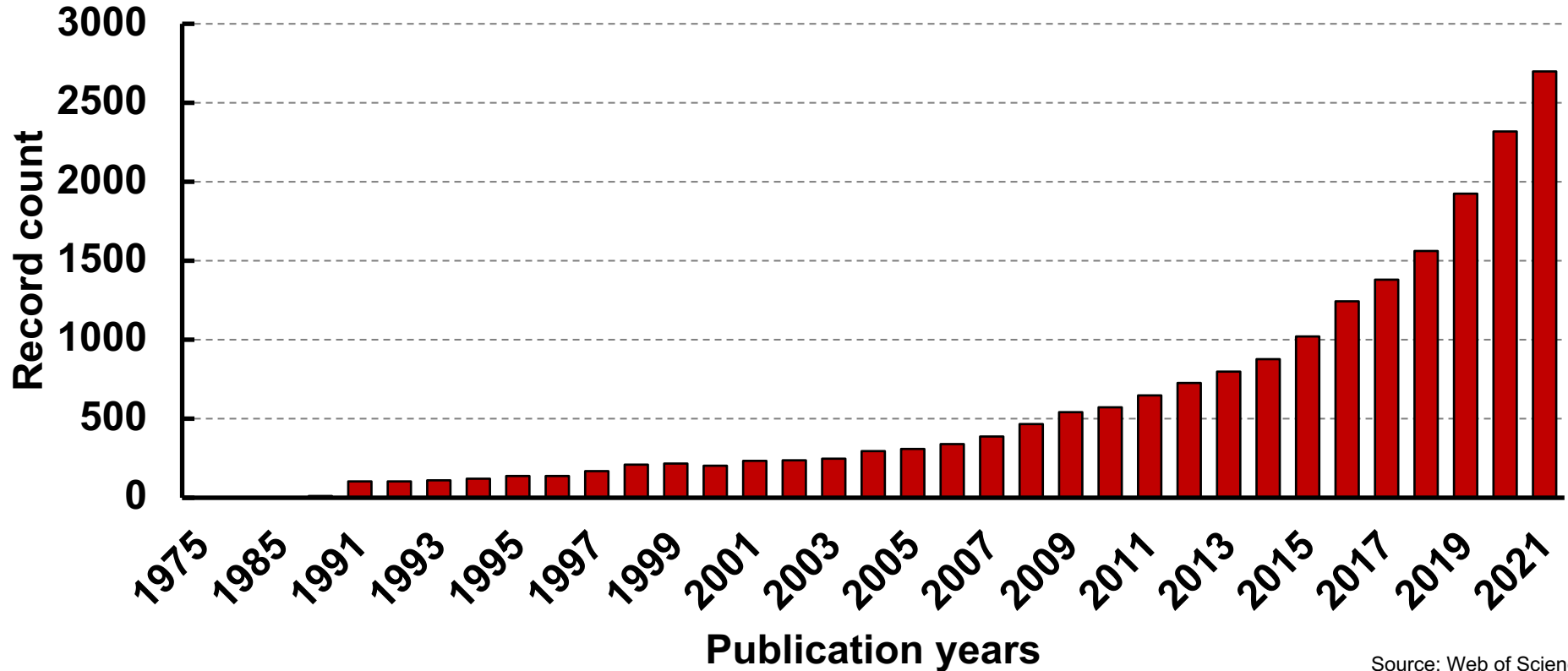


Young animals are more sensitive!



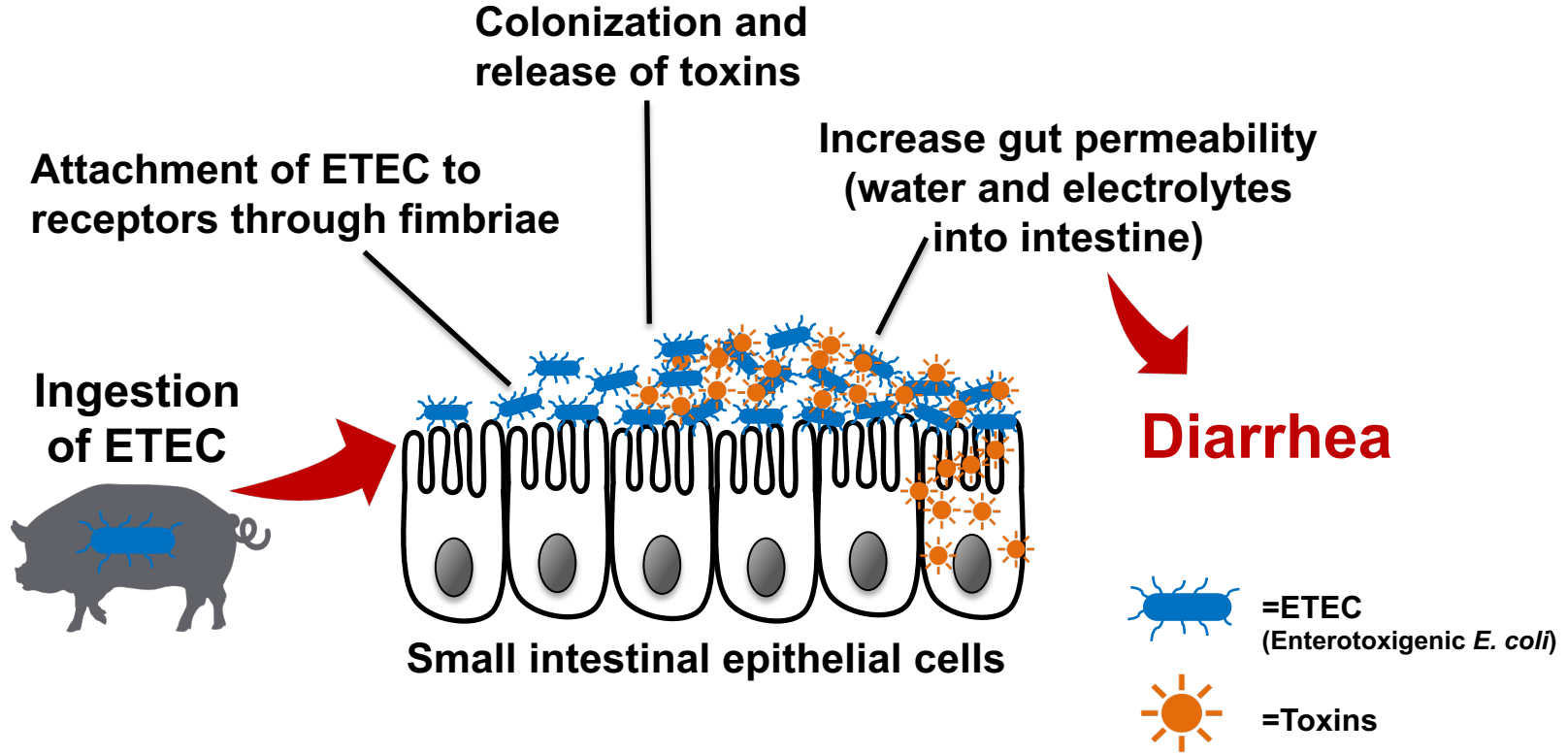
Delay the growth & recovery
from diseases

Keyword occurrence in academic papers: “Antibiotic alternatives”

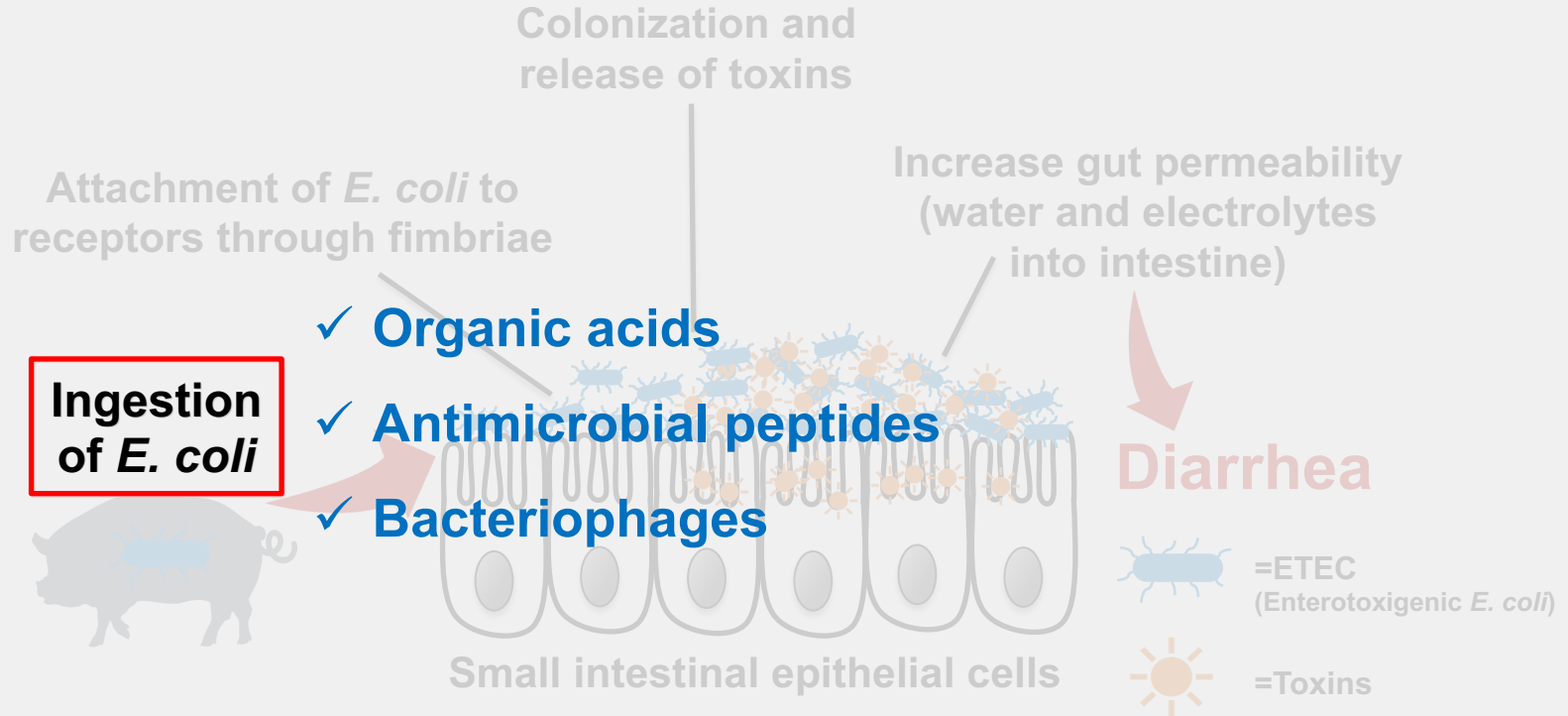


Source: Web of Science

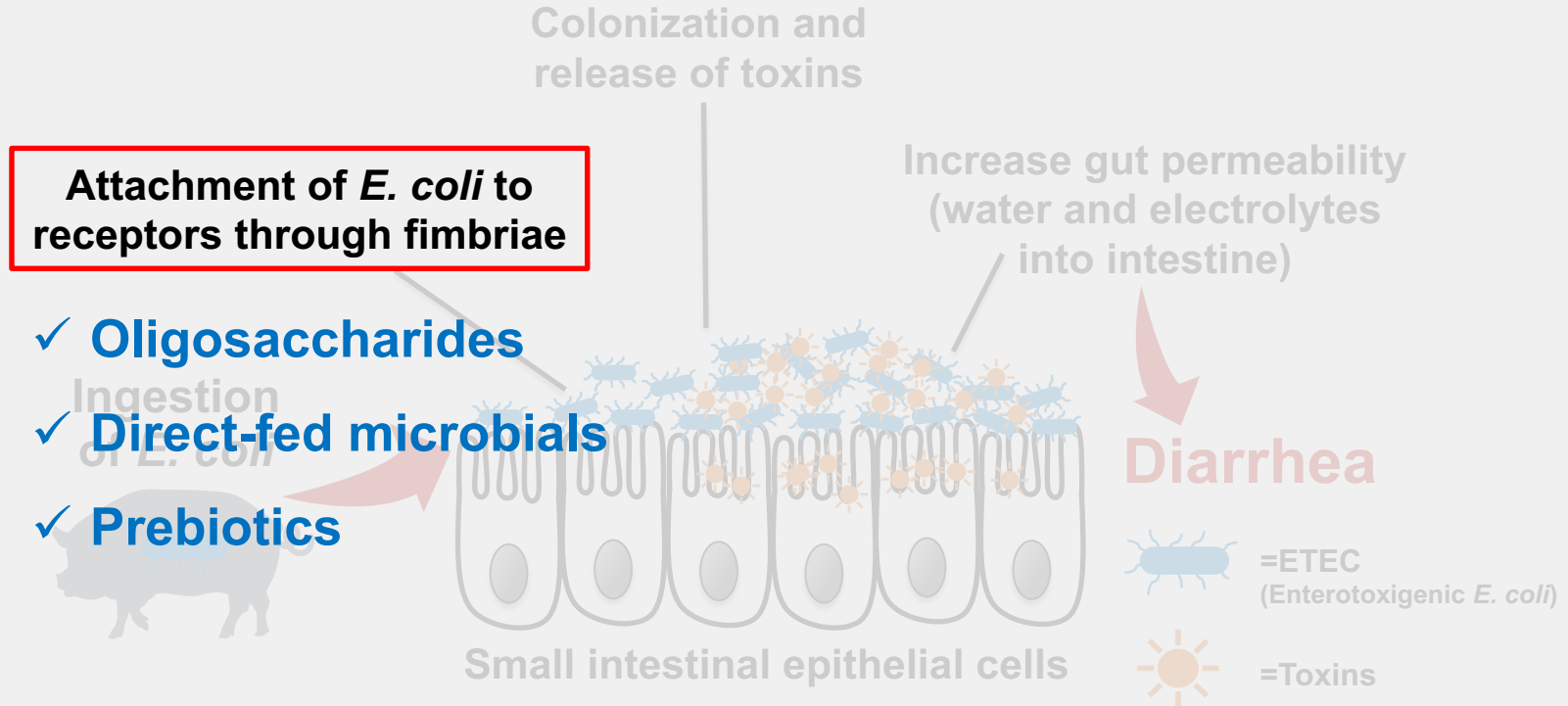
ETEC pathogenesis



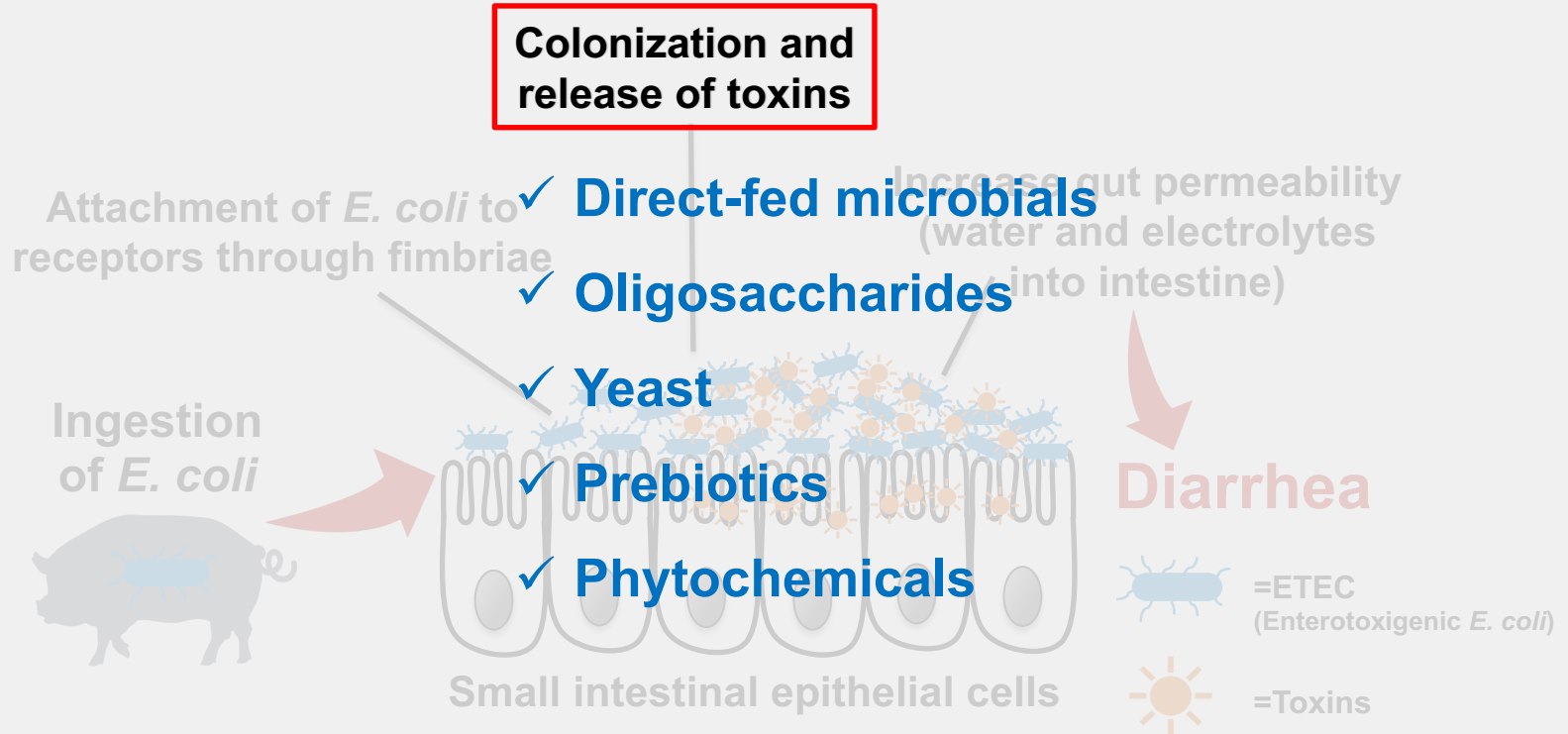
Alternative antimicrobial approaches against ETEC



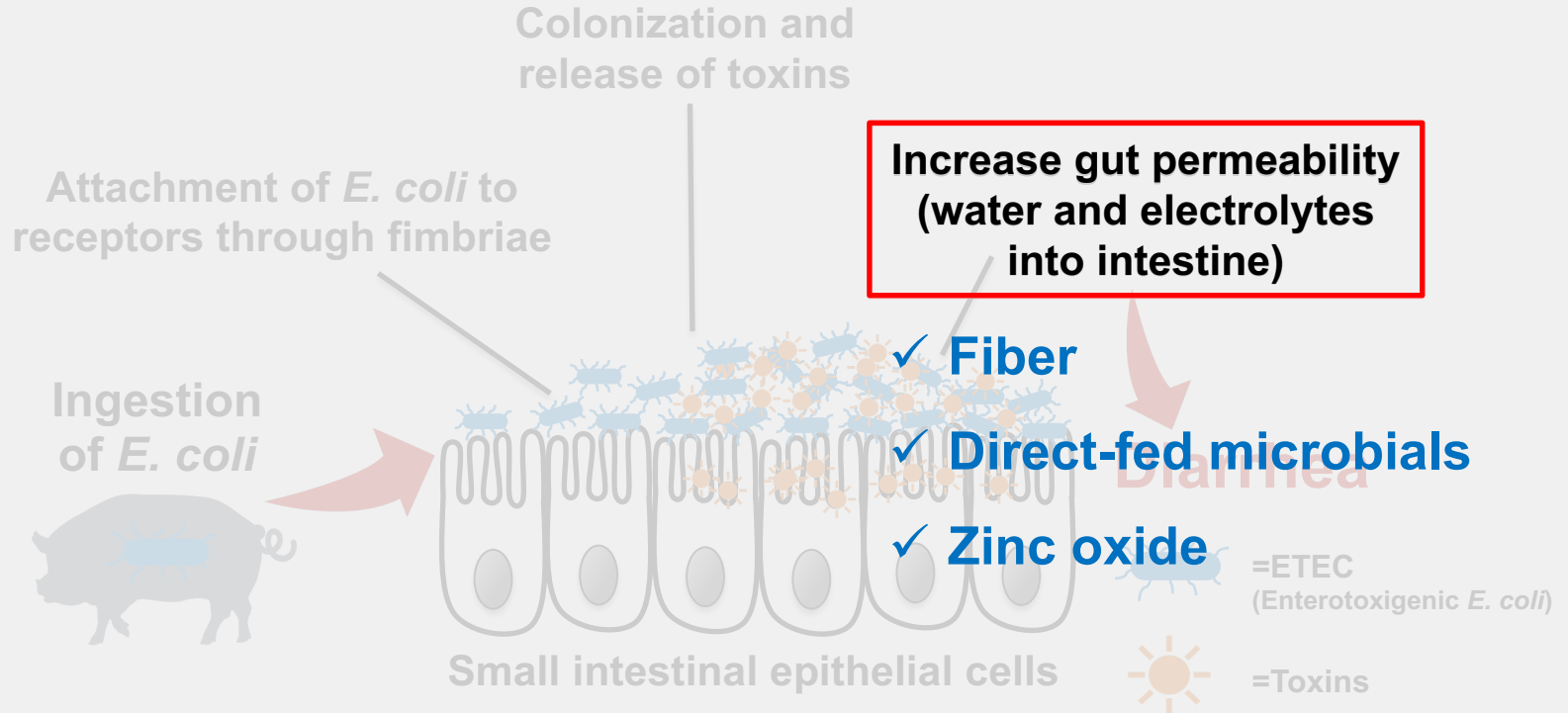
Alternative antimicrobial approaches against ETEC



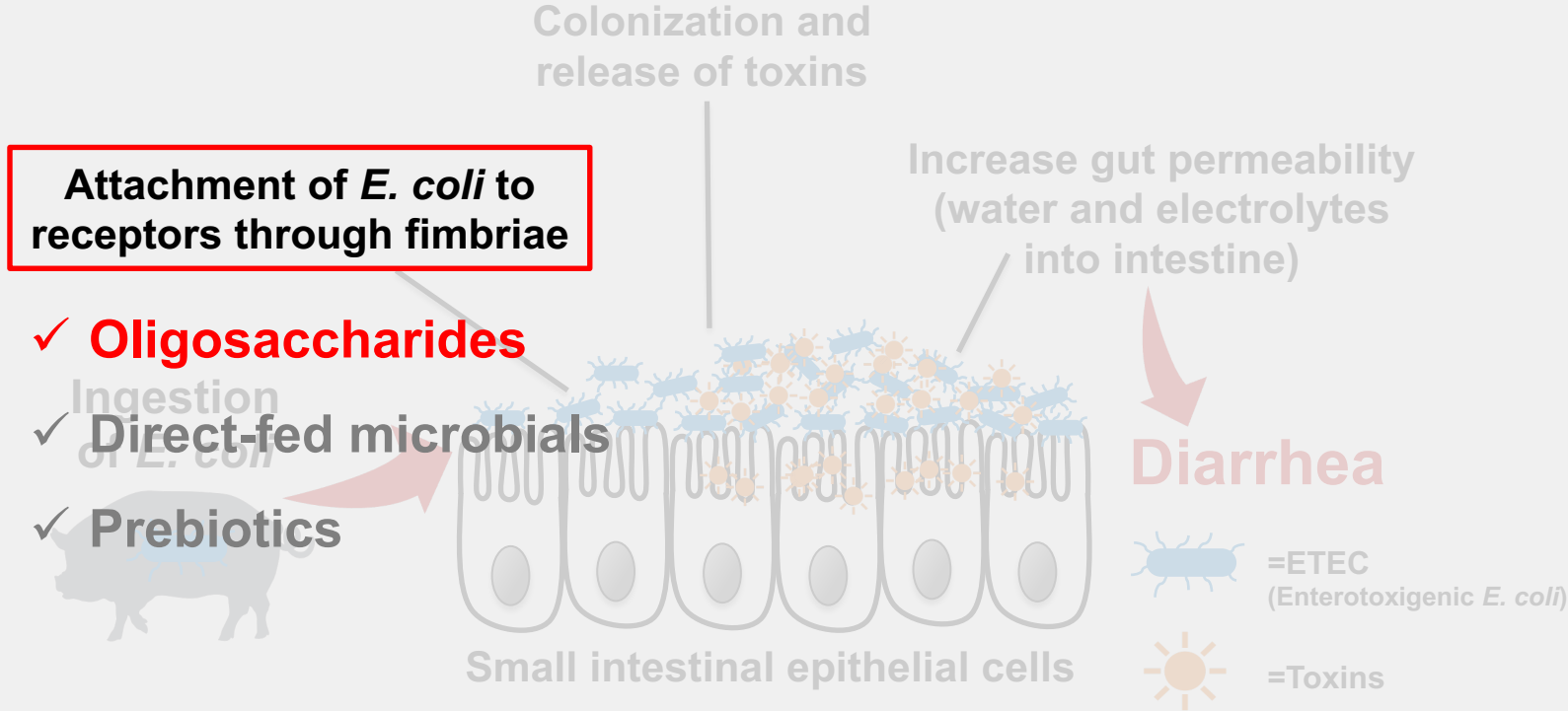
Alternative antimicrobial approaches against ETEC



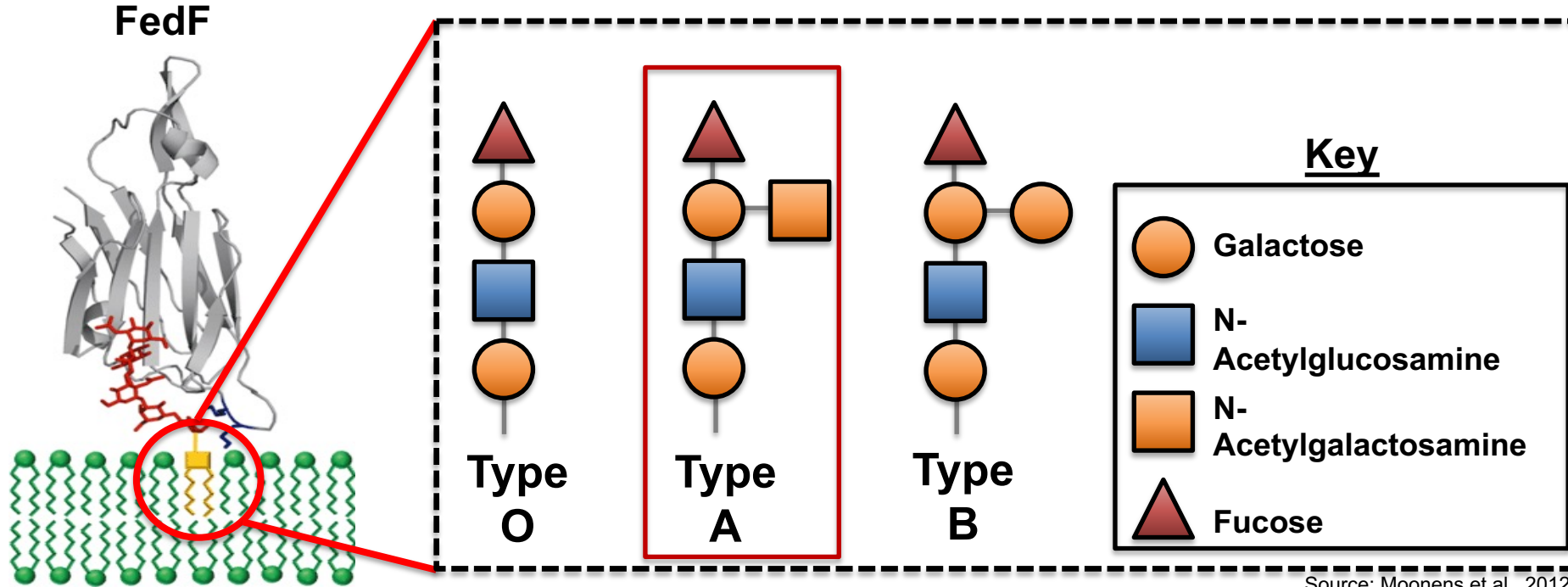
Alternative antimicrobial approaches against ETEC



Alternative antimicrobial approaches against ETEC

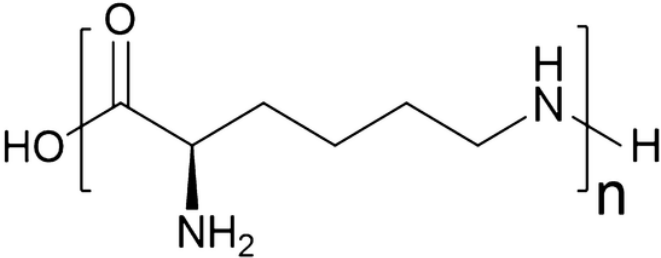


Blood group antigen oligosaccharides: Receptor for fimbrial subunit FedF

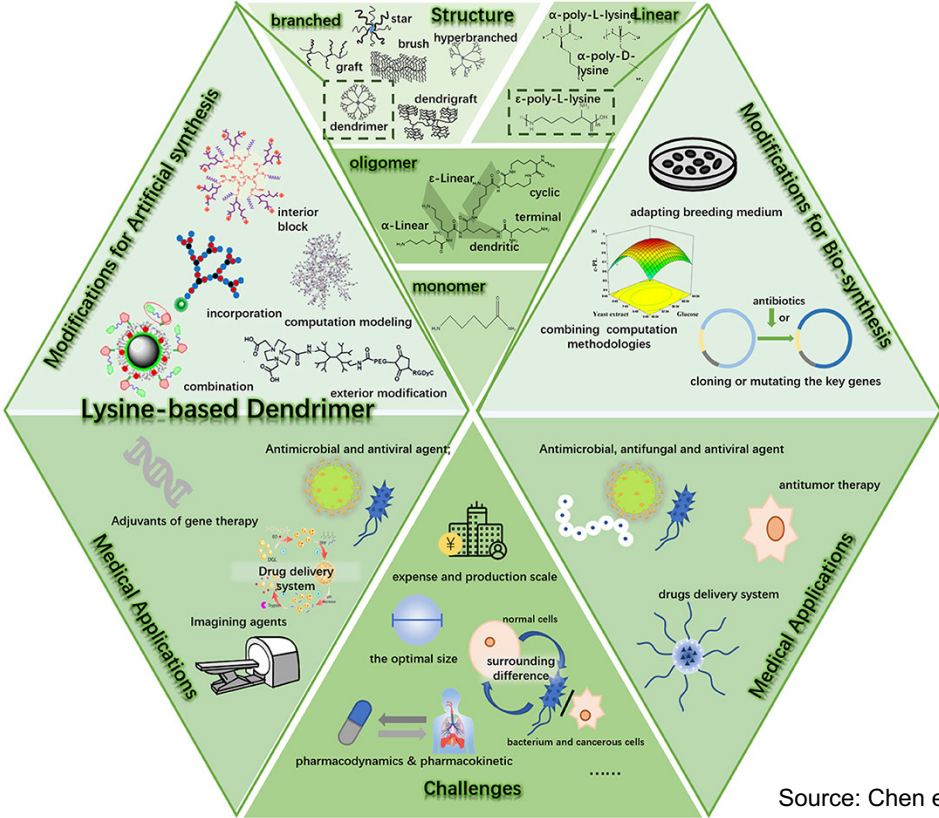


Source: Moonens et al., 2012

Epsilon-poly-lysine (ϵ -PL): Stable delivery vehicle

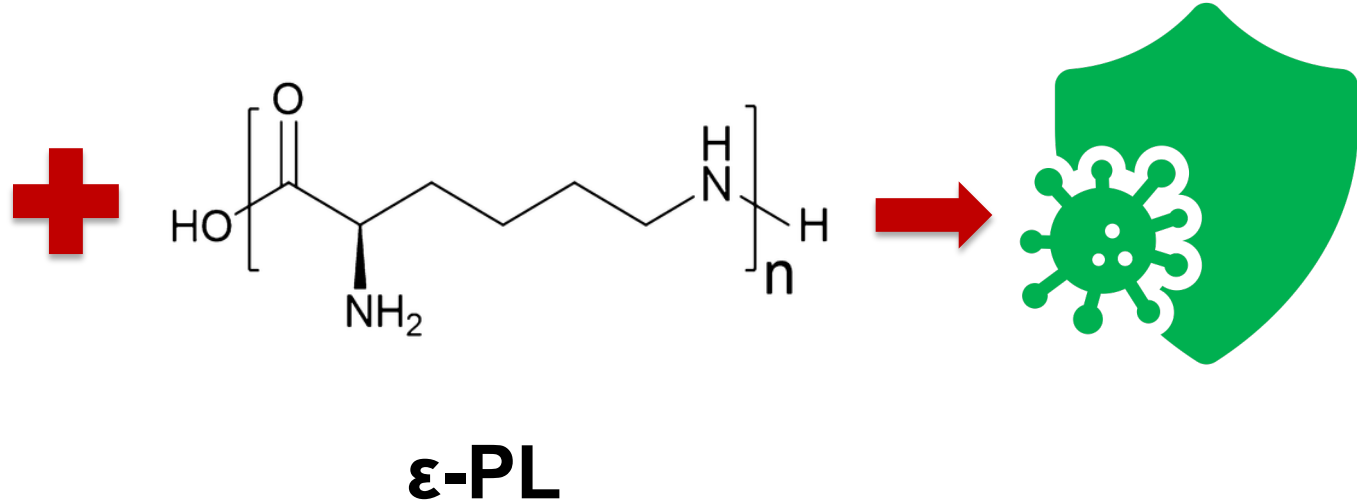
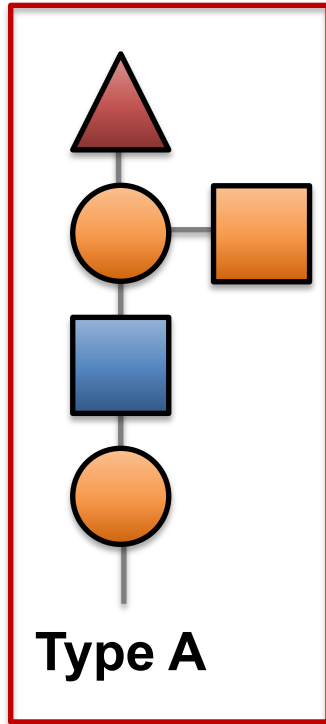


ϵ -PL

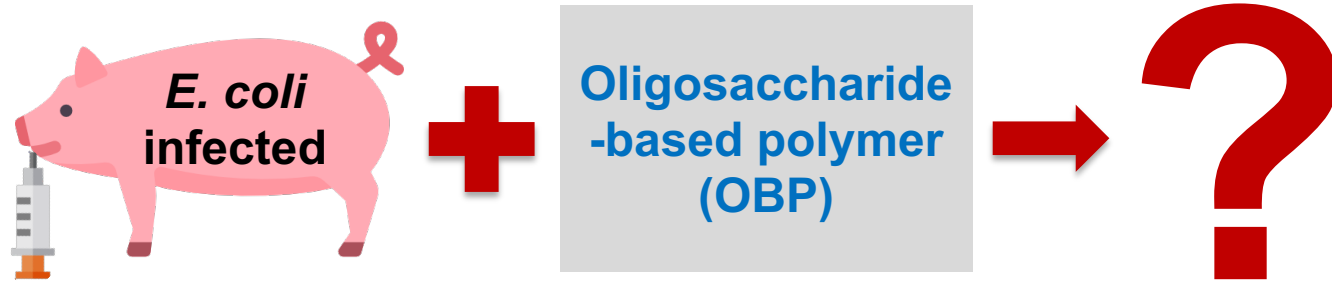


Source: Chen et al, 2021

Grafted polymer: Potential synergistic effects



Objective



To investigate the efficacy of blood group A type-based polymer on intestinal health and disease resistance of weanling pigs challenged with ETEC F18.

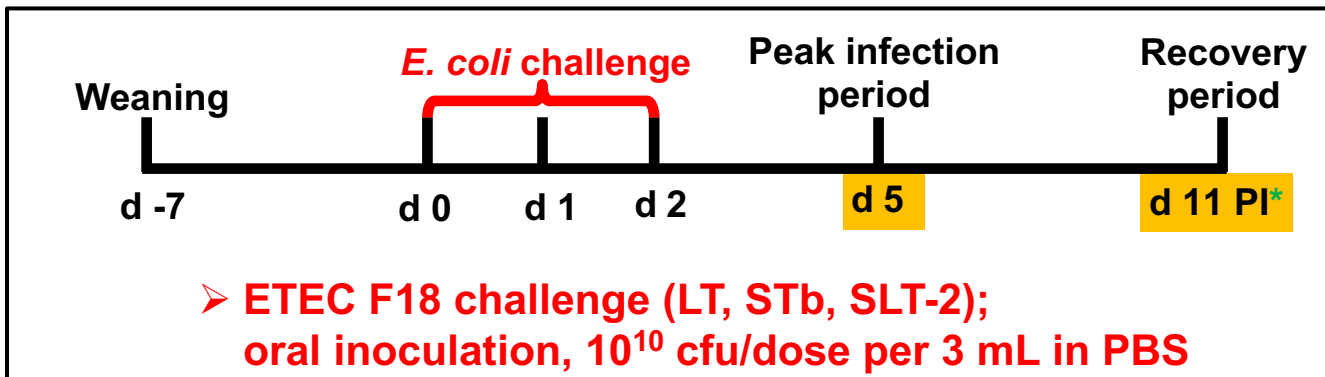
Experimental design & treatments

- Experimental design: RCBD (Blocks: BW x Sex)
- 48 weaning pigs (7.23 ± 1.14 kg BW, 21 d old)
- Treatment: 4 treatments (12 pigs/treatment)

Nursery basal diet as control (CON)	} <i>E. coli</i> challenged
CON + 10 mg/kg of oligosaccharide-based polymer* (LOW)	
CON + 20 mg/kg of oligosaccharide-based polymer* (HIGH)	
CON + 50 mg/kg of antibiotics (Carbadox; CAR)	

*Glycoconjugate composed of blood group A antigen oligosaccharides grafted on carrier and was designed and synthesized by Elicityl (France) in cooperation with Dr. Eric Cox (Ghent Univ., Belgium) and provided by Pancosma (Geneva, Switzerland)

Experimental timeline & Data acquisition

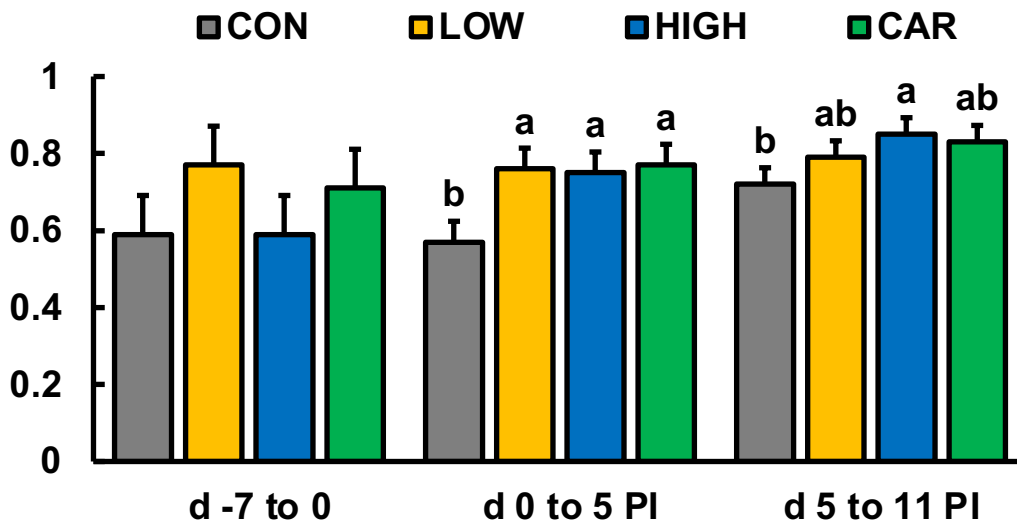


- Growth performance
- Diarrhea severity
- β -hemolytic coliforms
- Bacterial translocation
- Intestinal morphology
- Gene expression in intestinal mucosa

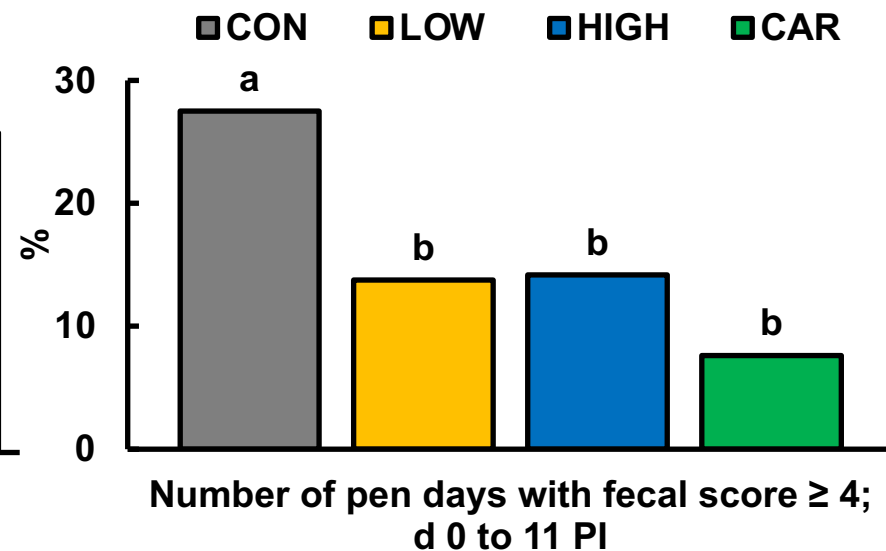
* PI=post-inoculation
PBS= phosphate-buffered saline

OBP supplementation enhanced feed efficiency and reduced diarrhea

Gain:Feed



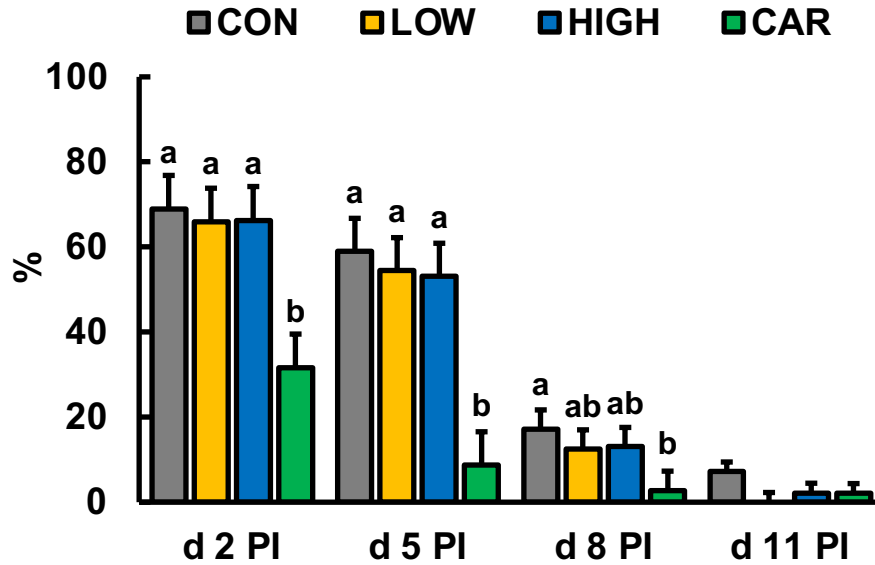
Frequency of diarrhea



PI=post-inoculation

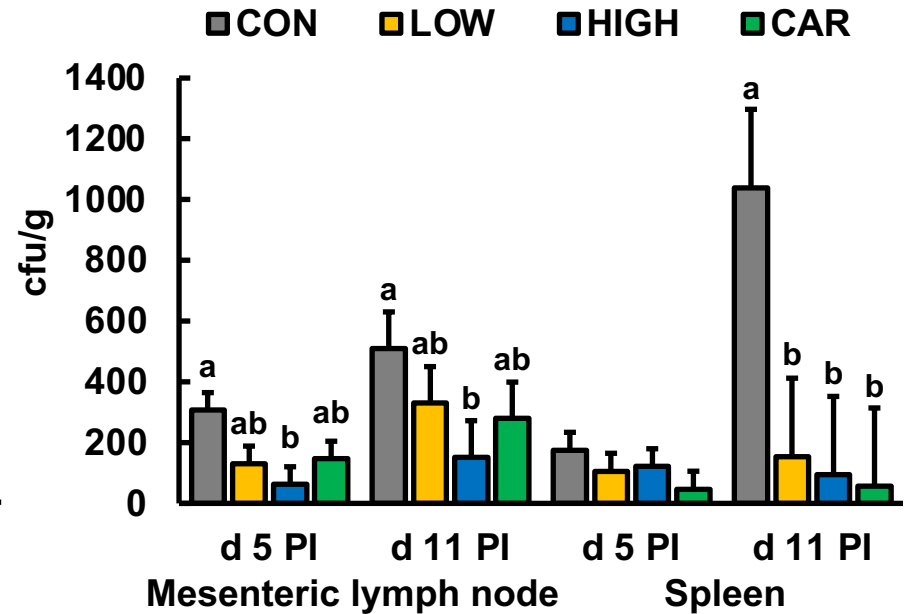
OBP supplementation enhanced ETEC excretion, thus reduced bacterial translocation

β -hemolytic coliforms in feces



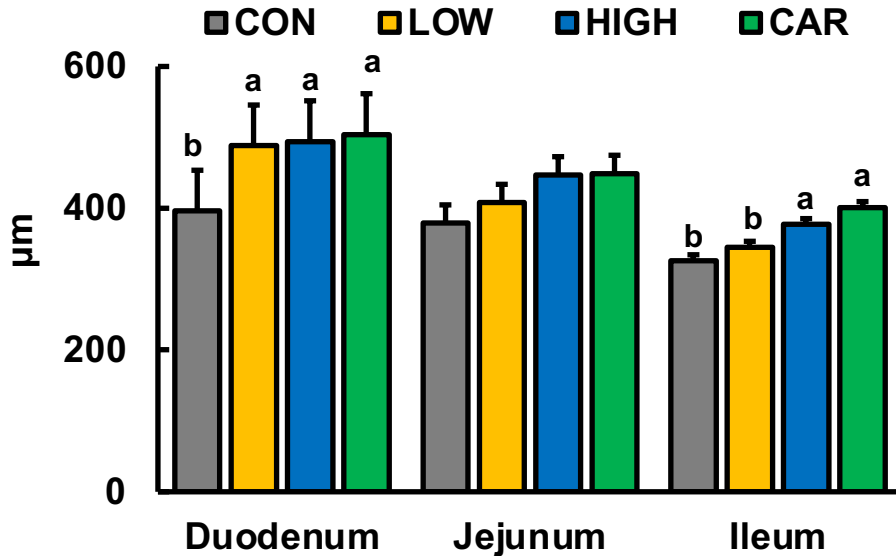
PI=post-inoculation

Bacterial translocation

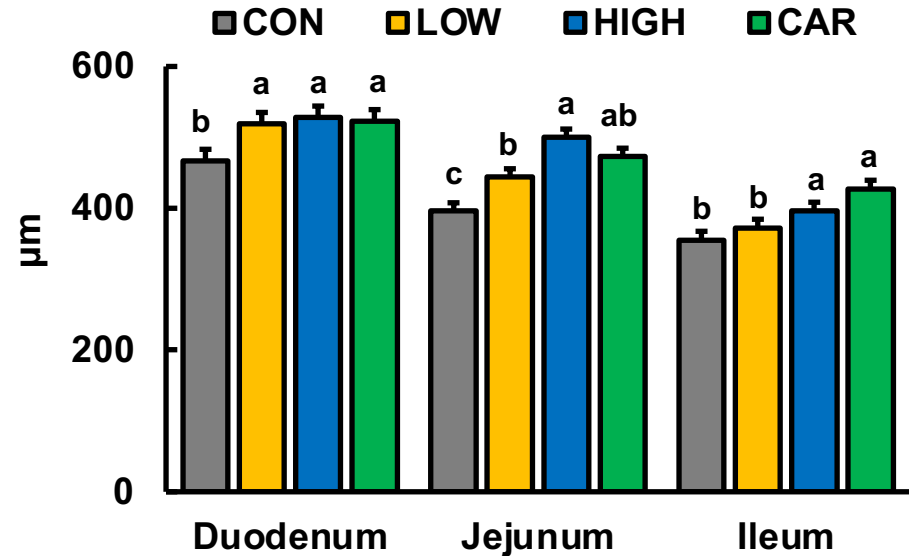


OBP supplementation is beneficial for pigs' intestinal morphology

Villous height, d 5 PI



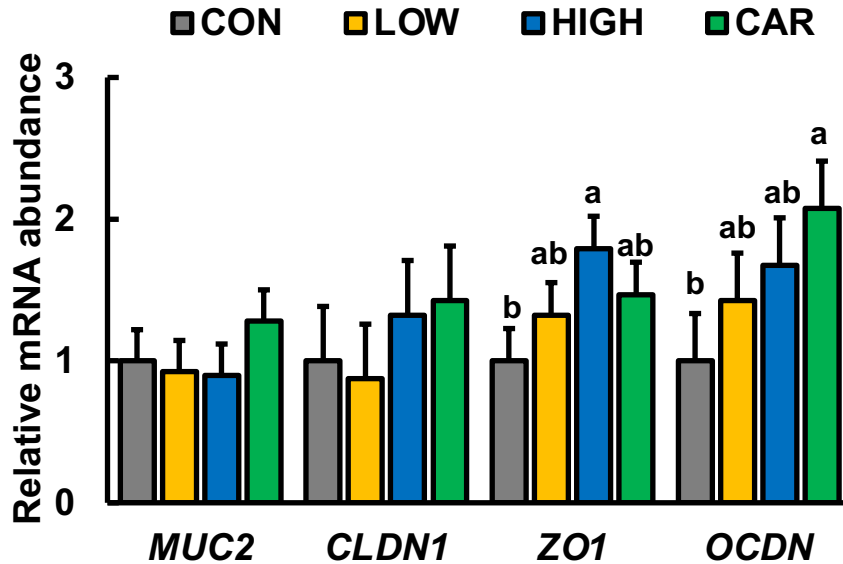
Villous height, d 11 PI



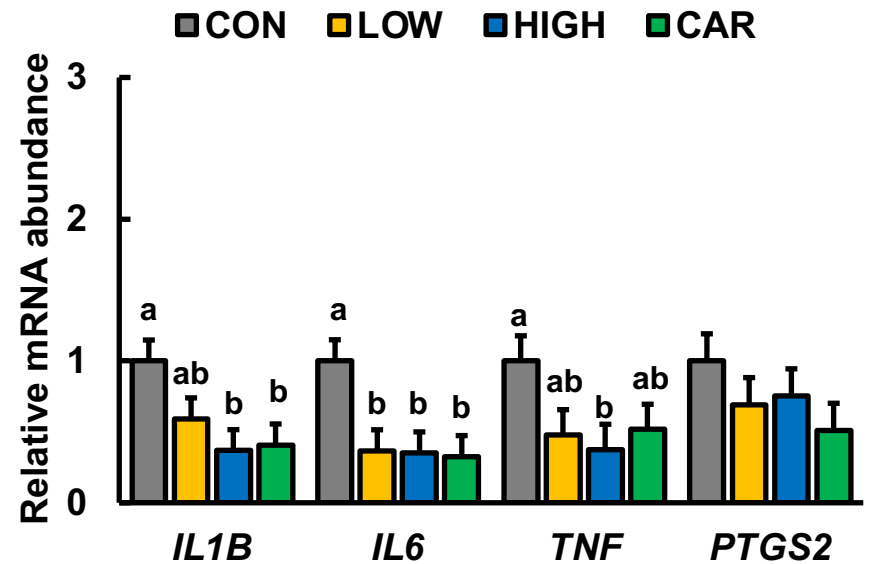
PI=post-inoculation

OBP supplementation is beneficial for pigs' intestinal health

Gene expression profiles in jejunal mucosa, d 5 PI



Gene expression profiles in ileal mucosa, d 5 PI



PI=post-inoculation

Key takeaways



Oligosaccharide-based polymer supplement enhanced disease resistance of weaned pigs



Smart use of antibiotics:

Minimize the use of antibiotics and explore the possible alternatives



The global food crisis:

Developing sustainable livestock production system

Acknowledgements

Kim *et al.* *Journal of Animal Science and Biotechnology* (2022) 13:10
<https://doi.org/10.1186/s40104-021-00655-2>

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Biotechnology

RESEARCH

Open Access

Supplementation of oligosaccharide-based polymer enhanced growth and disease resistance of weaned pigs by modulating intestinal integrity and systemic immunity



Kwangwook Kim¹, Yijie He¹, Cynthia Jinno¹, Lauren Kovanda¹, Xunde Li², David Bravo³, Eric Cox⁴ and Yanhong Liu^{1*}



Research project No. W4002 and NC1202



Comparative Animal Nutrition & Physiology
Laboratory
University of California, Davis

Thank you for your attention!



Thank you for your attention!

