

# Unlock the growth potential: The role of saponins in enhancing shrimp gut health



# Agenda

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- Gut health and the importance for performance improvement

2

- Saponins in Aquaculture

3

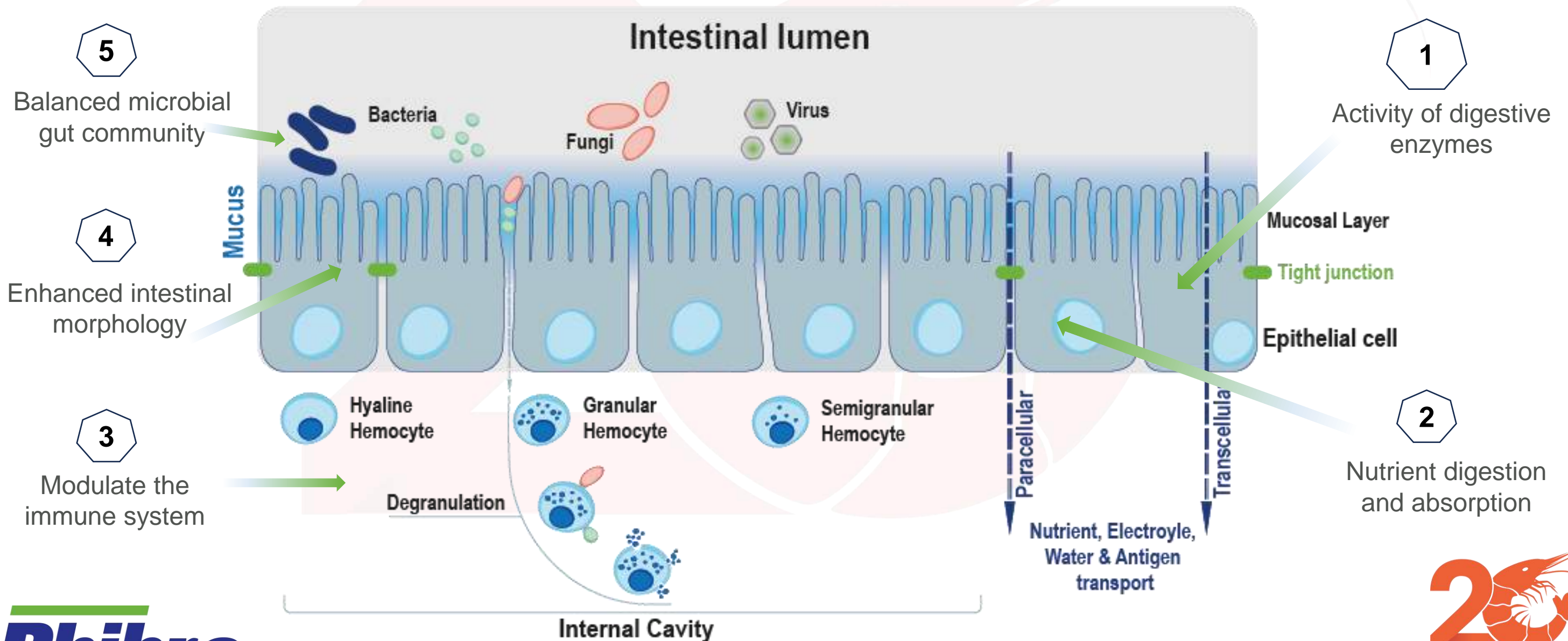
- Influence of saponins on shrimp and fish gut health

4

- Conclusions



# How can we improve gut health and functionality?



# What are Saponins?

- Secondary plant compounds.
- Contain lipophilic part & hydrophilic sugar side chains.
- Can be found in several molecular forms.
- Known for their hemolytic and piscicidal effects.
- Can be found in several plant sources:
  - Ginseng
  - Quillaia
  - Yucca
  - Soy
  - Asparagus
  - Alfalfa





# Literature review of benefit of Saponin in aquafeed

## Research Article

The effects of *Yucca schidigera* and enzymes activities on growth performance and histomorphology of Nile tilapia, *Oreochromis niloticus*

*Quillaja saponaria* and/or *Yucca schidigera* ameliorate water quality, growth performance, blood health, intestine and gills histomorphology of Nile tilapia, *Oreochromis niloticus*

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## The biological action of saponins in animal systems: a review

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Saponins are steroid or triterpenoid glycosides, common in a large number of plants and plant products that are important in human and animal nutrition. Several biological effects have been ascribed to saponins. Extensive research has been carried out into the membrane-permeabilizing, immunostimulant, hypocholesterolaemic and anticarcinogenic properties of saponins and they have also been found to significantly affect growth, feed intake and reproduction in animals. These structurally diverse compounds have also been observed to kill protozoans and nematodes, to be antioxidants, to impair the digestion of protein and the uptake of vitamins and minerals in the gut, to cause hypoglycaemia, and to act as antifungal and antiviral agents. These compounds can thus affect animals in a host of different ways both positive and negative.

Saponins: Steroids; Triterpenoids; Biological activity

## Research Article

The effects of *Yucca schidigera* and *Quillaja saponaria* on growth performance and enzymes activities of juvenile shrimp *Litopenaeus vannamei*

*Quillaja saponaria*—a natural growth promoter for fish

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## Abstract

Environmental concerns and the forthcoming ban on antibiotics in the European Union have renewed interest in renewable and non-persistent plant-based growth promoters in fish feeds. A review of the published literature and unpublished recent results following addition of a *Quillaja* saponin mixture as the diets of common carp and Nile tilapia are presented. It emerges that *Quillaja* saponins have the potential to increase growth in culture fish species, reduce their metabolic rate and suppress reproduction in tilapia. The current study is the first to have demonstrated beneficial effects of a *Quillaja* saponin-rich fraction when used as a feed additive in fish diet. It is hoped that this collation of information and synthesis of results, discussion and conclusions will act as a catalyst for future research on isolation of the active fraction, its optimum concentration for obtaining the desired effects, and physiological mechanisms of action for the diverse biological effects of these compounds.

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Keywords: Saponins; Fish; Carp; Tilapia; Performance; Reproduction

On the other hand, however, any significant differences in enzyme activities were detected between the control group and treatments. The increase effect in shrimp growth and any decrease effect in enzyme activity detected in present study suggest that NTF shows potential as a feed additive for shrimp cultured at low-salinity.

Keywords: *Litopenaeus vannamei*, growth, enzyme activity, low-salinity, aquaculture.

Amirán-Saenz<sup>2</sup>

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aquatic organisms  
) with low-salinity  
eight) feeding with  
cultured in a close  
parameters (body  
enzyme activities  
ere evaluated after  
and feed conversion  
compared to other  
shrimp feeding with  
were detected with

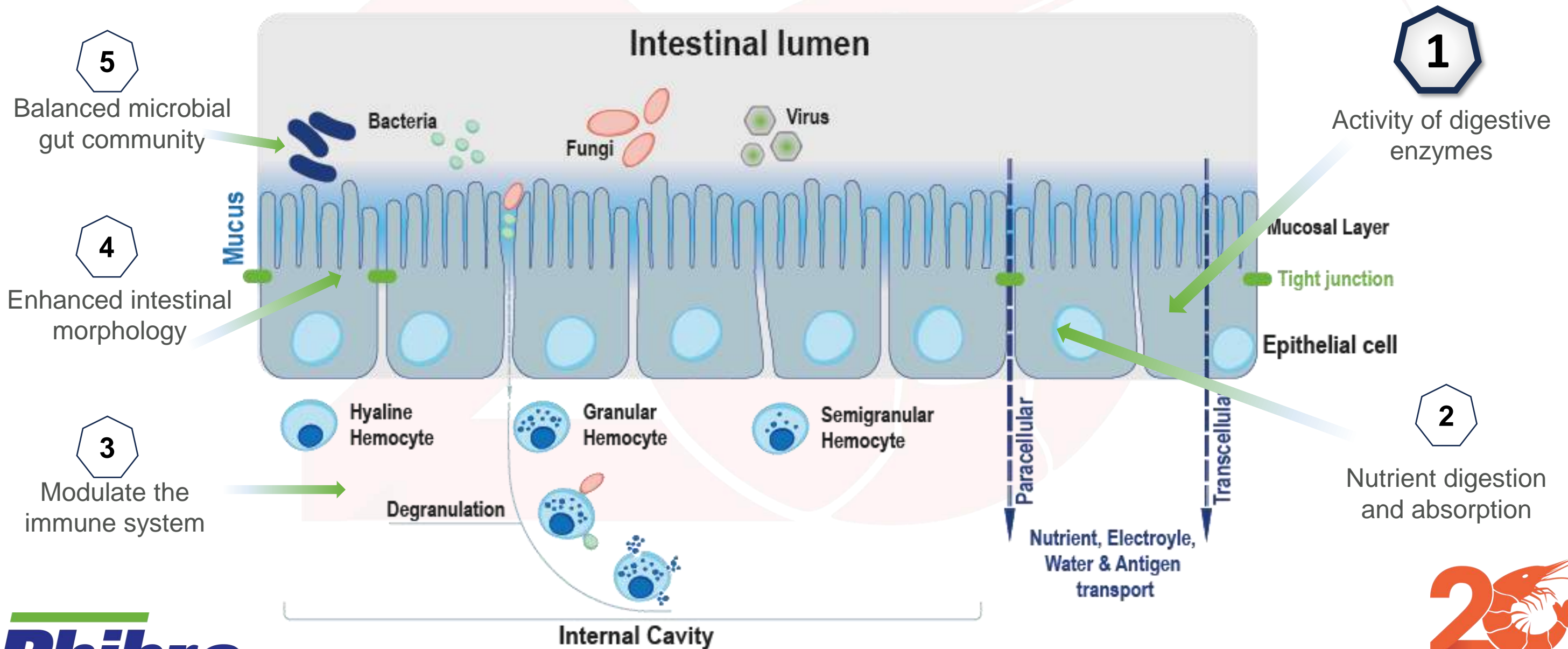
*Quillaja Saponaria* (QS) and culture profile, blood health in tilapia fingerlings. Fish (2 aquaria in triplicate, 100 liter) control group, C0; (2 liter) QS; (5 liter) diet supplemented with 200 mg kg<sup>-1</sup> QS. A significant ( $p < 0.05$ ) in specific growth rate and nitrogen and unincorporated amino acids) in fish received QS. Dietary inclusion of QS in and reduced the cholesterol levels in fish. The best findings in QS/L0, glucose and reduced metabolic rate and reduced cholesterol levels were observed in QS/L0. In conclusion, dietary inclusion of QS improved growth performance, water quality and health of fingerlings. The best feed-

tion, *Quillaja Saponaria*.

Phosphorus, 2016, Egypt to the on the African continent, with 3.61, 4.57 tonnes in 2018 (FAO, 2018). It was introduced to many tropical, subtropical and temperate regions (Cavett, 2009). Tilapia fish production is one of the most important aquaculture activities in the world, which enable their culture under

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# How can we improve gut health and functionality?



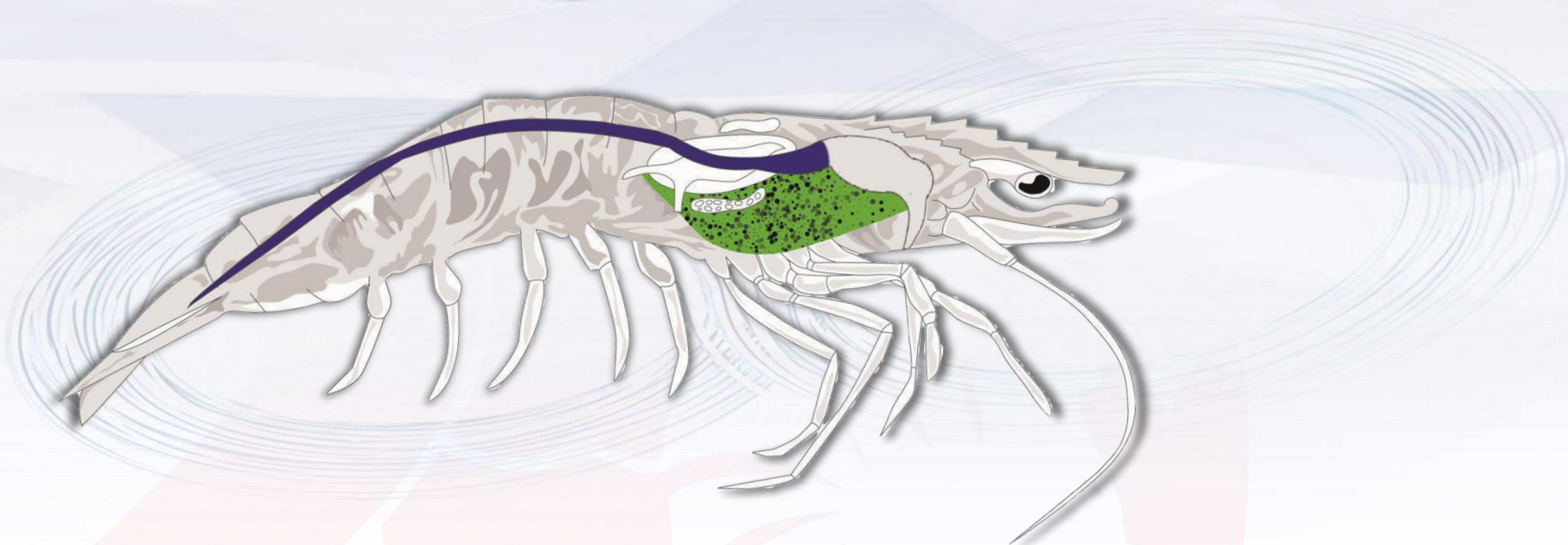


# Evaluation of saponin-based supplement (SBS) on the enzymatic activity of Pacific white shrimp, *Litopenaeus vannamei*

Production of digestive enzymes

	Species	Shrimp
	Treatment	Control vs SBS
	Number Replicas	4
	Duration	28 days
	Stocking	30 Shrimps/tank
	Initial Weight	2g
	Inclusion of SBS	2kg/MT

# Enhanced enzyme activity



## Enzyme activity in the hepatopancreas

Enzyme (UI/g)	Control	SBS
Amylase	311.79 ±175	<b>378.63 ±129*</b>
Lipase	58 ± 28	57.03 ± 42

## Enzyme activity in the gut

Enzyme (IU/g)	Control	SBS
Amylase	1242±384	<b>1811±312*</b>
Lipase	104±25	<b>123±50*</b>



# Enhanced enzyme activity

Amylase activity

Higher amylase activity  
leads to better chitin  
synthesis = induce growth

Shrimp molting is made of  
chitin that made of mono-  
sugars

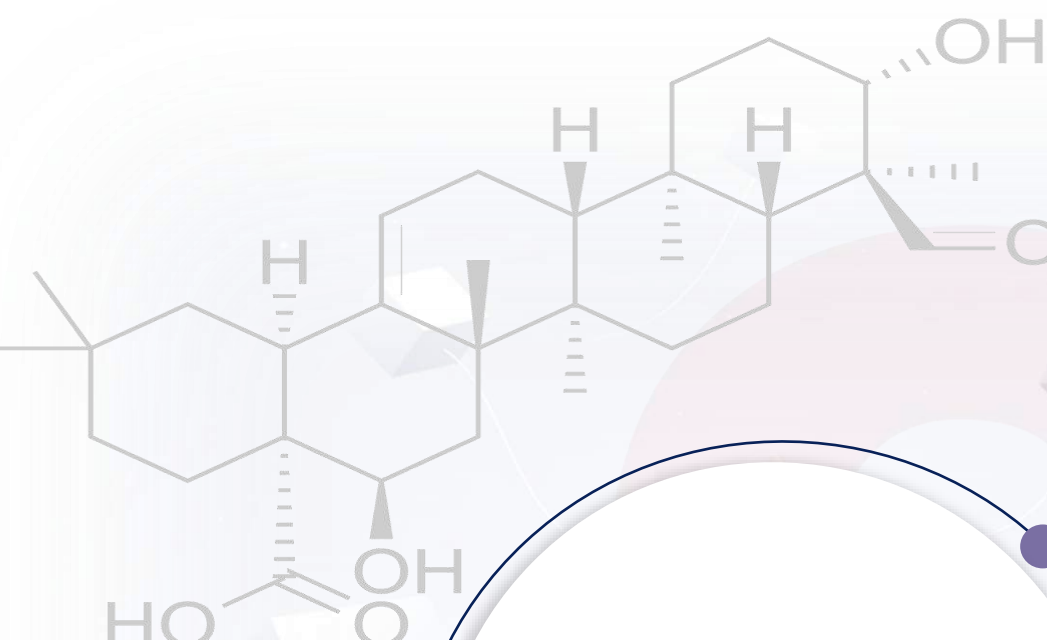
Saponin supplement:  
Yucca (15%) and Quillaia  
(85%):  $\geq 3.0$  % w/w of  
saponin

Saponins = glucosides  
that consist of a polycyclic  
aglycones

Polycyclic aglycones  
trigger amylase activity

Amylase is an enzyme that  
catalyzes the hydrolysis of  
starch into sugars

# Lipase activity



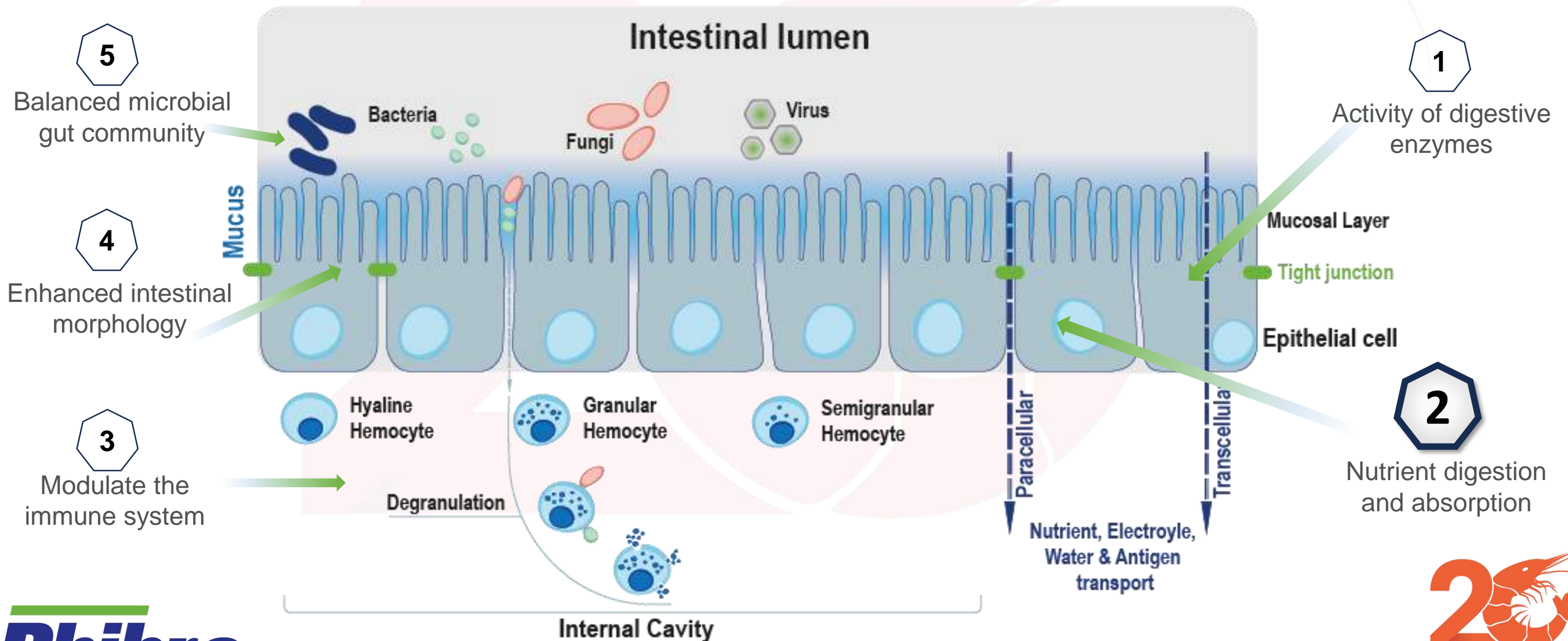
**Lipid requirement in shrimp is limited to 5-8%.**

**Enhanced lipase activity enable better extraction of fatty acids.**

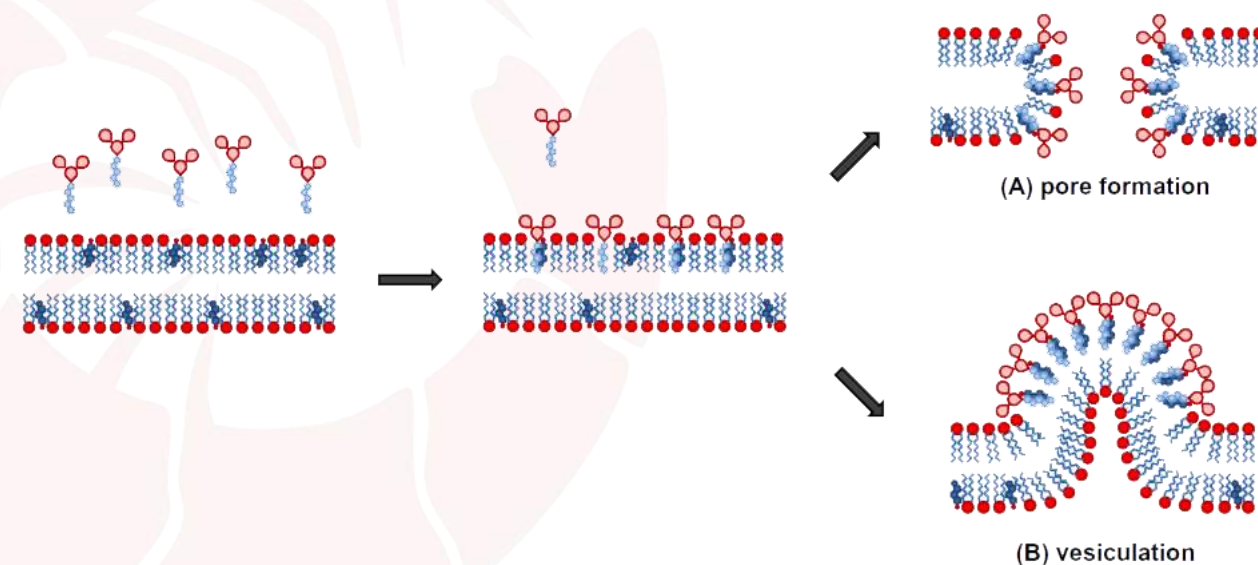
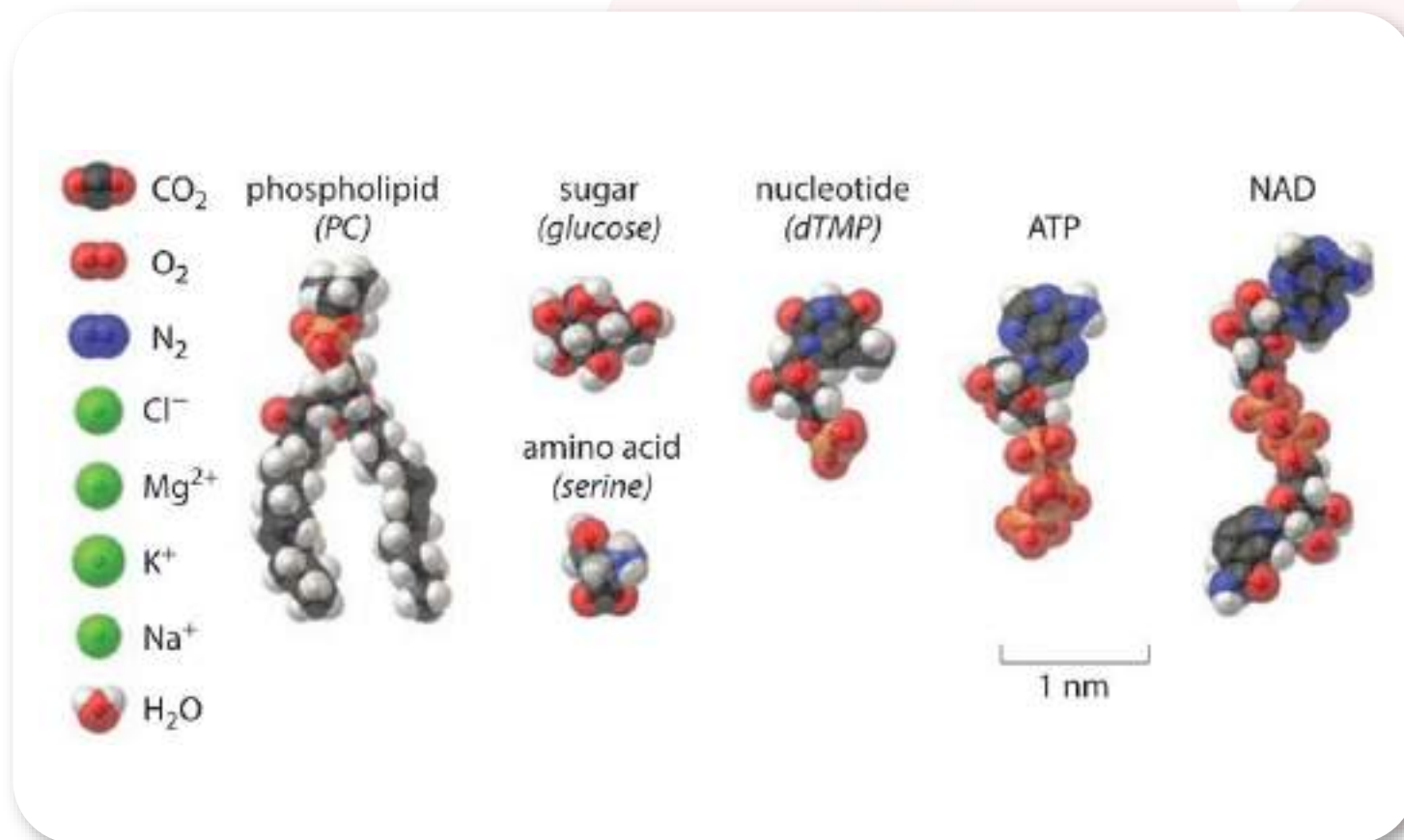
**Inducing lipase activity can lead to optimum growth by improving digestibility of fatty acids within the lipid constraint.**



# How can we improve gut health and functionality?




# The ability of Saponins to form pores and membrane elasticity

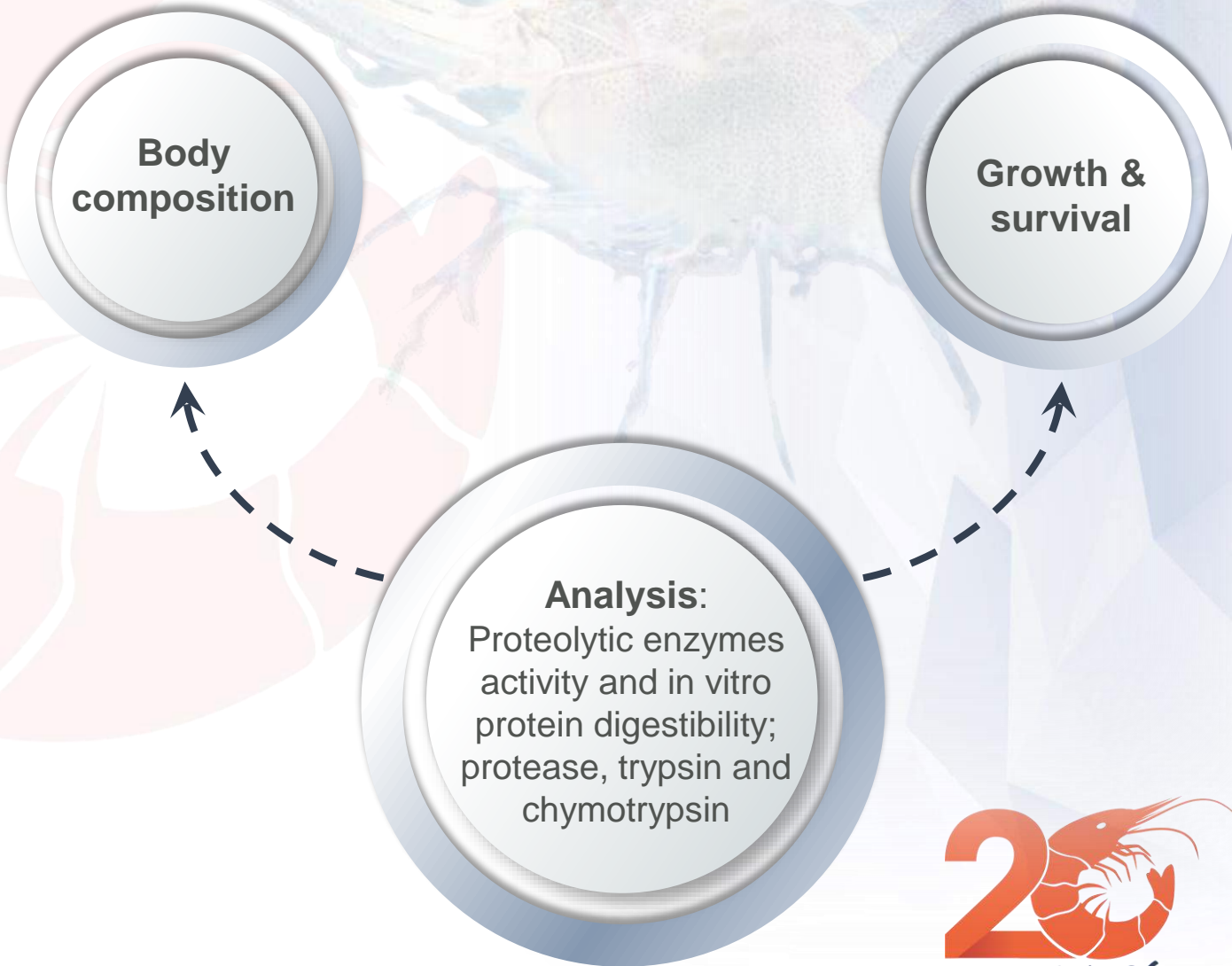




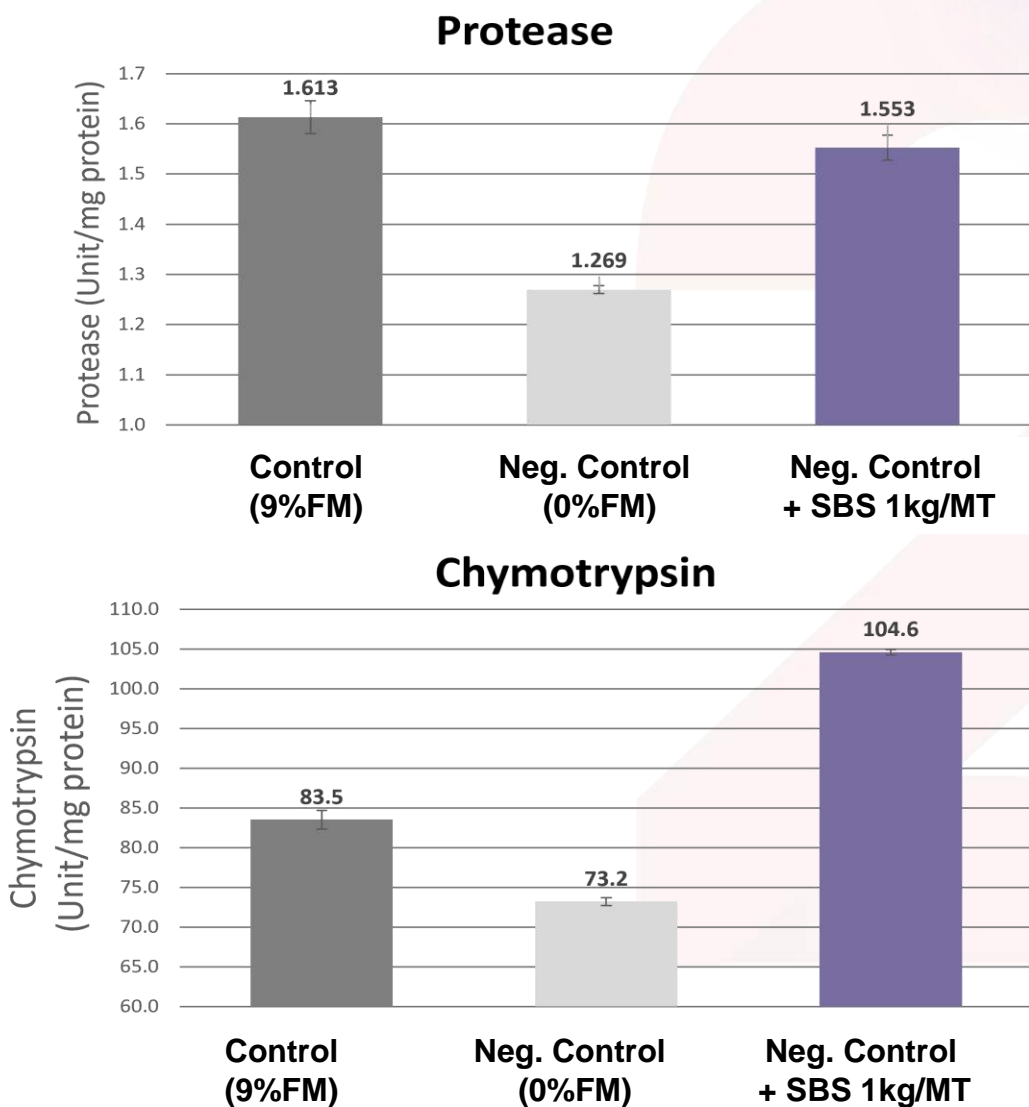
# Effect of SBS on digestibility of soybean-meal-based diet in *L. vannamei*

Improvement in digestion and absorption

	Species	Shrimp
	Treatment	Control vs SBS <ul style="list-style-type: none"><li>Control (9% fishmeal inclusion) without SBS</li><li>Negative control (0% fishmeal inclusion Soybean based meal) without SBS</li><li>Negative control with SBS 1kg/MT</li></ul>
	Number Replicas	4
	Duration	60 days
	Stocking	100 Shrimps/tank
	Initial Weight	0.51± 0.10g



# Effect of SBS on digestibility of high soybean meal diet with *L.vannamei*



	Control (9%FM )	Neg. control (0%FM)	Neg. control + SBS 1kg/MT
Protein	75.8±1.1	75.0±0.7	75.3±2.1
Arginine	7.74	7.93	8.95
Histidine	0.71	0.73	0.74
Isolucine	1.2	1.3	1.59
Leucine	1.99	1.93	2.44
Lysine	3.69	3.76	4.44
Methionine	0.79	0.81	0.85
Phenylalanine	1.37	1.34	1.17
Threonine	1.21	1.36	1.07
Tryptophan	0.53	0.39	0.42
Valine	1.21	0.35	1.32
Sum EAA	20.4	19.9	22.9

\*EAA (Essential Amino Acids)



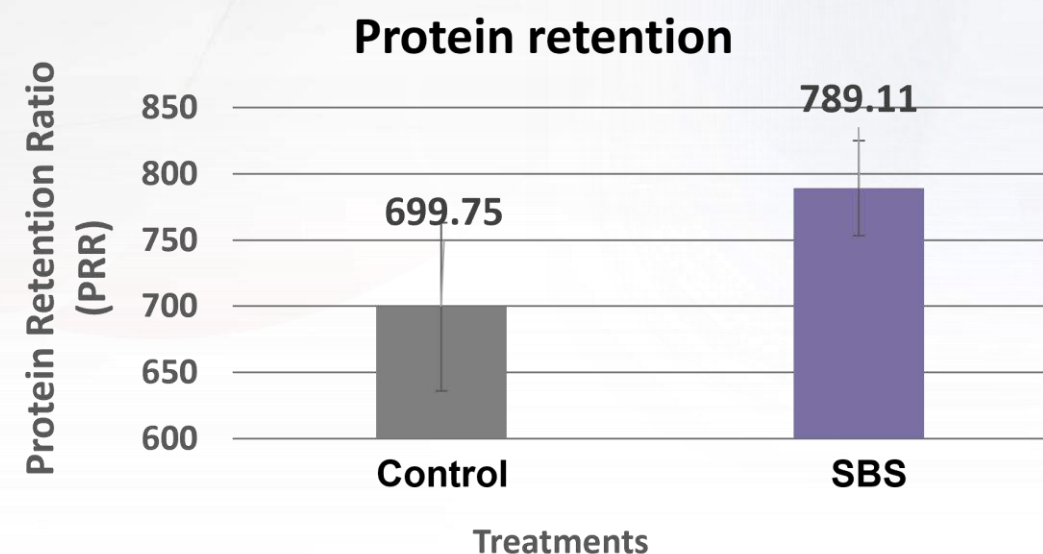
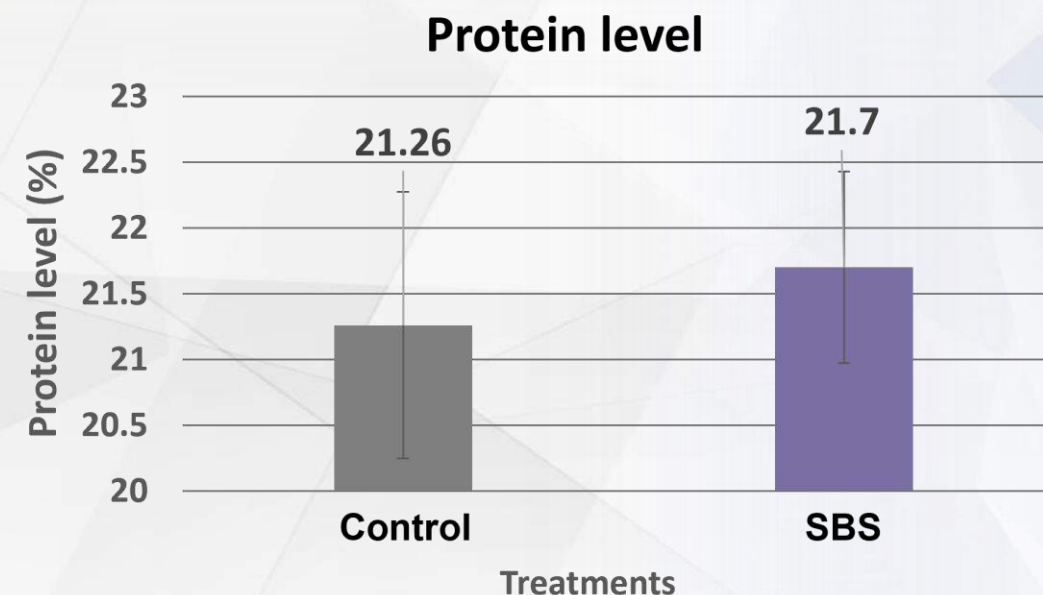
# SBS Metabolic analyses of shrimp – protein level and retention

Batam Dae Hae Seng research station, Indonesia

	<b>Species</b>	Shrimp
	<b>Treatment</b>	Control vs SBS
	<b>Number Replicas</b>	6
	<b>Duration</b>	60 days
	<b>Stocking</b>	180 Shrimps/tank
	<b>Initial Weight</b>	Size- 4.24±0,03 g initial weight with <i>L. vannamei</i>
	<b>Inclusion of SBS</b>	2kg/MT

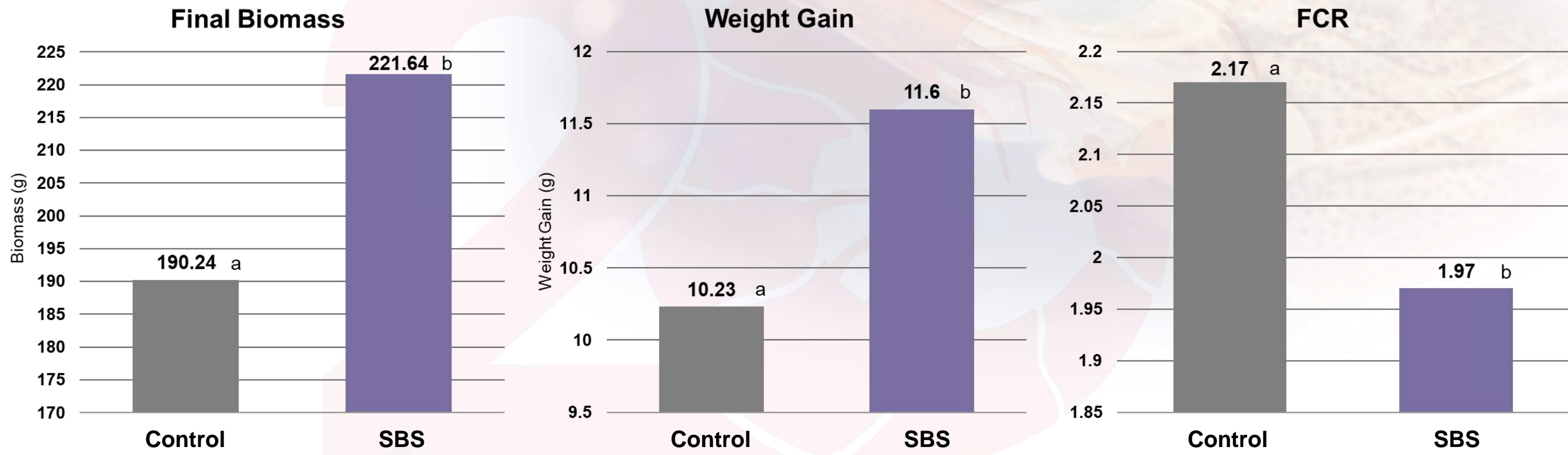
- Analysis:**

- Protein level %: Kjeldahl method
- Protein retention ratio (PRR)



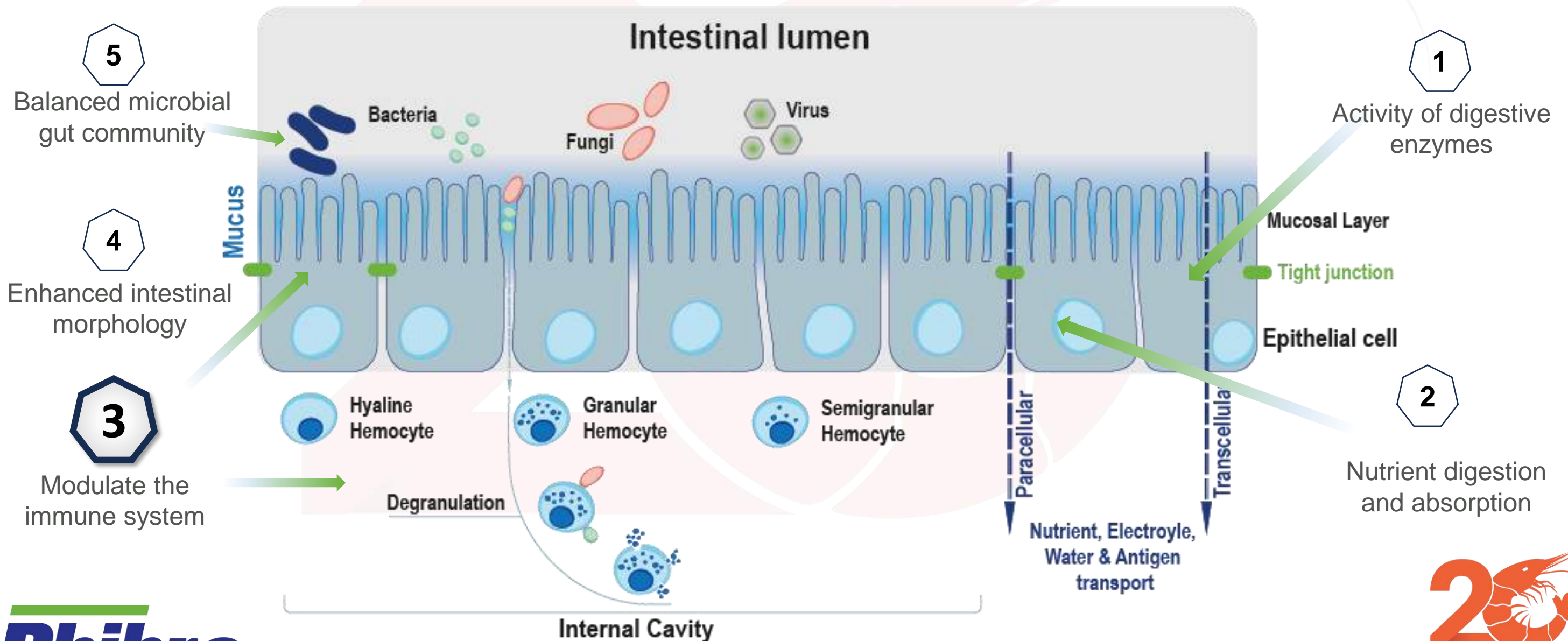
# Results

## Performance

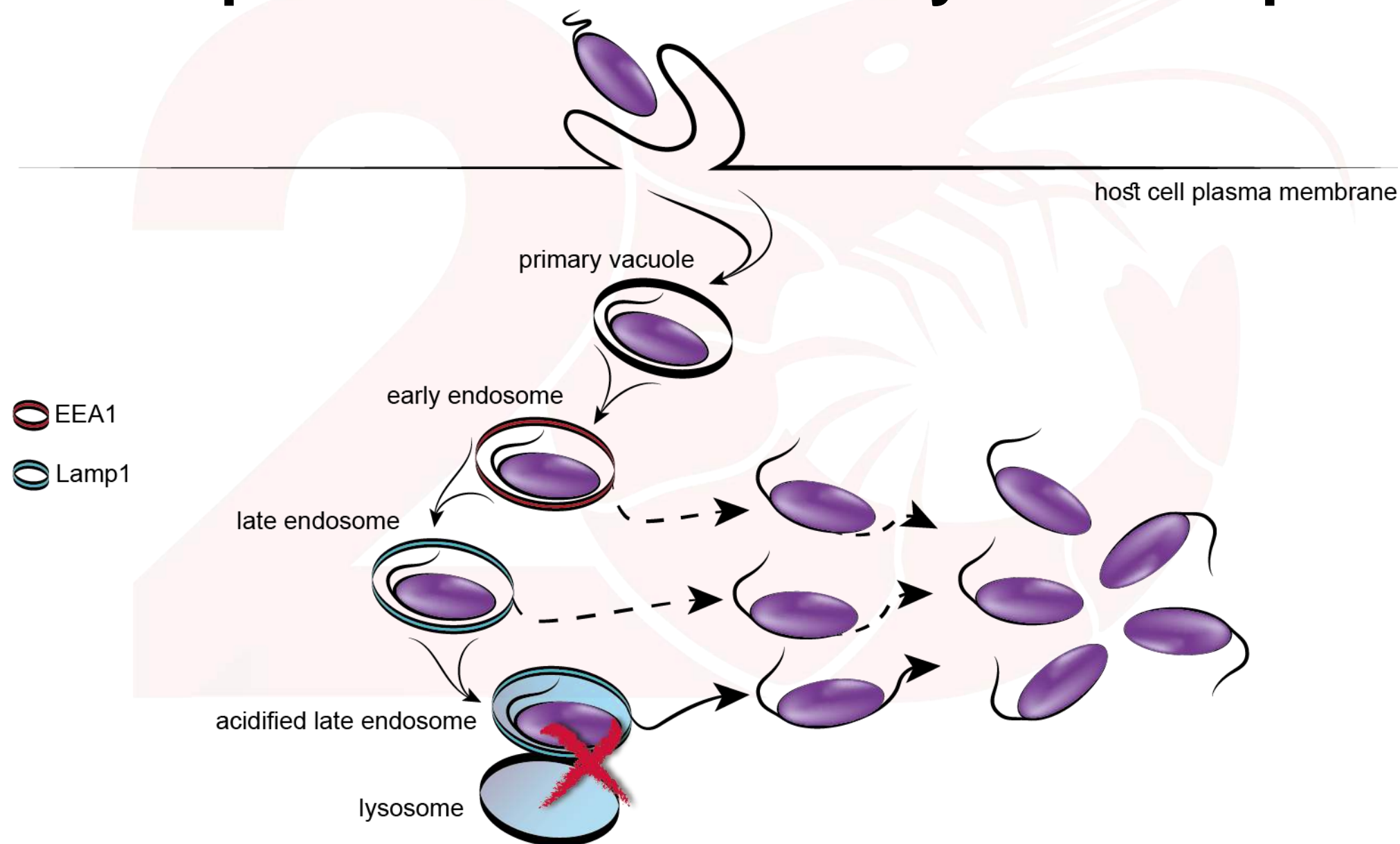




# How can we improve gut health and functionality?

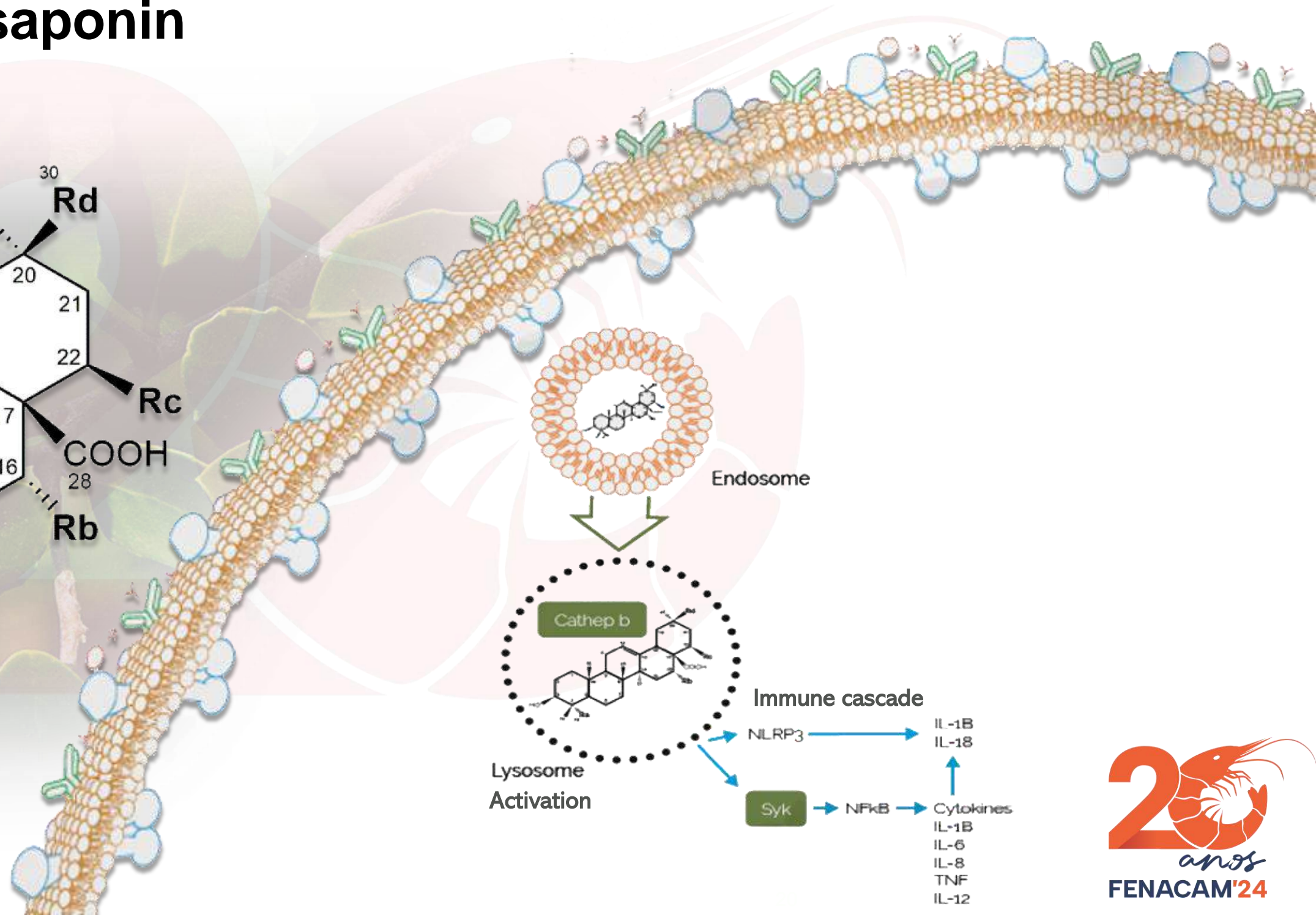
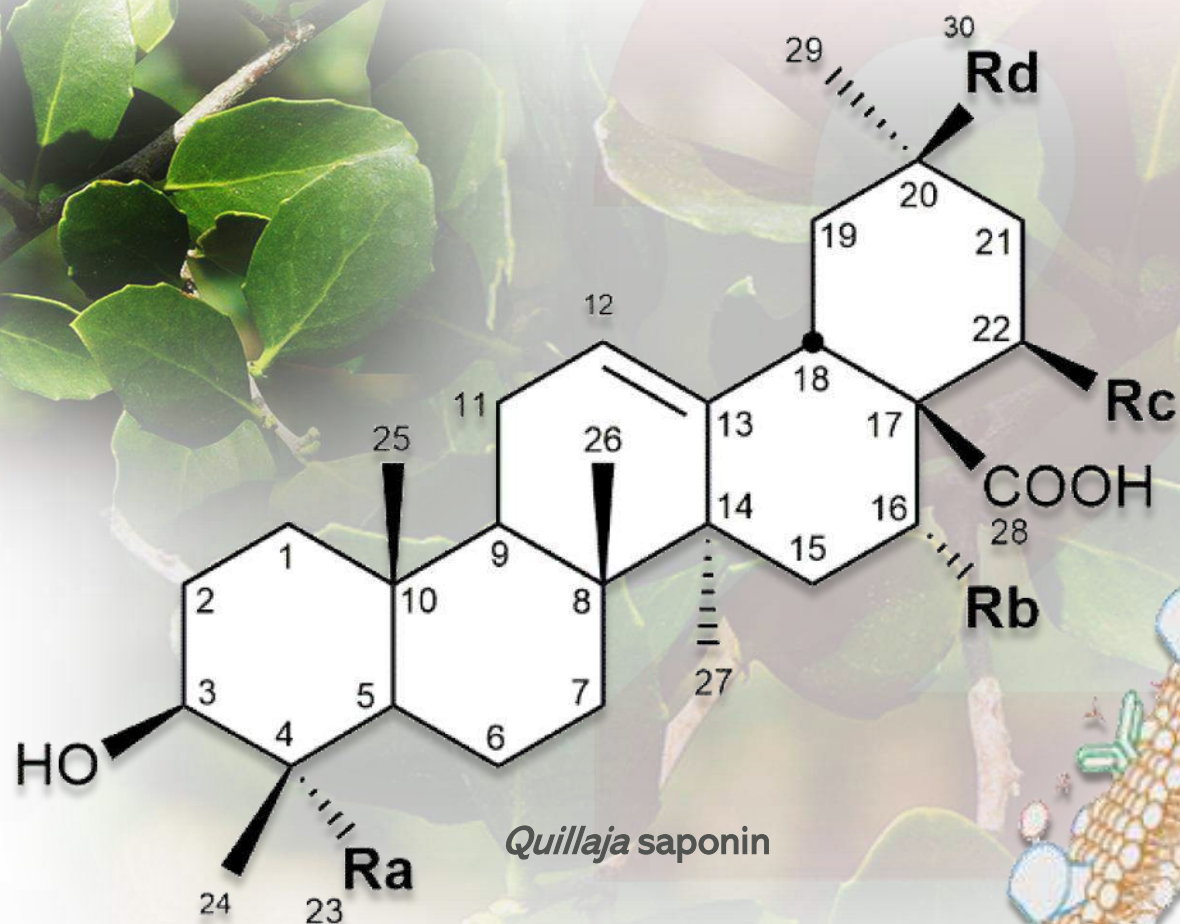


# Intracellular *Vibrio parahaemolyticus* escapes the vacuole and establishes a replicative niche in the cytosol of epithelial cells





# Proposed mechanism of enhancement of immune response in shrimp by *Quillaja* saponin



# Evaluating the effect of SBS on growth performance and overall health status of *Litopenaeus vannamei* culture under normal and challenge conditions

Kasetsart University, Thailand - 2021

	<b>Species</b>	Shrimp <i>L. vannamei</i>
	<b>Treatment</b>	Control vs SBS 3 Kg/MT feed
	<b>Number Replicas</b>	6
	<b>Duration</b>	8 weeks
	<b>Stocking</b>	25 Shrimps/tank
	<b>Initial Weight</b>	Size 2±0.05g
	<b>Challenge</b>	<i>Vibrio parahaemolyticus</i>

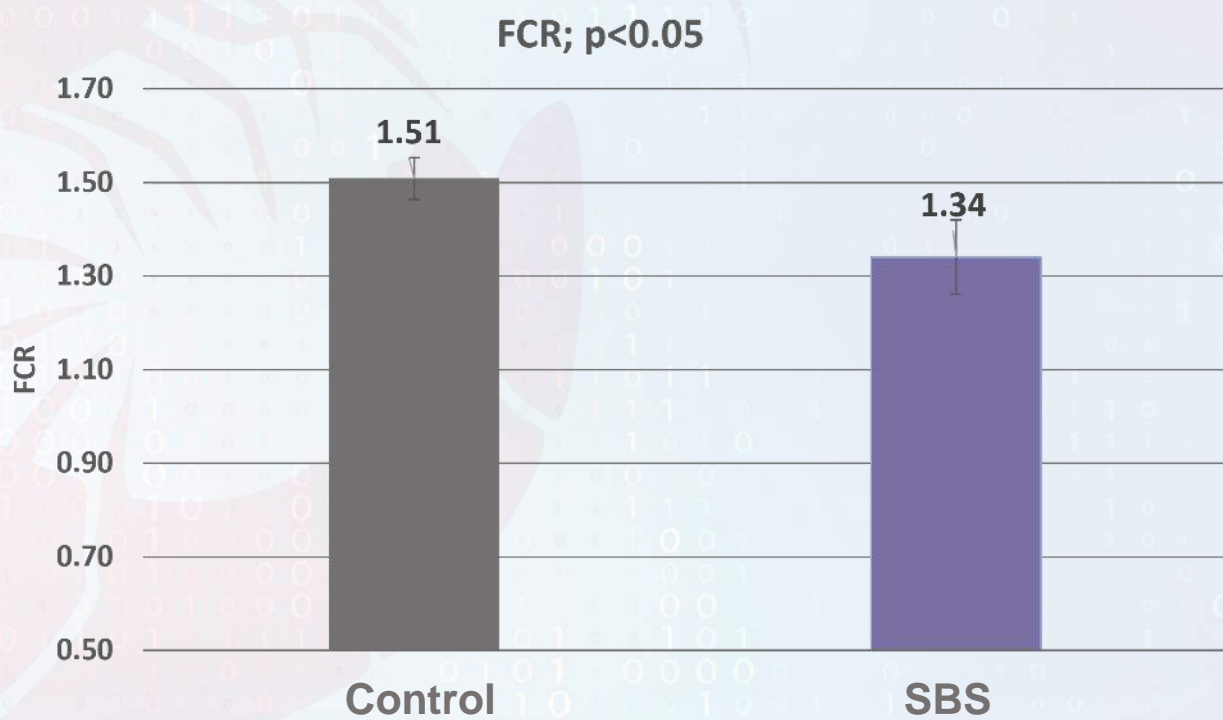
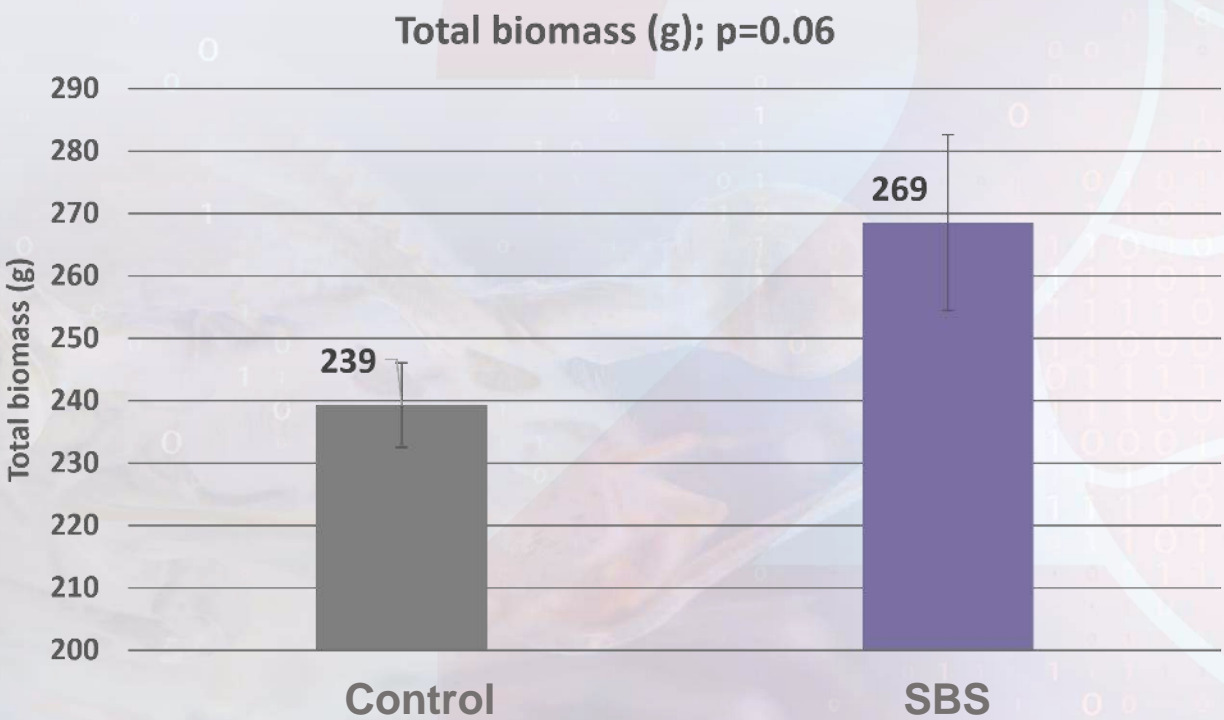
## Analysis:

- Growth performance
- Blood and biochemistry
- Bacteria count



# Evaluating the effect of SBS on growth performance and overall health status of *Litopenaeus vannamei* culture under challenge conditions

Growth performance normal conditions



Survival was higher with SBS

# Evaluating the effect of SBS on growth performance and overall health status of *Litopenaeus vannamei* culture under challenge conditions

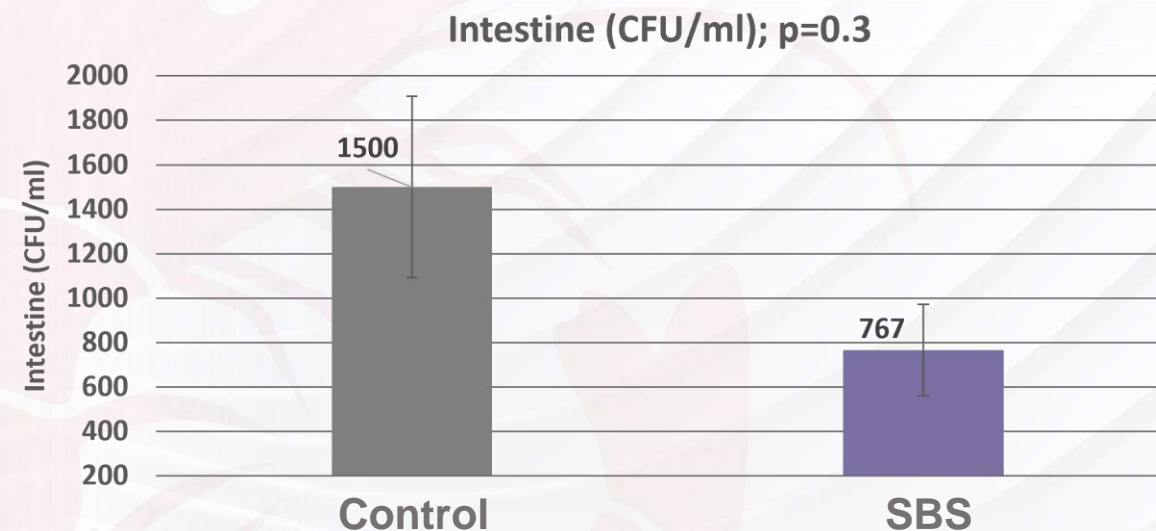
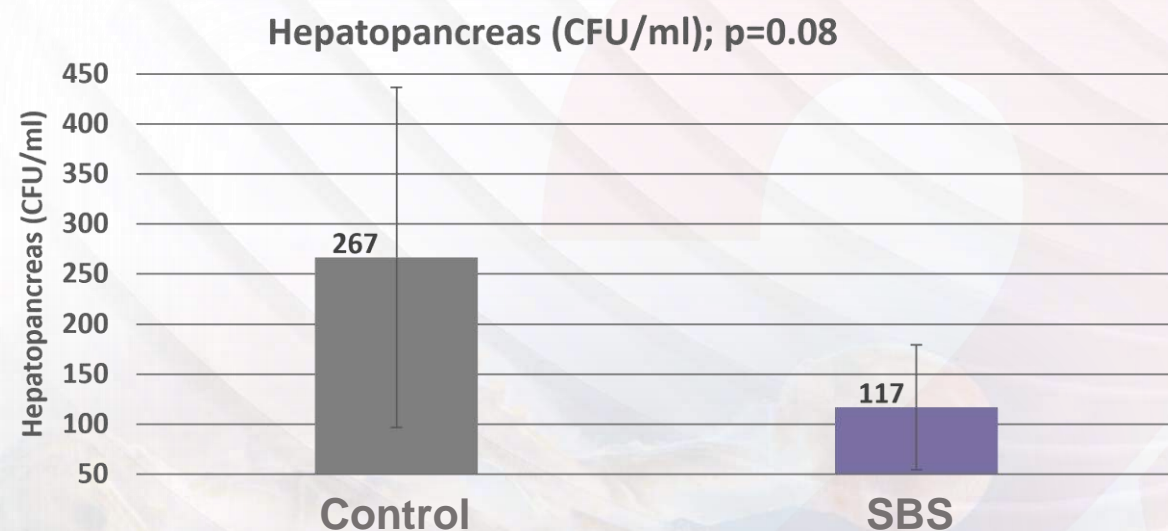
*Immune parameters under challenge, one week after challenge*

	Hemocyte count (x10 <sup>5</sup> cell/ml)	Hemolymph Protein (g/dL)	Phenoloxidase activity(unit/min/mg Protein)	Lysosyme	Superoxide dismutase (SODN)	Glutathionine
Control	29.7	1.0	250.6	30.0	7.4	30.3
SBS	32.7	2.1	284.3	43.3	11.1	32.4
P value	0.02	0.31	0.21	0.001	0.04	0.01

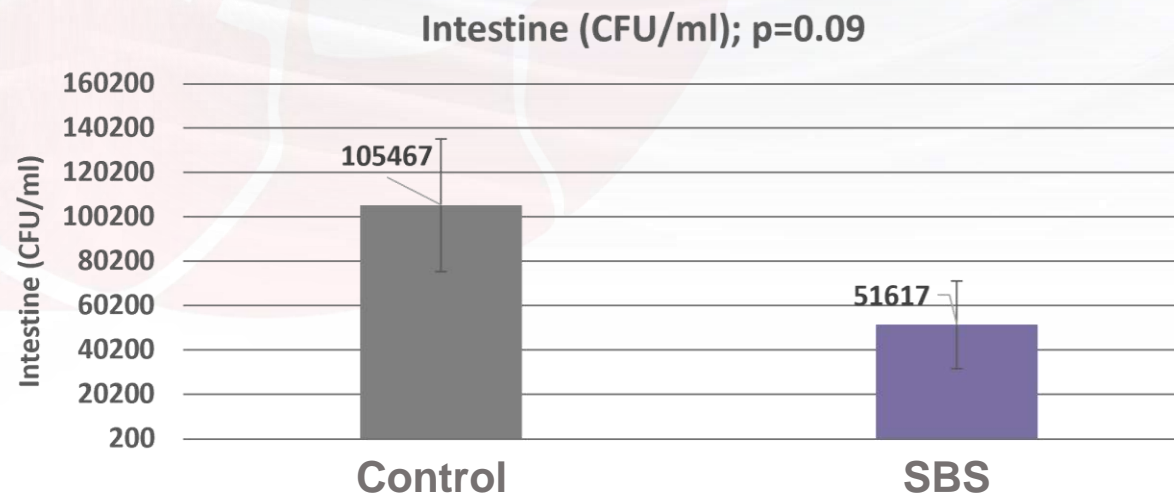
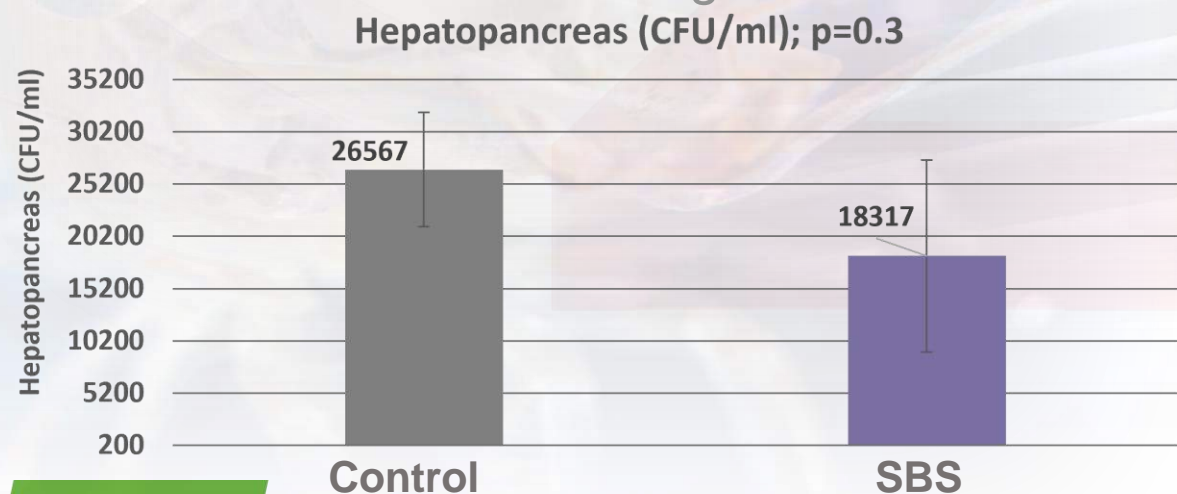


# Evaluating the effect of SBS on growth performance and overall health status of *Litopenaeus vannamei* culture under normal and challenge conditions

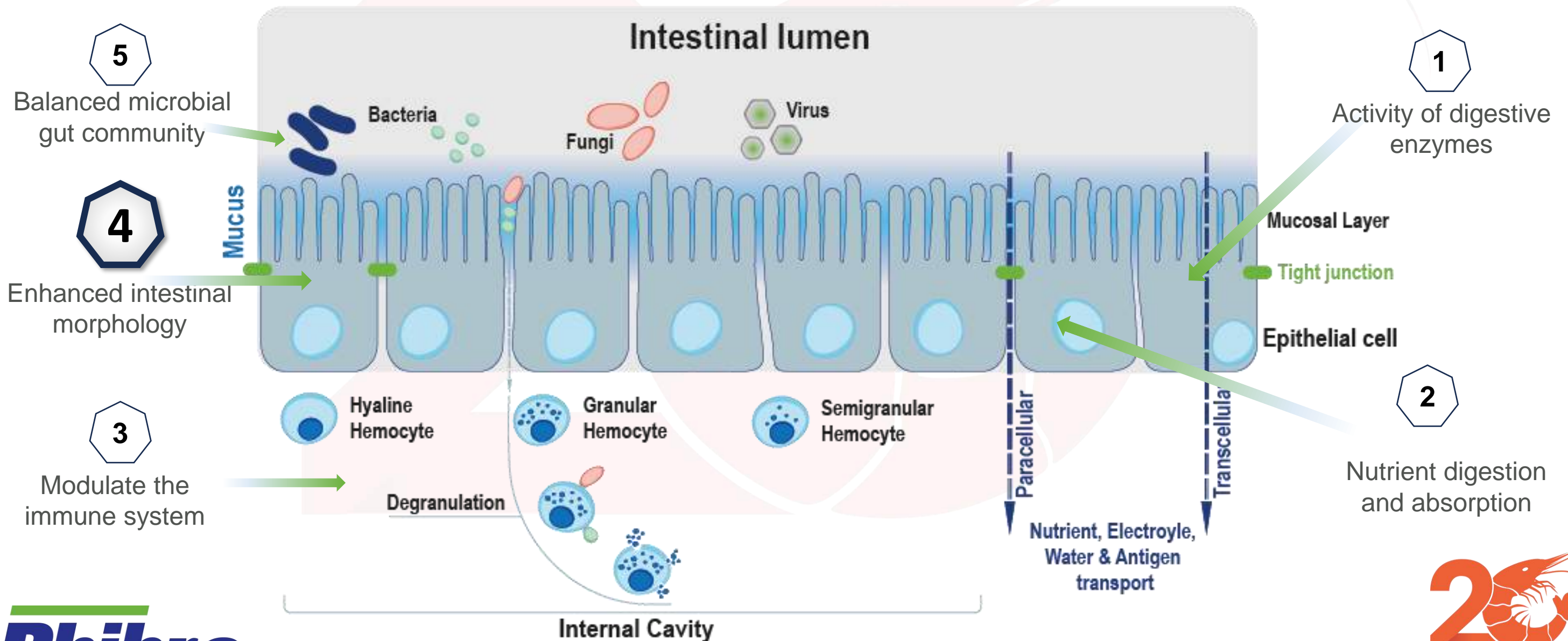
## Bacteria count under normal condition



## Bacteria count after challenge



# How can we improve gut health and functionality?

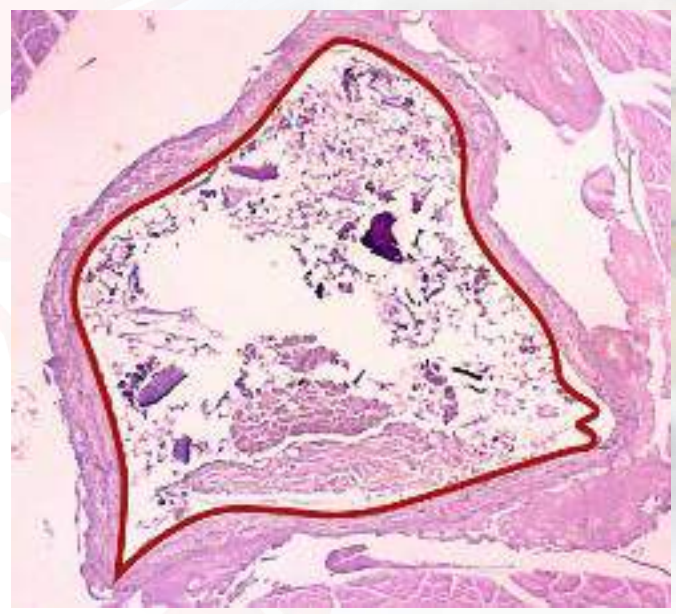




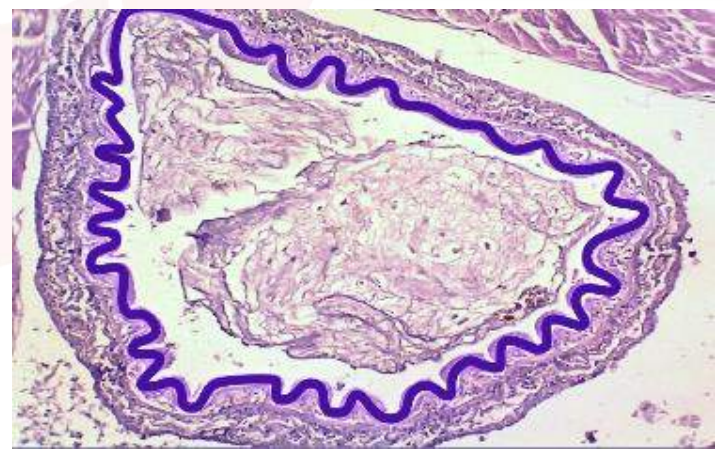
# Inclusion effect of SBS in plant-based diet on histomorphology conditions of white-leg shrimp, *Litopenaeus vannamei*



<b>Treatment</b>	<ul style="list-style-type: none"><li>- Commercial feed</li><li>- Commercial feed + 2kg/MT of SBS</li></ul>
<b>Animals</b>	<i>Litopenaeus vannamei</i> , 2g (initial weight) 15 shrimp/aquarium
<b>Duration</b>	90 days
<b>Facility</b>	24 aquariums tanks: 75 x 40 x 40 cm (100 L each)
<b>Temp</b>	26 °c
<b>Replicates</b>	8
<b>Location</b>	Center for marine and fisheries, Jakarta Technical University of Fisheries located in Serang, Banten, Indonesia.



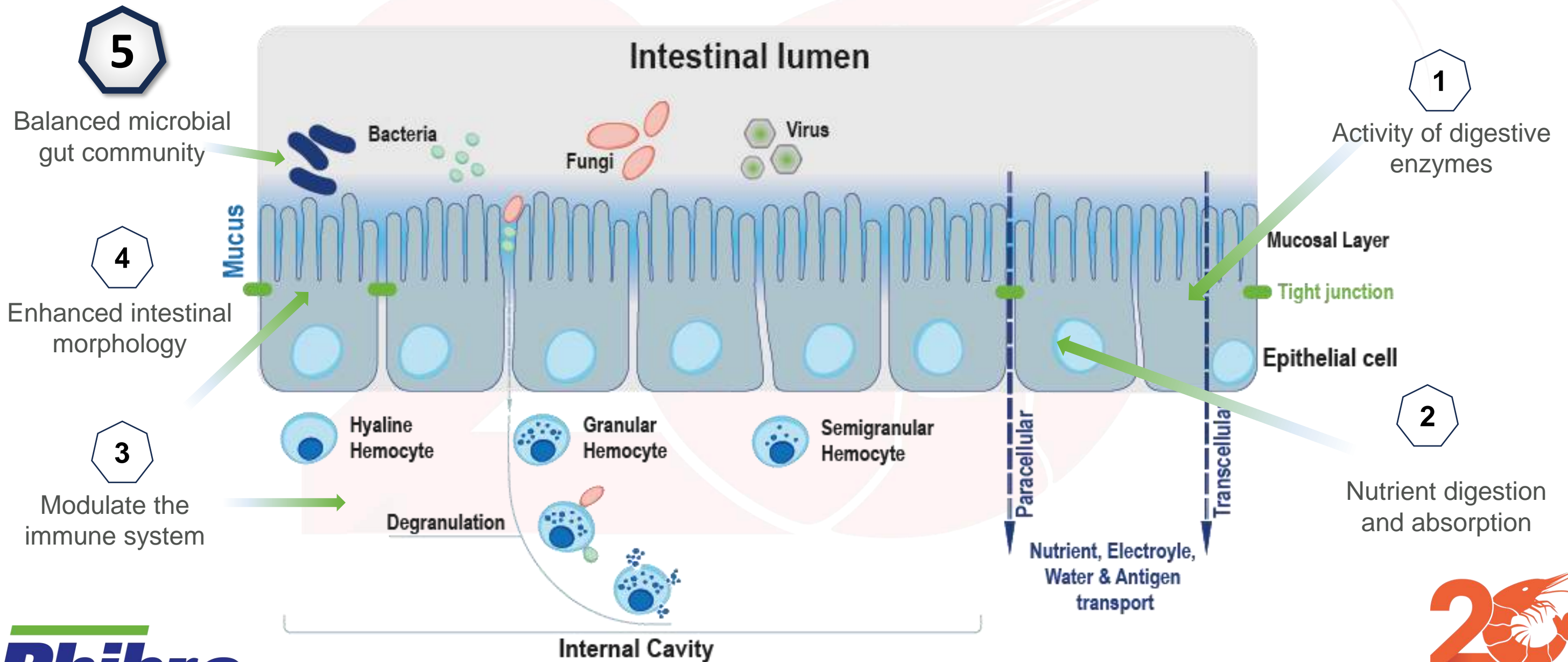
1. Commercial feed  
Grade 0 – Low level to no intestinal folds



2. Commercial feed + 2kg/MT of SBS  
Grade 4 – High level of intestinal folds

Growth performance was significantly better at the SBS treatment

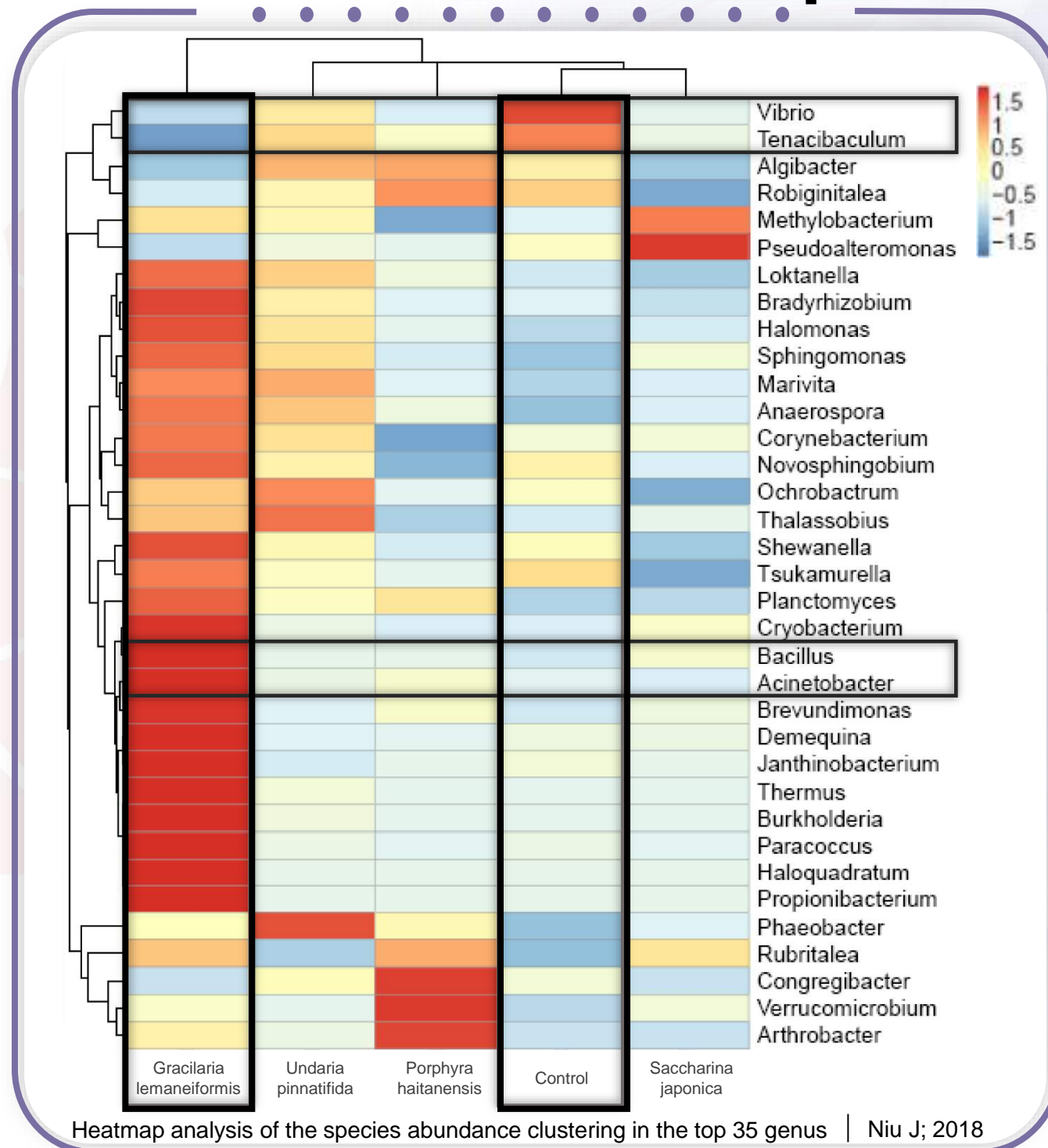
# How can we improve gut health and functionality?



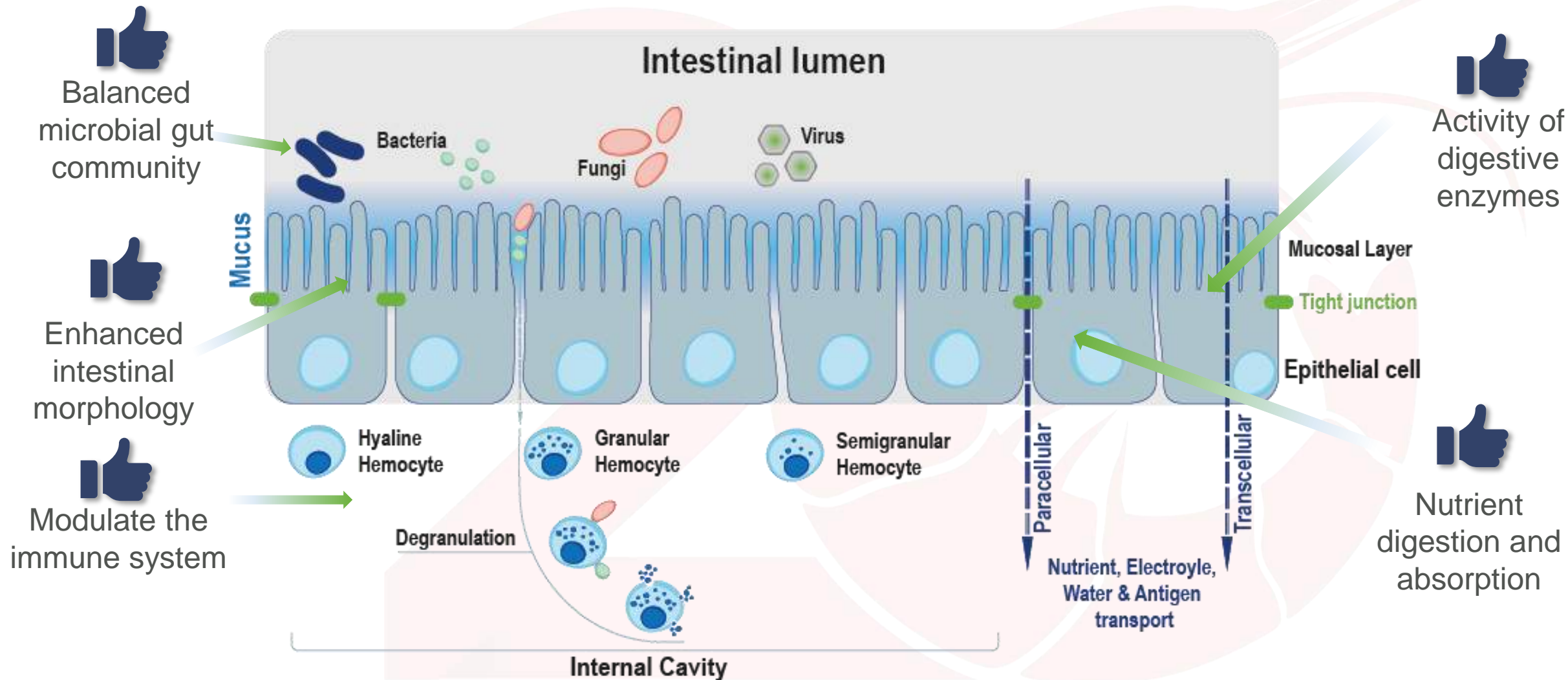


# The Effect of Phytogenic on Microbiome in Shrimp Gut

- Intestinal microbiota supplies the host with nutritional and energy, acts as a pathogenic barrier, and exerts great influence on the maintenance of immune homeostasis
- *Gracilaria lemaneiformis* contains triterpenic saponins.
- *Gracilaria lemaneiformis* increased  $\alpha$ -diversity of microbes in the intestine.
- We see significant impact on the microbial community vs control



# How can we improve gut health and functionality?



## PAQ-Protex®

Gratificação e Valor Anticópsico  
Ativo Inibidor de Osmotose

**Indicação do Produto:**  
Ativo inibidor de osmose para controle da integridade intestinal e aumento do grau de peso, eficiência alimentar e redução de perdas e custos.  
**Composição da Matéria de Produto:**  
Gratificação (Gratificação) 95 % e Inibidor de Osmotose 5 %.  
**Atividade do Produto:**  
Gratificação (Gratificação) 95 % e Inibidor de Osmotose 5 %.  
**Indicação e Modo de Uso:**  
Ativo inibidor de osmose para controle da integridade intestinal e aumento do grau de peso, eficiência alimentar e redução de perdas e custos.  
**Condições de Armazenamento:**  
Armazenar em local seco, fresco e ventilado, longe da luz solar direta. Evitar contato com alimentos.

Preço	Quantidade
300 - 500 g/kg	1.000 - 2.000 g/kg

**Indicações de Uso, Contraindicações e Cuidados:**  
Assim como qualquer medicamento, o PAQ-Protex® deve ser usado com cuidado e atenção. Não usar o produto em animais com doenças graves, especialmente aquelas relacionadas ao sistema digestivo. Não usar o produto em animais com doenças graves, especialmente aquelas relacionadas ao sistema digestivo. Não usar o produto em animais com doenças graves, especialmente aquelas relacionadas ao sistema digestivo.

**Condições de Armazenamento:**  
Armazenar em local seco, fresco e ventilado, longe da luz solar direta. Evitar contato com alimentos.

**Indicação e Modo de Uso:**  
Ativo inibidor de osmose para controle da integridade intestinal e aumento do grau de peso, eficiência alimentar e redução de perdas e custos.

**Condições de Armazenamento:**  
Armazenar em local seco, fresco e ventilado, longe da luz solar direta. Evitar contato com alimentos.



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# Thank you!

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