

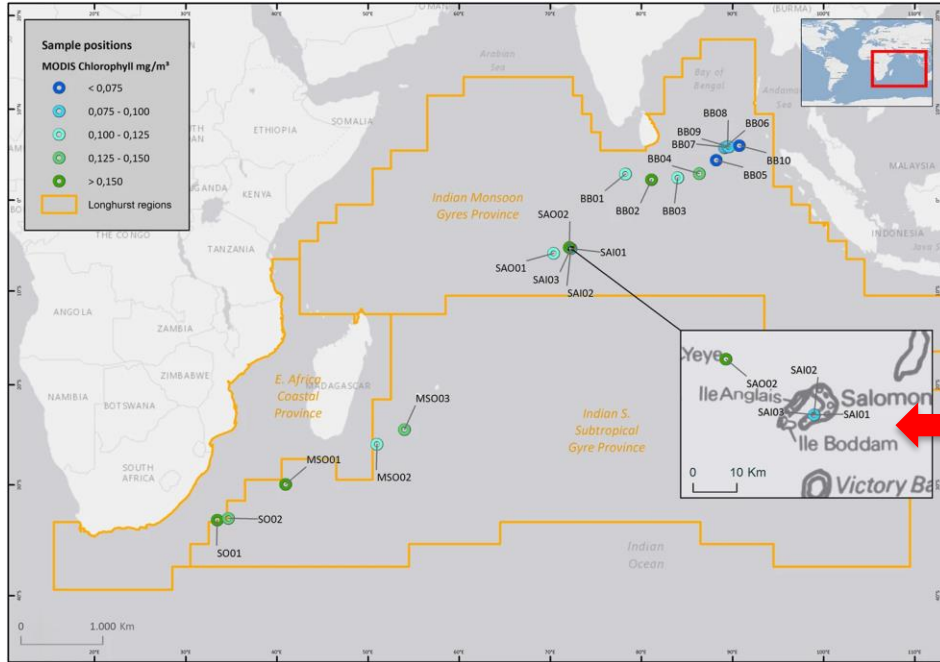
Decoding the microbiome

To solve the disease crisis in aquaculture





Established first microbiome baseline across the Indian Ocean and Chagos Archipelago (British Indian Ocean Territory)



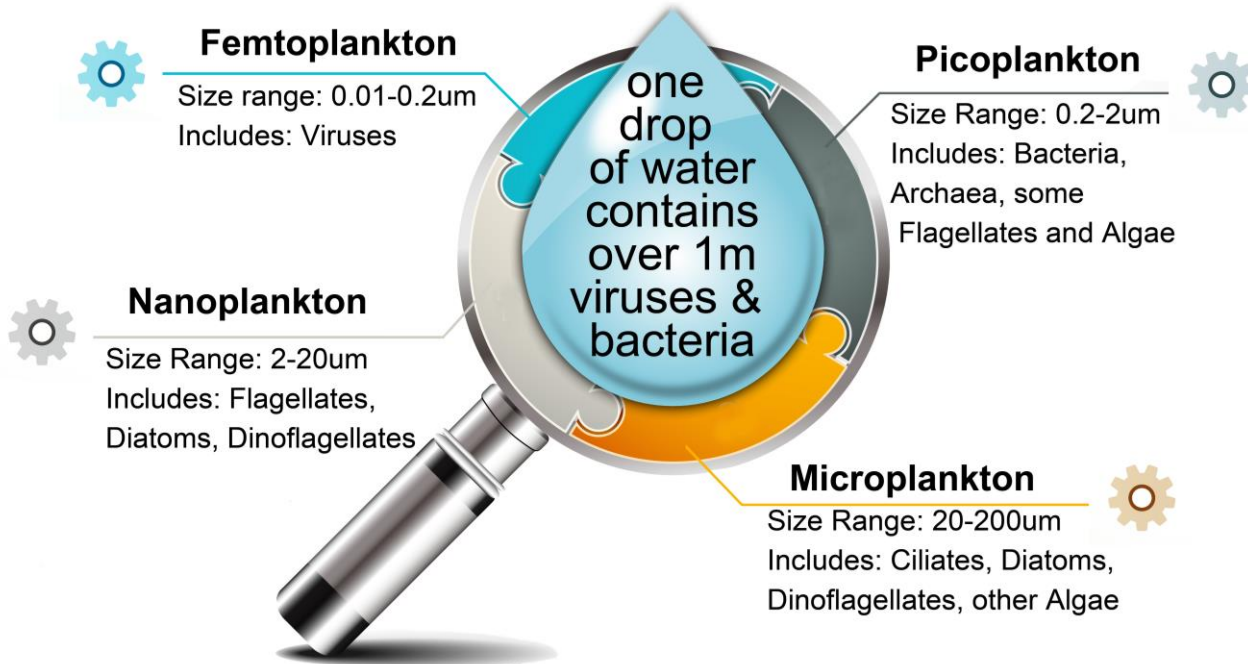


how to obtain a healthy scalp microbiome



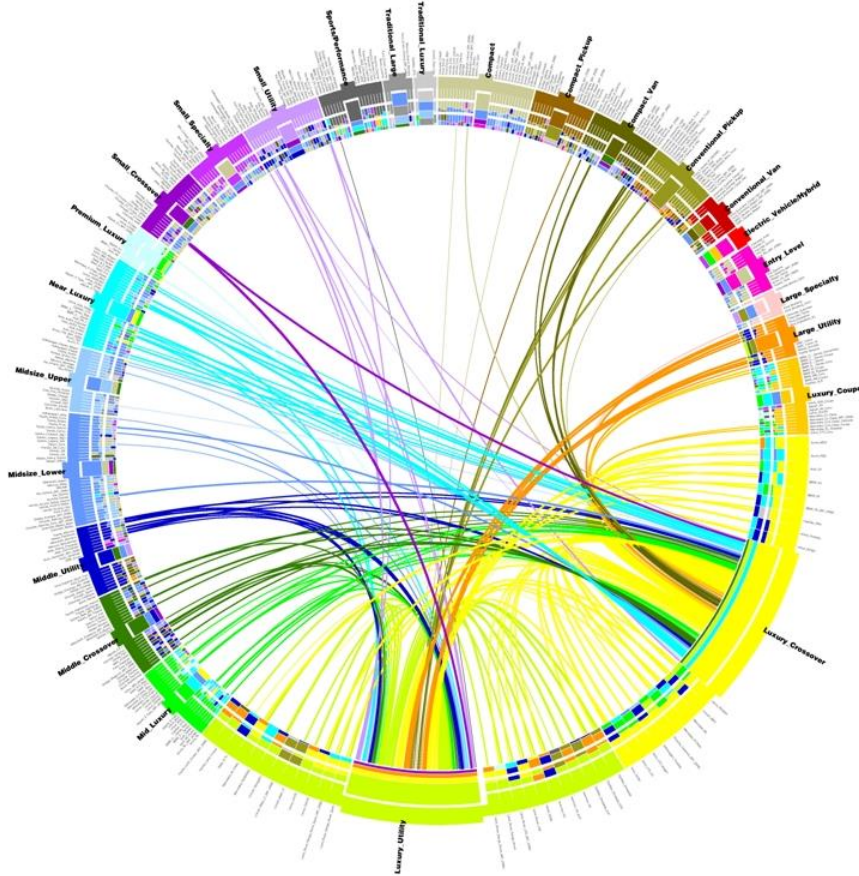
happiness
habitat.

What is the microbiome? Why is it gaining so much interest? Why is it important? And why haven't we looked at it before?

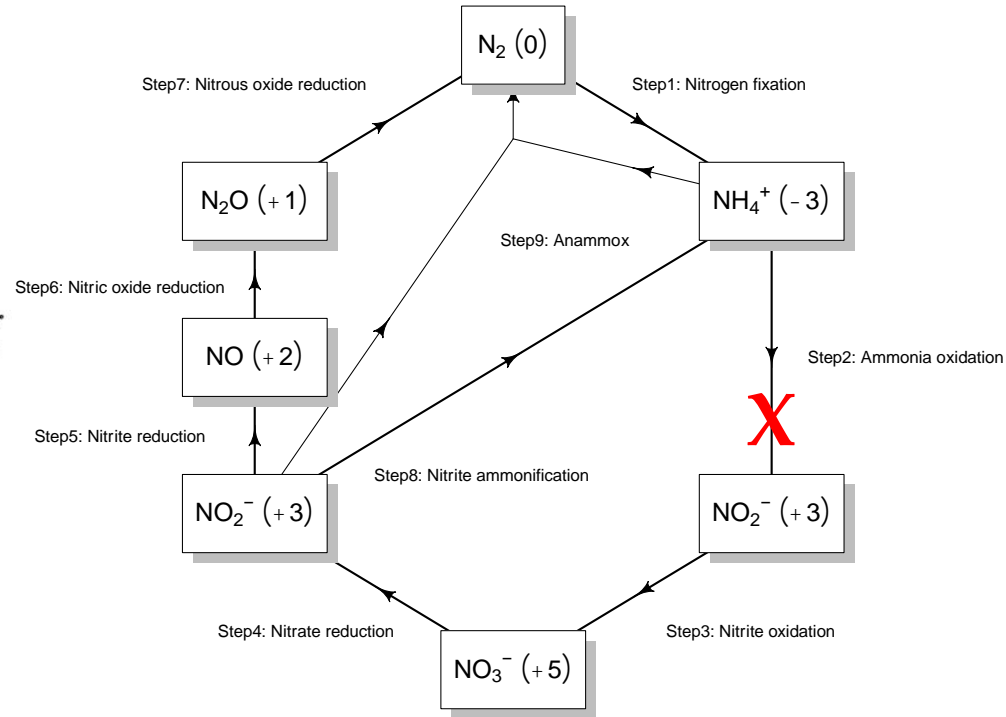




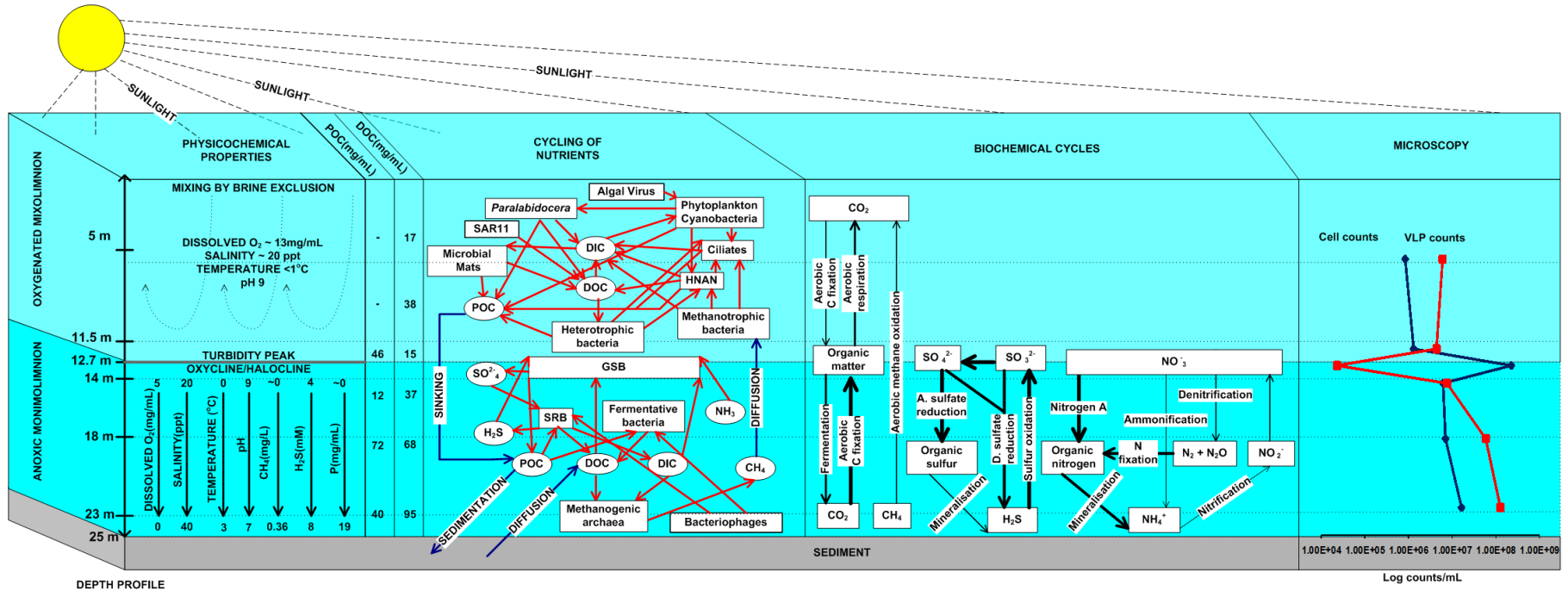
Functional complexity



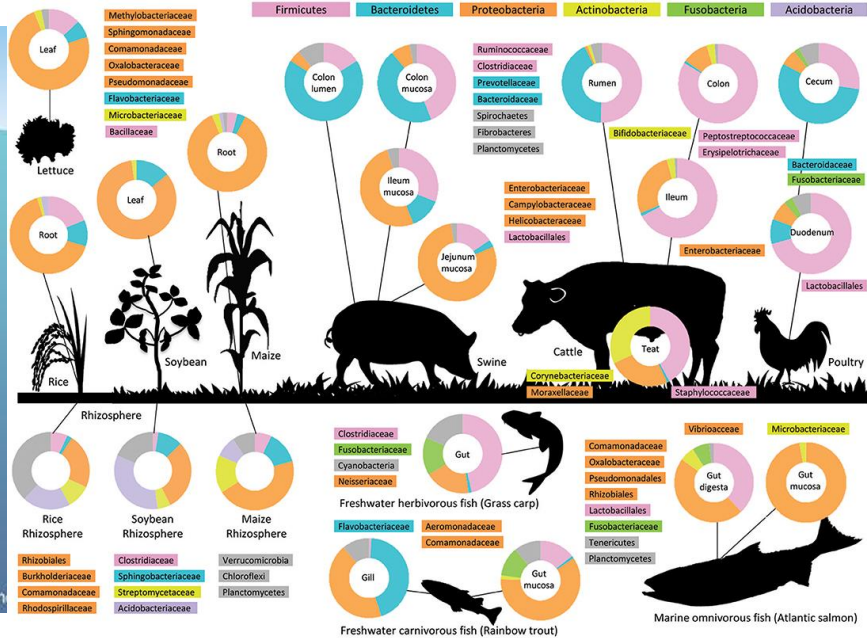
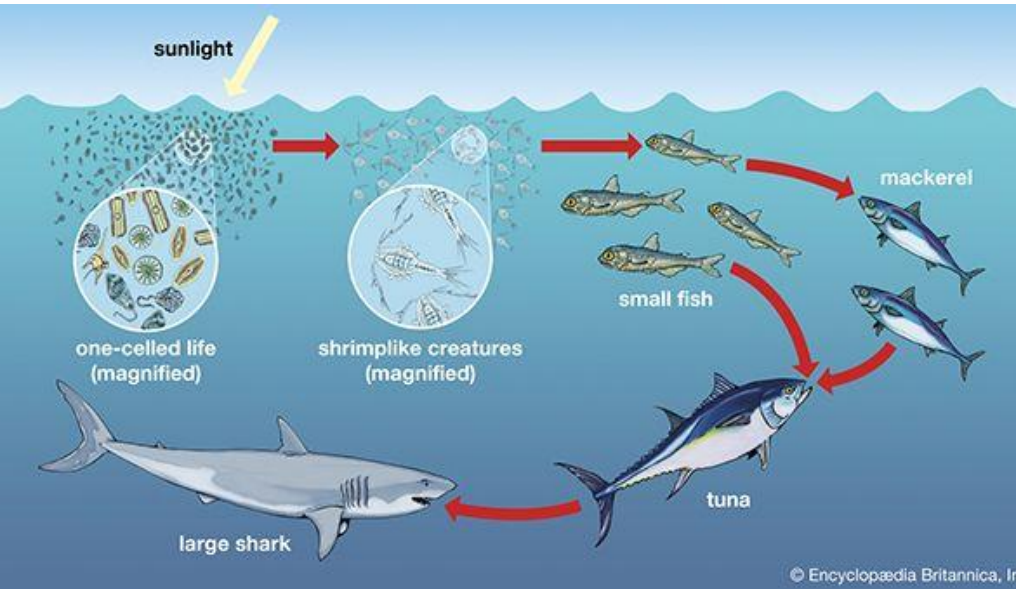
Nitrogen Cycle: 1



System complexity



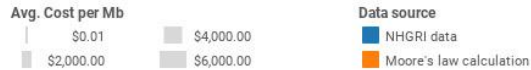
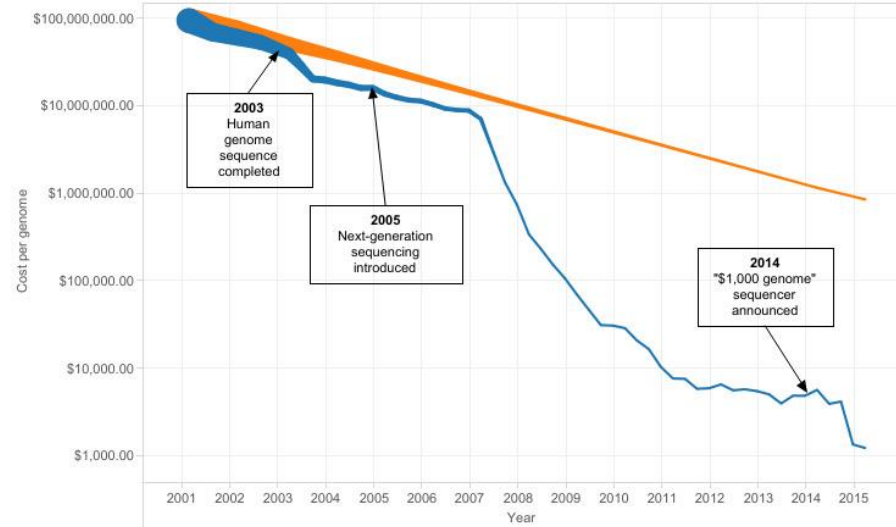
Why is the microbiome important?



Underpins all life on planet earth

Why now?

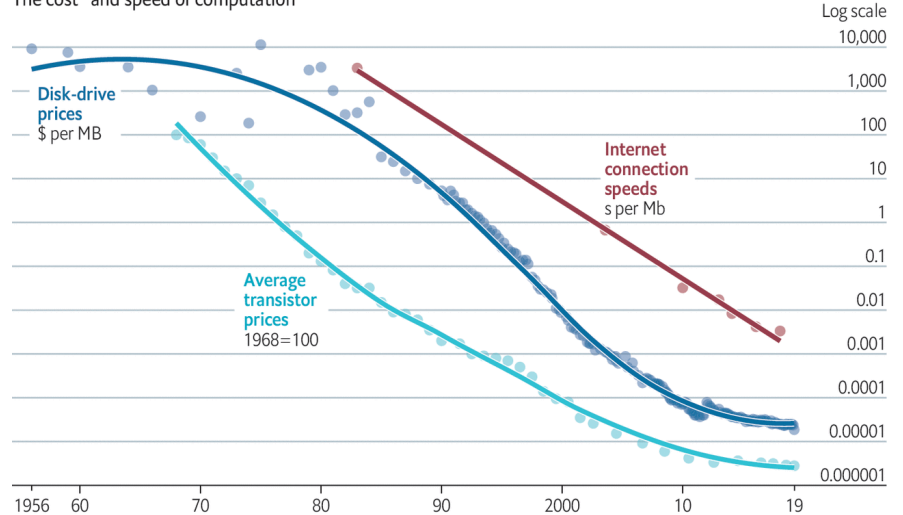
DNA sequencing costs over time



Decline in real costs compared to expected declines based on Moore's Law.
 Trend line: Cost per human genome. Line width: Cost per megabase (Mb)
 (Data: NHGRI <https://www.genome.gov/27541954/dna-sequencing-costs-data/>)

Decline and fall

The cost* and speed of computation



Sources: John C. McCallum; Gordon Moore; The Linley Group; Nielsen Norman Group; *The Economist*

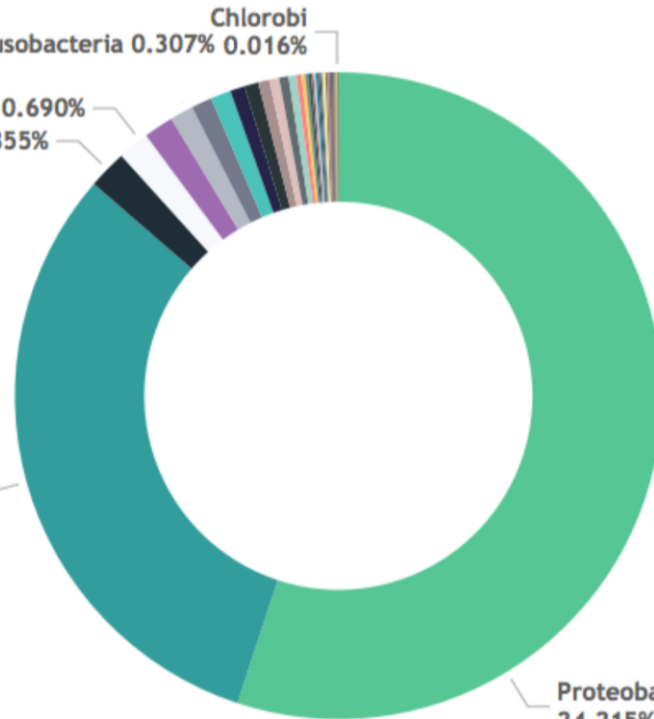
The Economist

*Nominal prices

Putting Faces to the Names

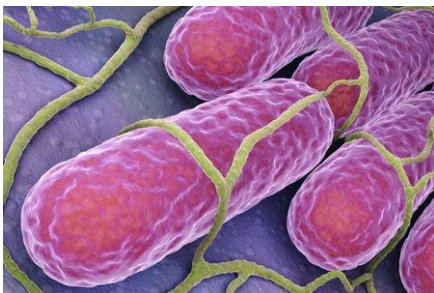


Chloroflexi 0.690%
Firmicutes 0.855%
Fusobacteria 0.307%
Chlorobi 0.016%



Bacteroidetes
13.777%

Proteobacteria
24.215%



The Zen State of Balance = Free of Disease

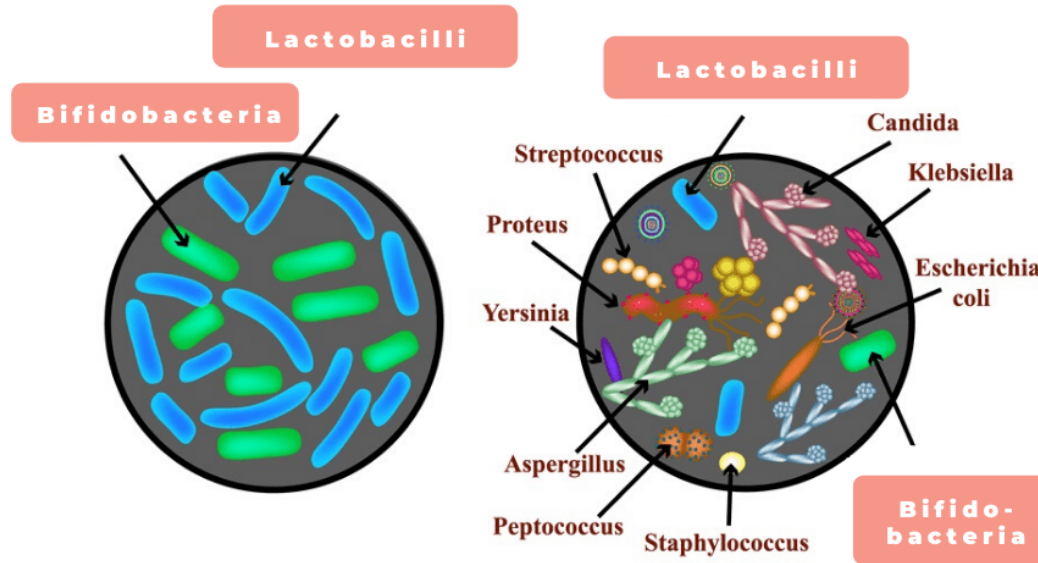


Loss of competitive pressure for resources
The Two Step Mechanism of Disease

Step One: Reduced biodiversity

Step Two: A shift in the types of microbes present

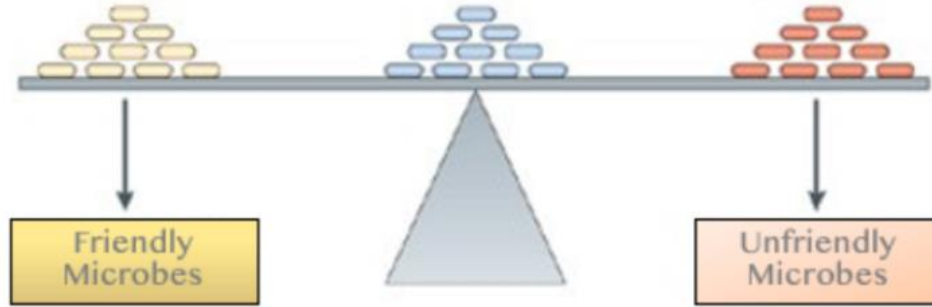
DYSBIOSIS



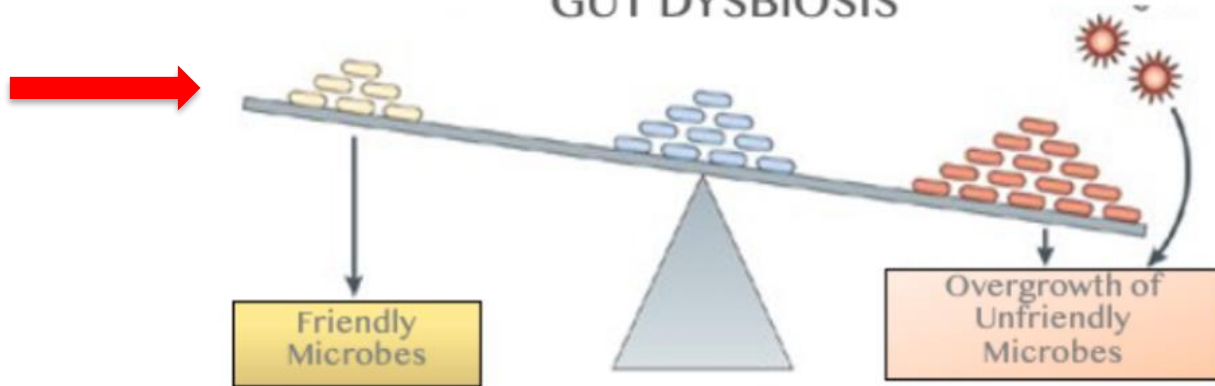
NORMAL

DYSBIOSIS

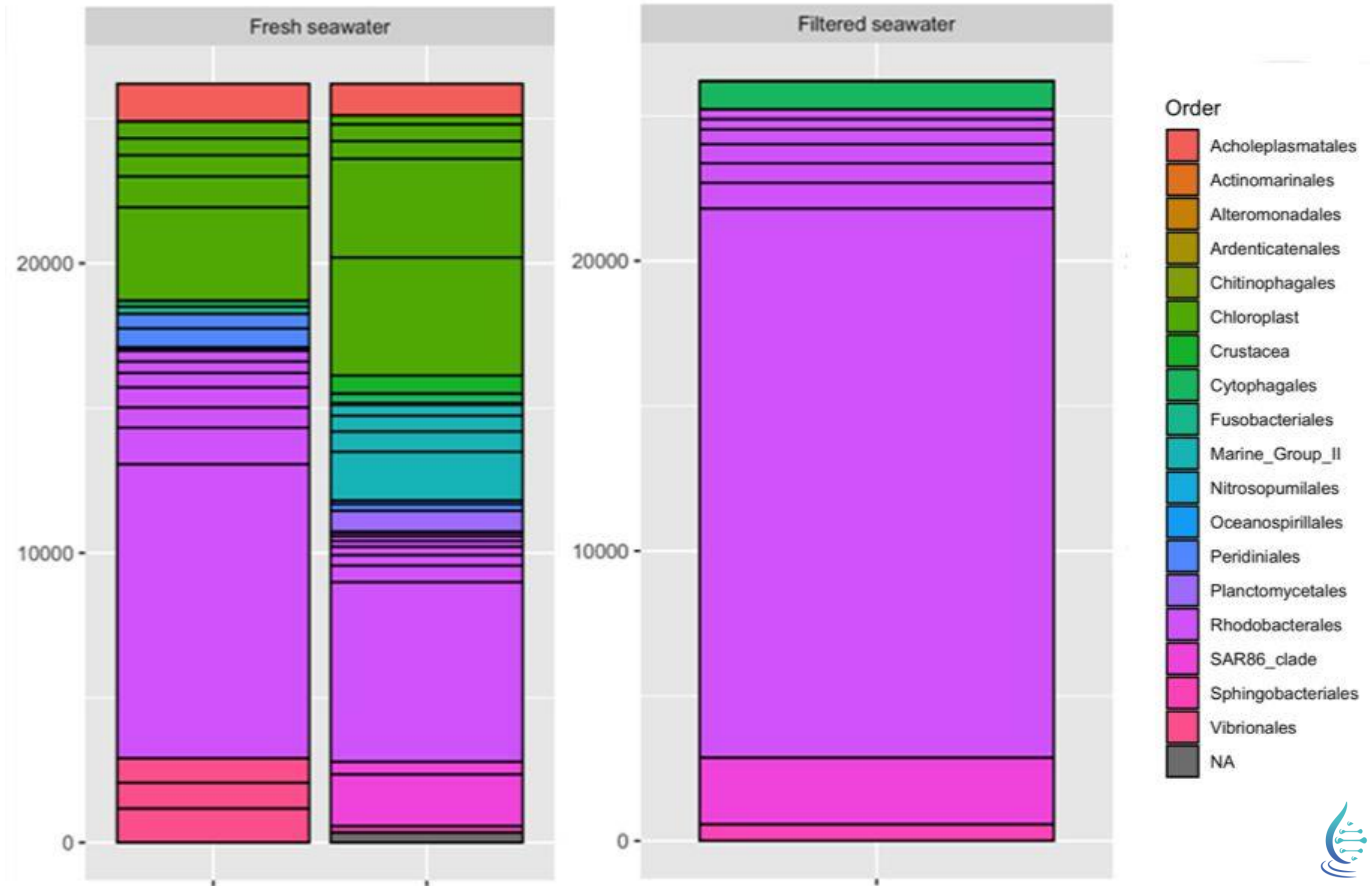
BALANCED GUT MICROBIOTA



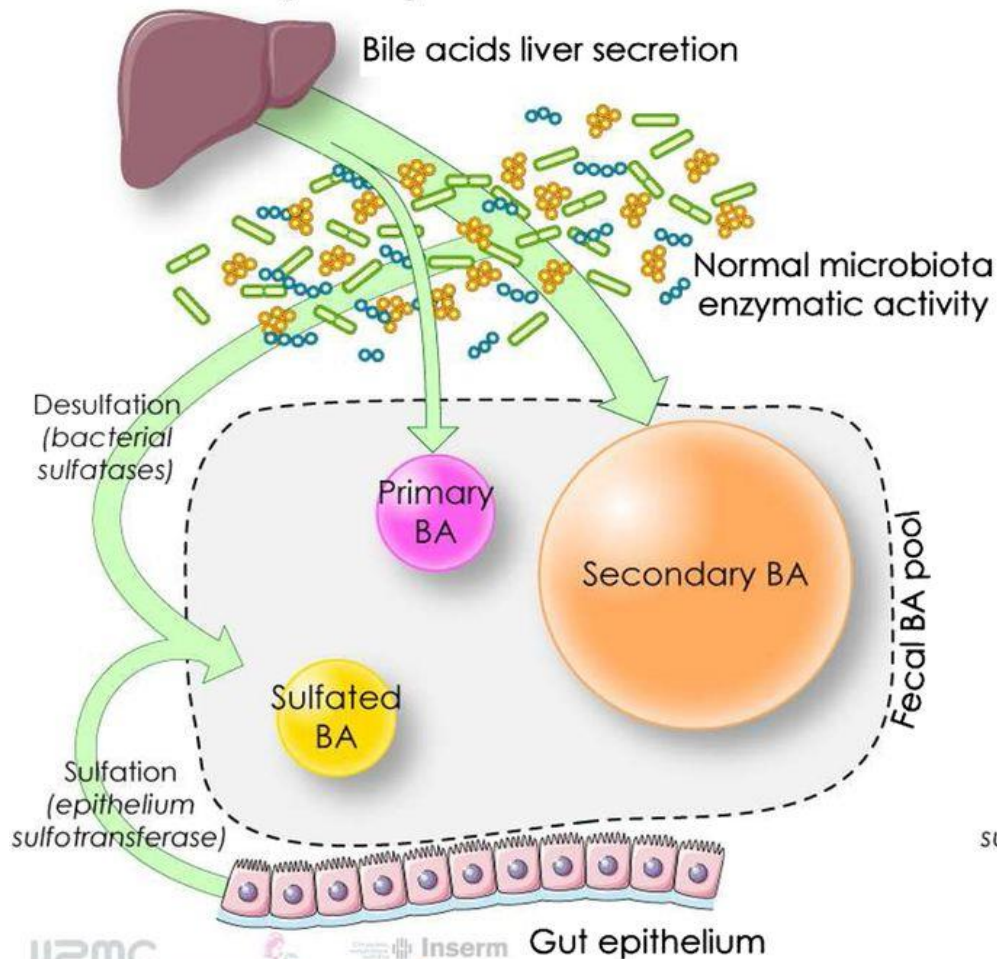
GUT DYSBIOSIS



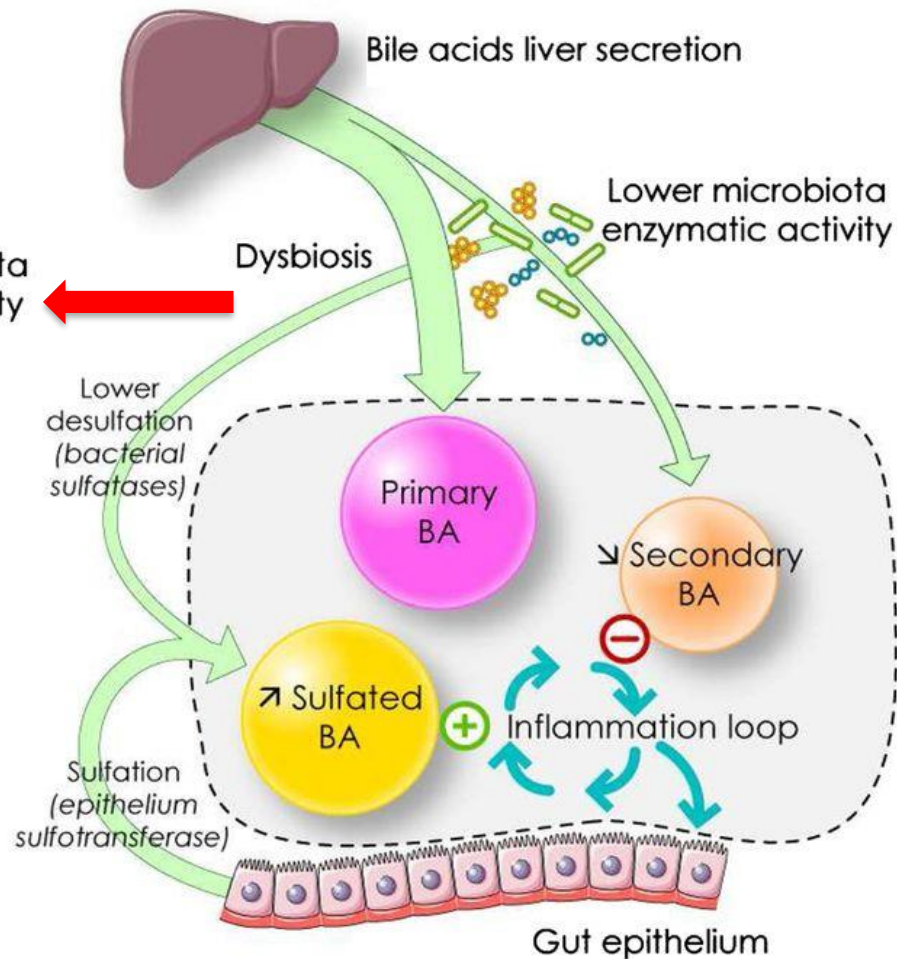
Good vs Bad Biodiversity in Recirculated Aquaculture System (RAS)




Healthy subjects



IBD



Toxin Removal Dysfunction

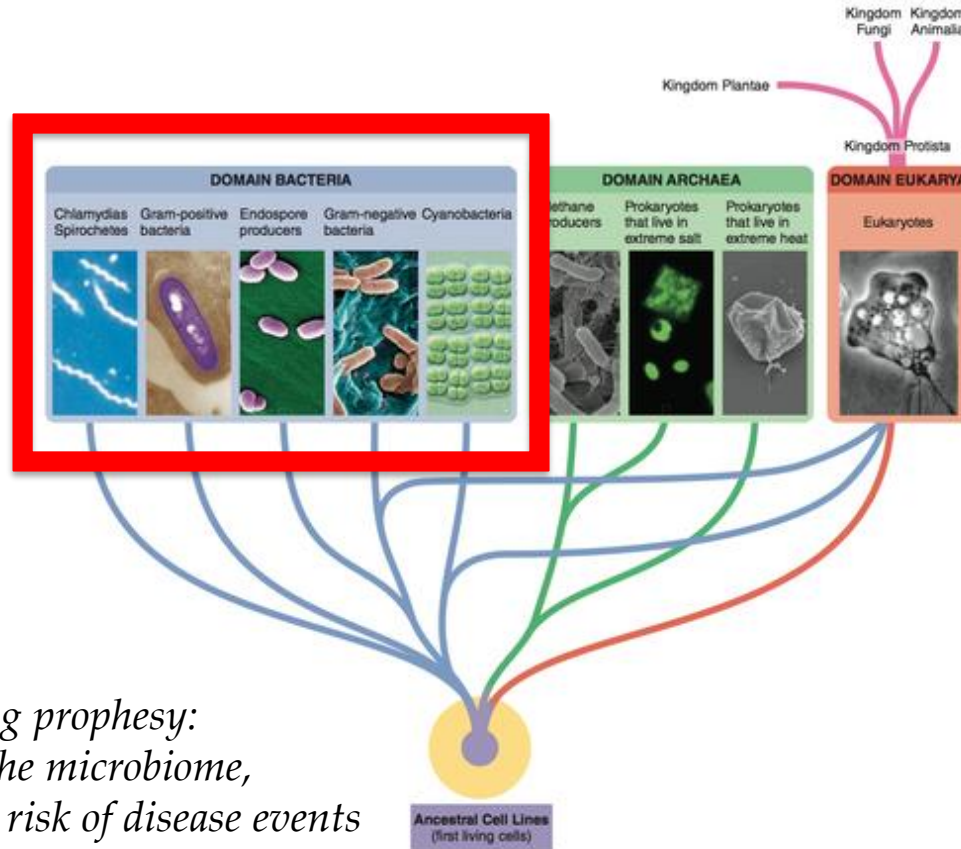
| Function | Alteromonas | Phaeobacter | Kangiella | Marivita |
|---|-------------|-------------|---|-------------|
| C-S-01:Organic carbon oxidation - CO oxidation | 0 | 6 |  0 | 6.8 |
| C-S-01:Organic carbon oxidation - amino acid utilization | 1.8 | 2.1 | 0 | 2.4 |
| C-S-01:Organic carbon oxidation - aromatics degradation | 3.3 | 0 | 0.2 | 0 |
| C-S-01:Organic carbon oxidation - complex carbon degradator | 1.9 | 0 | 0 | 2.5 |
| C-S-01:Organic carbon oxidation - fatty acid degradation | 1.9 | 2.2 | 0 | 2.5 |
| C-S-01:Organic carbon oxidation - formaldehyde oxidation | 9.4 | 11.2 | 0 | 12.6 |
| C-S-01:Organic carbon oxidation - formate oxidation | 9.8 | 19.8 | 0 | 22.3 |
| C-S-01:Organic carbon oxidation - methanol oxidation | 0 | 47 | 0 | 53 |
| C-S-02:Carbon fixation - CBB cycle (Rubisco) | 0 | 80.2 | 0 | 0 |
| C-S-03:Ethanol oxidation | 1.8 | 3.6 | 0 | 4 |
| C-S-04:Acetate oxidation | 1.1 | 0 | 0.1 | 0 |
| C-S-05:Hydrogen generation | 0 | 0 | 0 | 0 |
| C-S-06:Fermentation | 1.9 | 2.2 | 0 | 2.5 |
| C-S-08:Methanotrophy | 5.3 | 10.6 | 0 | 0 |
| C-S-09:Hydrogen oxidation | 22.1 | 0 | 0 | 0 |
| N-S-04:Nitrate reduction - napAB | 0 | 0 | 0 | 0 |
| N-S-04:Nitrate reduction - narGH | 47.9 | 0 | 0 | 76.4 |
| N-S-05:Nitrite reduction - nirKS | 0 | 0 | 0 | 0 |
| N-S-07:Nitrous oxide reduction | 0 | 0 | 0 | 0 |
| N-S-08:Nitrite ammonification - nirBD | 97.8 | 48.4 | 0 | 0 |
| N-S-08:Nitrite ammonification - nrfADH | 2.2 | 0 | 0 | 0 |
| O-S-01:Iron reduction | 1.2 | 0 | 0 | 0 |
| O-S-02:Iron oxidation: | 10.2 | 12.1 | 0.2 | 0 |
| S-S-01:Sulfide oxidation - sqr | 11.6 | 0 | 0 | 0 |
| S-S-03:Sulfur oxidation - sdo | 0.8 | 2.3 | 0 | 2.6 |
| S-S-04:Sulfite oxidation | 0 | 0 | 0 | 43.5 |
| S-S-05:Sulfate reduction | 0 | 0 | 0 | 43.5 |
| S-S-07:Thiosulfate oxidation | 0 | 26.1 | 0 | 29.4 |

How Is Dysbiosis Induced?

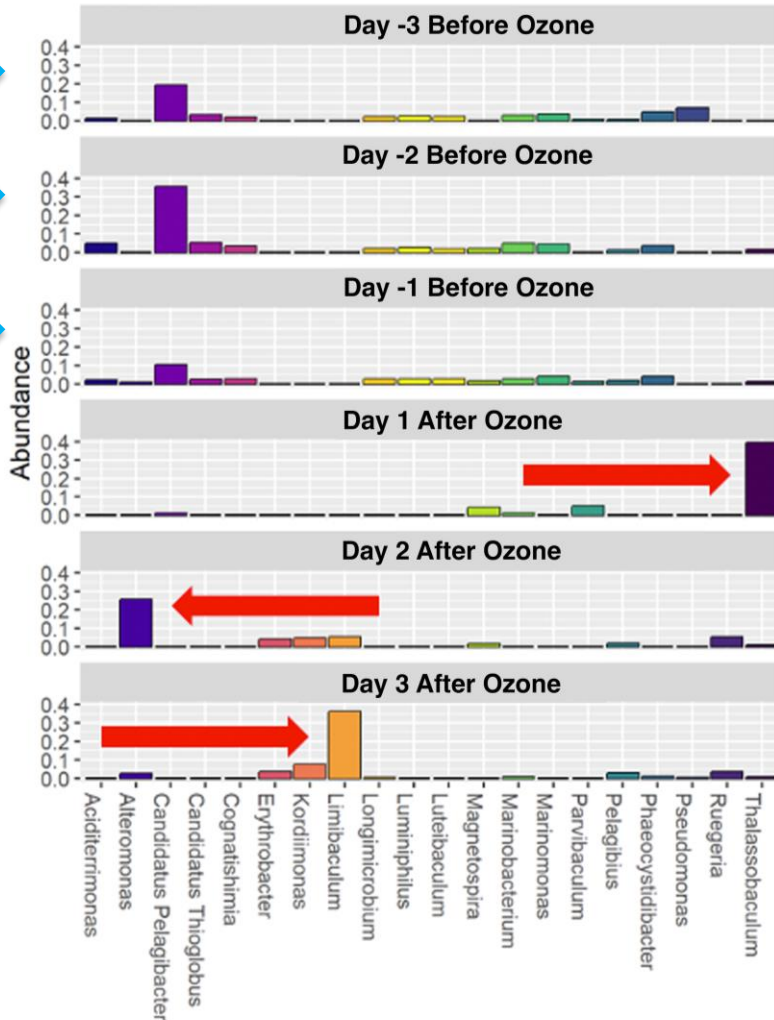
Reason 1. Disinfection & Use of Antibiotics

Reason 2. Protocols are not optimized

Antibacterial Catch 22: Kill off some pathogens, but also lose biodiversity



*Self fulfilling prophesy:
The cure kills the microbiome,
Which then increases risk of disease events*

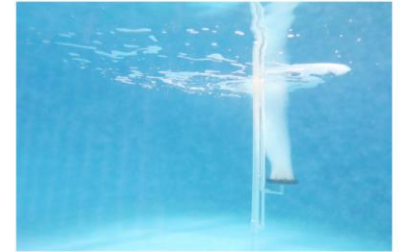


- genus
- Aciditerrimonas
 - Alteromonas
 - Candidatus Pelagibacter
 - Candidatus Thioglobus
 - Cognatishimia
 - Erythrobacter
 - Kordiimonas
 - Limibaculum
 - Longimicrobium
 - Luminiphilus
 - Luteibaculum
 - Magnetospira
 - Marinobacterium
 - Marinomonas
 - Parvibaculum
 - Pelagibius
 - Phaeocystidibacter
 - Pseudomonas
 - Ruegeria
 - Thalassobaculum



≡ MENU NEWS FEATURES PRODUCTS EVENTS

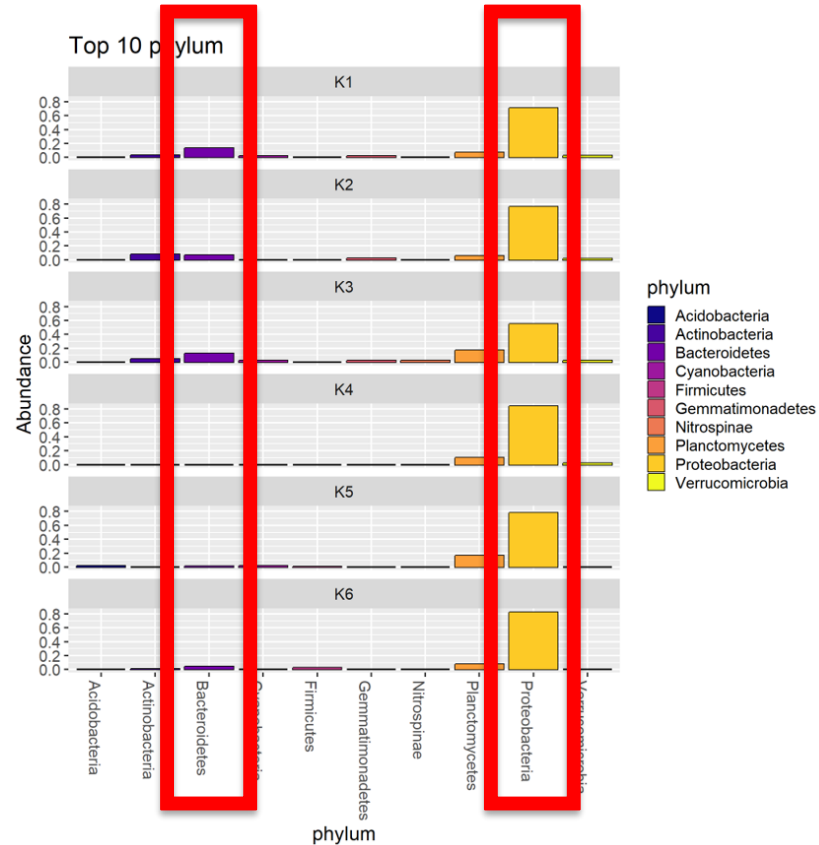
Features



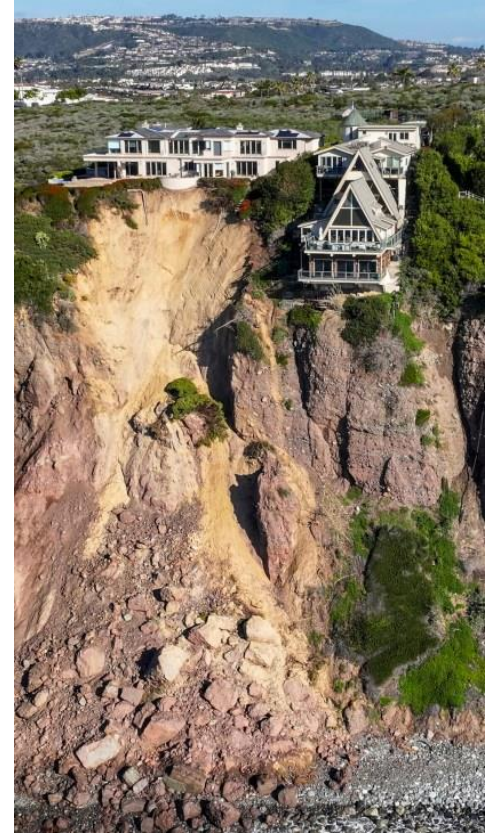
The unintended cost of water disinfection in RAS

Water in this state of chaos is not capable of productive farming.

Reason 2. Protocols Are Not Optimised (disinfection is too aggressive, dosing is wrong, etc)



Typical State of Water Health During Growout



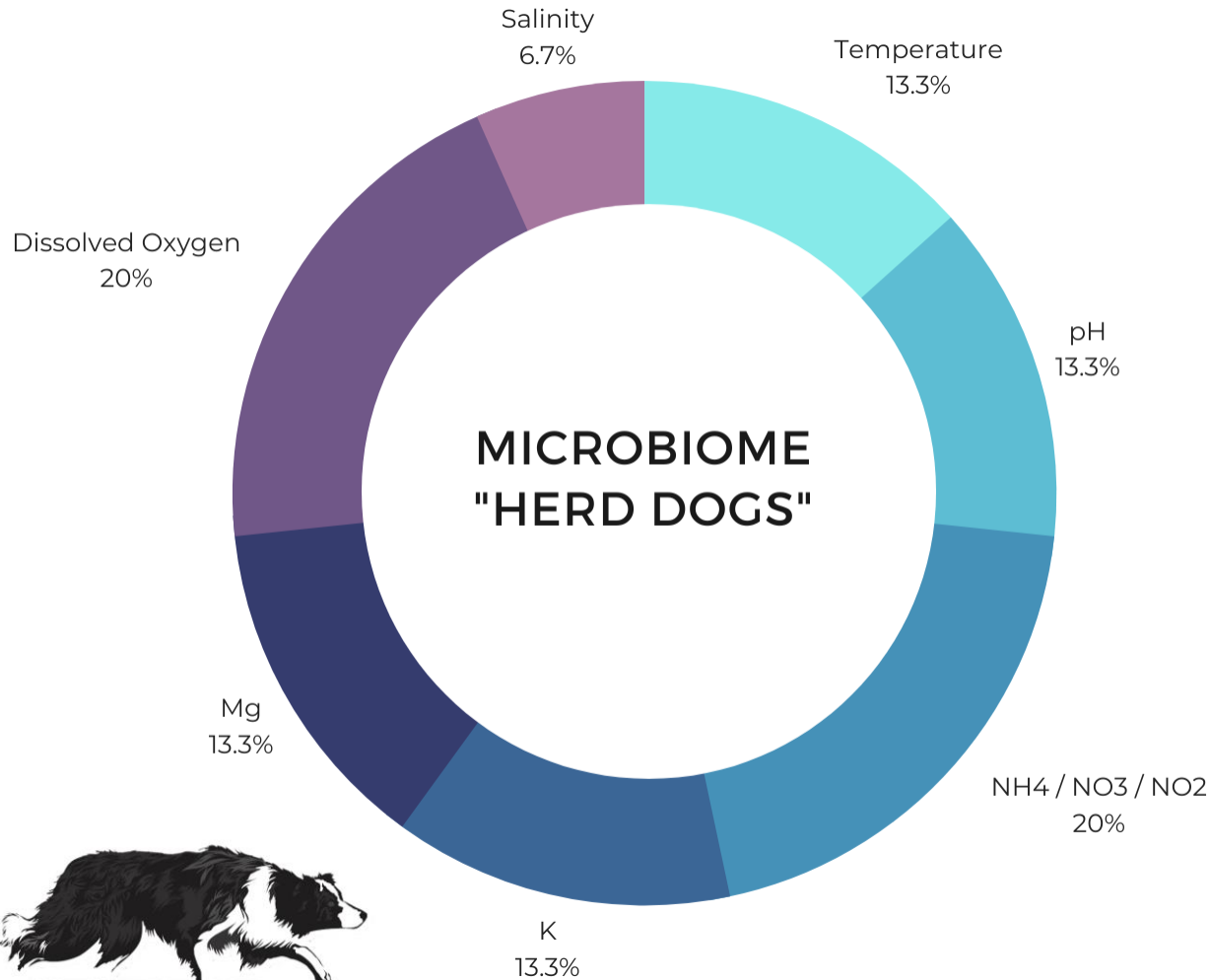


Solution:

Next Gen Sequencing based Microbiome Engineering



MICROBIOME "HERD DOGS"



- TEMPERATURE
- PH / ALKALINITY
- NH₃ / NO₃ / NO₂
- K
- MG
- OXYGEN
- SALINITY



NGS-Guided Precision Probiotics

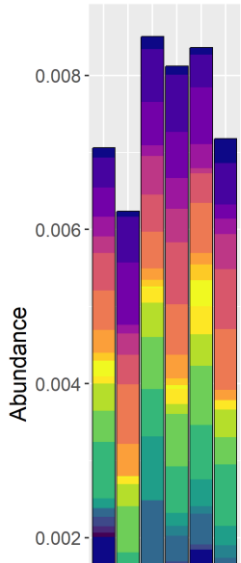
and Targeted Inoculants



Personalised Medicine for Ponds and Tanks



Six Key Aspects of Water Health



species

- | | |
|--|--|
| ■ Bacillus amyloliquefaciens | ■ Enterococcus faecium |
| ■ Bacillus cereus | ■ Lactobacillus crispatus |
| ■ Bacillus coagulans | ■ Lactobacillus gasseri |
| ■ Bacillus licheniformis | ■ Lactobacillus helveticus |
| ■ Bacillus marisflavi | ■ Lactobacillus jensenii |
| ■ Bacillus pumilus | ■ Lactobacillus johnsonii |
| ■ Bacillus subtilis | ■ Lactobacillus kefiranoferiens |
| ■ Bifidobacterium adolescentis | ■ Lactococcus lactis |
| ■ Bifidobacterium animalis | ■ Pediococcus acidilactici |
| ■ Bifidobacterium bifidum | ■ Pediococcus pentosaceus |
| ■ Bifidobacterium breve | ■ Saccharomyces cerevisiae |
| ■ Bifidobacterium longum | ■ Streptococcus thermophilus |
| ■ Enterococcus faecalis | |



Optimised Protocols

CLEAR STEPS TO CORRECT IMBALANCES

IMBALANCE



BALANCE



Luminis provides clear, actionable recommended steps to help bring your system back into balance and maintain optimum balance over time.



Luminis Optimised Microbiome Unlocks 56% More Growth



Luminis



Control



Our Mission

To solve the disease crisis in aquaculture

To underpin sustainability

For a food secure future

We're not
ALL BAD!!



For you!



I LOVE IT!



Bacteria give the
most thoughtful gifts.
Beatrice the Biologist

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Rachelle Jensen
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LUMINIS
WATER TECHNOLOGIES

Disease-free aquaculture

Thank you

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