We open a new window to the microbial world of water

DNA Applications in Wastewater Treatment and Resource Recovery

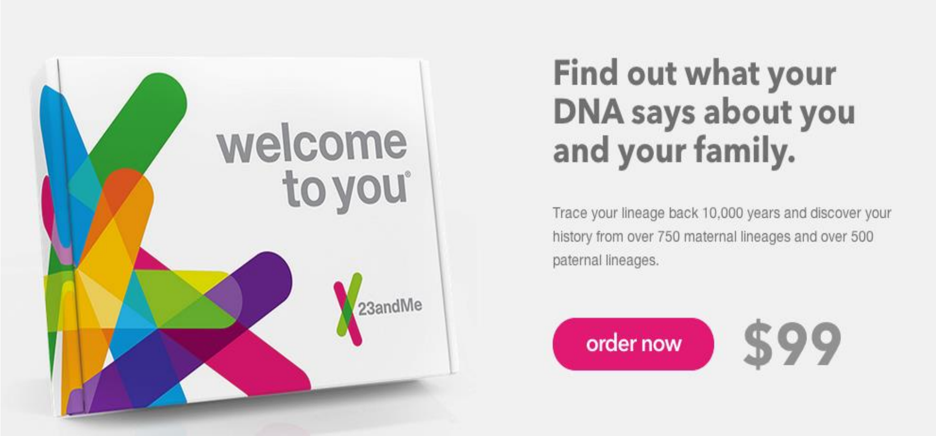
John Tillotson, CEO
john@microbedetectives.com 630-310-9353
MicrobeDetectives.com

Outline

- DNA Technology
- DNA in Wastewater
- Case Studies

Commercial DNA Technology

Human Genome



INVITAE

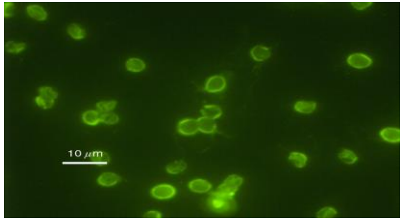
Problem worth solving

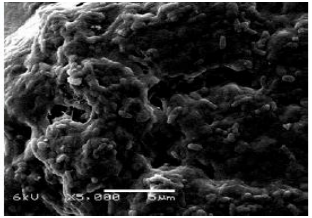
99% of microbes can’t be cultured
or identified under a microscope

MICROBE
DETECTIVES

Problem

- Wastewater treatment inefficiency
  - –Poor effluent quality
  - –Excess consumption of chemicals and energy
  - –Poor digester gas production



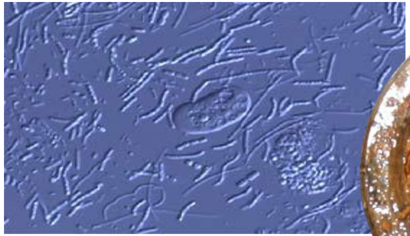


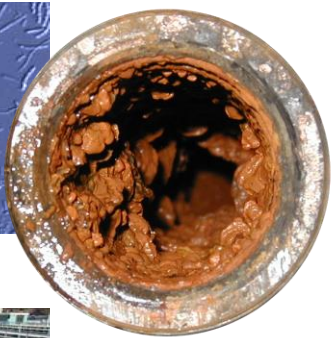
MICROBE DETECTIVES

99% More Data

Solve unresolved problems - Wastewater

- Phosphorous removal
- Nitrification
- Anammox
- Bulking/foaming/poor settling
- Aeration efficiency
- Digester Gas Production
- Source Tracking Fecal Pollution
- Pathogens

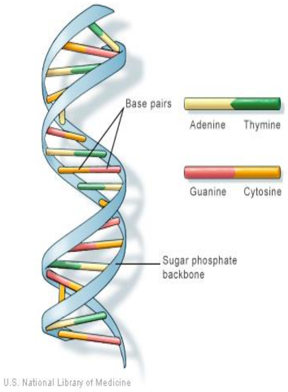




MICROBE DETECTIVES

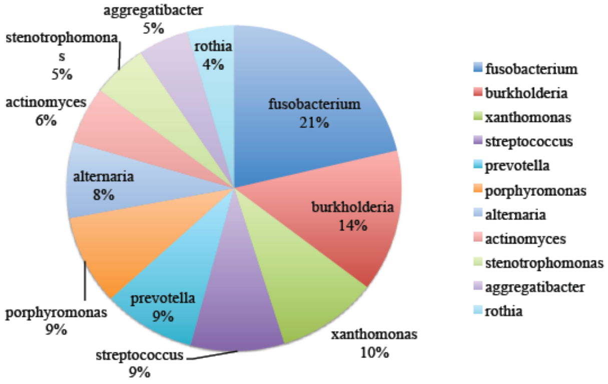
Our Solution

DNA sequencing detects all microbes known to science



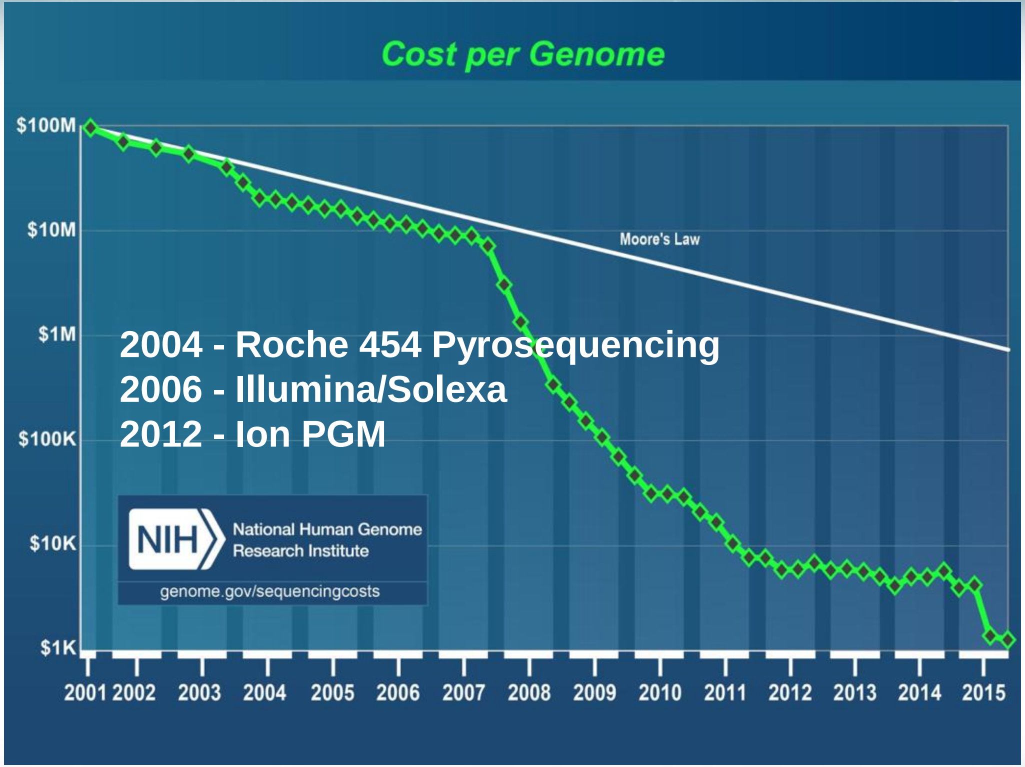
Ammonia Oxidation	Lateral.1	Lateral.2	Lateral.3	Lateral.4
Jettenia	0.00%	0.00%	0.00%	0.00%
Nitrosomonas	0.00%	0.00%	0.00%	0.00%
Brocadia	0.00%	0.00%	0.00%	0.00%
Scalindua	0.00%	0.00%	0.00%	0.00%
Pirellula	0.26%	0.02%	0.04%	0.50%
Gemmata	0.00%	0.06%	0.02%	1.55%
Planctomyces	0.09%	0.29%	0.10%	0.12%
Candidatus_Nitroso	0.00%	0.00%	0.00%	0.00%
Planctomycetaceae	0.00%	0.00%	0.00%	0.00%
Isosphera	0.00%	0.00%	0.00%	0.00%
Candidatus_Kuenen	0.00%	0.00%	0.00%	0.00%
Anammoxoglobus	0.00%	0.00%	0.00%	0.00%
Nitrosococcus	0.00%	0.08%	0.02%	0.00%
Nitrosopumilus	0.00%	0.00%	0.00%	0.00%
Nitrosocaldus	0.00%	0.00%	0.00%	0.00%
Nitrososphaera	0.00%	0.00%	0.00%	0.00%
Crenarchaeum	0.00%	0.00%	0.00%	0.00%
Nitrite Oxidation	**Lateral.1**	**Lateral.2**	**Lateral.3**	**Lateral.4**
Nitrospira	0.40%	0.60%	0.46%	0.02%
Nitrobacter	0.00%	0.00%	0.00%	0.00%
Nitrospina	0.00%	0.18%	0.07%	0.00%
Nitrococcus	0.00%	0.00%	0.00%	0.00%

Iron Oxidation	Lateral.1	Lateral.2	Lateral.3	Lateral.4
Ferribacterium	0.00%	0.00%	0.00%	0.00%
Sediminibacterium	0.54%	6.04%	9.30%	9.37%
Sideroxydans	0.49%	1.08%	1.06%	0.74%
Acidithiobacillus	0.00%	0.00%	0.00%	0.00%
Geobacter	0.62%	0.41%	1.06%	0.53%
Gallionella	5.82%	6.88%	13.55%	5.97%
Leptospirillum	0.07%	0.00%	0.00%	0.01%
Crenothrix	0.00%	0.00%	0.00%	0.00%
Ferritrophicum	0.00%	0.00%	0.00%	0.00%
Ferrovibrio	0.00%	0.00%	0.00%	0.00%
Acidiferrobacter	0.00%	0.00%	0.00%	0.00%
Sulfate Reduction	**Lateral.1**	**Lateral.2**	**Lateral.3**	**Lateral.4**
Desulfuromonas	0.00%	0.00%	0.01%	0.00%
Desulfurivibrio	0.00%	0.00%	0.00%	0.00%
Desulfovibrio	1.17%	0.11%	0.14%	0.01%
Desulfocapsa	0.00%	0.00%	0.00%	0.00%
Desulfomonile	0.00%	0.09%	0.02%	0.00%
Desulfobacteraceae	0.00%	0.00%	0.00%	0.00%
Desulfobulbaceae	0.00%	0.00%	0.00%	0.00%
Desulfobacterium	0.00%	0.00%	0.01%	0.00%
Desulfosporosinus	0.00%	0.00%	0.01%	0.00%



MICROBE DETECTIVES

Rate of Change is Unprecedented



MICROBE DETECTIVES

Case Study

What was the value proposition?

The estimated capital costs of a BNR system was reduced by $35 million. $490 thousand was saved in annual operating expenses.

Details of the demo / pilot:

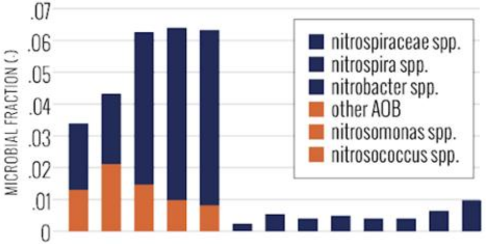
Trinity River Authority, Dallas, Texas USA
Application - Biological Nutrient Removal
Rated Capacity - 162 MGD

Northwestern | McCORMICK SCHOOL OF ENGINEERING

Hypothesis: As we adopt lower aeration operation, ecology will shift and nutrient removal capacity will not be be decreased.

Action: Gradually progressed from 2.0 mg/l to 0.2 mg/l dissolved oxygen (DO) operating conditions over 5 years in 4 aeration basins.

Result: Metagenomic testing confirmed the hypothesis to be true. Commamox (CMX) bacteria emerged and became the primary "workhorse" delivering an improvement in nutrient removal at a super low DO setpoint.



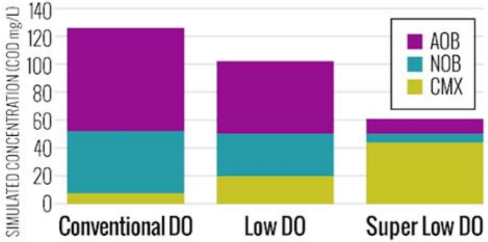
- **Basin Design Savings:** $35 million
  - Pre-study $50 million estimated
  - Post-study $15 million actual cost
- **Operating Savings**: $490,000/year
  - $350,000/year aeration savings
  - $140,000/year chlorine savings
- **Operator Confidence**: Quantification of ecology shift educated operators

What problem did this solve?

Nutrient pollution is one of the world's most widespread, costly and challenging environmental problems, and is caused by excess nitrogen and phosphorus in the air and water. Wastewater is a primary source.

TRA Objectives:

- Optimize process efficiency while not decreasing nutrient removal capacity.
- Provide operator confidence that low DO conditions selects for a different ecology that provides same nitrification capacity as high DO.



What this means for the future?

BNR optimized by metagenomic analysis can drive transformative gains in design and operational costs, and smaller footprint.

Let's

~~We~~ open a new window to the **microbial** world of water