Tolerance comparison of *Chlorella sp.* [ACW1] and *Brassica chinensis* to human urine

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Problem Definition

- Urine is a unavoidable human "waste" with resource potential
  - Fertilizer
  - Medium for algal culture
- Health and environmental problems
  - Algal blooms and odors when left untreated
  - Health concerns when combined with solid waste and untreated
- Objective: This study aims to show that algae can tolerate high urine concentrations for the purpose of urine remediation

Experimental Design

- Collect urine sample representative of random small household
- Test the tolerance of alga *Chlorella sp. [ACW1]* and crop *Brassica chinensis* to urine
- Qualitatively evaluate adult plant species tolerance to urine
- Investigate ideas for phycoremediation and algae harvesting

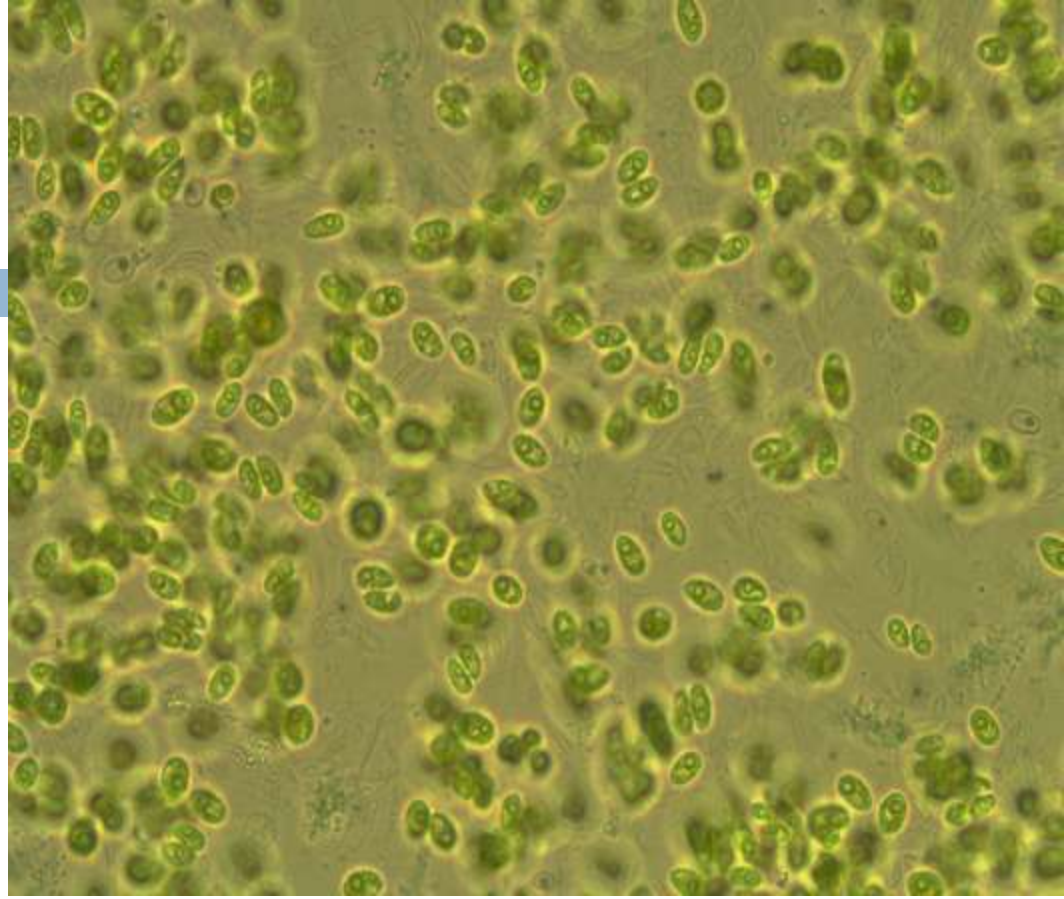
Urine composition

- Main components
  - Urea
  - Chloride
  - Sodium
  - Potassium
  - Creatinine
  - Phosphorus
- Urea
  - Hydrolysis by urease to NH3 (aq)
    - O2 - NH3 (g)
    - H2O – NH4+

Urine Sample Data

Stock Dilution	Mg NH4 – N/L	pH
0 %	0.065	5.19
10 %	17.365	6.71
25 %	48.369	6.77
50 %	102.564	6.78
75 %	151.493	6.78
100 %	196.756	6.78

Chlorella sp. [ACW1]



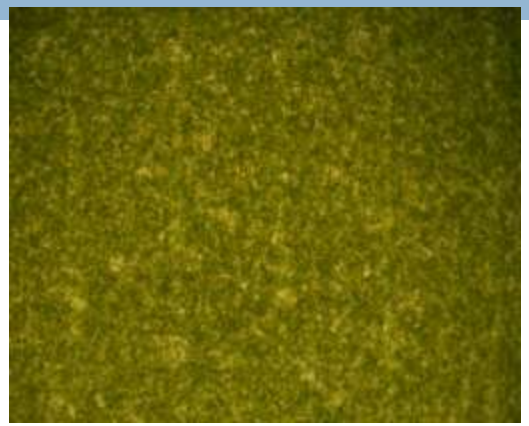
- Autotrophic, unicellular green alga

- *Chlorella* genus grows rapidly, high photosynthetic efficiency of 34% (Lee 1980)

- Thrive in high nutrient environments such as landfill leachate, sewage (Abeliovich & Azov 1975)

- ACW1 discovered thriving on dairy manure

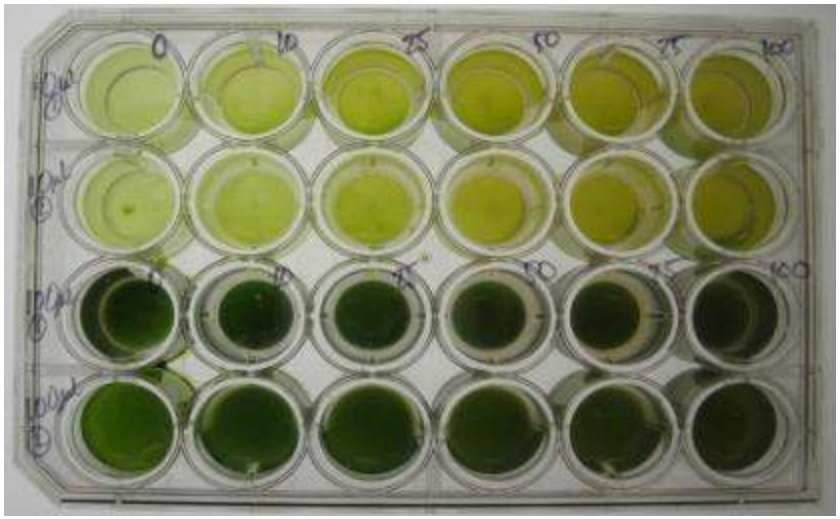
Chlorella sp. [ACW1] tolerance tests



Cell count 13.2 x 10^6 cells/ml

Algae ACW1 stock solution

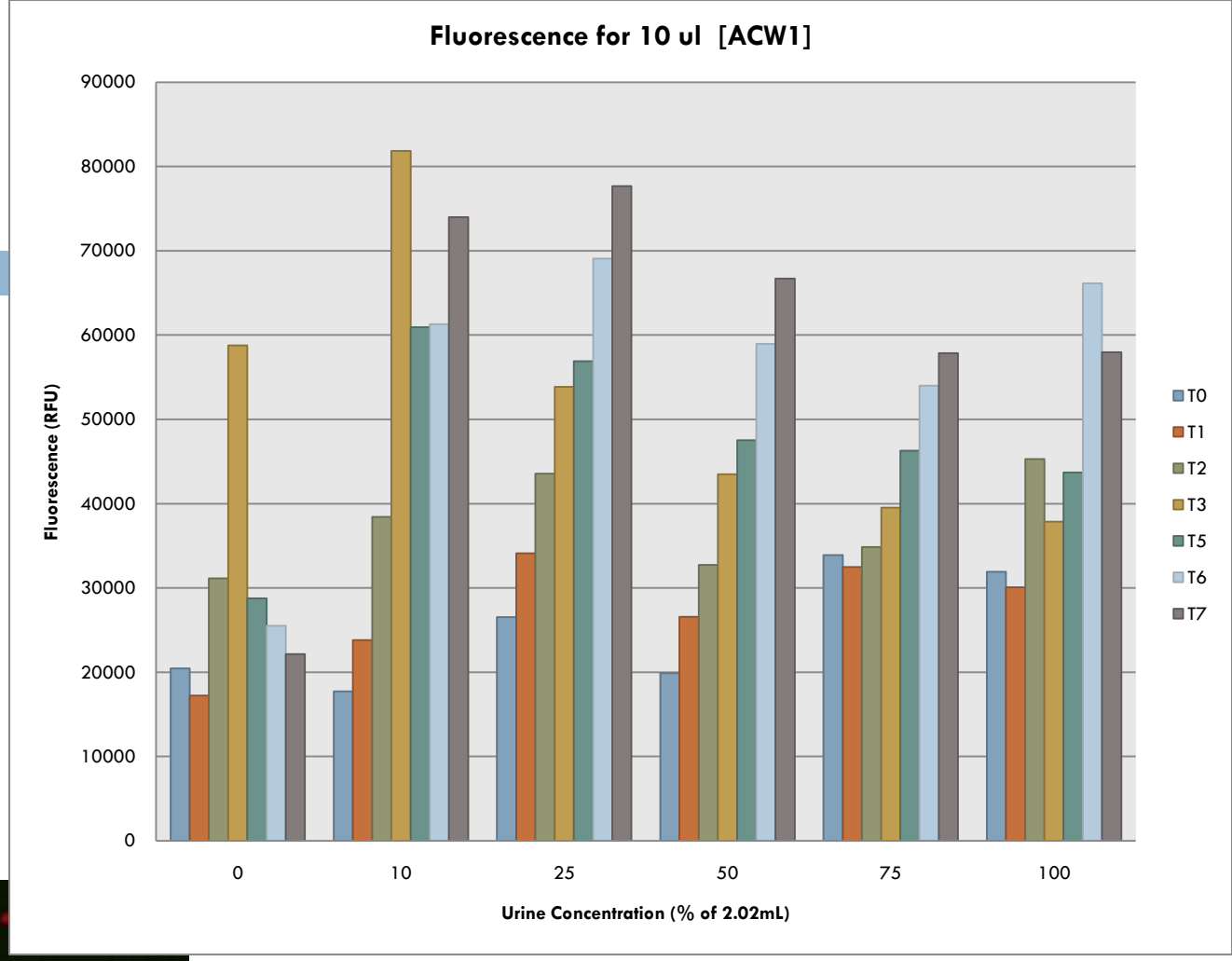
Multi-well tray for algae urine tests

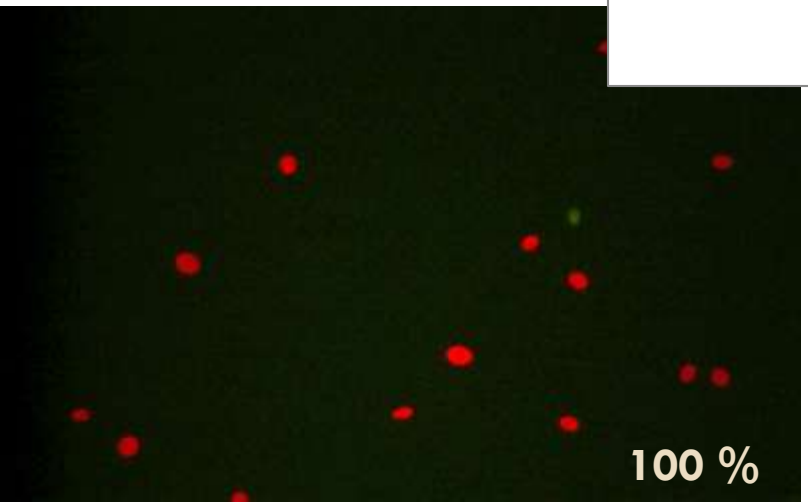


Low innoculum

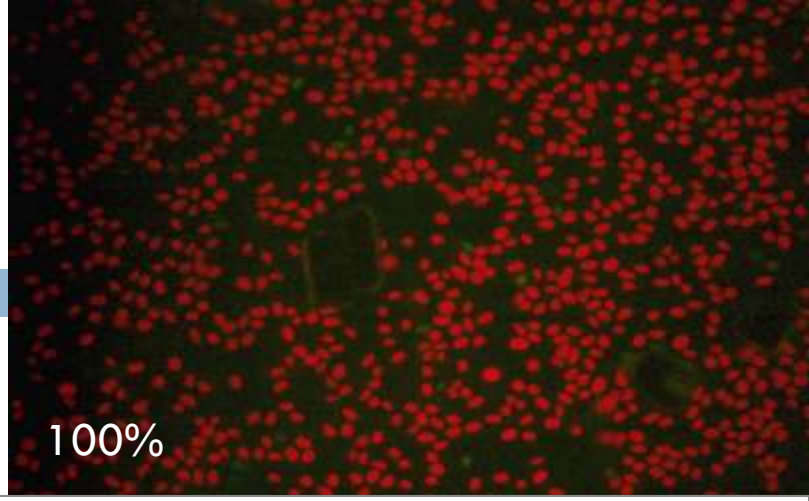
High innoculum

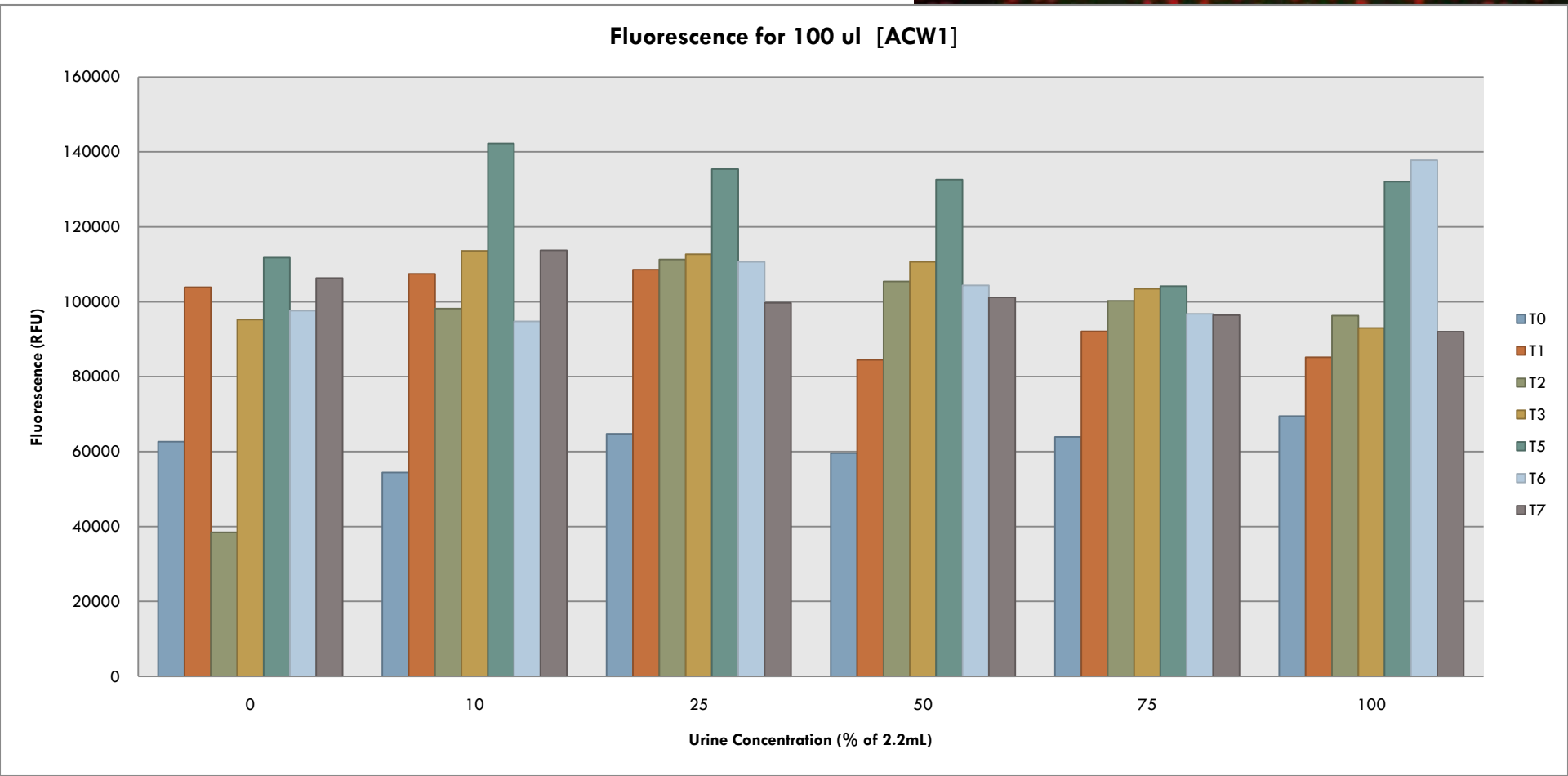
Fluorescence for 10 uL





Fluorescence for 100 uL

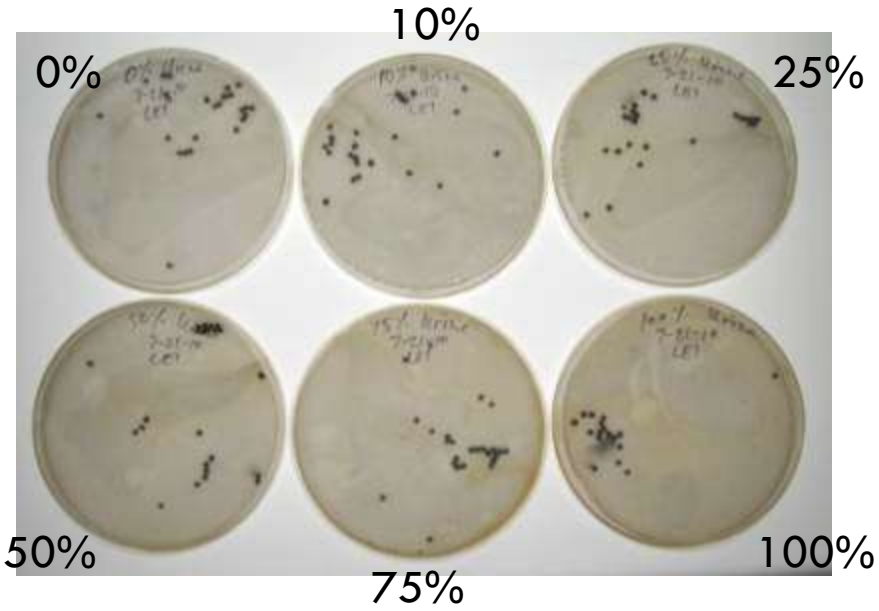




Brassica chinensis germination tests

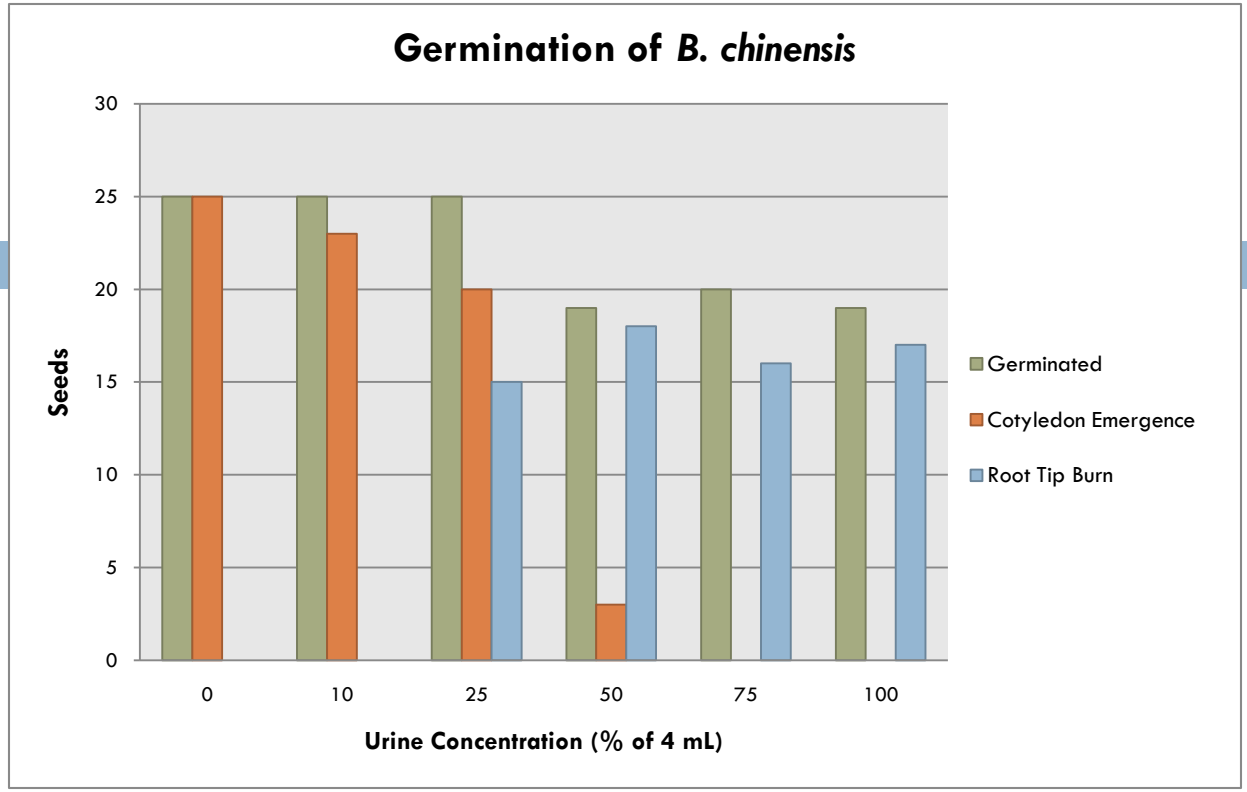
- *B. chinensis* (Chinese Cabbage Michihili)
  - Wide climate range
  - Fast germination rate
  - High N requirement

http://gstuff.co.nz/shop/garden/index.php?main_page=product_info&products_id=640



Petri dishes for germination tests

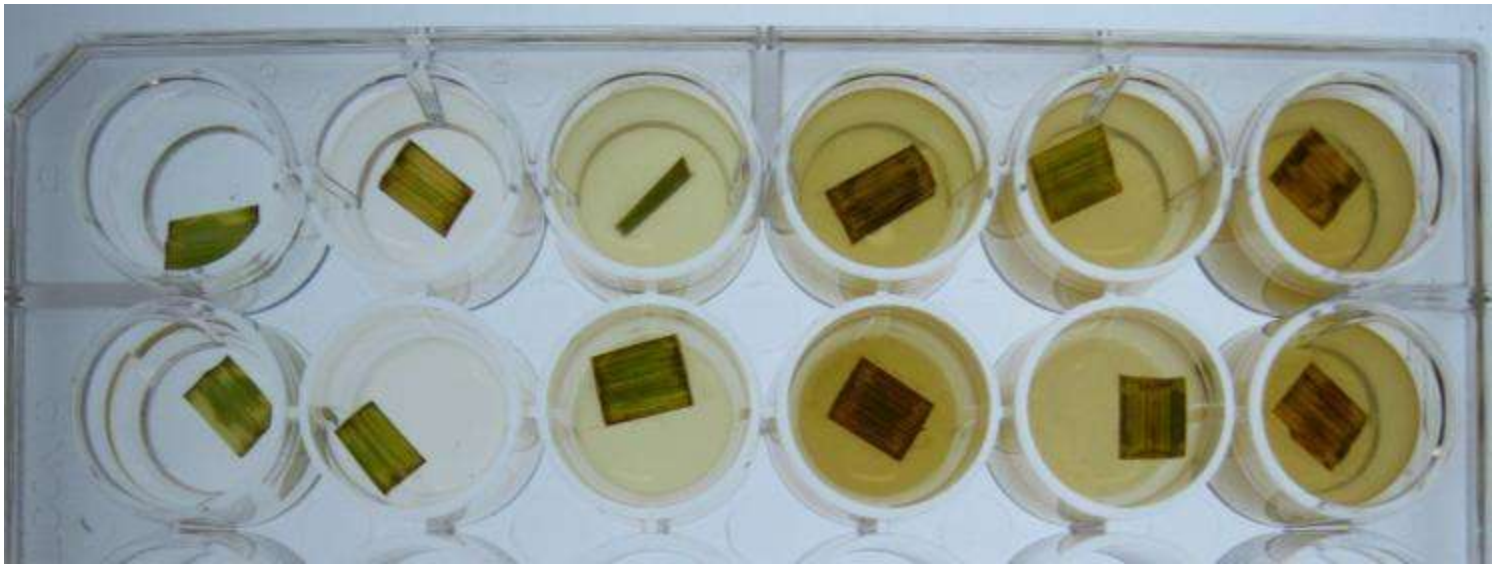
Germination Test Results



0% 10% 25% 50% 75% 100%

Adult Leaf tolerance evaluation

- Qualitative analysis
  - Leaf “browning”
  - Fluorescence



Implications

- *B. chinensis* showed evidence of urine toxicity at 25% concentration
- ACW1 grew prolifically and survived in 100% urine which place it as a candidate for urine remediation

- Implications are that less water would be required for urine dilution, there is a potential to treat human urine, and the possibility of harvesting a slow-release algal fertilizer.

Future research

Phycoremediation

Harvesting

Distillation and solar heating

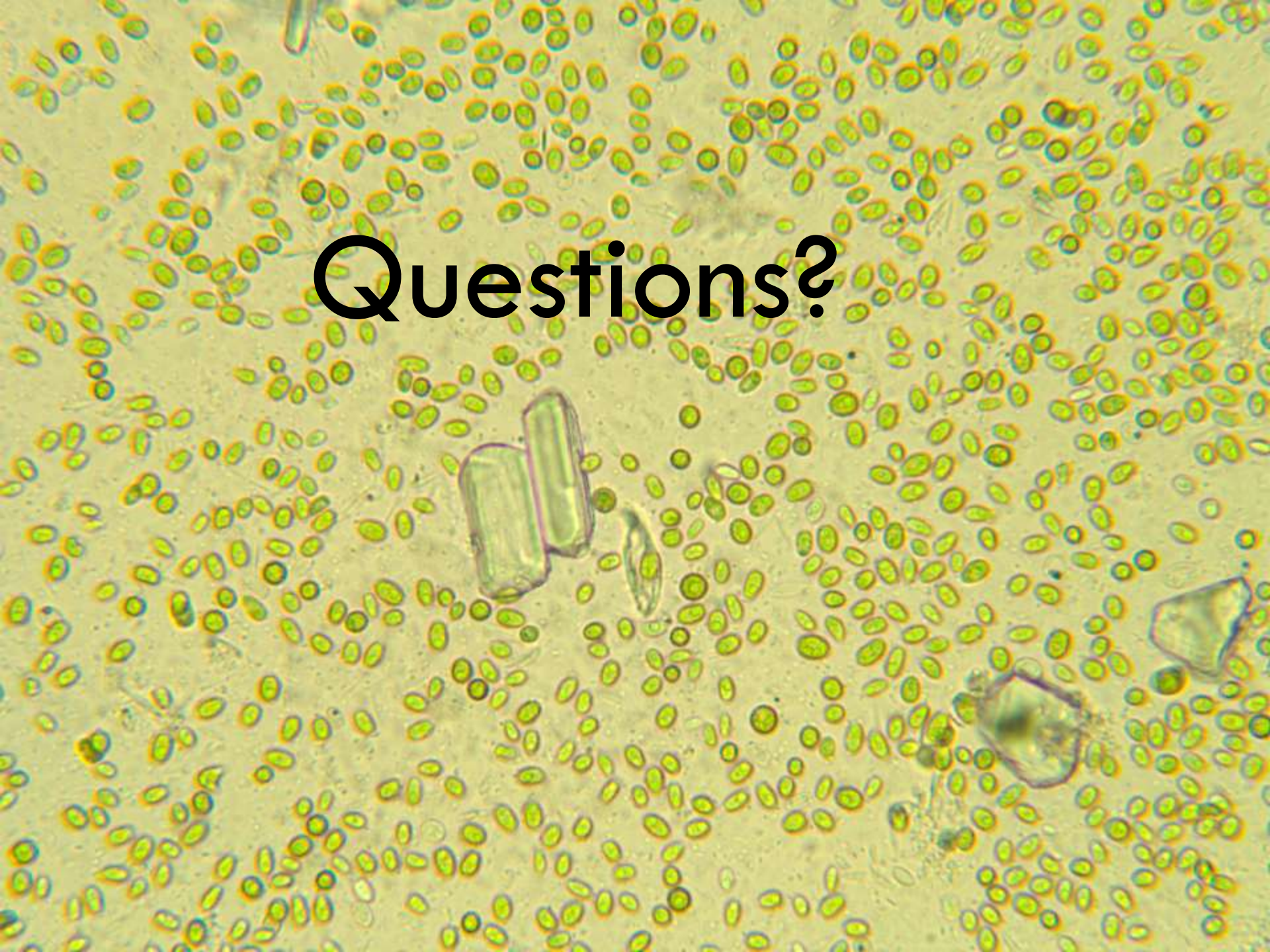
References

Abeliovich, A. & Azov, Y. (1975). Toxicity of Ammonia to Algae in Sewage Oxidation Ponds. *Applied and Environmental Microbiology*, *31*(6), 801-806.

Azov, Y. and Goldman, J.C. (1981). Free Ammonia Inhibition of Algal Photosynthesis in Intensive Cultures. *Applied and Environmental Microbiology*, *42* (4), 735-739.

Lee, Y.K. (1980). The Photosynthetiic efficiency of *Chlorella* biomass growth with reference to solar energy. *Journal of Chemical Technology and Biotechnology.* 30 (1), 25-34.

Lin, L., Chan, G.Y.S., Jiang, B.L., & Lan, C.Y. (2007). Use of ammoniacal nitrogen tolerant microalgae in landfill leachate treatment. *Waste Management, 27*(2007), 1376-1382.


Questions?