MICHIGAN STATE UNIVERSITY

Viruses in Ballast Water: What are They and Why do We Care?

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THE MICROBIAL WORLD

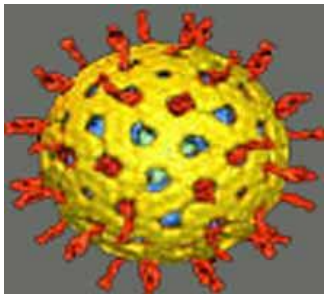
- ✓ **MICROSCOPIC**
- ✓ **CAN NOT SEE WITH OUR EYE**

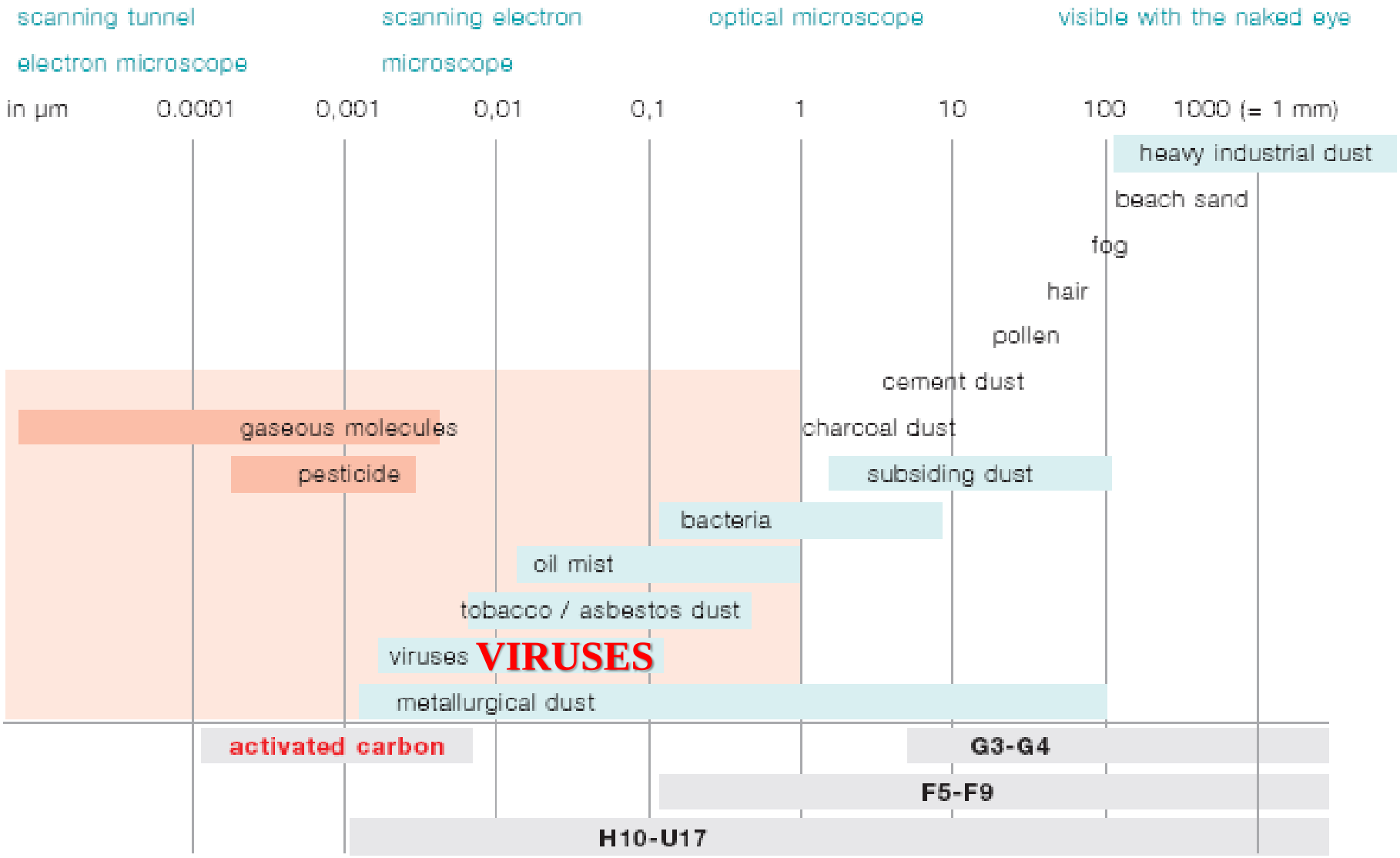
ALGAE
BACTERIA
FUNGI
VIRUSES

Number of bacteria cells on earth ~ 4 to 6 × 10^{30}
Viruses in ocean ~ 10^{30} (Suttle, 2007)

99% of all microbes can not be grown up in the laboratory (Amann et al. 1990)

- Viruses are bio nanoparticles





VIRUSES ARE OBLIGATE PARASITES: MUST HAVE A CELL TO REPRODUCE MANY CAUSE DISEASE

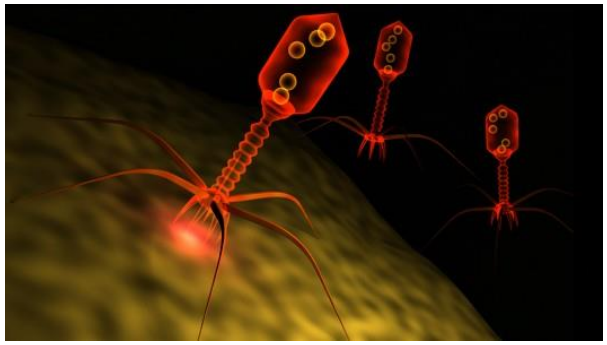
Public Health-Related Viruses

INFECT HUMANS

- adenovirus
- coxsackievirus
- Echovirus
- enteroviruses
- Hepatitis A and E
- Norovirus
- poliovirus
- rotavirus

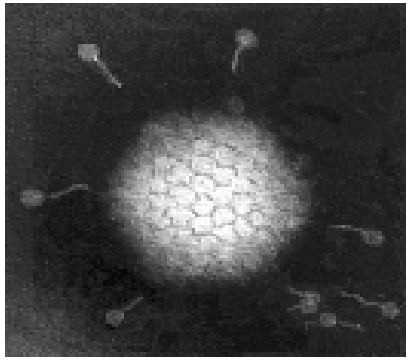
Bacteriophage are viruses that infect bacteria.

PHAGE INFECT BACTERIA

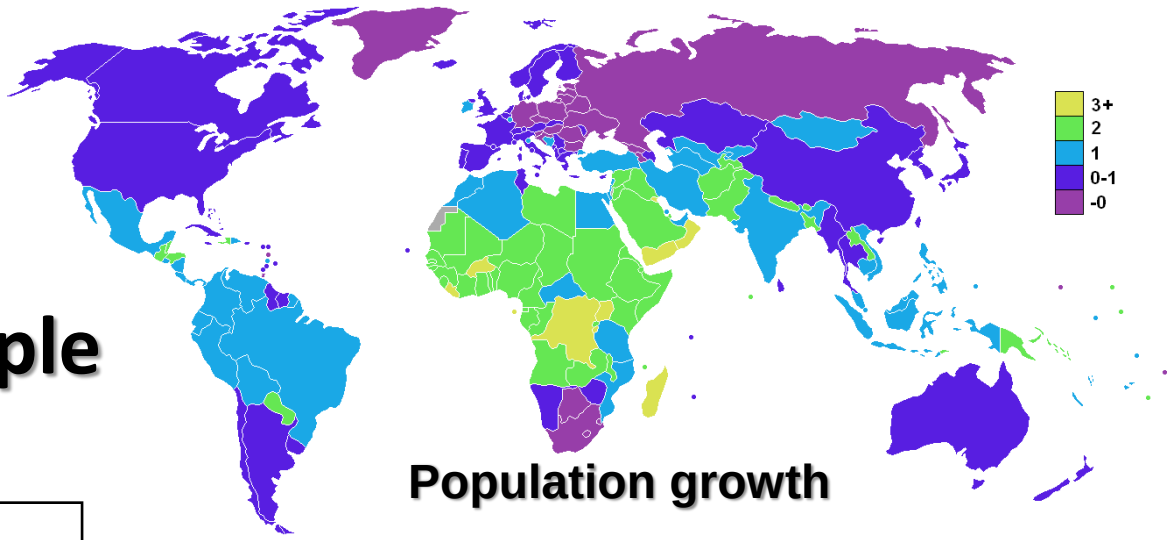


VIRUSES INFECT ALGAE

VIRUSES INFECT ANIMALS including FISH, BIRDS and MAMMALS

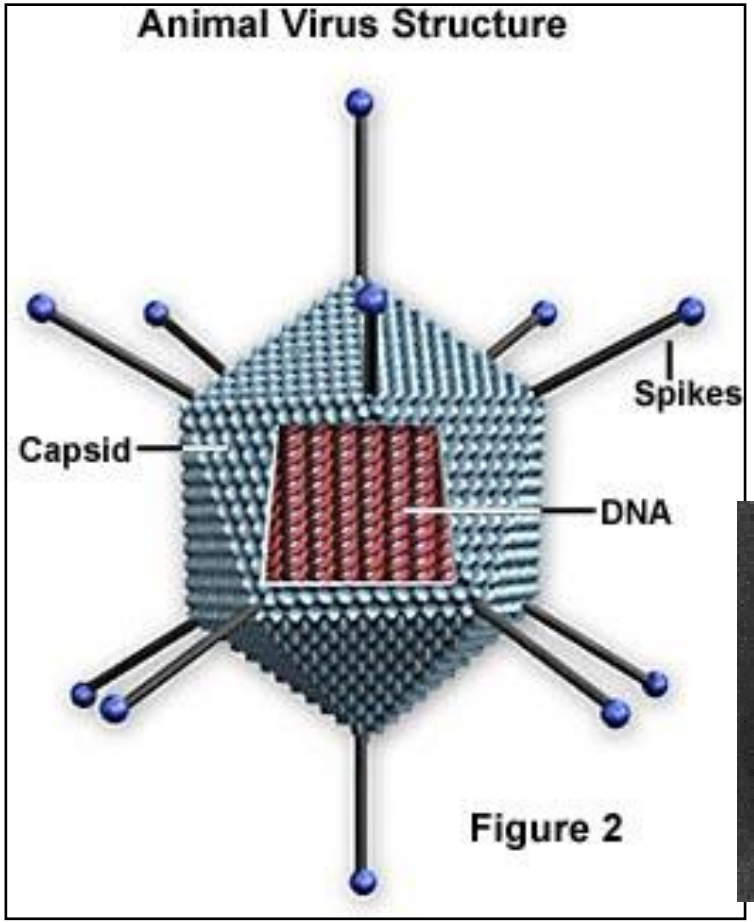


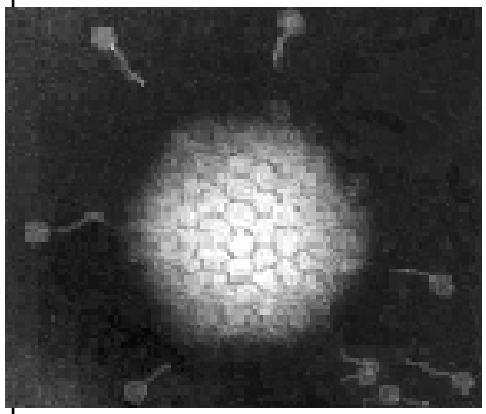
GLOBAL TRENDS IN THE ERA OF THE ANTHROPOCENE



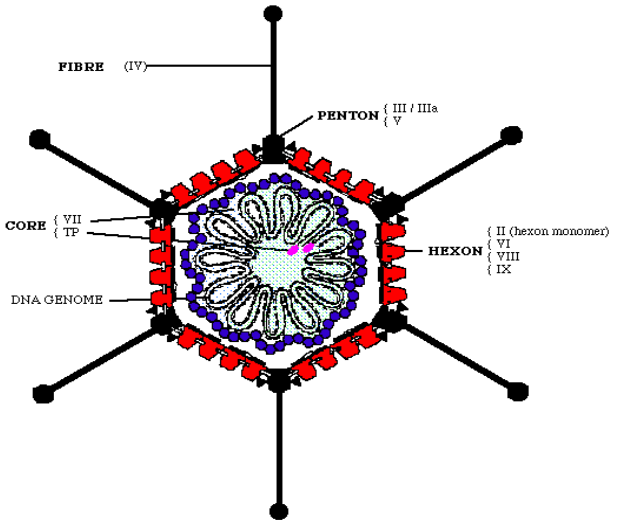
Population growth

- **Viruses have a simple structure**



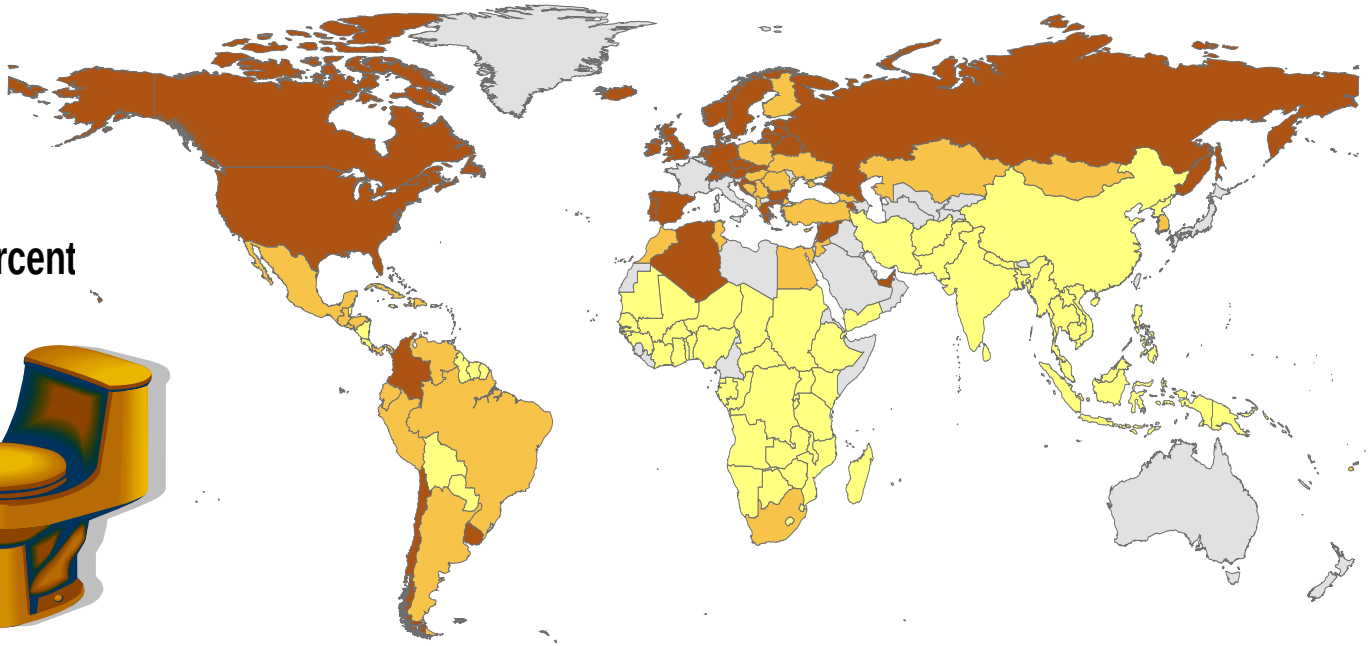


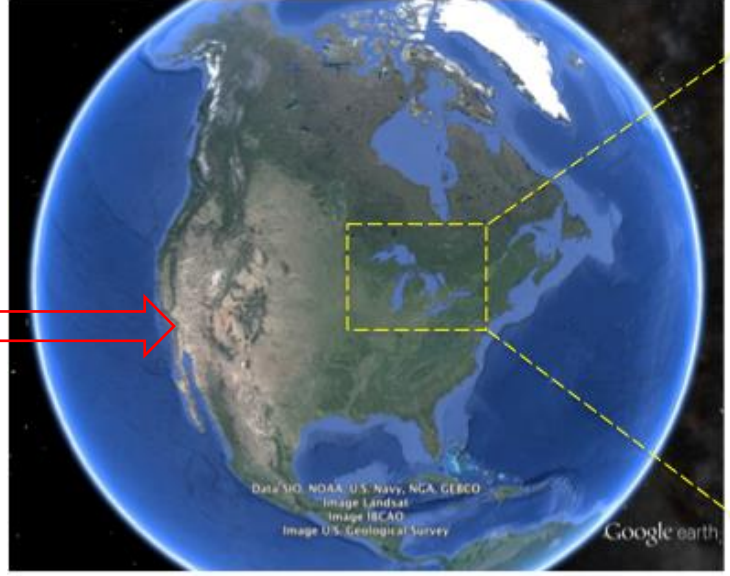
- **Viruses are everywhere in the world. Spread through out the world from people, animals, plants air and water.**



COASTAL SYSTEMS AND FRESH WATER RESOURCES ARE DEGRADING

World has 356,000 km of coastline (221,208 miles) US has 19,924 km of coastline Great Lakes 15,043 km of coastline. 44% of the global population (7 billion people) lives within 150 km (93 miles) of the coastline (that is 3 billion people who flush or dispose daily and send fecal pollution into the environment and eventually into waterways).





ARE VIRUSES A RISK TO ANIMALS, PLANTS AND HUMANS SPREAD THROUGH BALLAST WATERS?

WHAT TYPE OF VIRUS STANDARD IS NEEDED?


21/05/2014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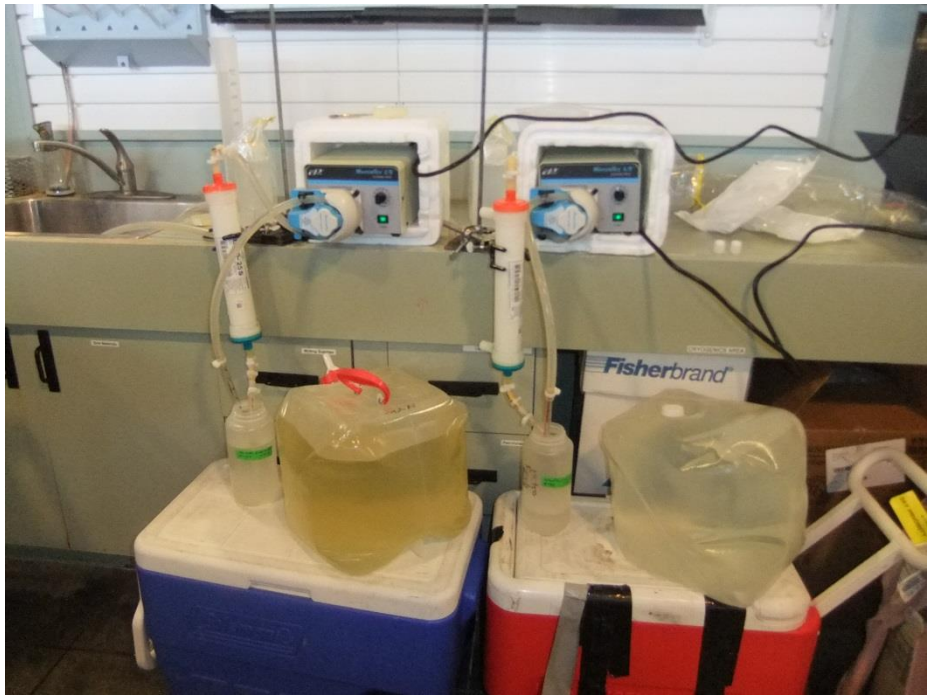
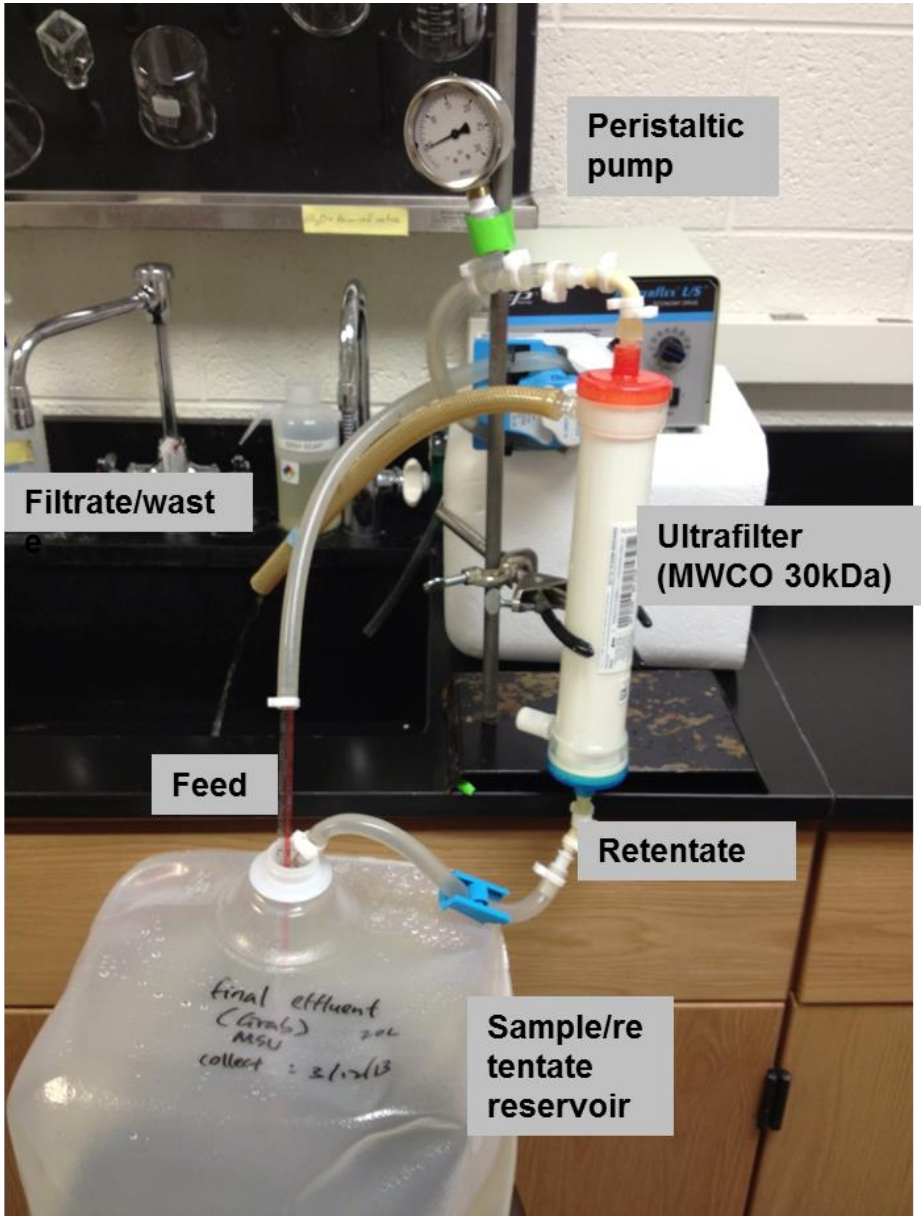
21/05/2014

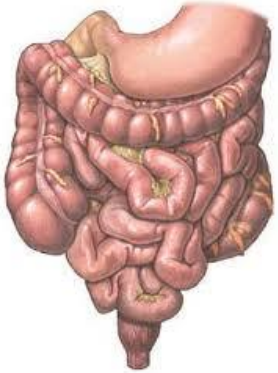
Concentrating ballast water



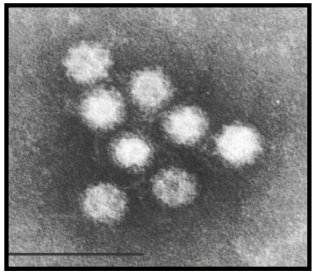


THE MICROBIOME

sources



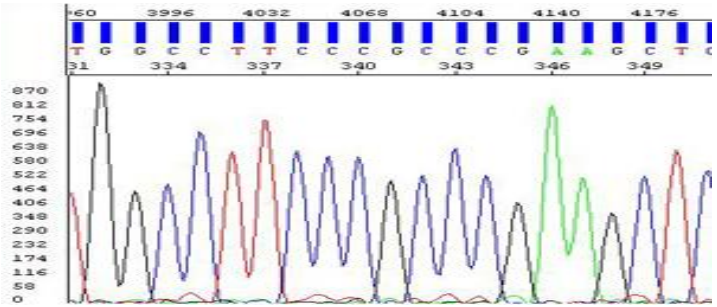
microbiota



Community DNA/RNA

Building Blocks of Life

Metagenome library & sequence analysis



CA BW sampling

Untitled layer

- ADO
- ATL
- LIB
- CAR
- TUL
- ASC
- NAD
- SAG
- BAL
- CEB
- COS

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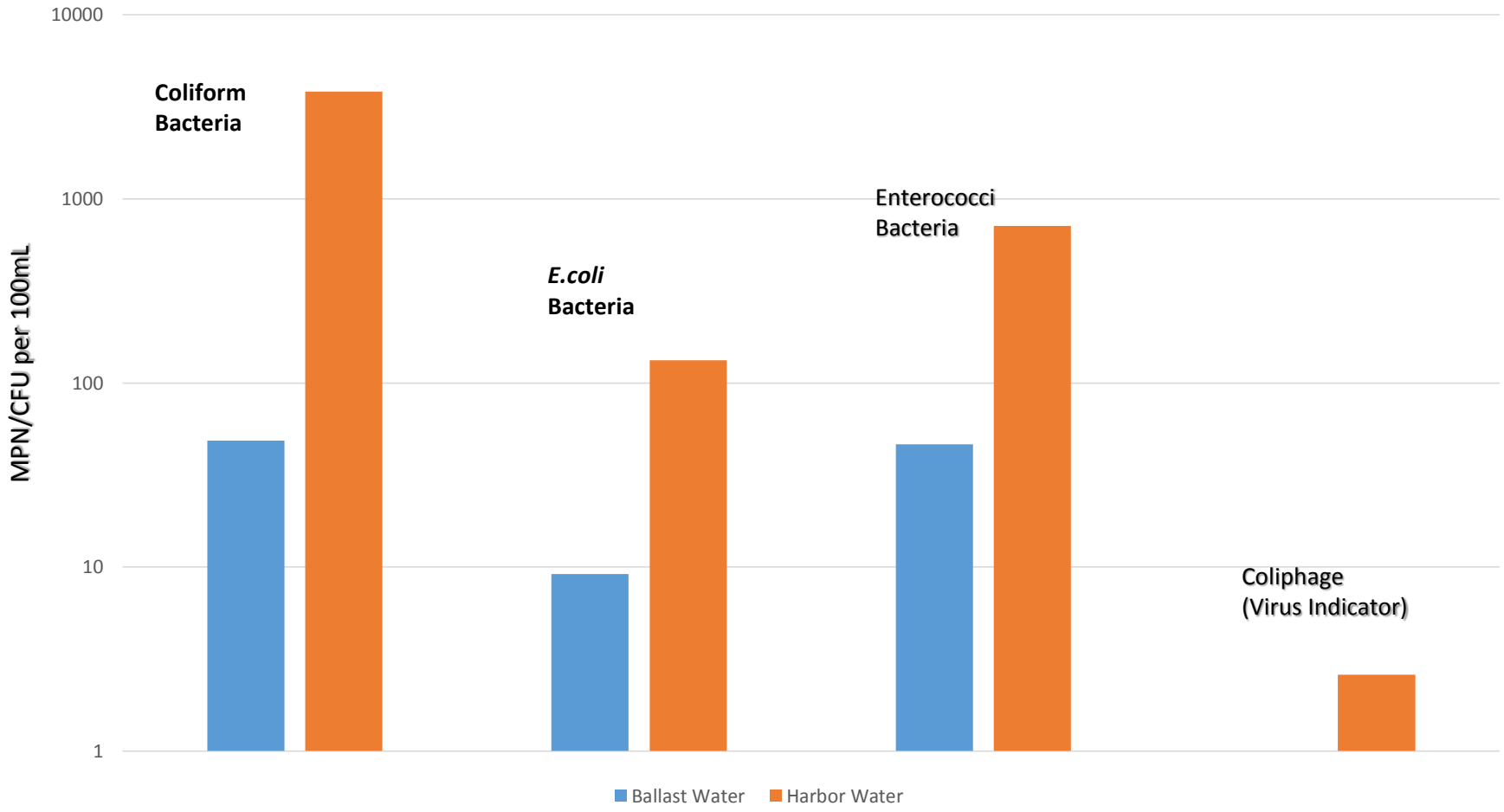
AVERAGE INDICATORS IN BALLAST AND HARBOR WATER



discharge of the indicator microbes shall not exceed (IMO)
(i) *Escherichia coli* less than 250 cfu per 100 millilitres; and
(iii) Intestinal *Enterococci* less than 100 cfu per 100 millilitres.

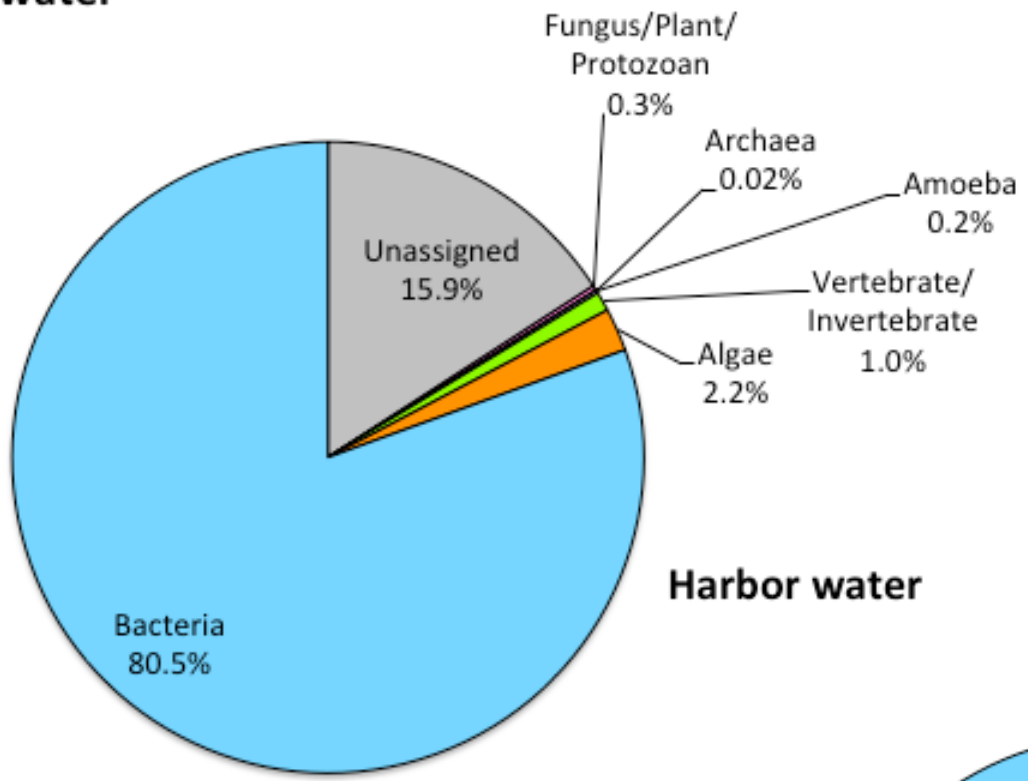
Ballast Water Characteristics

- **Temperature (°C)** 15-21; Avg. 18
- **Turbidity (NTU)** 0.09-11; Avg. 2.3 (3 samples 5,6 and 11 NTU)
- **pH** 7-7.96, Avg. 7.7
- **Salinity (ppt)** 13.7-32.9; Avg. 27.5 (3 samples 14 ppt)

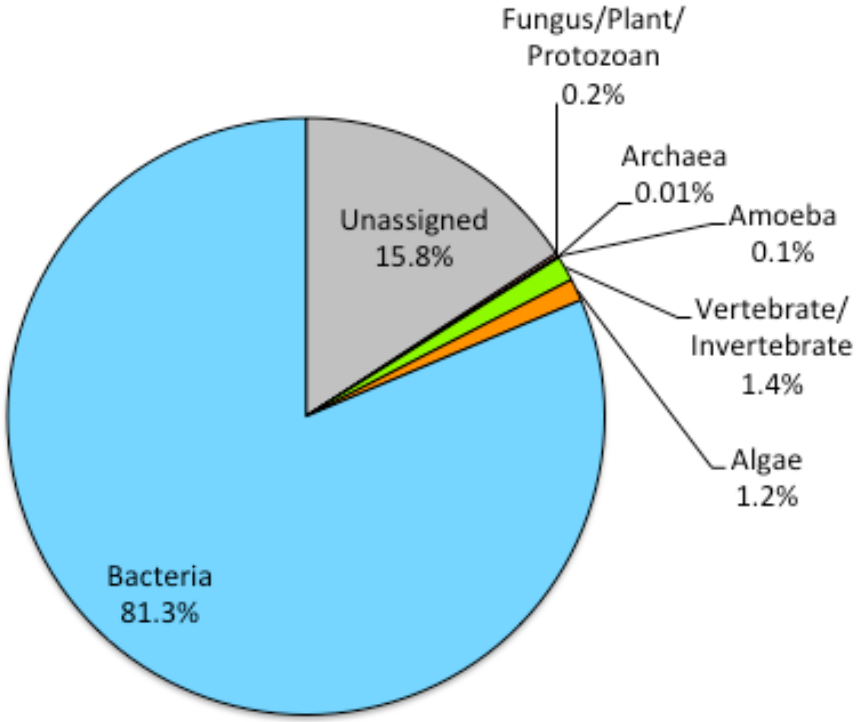
- TWO OF THE SAMPLES WITH HIGHER TURBIDITY HAD THE LOWER SALINITY.

VIRUS HOST

Ballast water



Harbor water



Bacterophage (viruses from bacteria) shown to move antibiotic resistant genes

VIRUS PATHOGENS

Virus host	Types of viral homologs
FISH	Ranavirus / European catfish virus Ranavirus / Frog virus 3 Megalocytivirus Singapore grouper iridovirus
SHRIMP	Whispovirus / White spot syndrome virus Penaeid shrimp infectious myonecrosis virus
HUMANS	Human herpesvirus 4 Human herpesvirus 8 Human picobirnavirus Molluscum contagiosum virus

Molluscum contagiosum is caused by a virus and usually causes a mild skin disease. Molluscum infections occur worldwide but are more common in warm, humid climates and where living conditions are crowded. spread from person to person by touching the affected skin, touching a surface with the virus on it, and might be spread by sharing swimming pools, baths, saunas, or other wet and warm environments,

Viruses in ballast water

- - Abundance of viruses in ballast water based on the estimation of the number of virus-like particles (VLPs)
- 7.4 x 10^9 VLPs per liter of ballast water (Ruiz et al., 2000)
- 2.6 x 10^{17} VLPs per ship (Drake et al., 2007)
- We are finding animal, fish, and human viruses.
- **Diversity and composition of viruses in ballast water have not been studied.**
- **WHAT VIRUSES ARE THERE? HOW MANY? CAN WE REMOVE AND DISINFECT THEM?**
- **Treatment: chlorine, ozone, UV, reverse osmosis.**

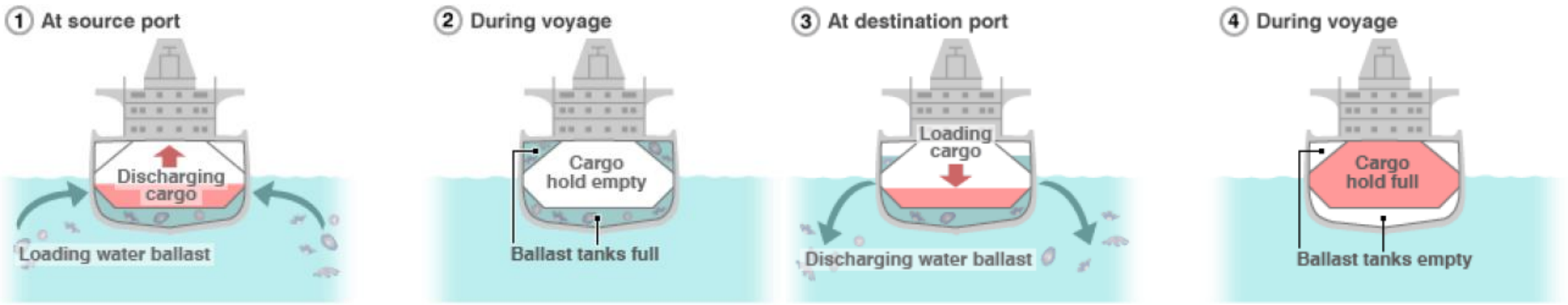


Image from www.globallast.imo.org

Acknowledgements

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Ballast water sampling

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Thank You!

Any Questions??