

Antibiotic Resistant Bacteria at the Beach

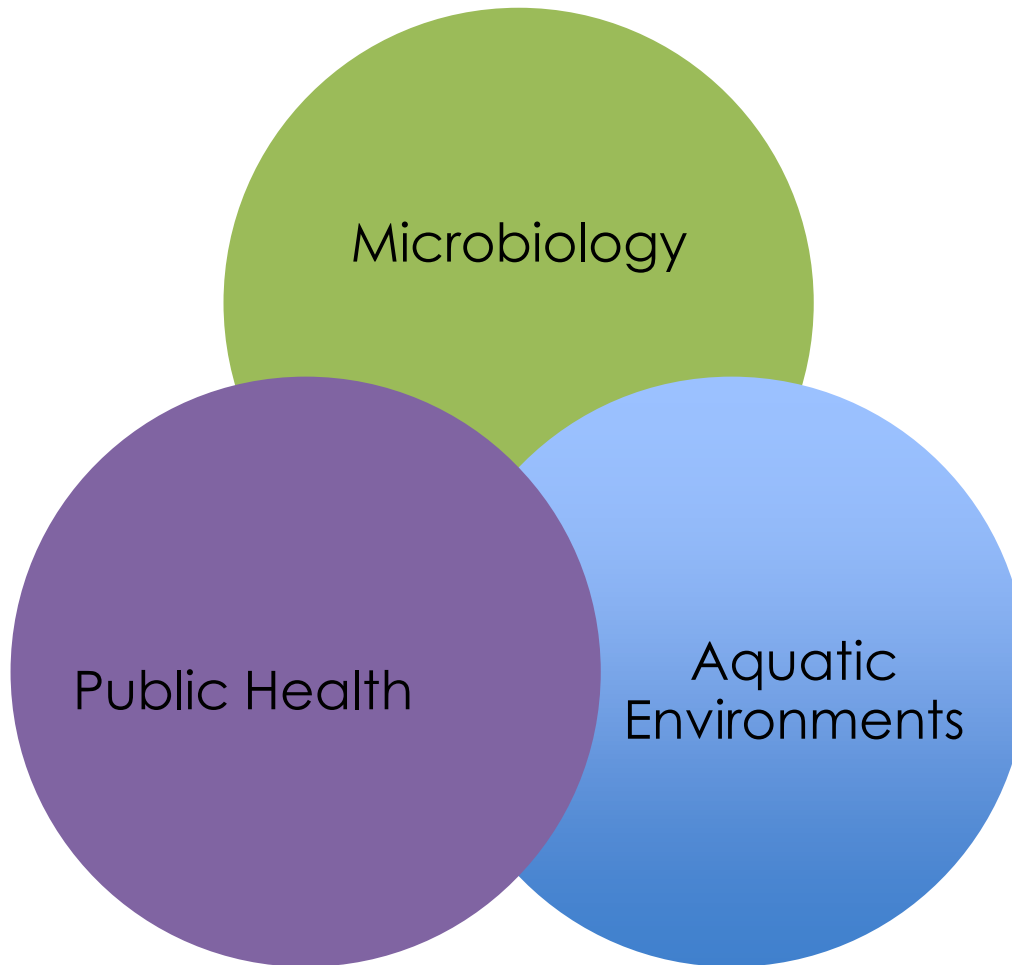


Megan May
Waquoit Bay Research Reserve
April 30, 2015

Outline

- My research background
- Background
 - Microbes
 - Antibiotics
 - Antibiotic Resistance
- My research project
- Larger significance

Applied Environmental Microbiology





DEPAUW UNIVERSITY



Research Experiences



Graduate School

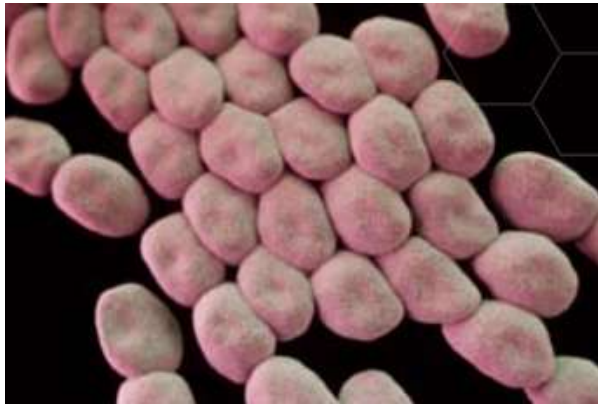
- MIT-WHOI Joint Program in Oceanography
- Dr. Rebecca Gast's Lab at WHOI



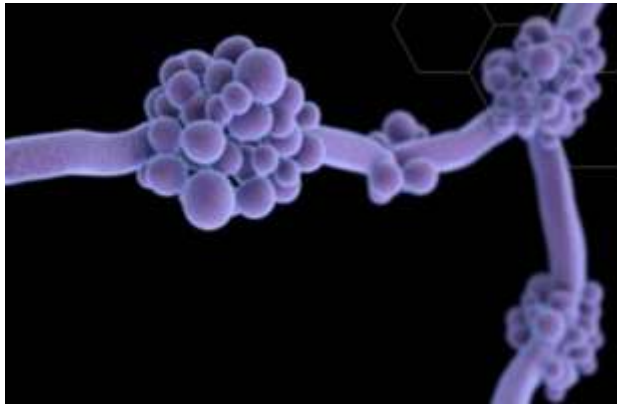
Background Information

What are microbes?

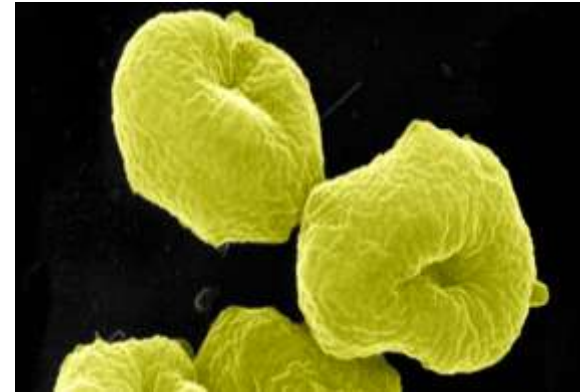
- Organisms that can be seen with a microscope



Actinetobacter
(Bacteria)

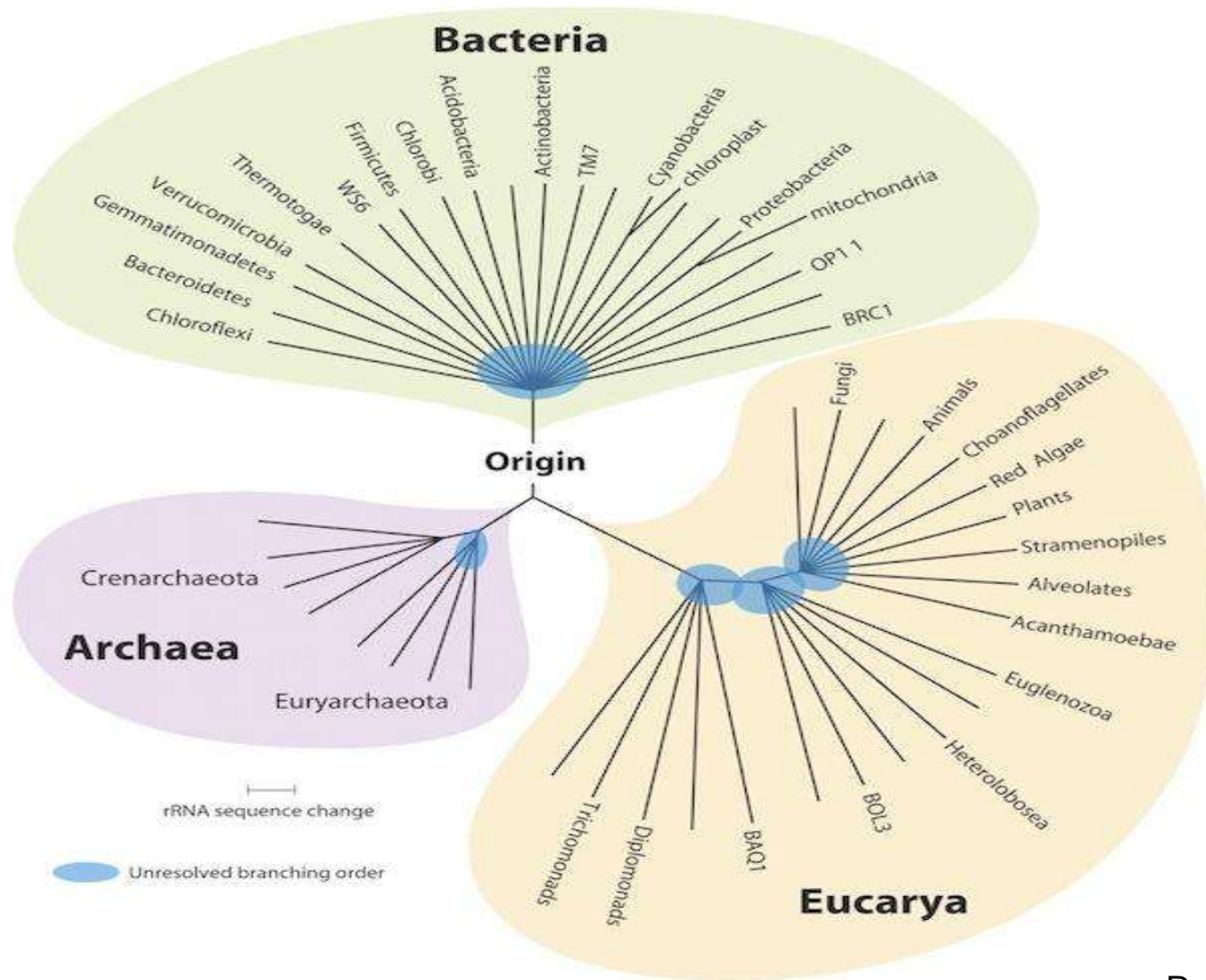


Candida
(Fungus, Eucarya)

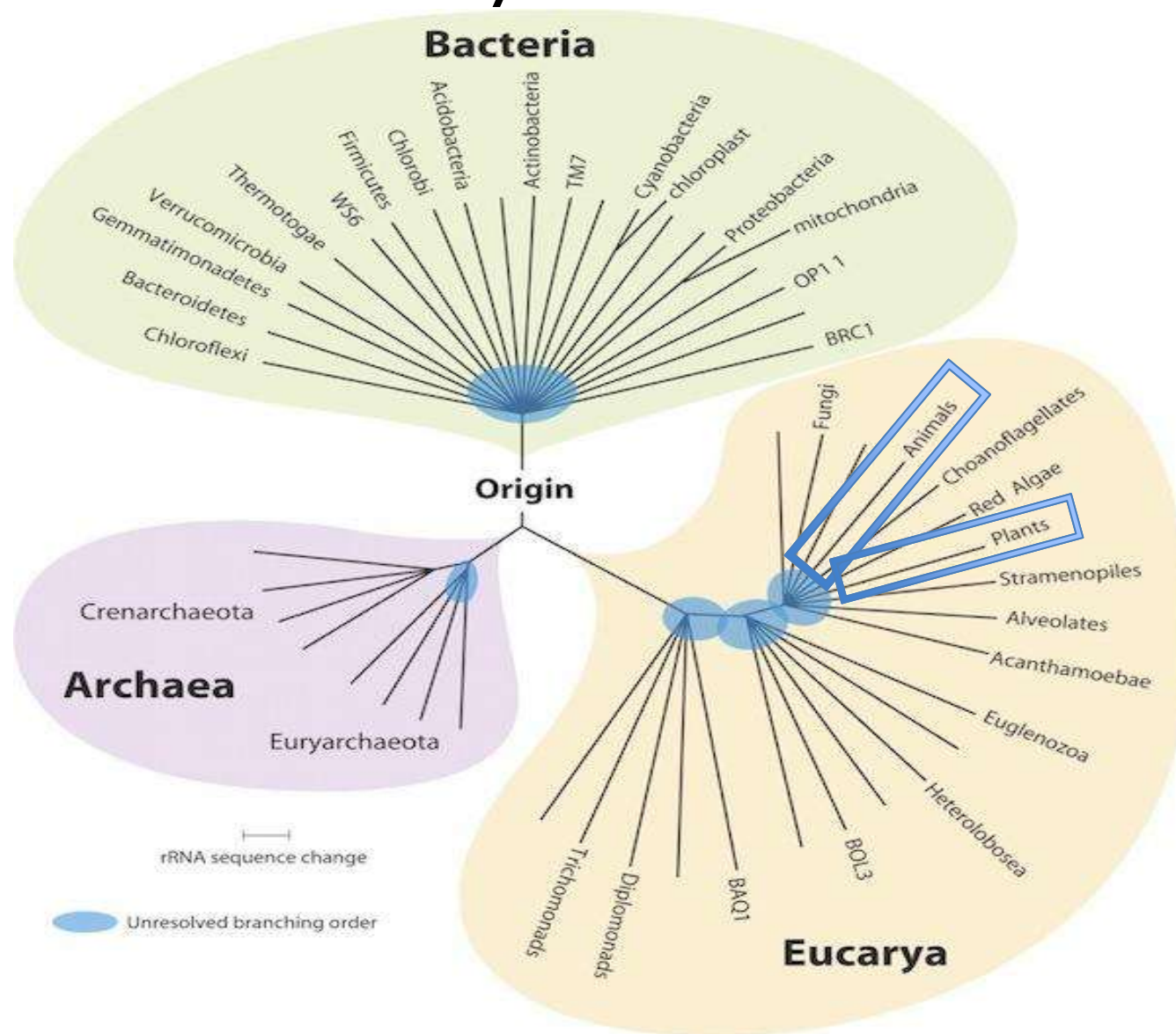


Sulfolobus
(Archaea)

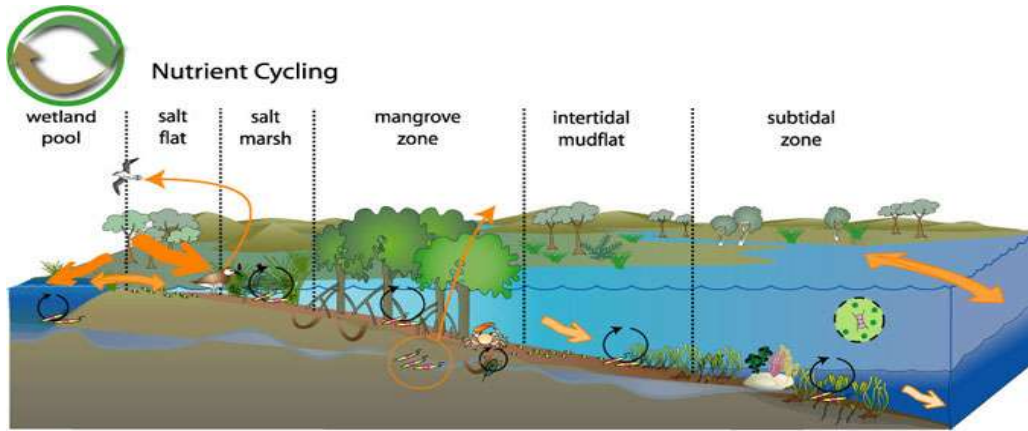
Life is divided into 3 groups.



Life is “Mainly Microbes”!



Why do we care about microbes?



Nutrient cycling, degradation



Fermentation



Bioremediation



Bioprospecting

Why do we care about microbes?



Hydrothermal vents



Ocean sediments



Yellowstone National Park

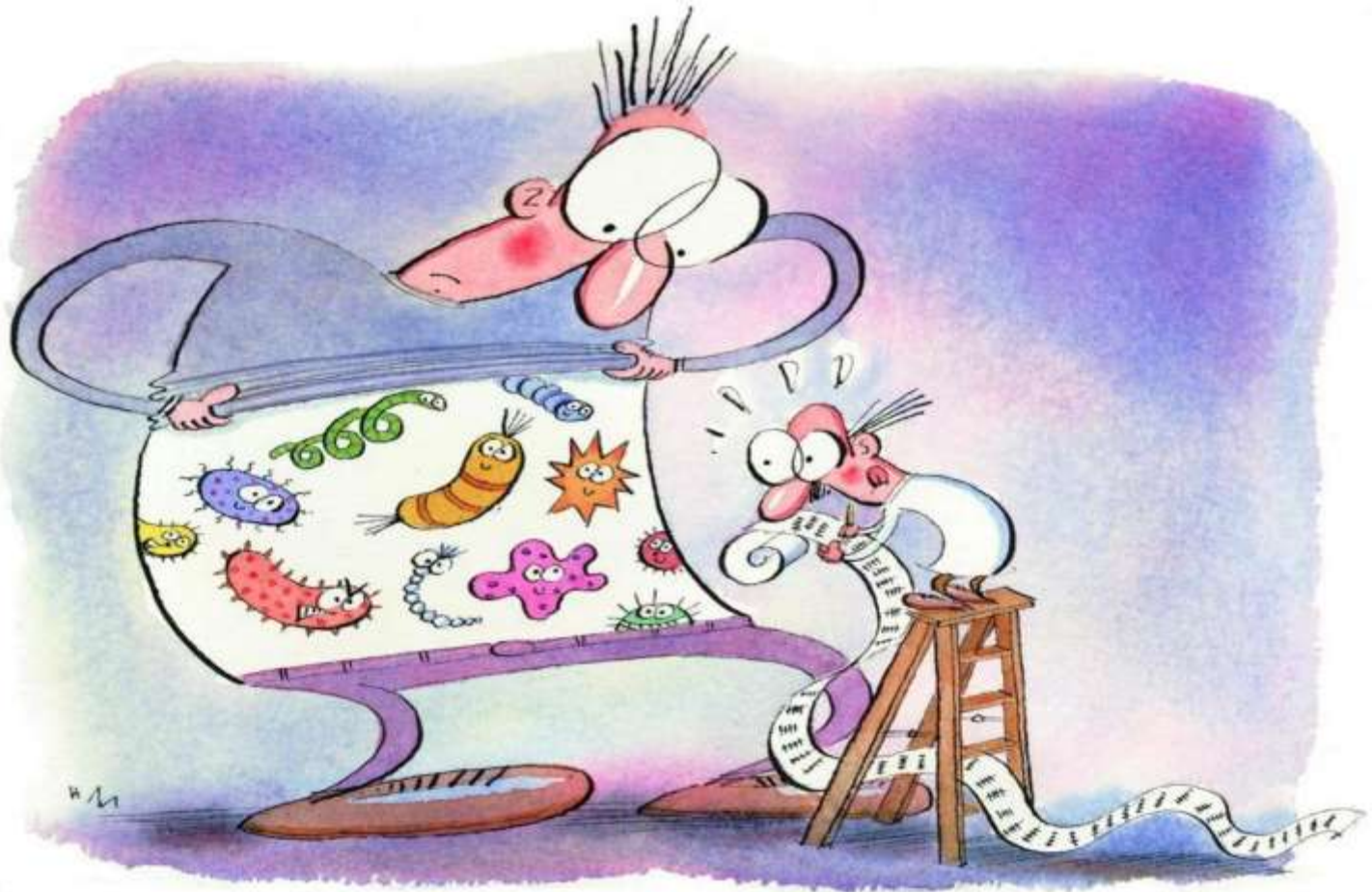


Ice

Microbes are all around us

Environment	Amount
Ocean Water	500,000 Cells/cm ³
Ocean sediments (top 10 cm)	220,000,000 cells/cm ³
Rivers	1,000,000 Cells/cm ³
Forest sediments	40,000,000 cells/gram

Microbes are all over us



Bacteria and archaea outnumber us...by a lot!

4,000,000,000,000,000,000,000,000,000,000,000,000

7,310,000,000

Disease-causing (pathogenic) microbes are not the majority



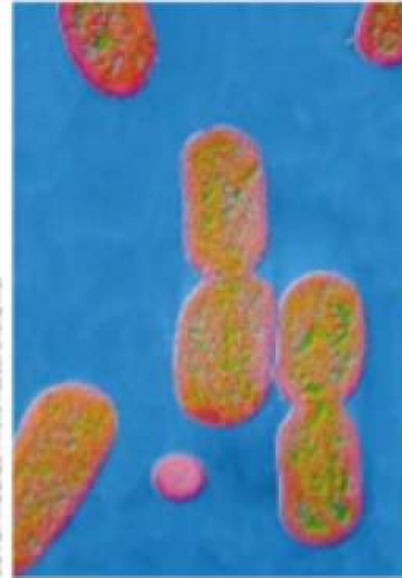
*Mycobacterium
tuberculosis*

Tuberculosis



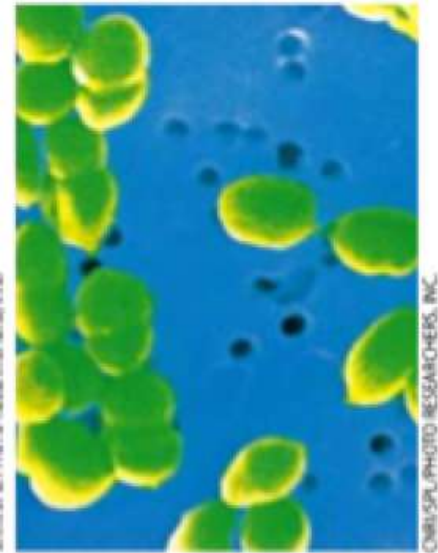
*Pseudomonas
aeruginosa*

Blood poisoning
Pneumonia



Shigella dysenteriae

Dysentery

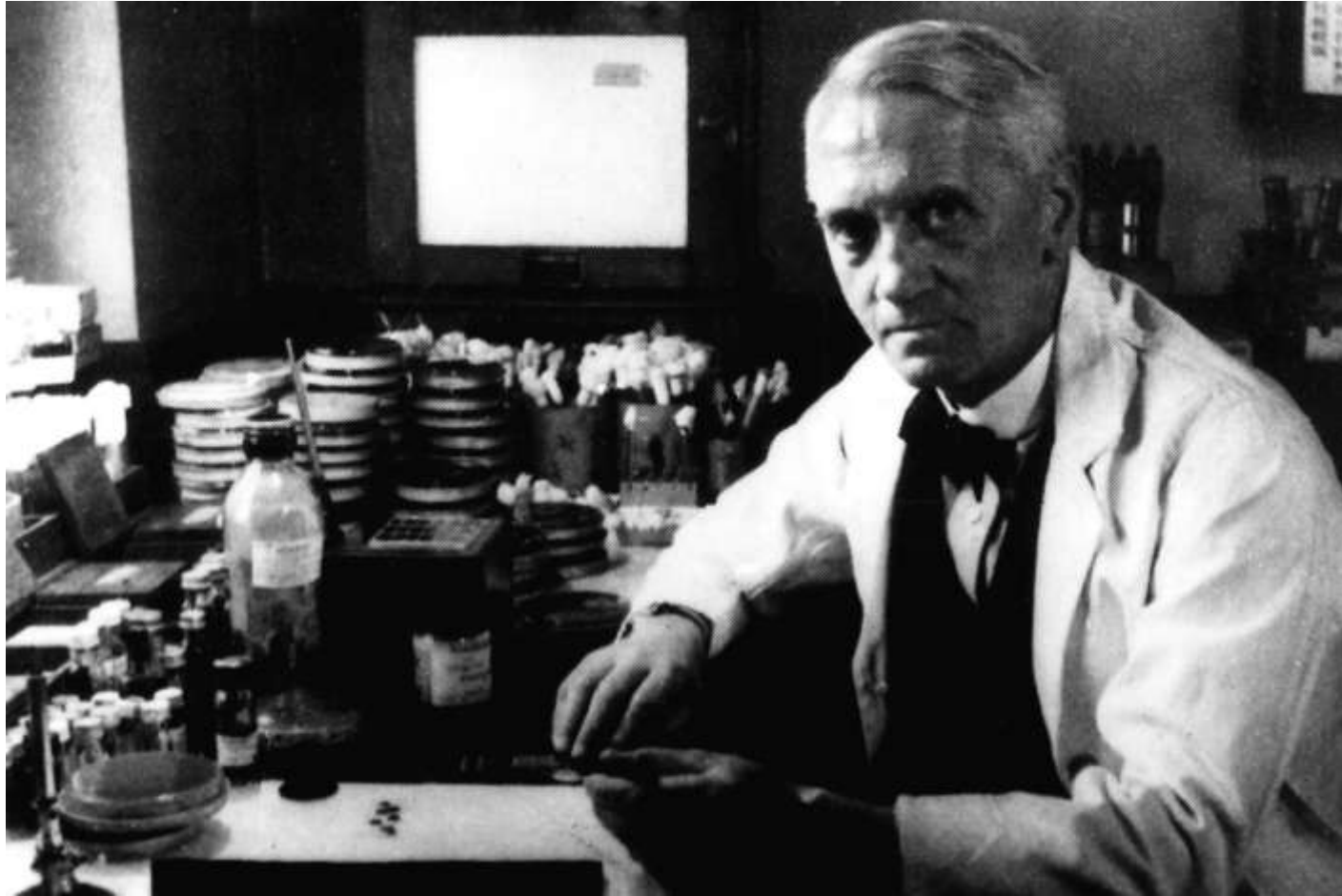


*Streptococcus
pneumoniae*

Pneumonia

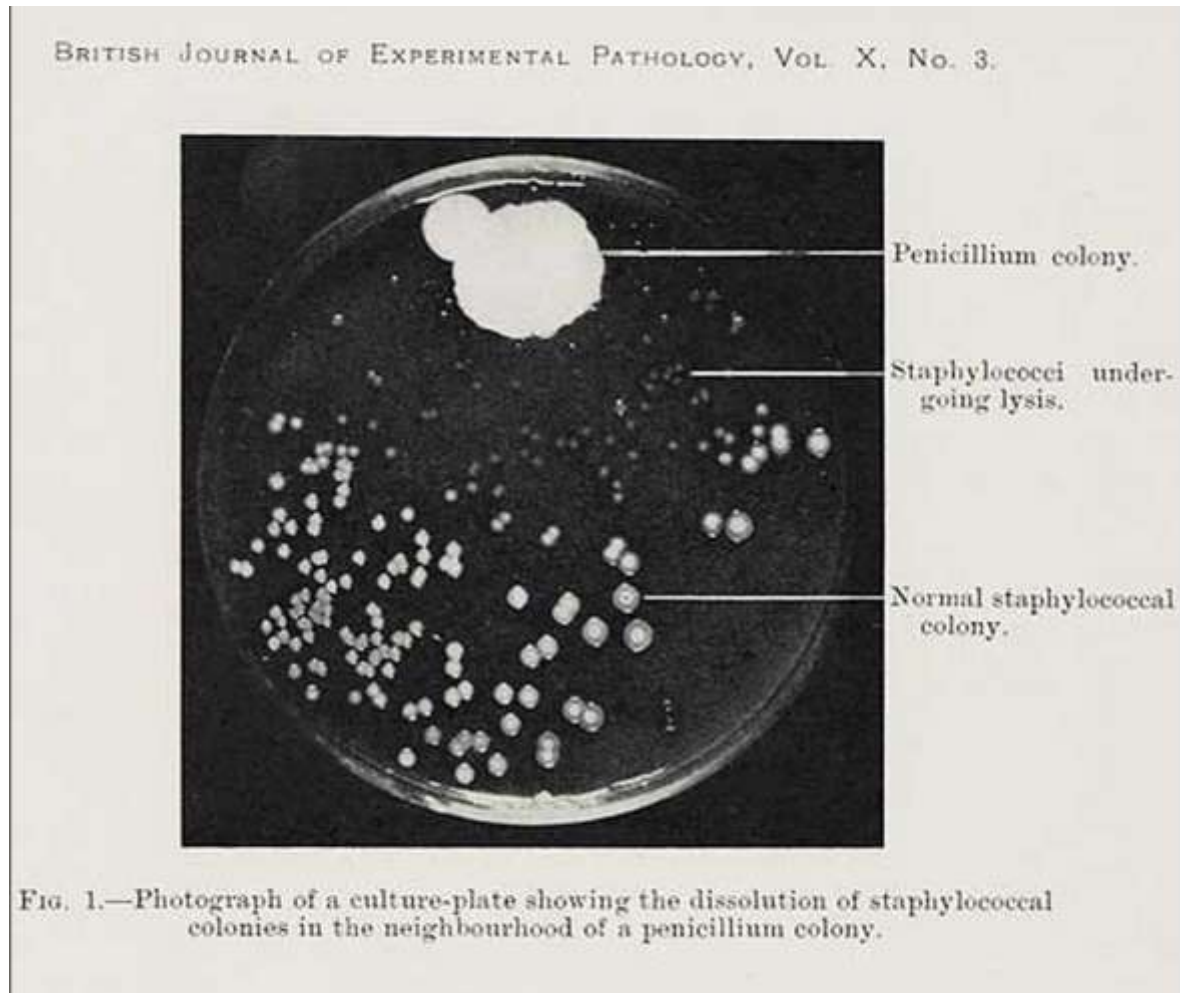
Antibiotics

Discovery of antibiotics

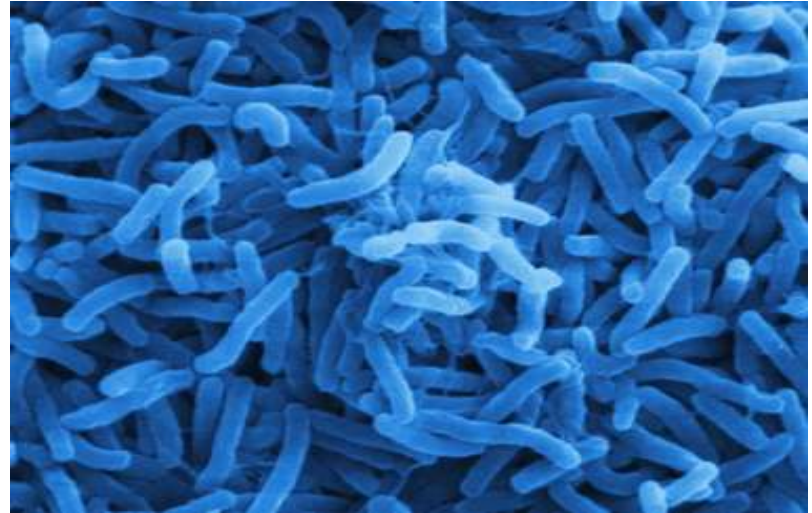


Alexander Fleming

Fleming's Work

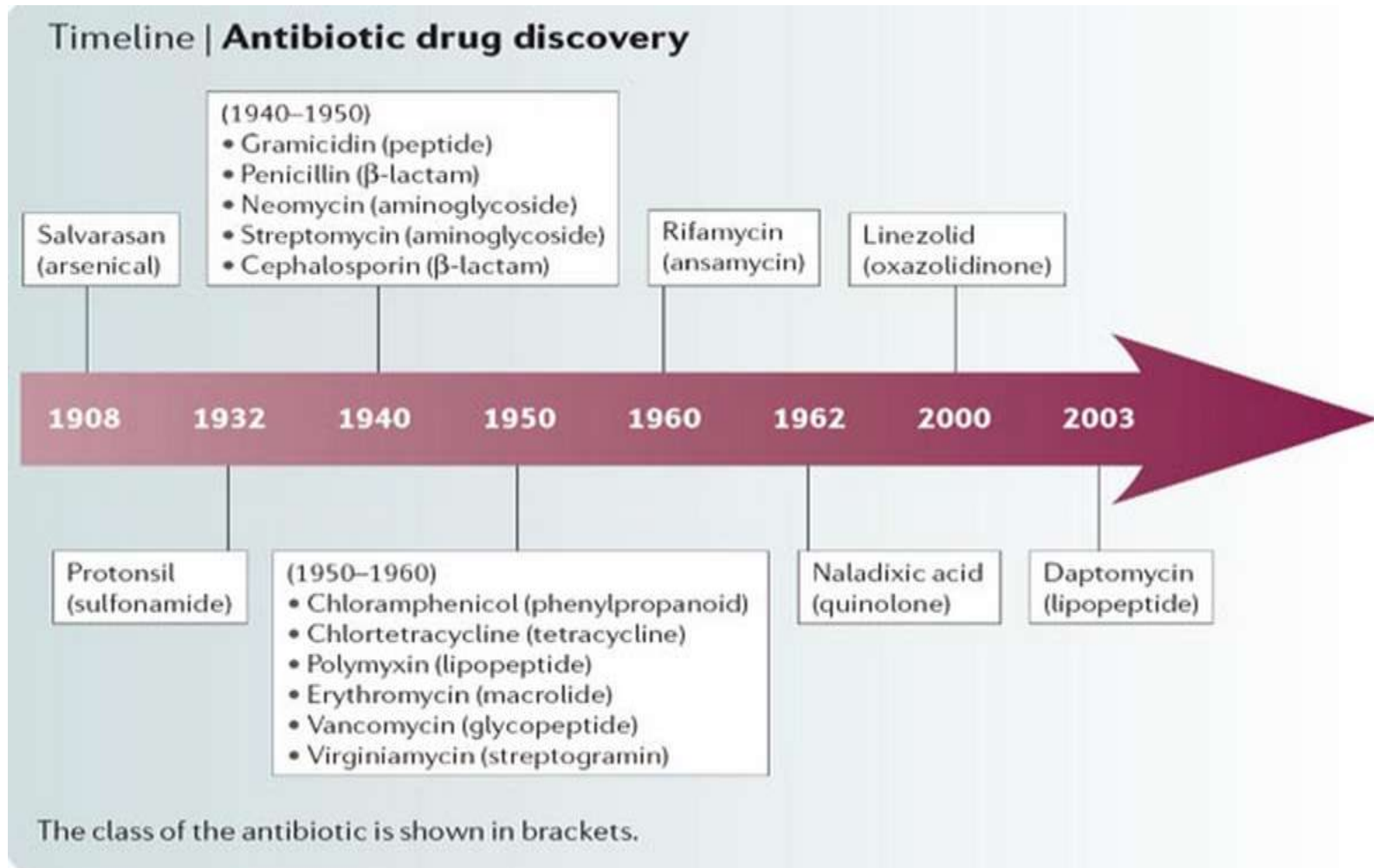


Antibiotics



- compound produced by a microorganism that inhibits the growth of another microorganism
- natural process
- can be chemically synthesized

Recent discovery by humans



Humans use antibiotics often.

Animal Agriculture



Aquaculture



Human health



Agriculture

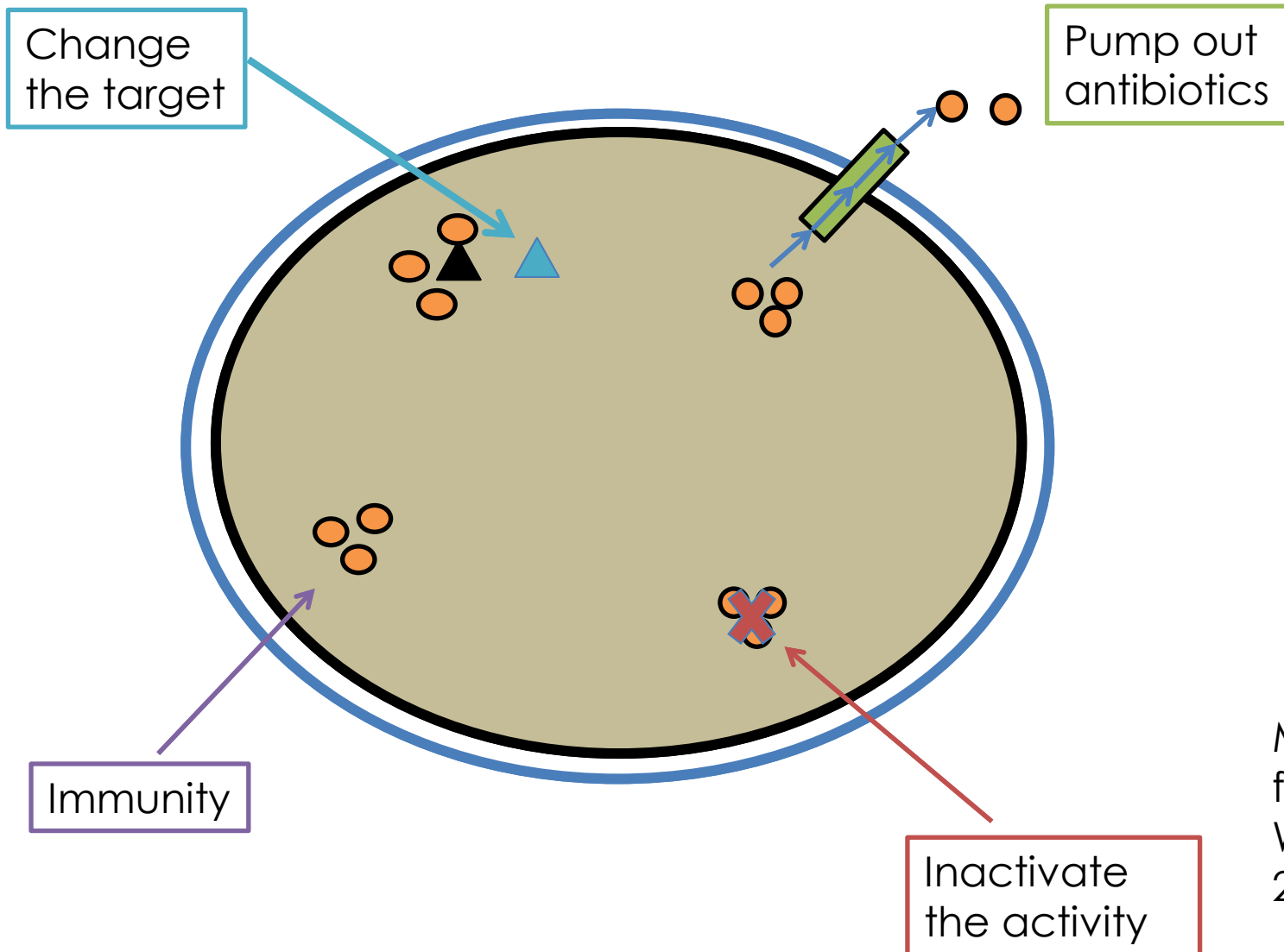
How do antibiotics work?

- Targeting the bacterial cells to stop them from growing or to kill them
- Can occur by attacking the outside of the cell or by affecting the processes inside the cell

What is antibiotic resistance?

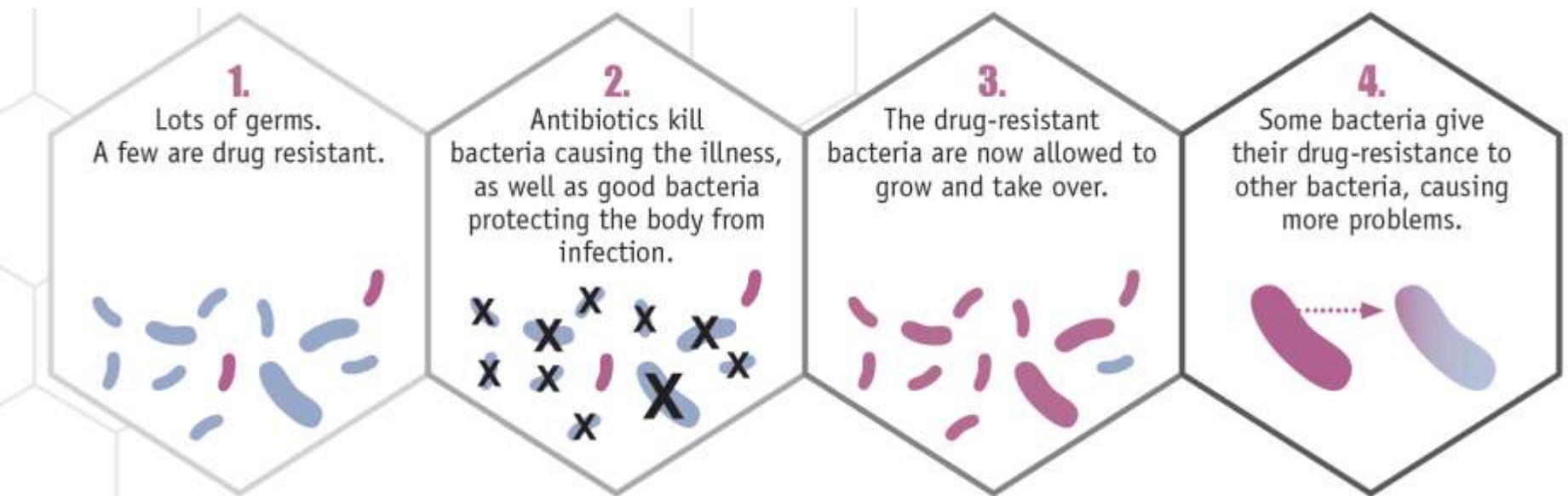
- Resistance is when a bacteria is not affected by a particular antibiotic
- Natural occurring process
 - Found in ancient sediments
 - Isolated caves
 - Isolated tribe of humans

How can bacteria resist antibiotics?



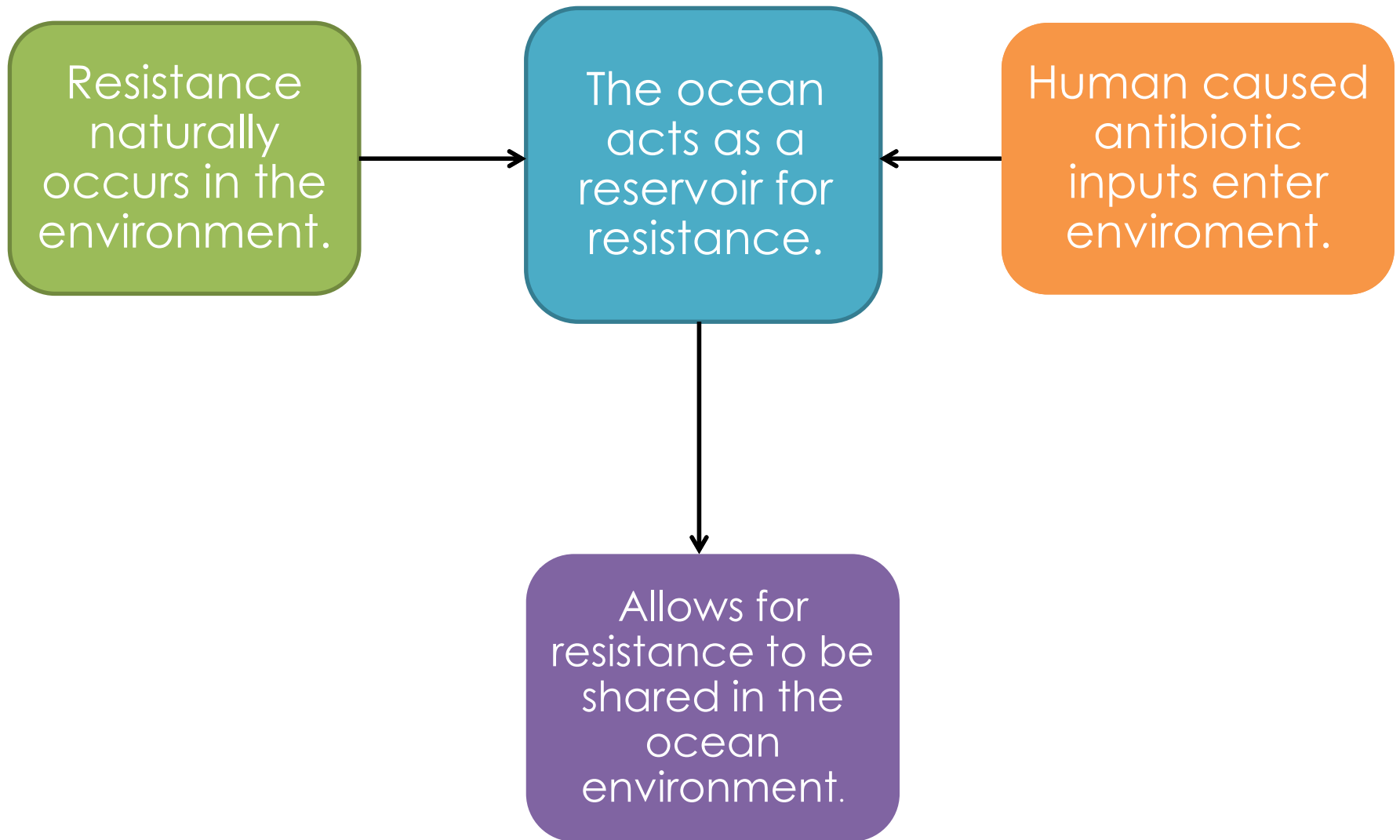
Modified
from:
Wright
2010

How can resistance be spread?

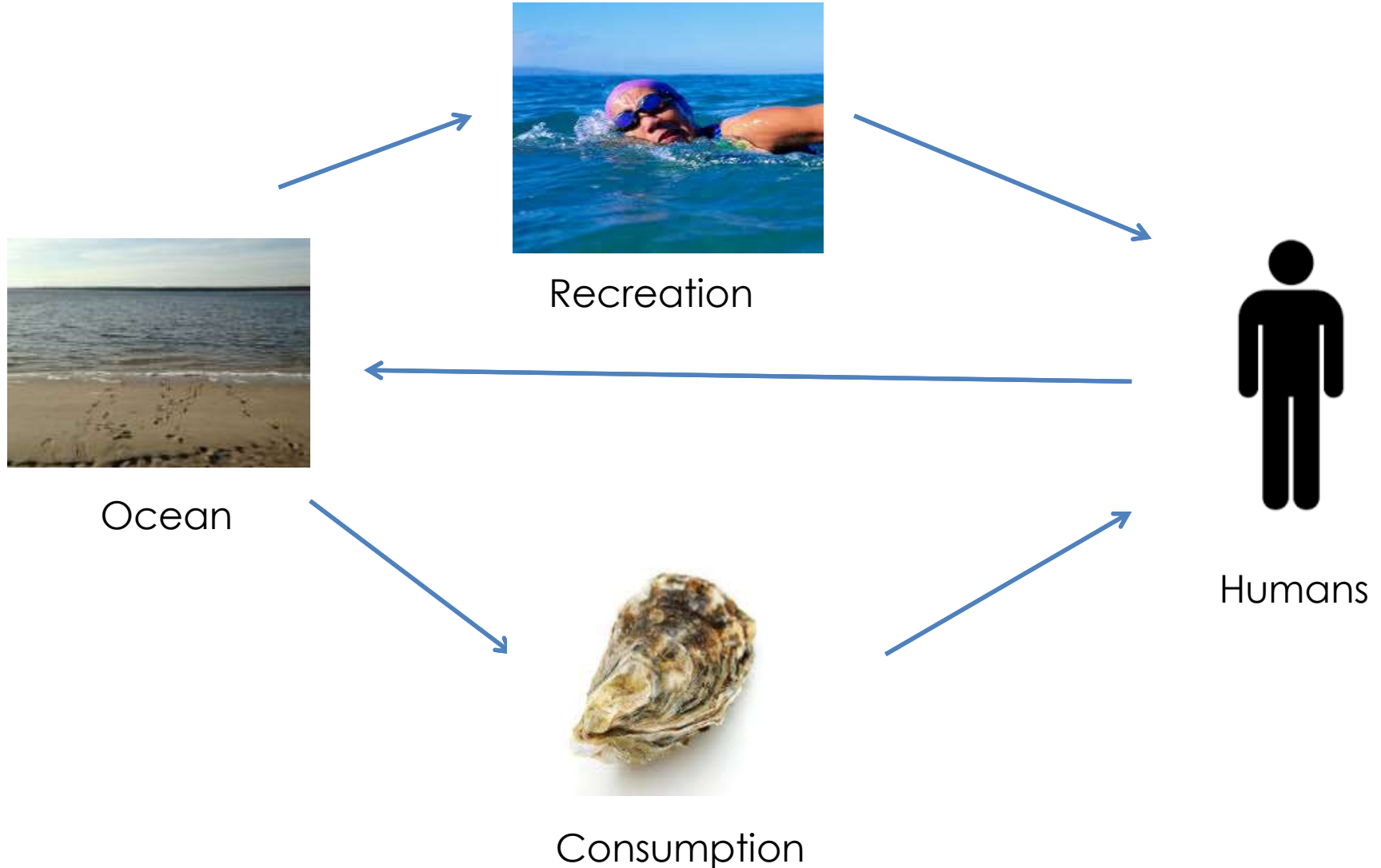


- Selections by exposure to antibiotics
- Bacteria sharing resistance

Marine Environmental Resistance



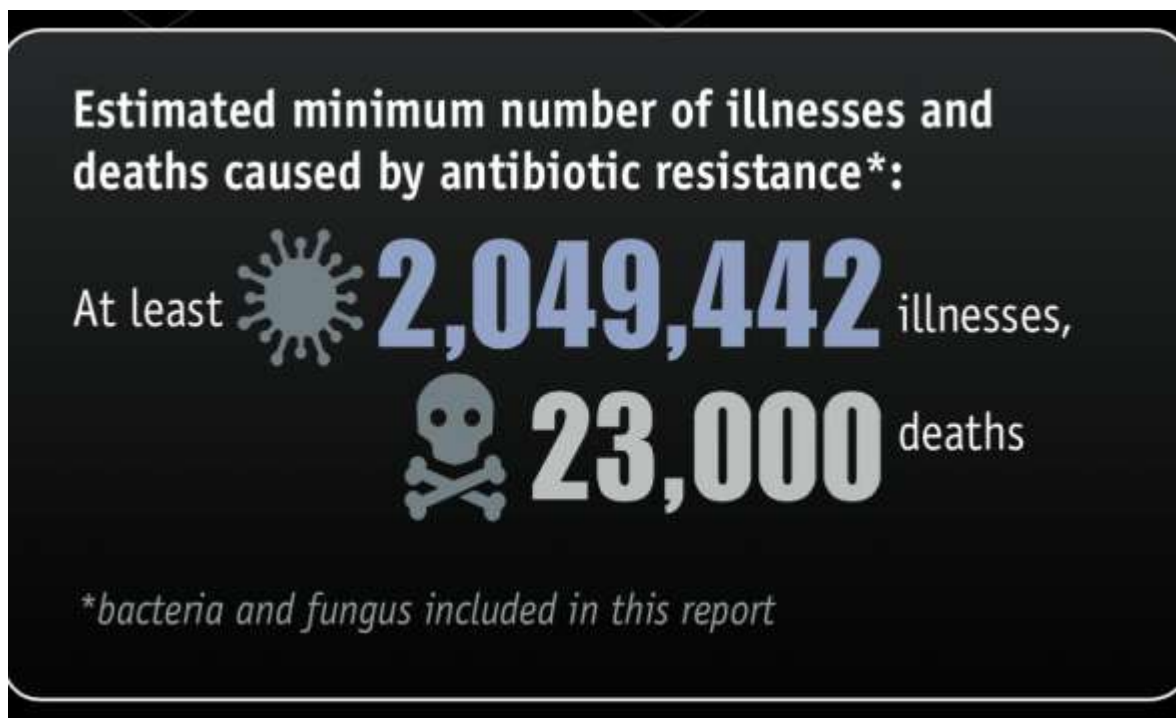
AR transfer from the ocean



Environment is important to understanding our health.



Antibiotic resistance has large impacts.



ranged as high as \$20 billion in excess direct healthcare costs, with additional costs to society for lost productivity as high as \$35 billion a year (2008 dollars).¹

What are the levels of
antibiotic resistance at
beaches around Cape Cod?

Why the beach?

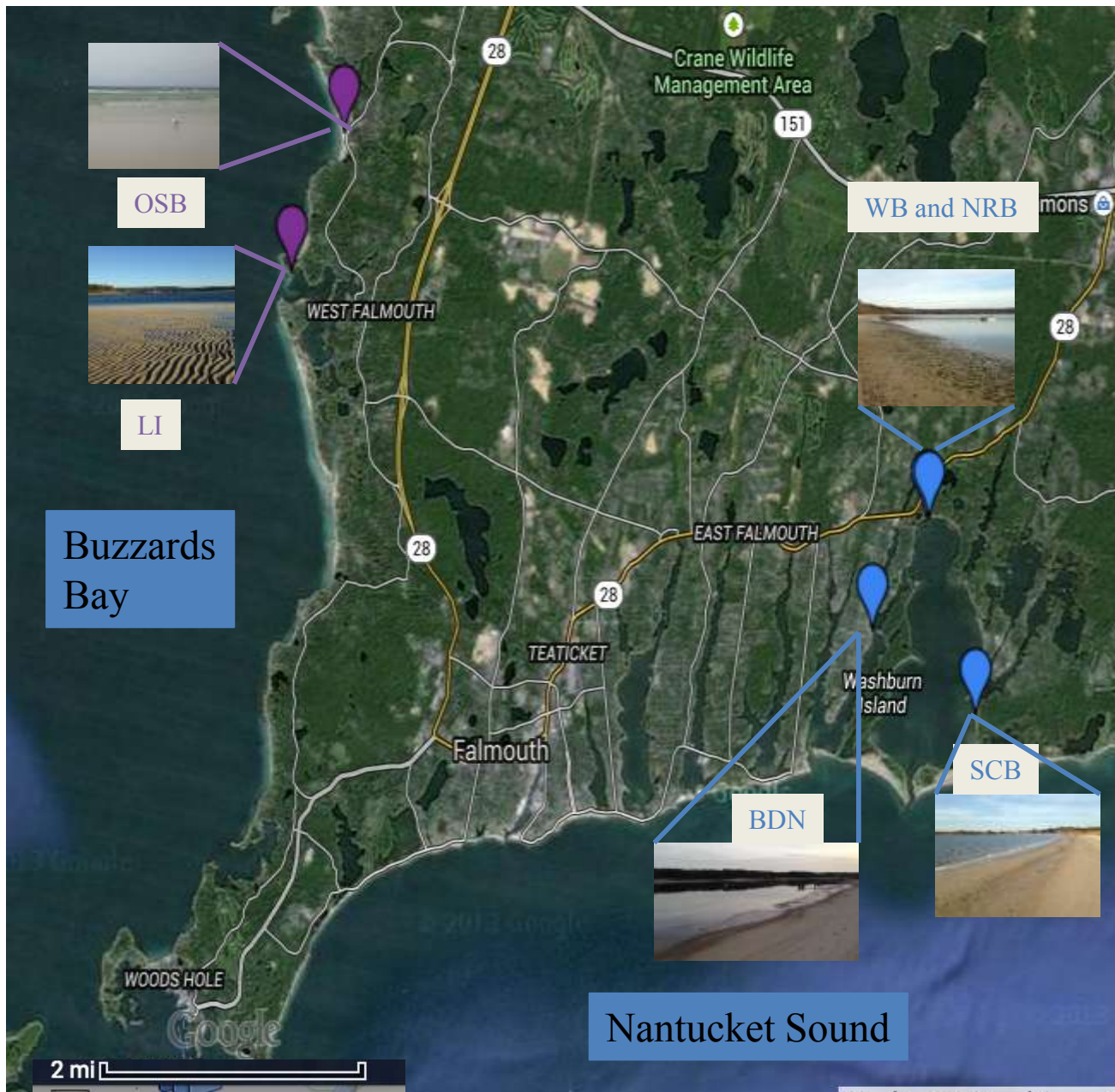
- Land-sea interface
- Humans interact
 - Consumption
 - Recreation



Why would we expect resistance in the environment?

- Natural process
- Likely enhanced by humans
 - Resistance can enter through wastes
 - Actual antibiotic residues can enter





Methods Flow Chart



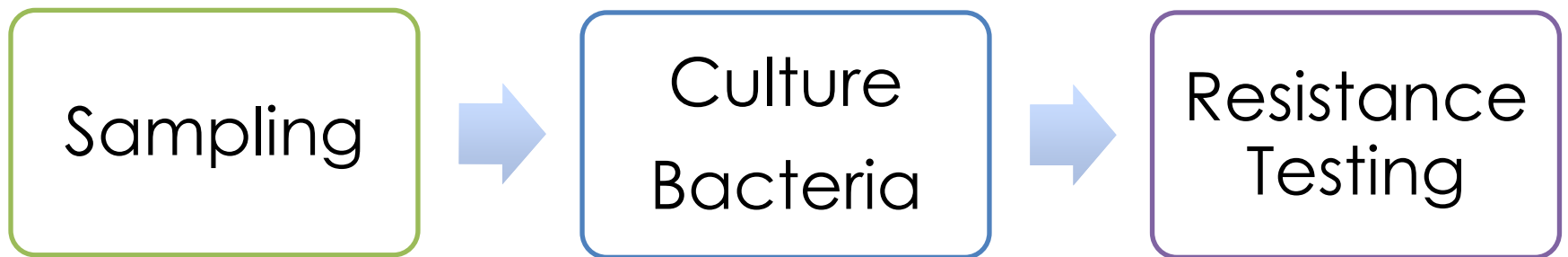
Field Sampling



Ice doesn't stop our sampling!

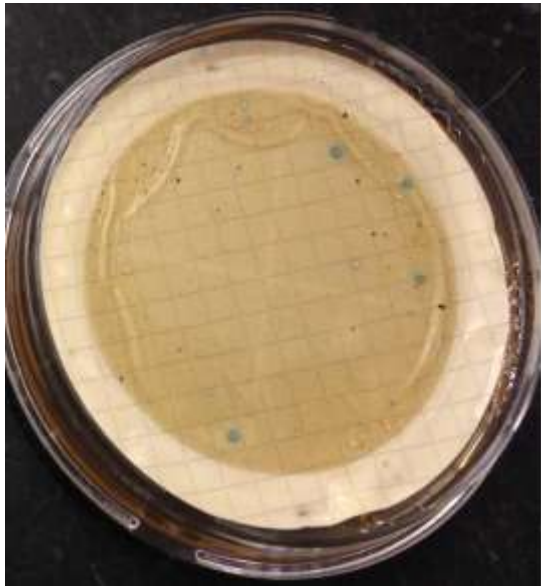


Methods Flow Chart



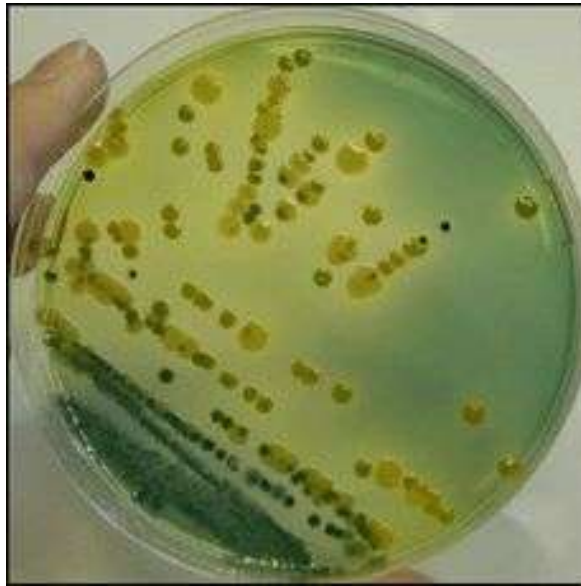
Culturing

Enterococcus



Fecal indicator used
By the EPA
-Can be pathogenic

Vibrio



Widespread in the
Marine environment
-Can be pathogenic

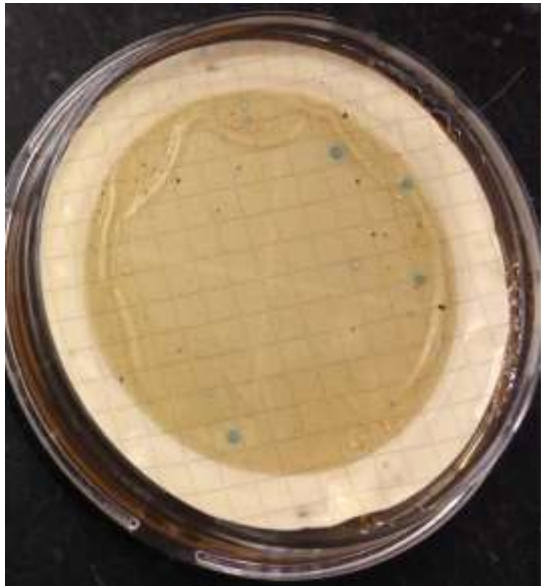
General Marine Bacteria



Indicates main
environmental reservoir

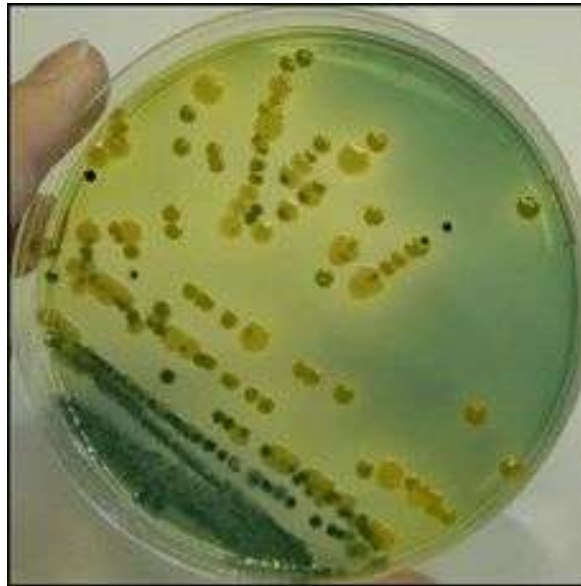
Picking isolates

Enterococcus



500 isolates

Vibrio



500 isolates

General Marine Bacteria

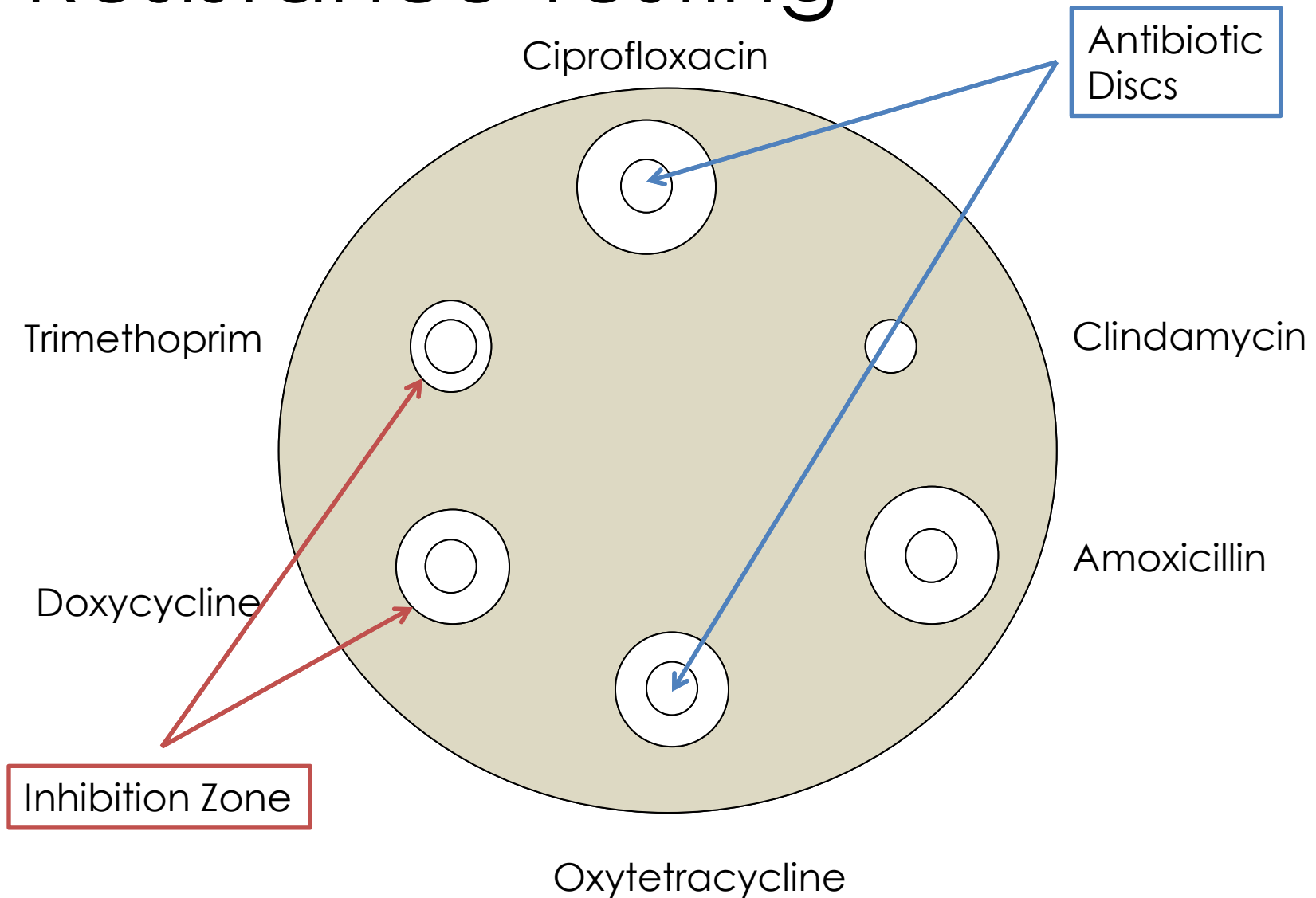


1500 isolates

Methods Flow Chart



Resistance Testing



Resistance Testing

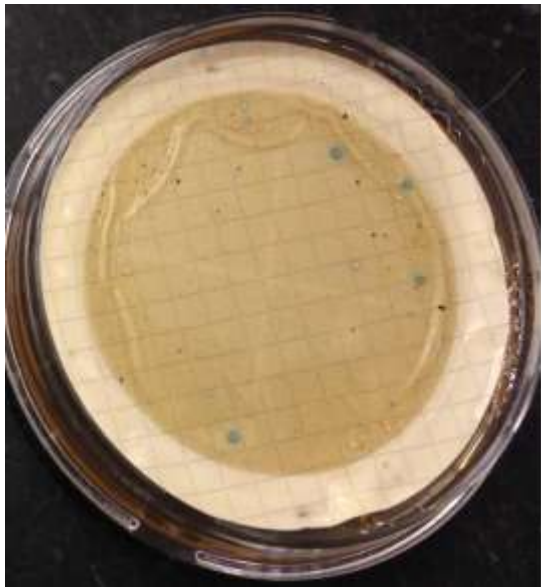


Why these antibiotics?

Antibiotic	Selected Uses	Use began
Amoxicillin	Ulcers, Lyme disease, bronchitis, ear infections	1972
Ciprofloxacin	Diarrhea, pneumonia, urinary tract infections	1987
Clindamycin	Blood poisoning, pneumonia, malaria, acne	1989
Doxycycline	Cholera, Gonorrhea, acne, diarrhea, Lyme disease	1967
Oxytetracycline	Syphilis, Pneumonia, Bronchitis, plague, throat irritation	1950s
Trimethoprim	Urinary tract infections, pneumonia	1982

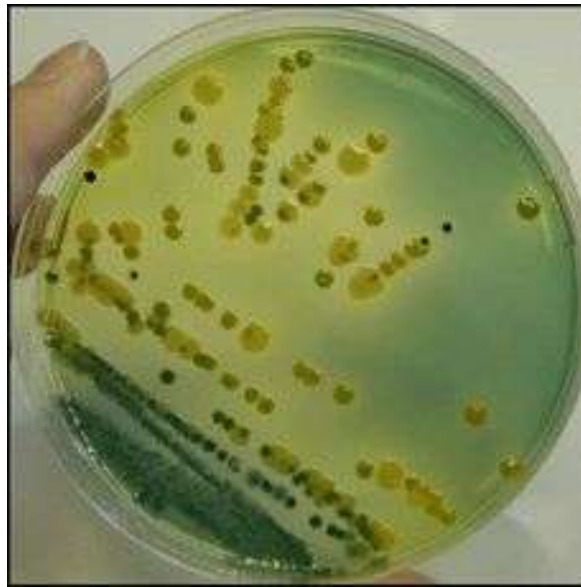
Resistance in cultured beach bacteria

Enterococcus



In process

Vibrio



94.3 %
(316 isolates)
~50 more to be collected

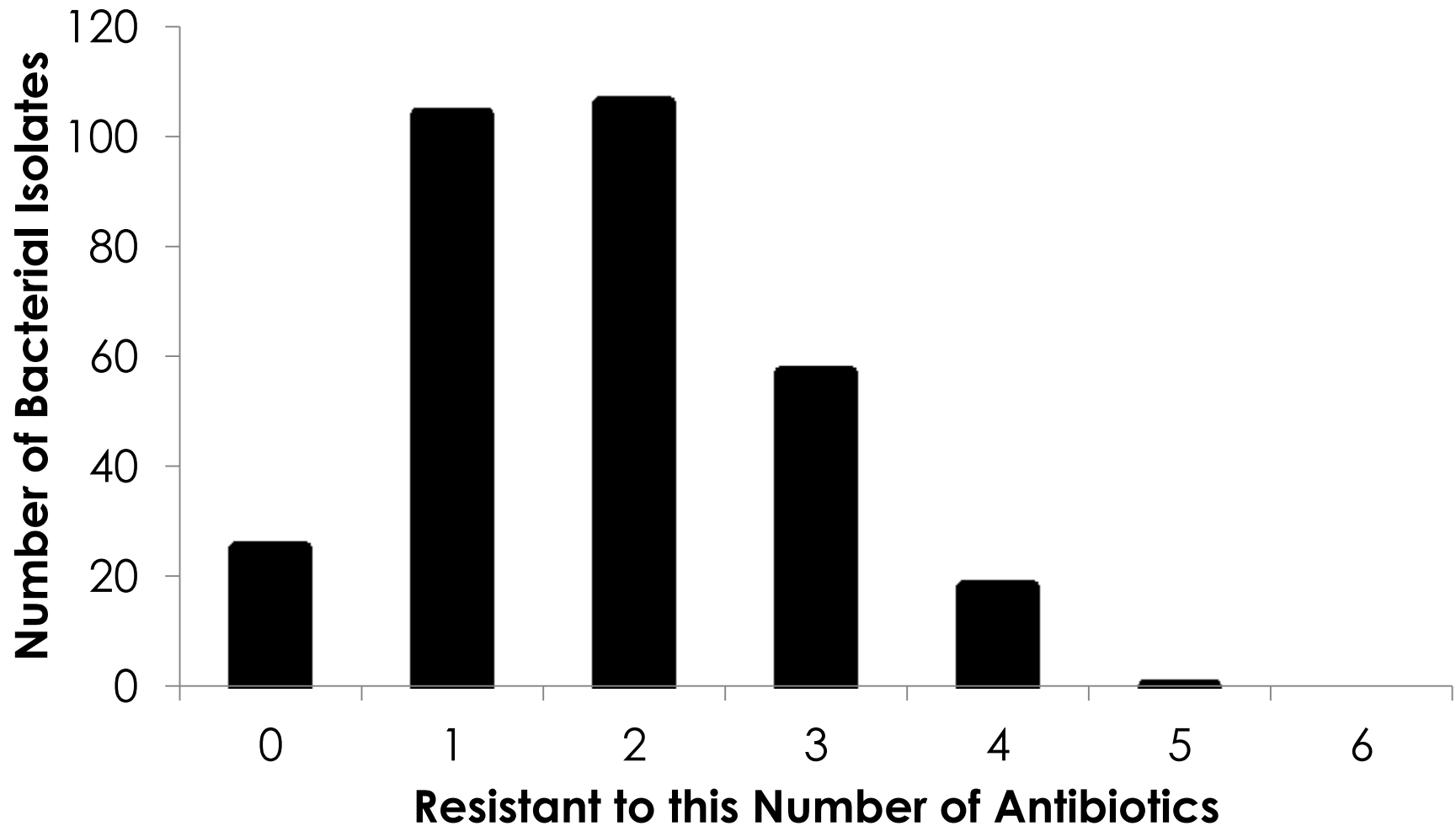
General Marine Bacteria



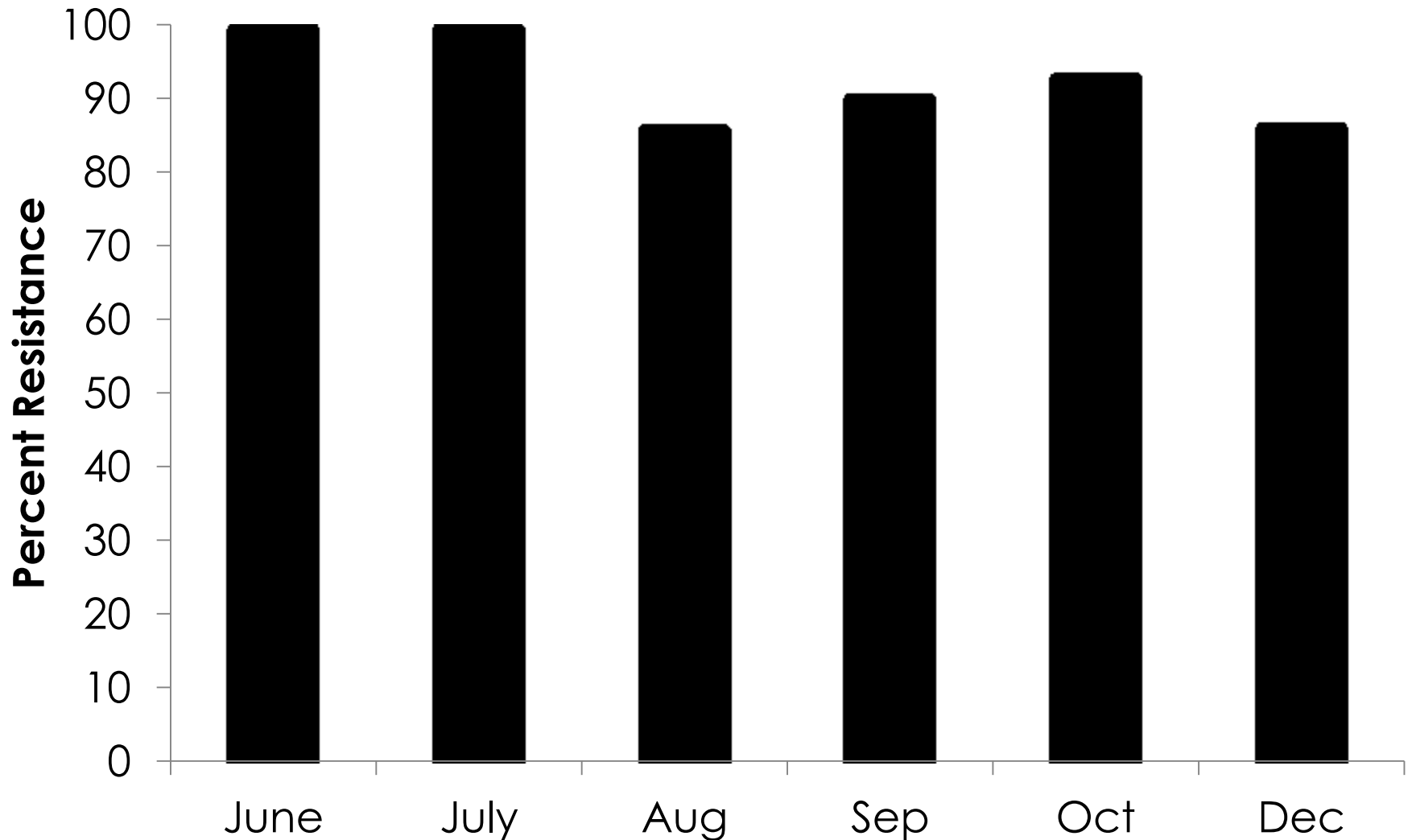
In process

What have we learned so far?

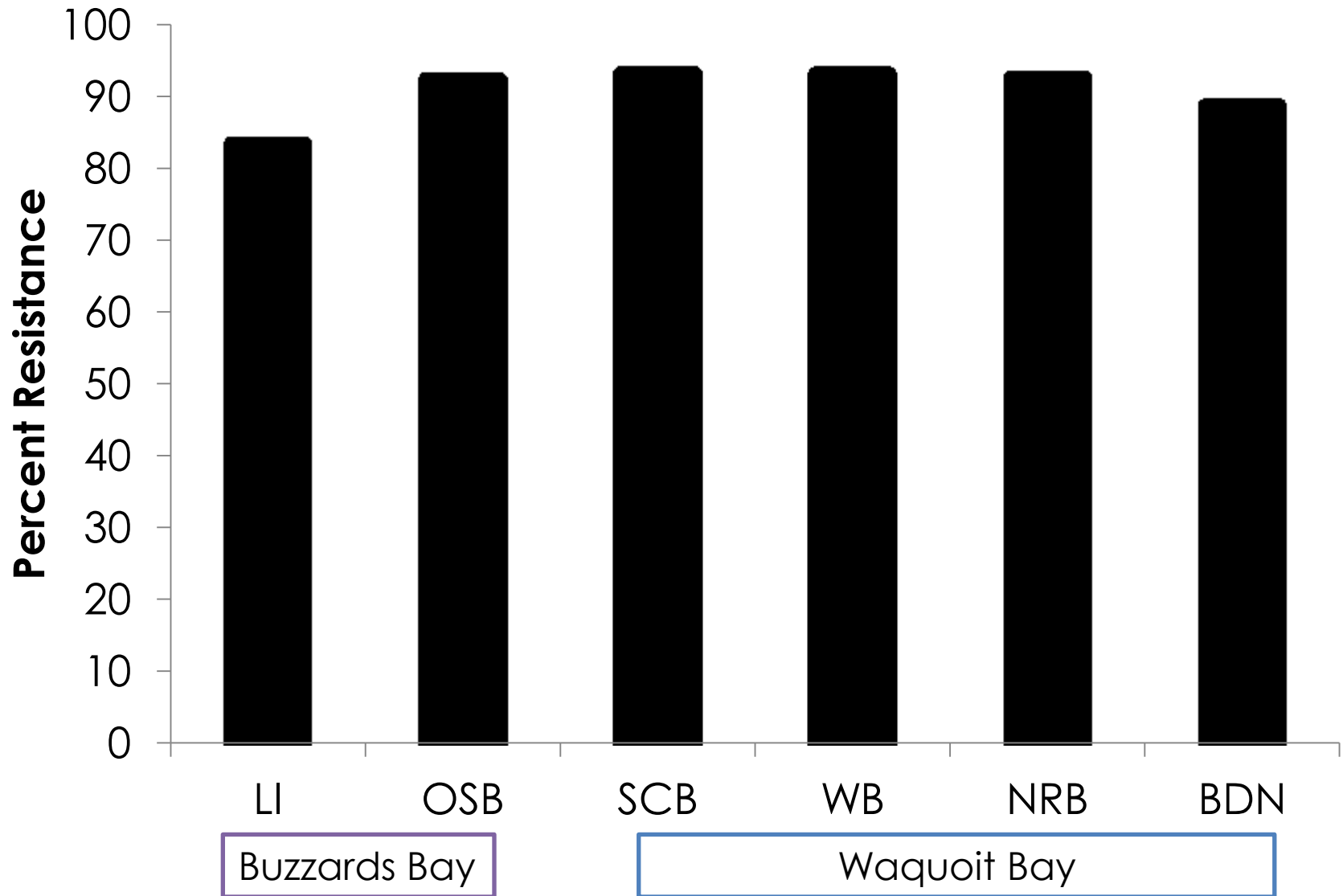
Resistance is prevalent within tested *Vibrio*



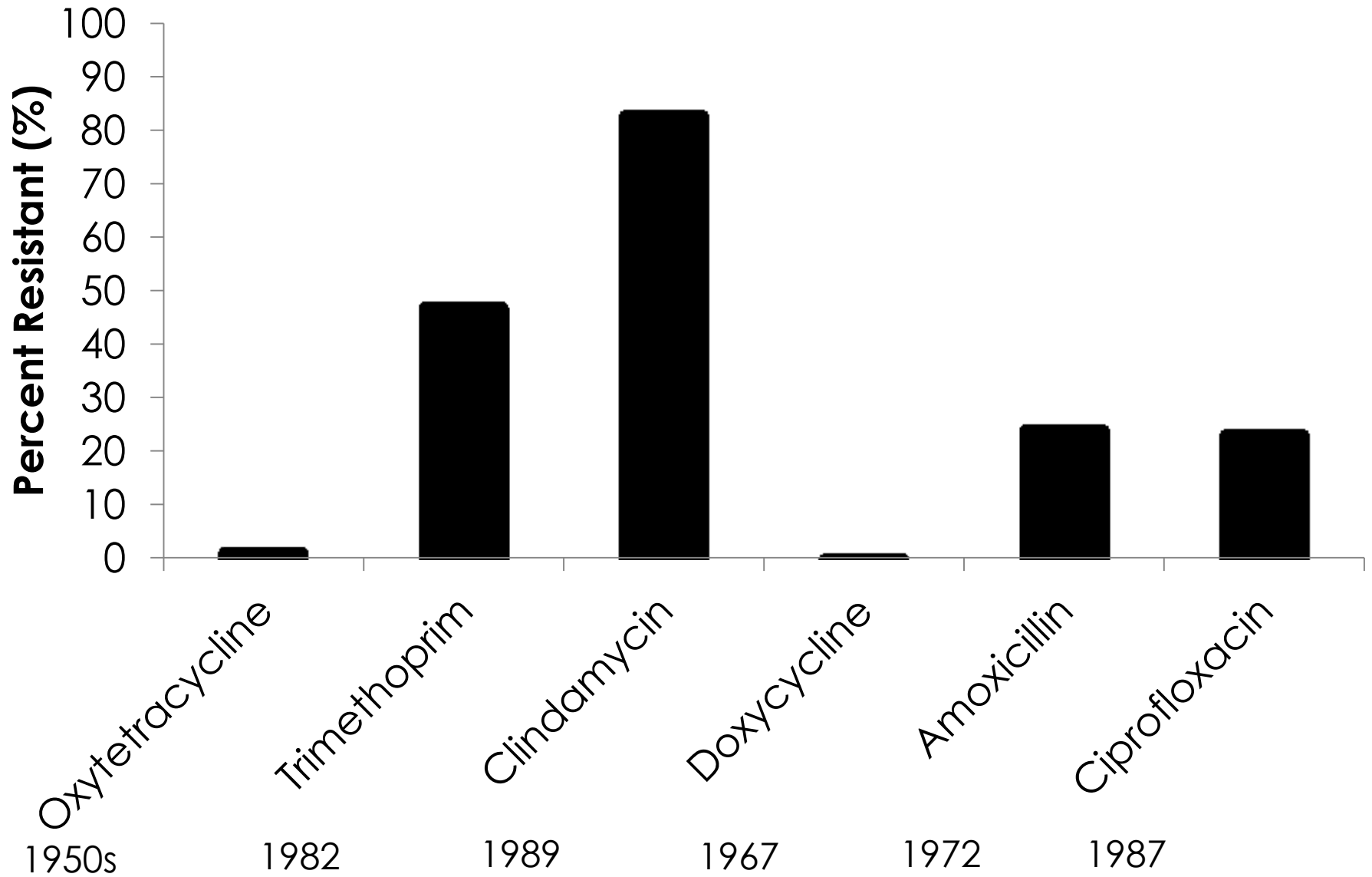
Preliminary seasonal pattern



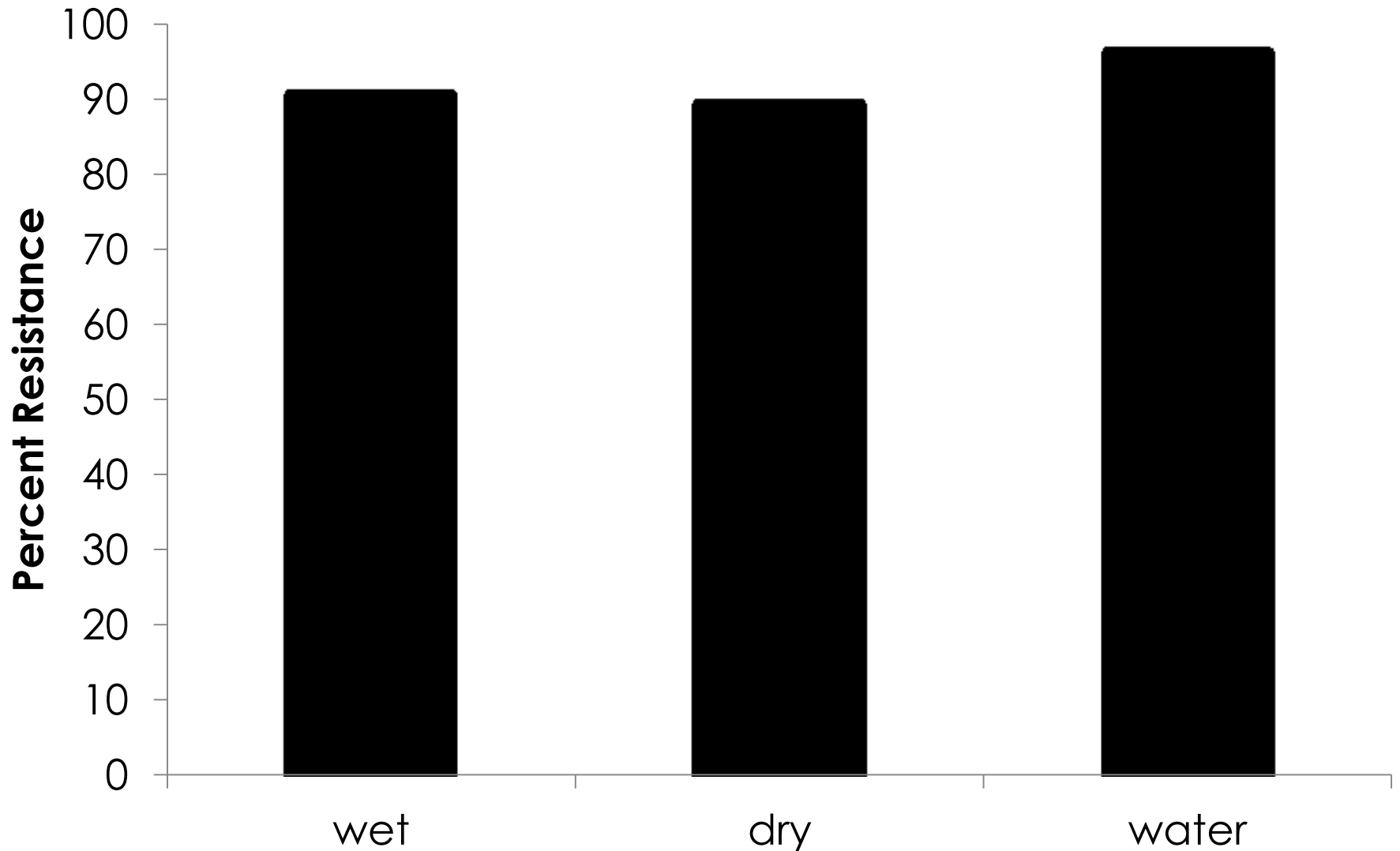
Site differences are not large



Antibiotic results vary



Sample type differences are small



More resistance compared to other studies

- Other studies done in the developing world
- Tend to have smaller numbers
- Test different antibiotics

Future work

- Working on resistance testing
 - *Enterococcus*
 - General marine bacteria
- Identify bacteria by genetic analysis
- Quantification of human impacts

Where does this research fit
into the larger picture?

Marine Resistance Study Goals

Better understanding of the marine environment

Understand if there are links to human impacts

Determine health risks

Determine if necessary to make changes in use

AR is a global and national problem.



What can you do?

Preserve the integrity of antibiotics



WARNING: Antibiotics don't work for viruses like colds and the flu. Using them for viruses will **NOT** make you feel better or get back to work faster.

Antibiotics are strong medicines. Keep them that way. Prevent antibiotic resistance. Antibiotics don't fight viruses—they fight bacteria. Using antibiotics for viruses can put you at risk of getting a bacterial infection that is resistant to antibiotic treatment. Talk to your healthcare provider about antibiotics, visit www.cdc.gov/getsmart, or call **1-800-CDC-INFO** to learn more.



Taking antibiotics for viral infections such as a cold, a cough, or the flu will **NOT**:

- Cure the infection
- Keep other people from catching it
- Help you feel better



If able to, buy antibiotic free food



Enjoy the beach!



Acknowledgments

- Gast lab
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