

# What Every Fish Culturist Should Know About Antibiotics



Guppy Blair DVM & Sonia Mumford DVM  
Idaho Fish Health Center & Olympia Fish Health Center

# What are bacteria?

Group of microscopic, single-celled organisms that inhabit virtually all environments.



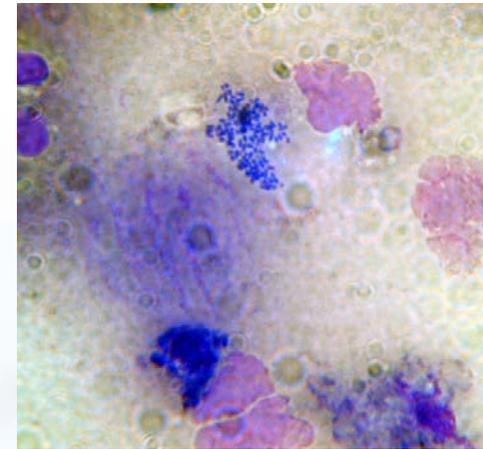
**Typically :**

**40 million bacterial cells in a gram of soil**

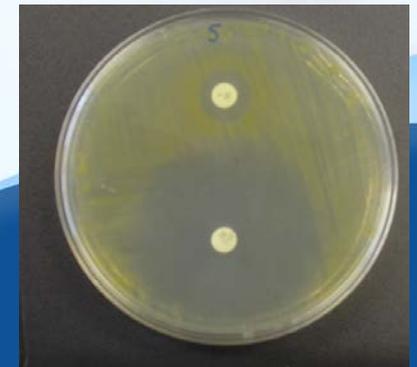
**1 million bacterial cells in a milliliter of freshwater**

**Estimated 500 to 1000 species of bacteria live in the human gut and a roughly similar number on the skin**

**There are at least ten times as many bacteria as human cells in the body (1-3% total body mass).**



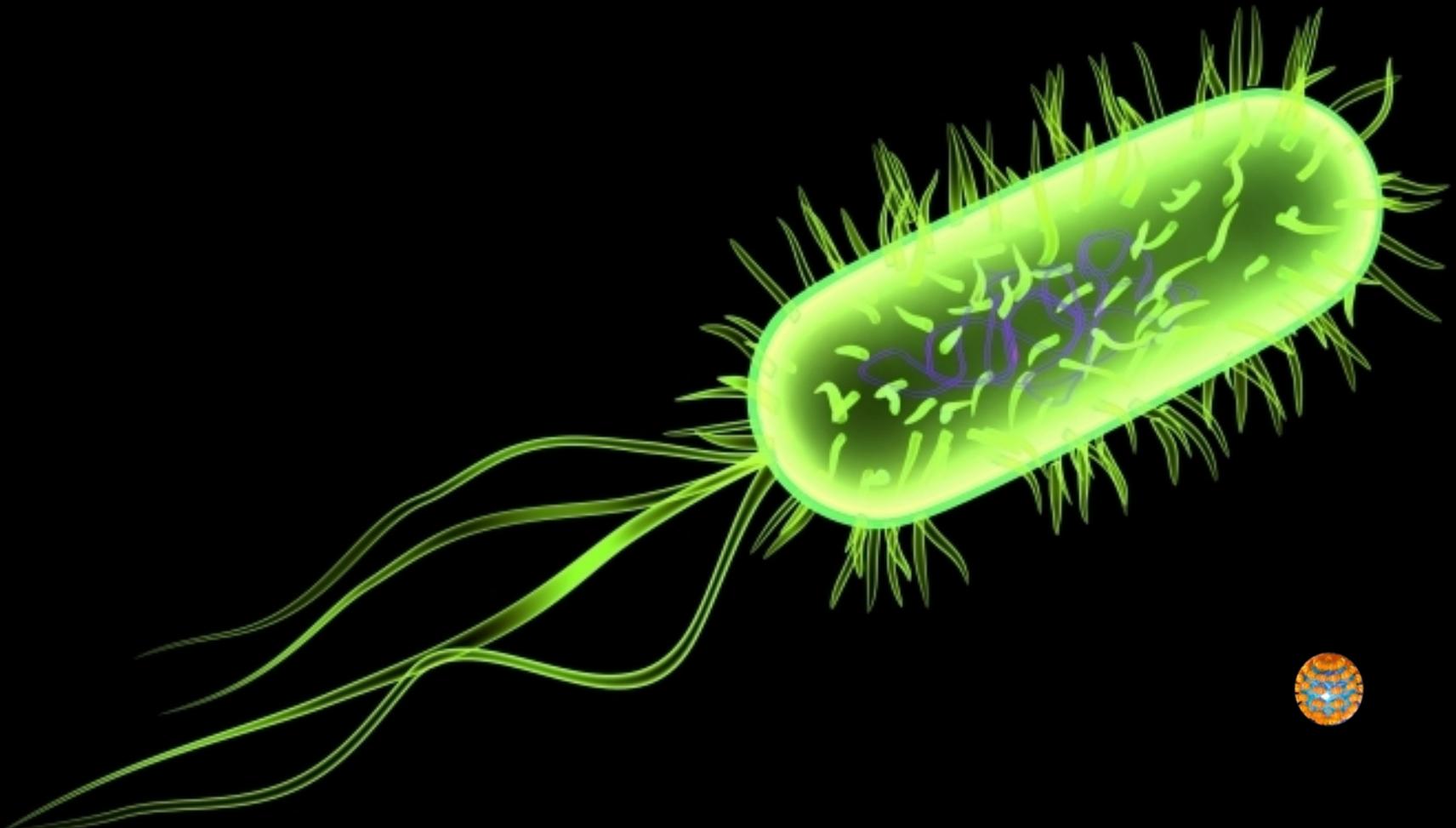
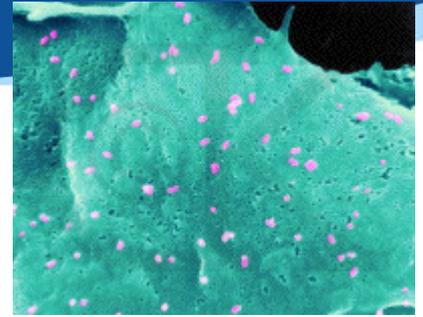
E. Coli - scharfphoto.com



*Aeromonas salmonicida*

# What are viruses?

Submicroscopic infective agents that need living cells for growth and multiplication.



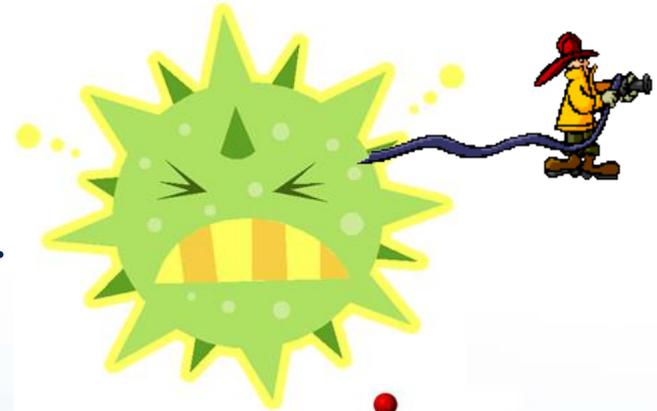
# What is an antibiotic?

A drug that kills or slows the growth of bacteria



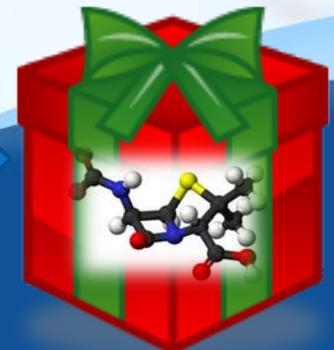
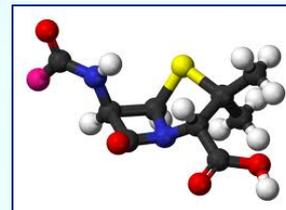
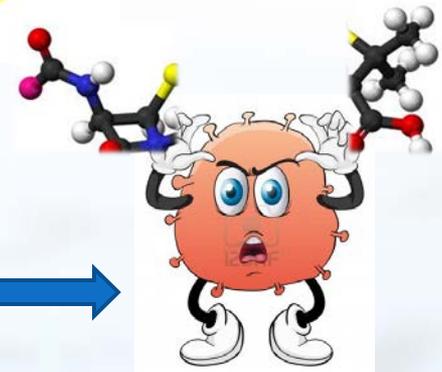
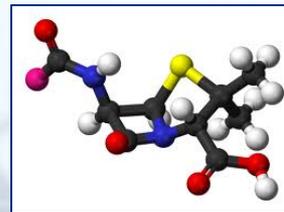
# How Bacteria Avoid Effects of Antibiotics

1. As the bacteria are exposed to the antibiotic, they pump it out.



2. The bacteria make a protein:

1. Breaks the antibiotic down
2. Attaches to the antibiotic, which stops the antibiotic from working.



# How do bacterial populations become resistant to antibiotics?

Some plants and animals use sexual reproduction and ensure genetic diversity which helps the population survive in a changing environment

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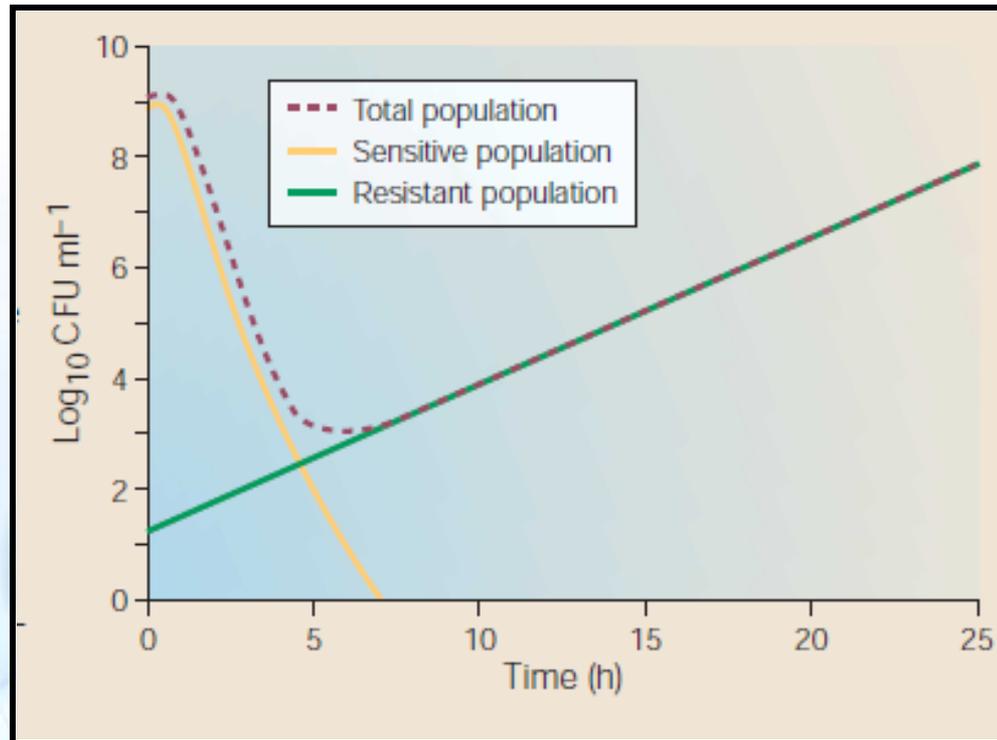
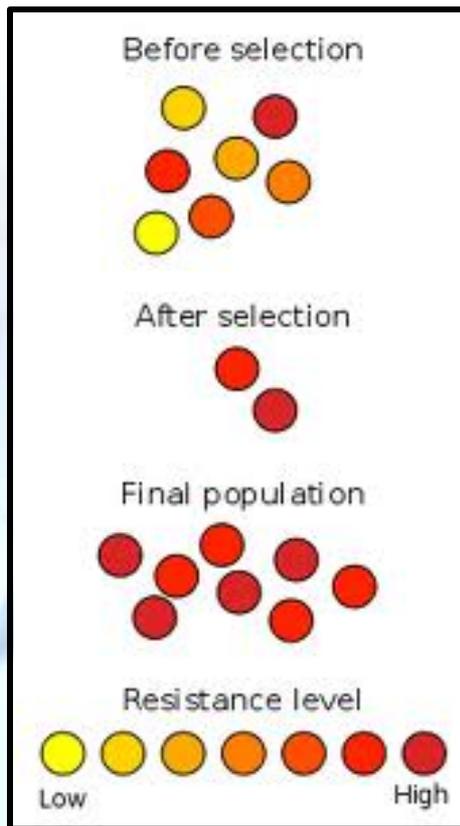


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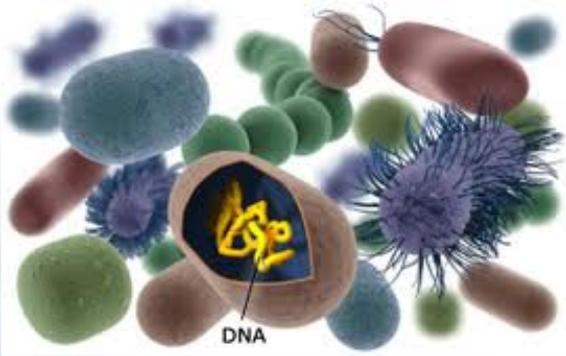
Here is a short video of "Bacterial Sex"

# Use of Antibiotics: applying a selective pressure for resistance



From ANTIMICROBIAL PHARMACODYNAMICS: CRITICAL INTERACTIONS OF 'BUG AND DRUG'  
George Drusano Nature 2004

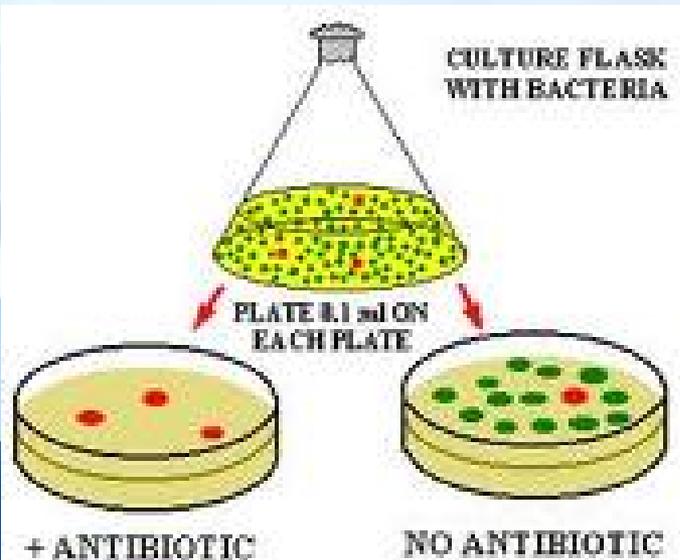
# Three key factors leading to drug resistant bacteria



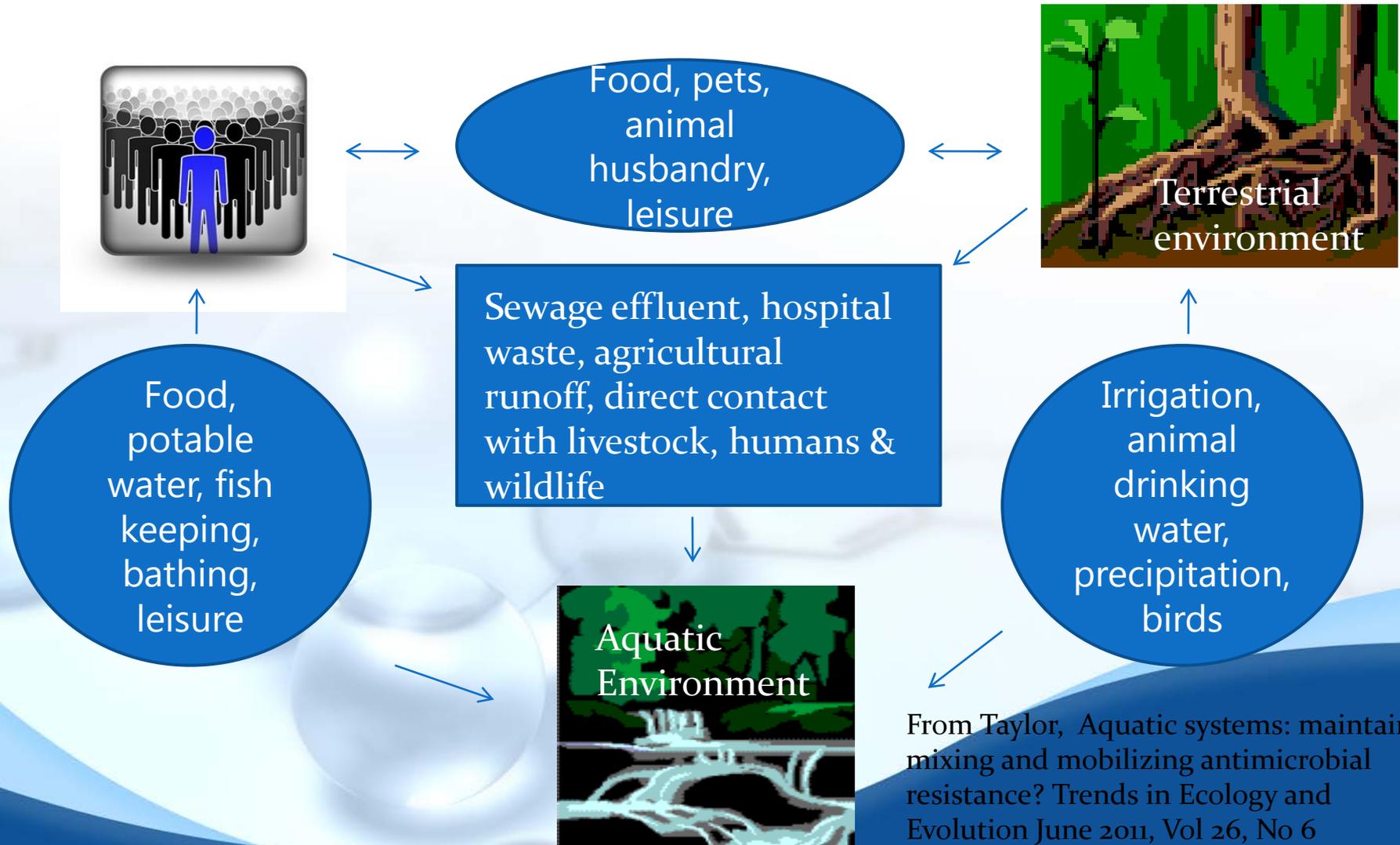
Ease of resistance gene moving from one bacteria to the next.

Close contact between bacteria in a polymicrobial environment

Selective pressure imposed by the use of antimicrobials



# Routes by which antimicrobial resistant bacteria and resistance genes can cycle through human populations, and terrestrial and aquatic systems



From Taylor, Aquatic systems: maintain, mixing and mobilizing antimicrobial resistance? Trends in Ecology and Evolution June 2011, Vol 26, No 6

# **Why worry about antimicrobial resistance?**

In June 2010, a National Institute for Medicine report described antimicrobial resistance as both a global public health and an environmental catastrophe

Strains of *E. coli* that are resistant to our most potent antibiotics documented in India, US, Canada, China, Australia, and many other countries

# Who is being blamed for the global crisis in antibiotic resistance?

- 1) Human doctors – for prescribing antibiotics for viral infections
- 2) Human Patients – for not taking antibiotics as prescribed
- 3) Wastewater treatment plants that do not remove all antibiotic residues
- 4) Livestock and Fish farmers for using antibiotics as growth promoters or preventative therapy  
(50-80% of the antibiotics produced are used on animals)
- 5) Drug companies are not producing as many antibiotics

# How do our antibiotics work?

Antibiotic Name	Mode of Action on <u>Bacteria</u>
Sulfadimethoxine ormetoprim (Romet)	Slows the making of folic acid (Vitamin B9) by the bacteria
Florfenicol (Aquaflor)	Slows making of protein by bacteria
Oxytetracycline (Terramycin)	Slows making of protein by bacteria
Erythromycin (Gallimycin, Aquamycin)	Slows making of protein by bacteria

# Why does how they work matter ?

- Bacteria need to make proteins and use vitamin B9 to grow and make more bacteria
- With the exception of Romet and sometimes florfenicol, the antibiotics we use only slow the growth of the bacteria; They don't actually kill the bacteria
- The fish needs a working immune system to kill the bacteria

# Why feeding fish antibiotics is especially challenging

- Uneven amount of food (doses), weaker fish eat less aggressively, therefore dose is less
- Some antibiotics are excreted largely unchanged and are relatively stable in water
- Antibiotics settle with particles into the silt below the fish and interact with environmental bacteria



# **Why antibiotic treatments sometimes seem to fail?**

- The clinical signs were not caused by a bacterial pathogen
- The bacteria were never susceptible to the antibiotic or acquired resistance
- The fish are re-infected after the treatment
- Mortality now caused by drug toxicity, and not by pathogen

# Why antibiotic treatments sometimes seem to fail? continued...



- The dose and/or duration of treatment was not adequate
- The bacteria are in places that the antibiotic cannot reach
- The fish's immune system wasn't functioning well**

# **Why do prophylactic (preventative) antibiotic treatments seem to work, but may actually cause a problem?**

- If the immune system of the fish is taking care of the pathogen on its own, no clinical signs occur.
- By exposing the bacteria to the drug over and over again, the few bacteria that survive each treatment are the ones to reproduce. This practice can lead to a population of bacteria forming a drug resistance.

# Why does FDA regulate use of antibiotics in Food fish?!?!?!?

Major objective: Protect Human Health



To ensure:

- 1) Drug is safe & effective for a specific use & species
- 2) For food fish, also ensure food made from treated fish is safe for people
- 3) Manufacturing process preserves the drug's identity, strength, quality, and purity
- 4) Drug's labeling is truthful and complete
- 5) Protect Public Health

# What should hatchery staff keep in mind when applying antibiotic treatments?

- Hatchery staff may be exposed to antibiotics when feeding medicated feed
- Hatchery staff may be exposed to antibiotic resistant bacteria when handling fish

# Categories of Antibiotics Used in Food Fish

**Extra-label Prescriptions**  
Azithromycin  
& Others

## Approved Antibiotics

Romet

Oxytetracycline

**Veterinary Feed Directives -**  
Florfenicol

## Investigational New Animal Drugs

(INAD)

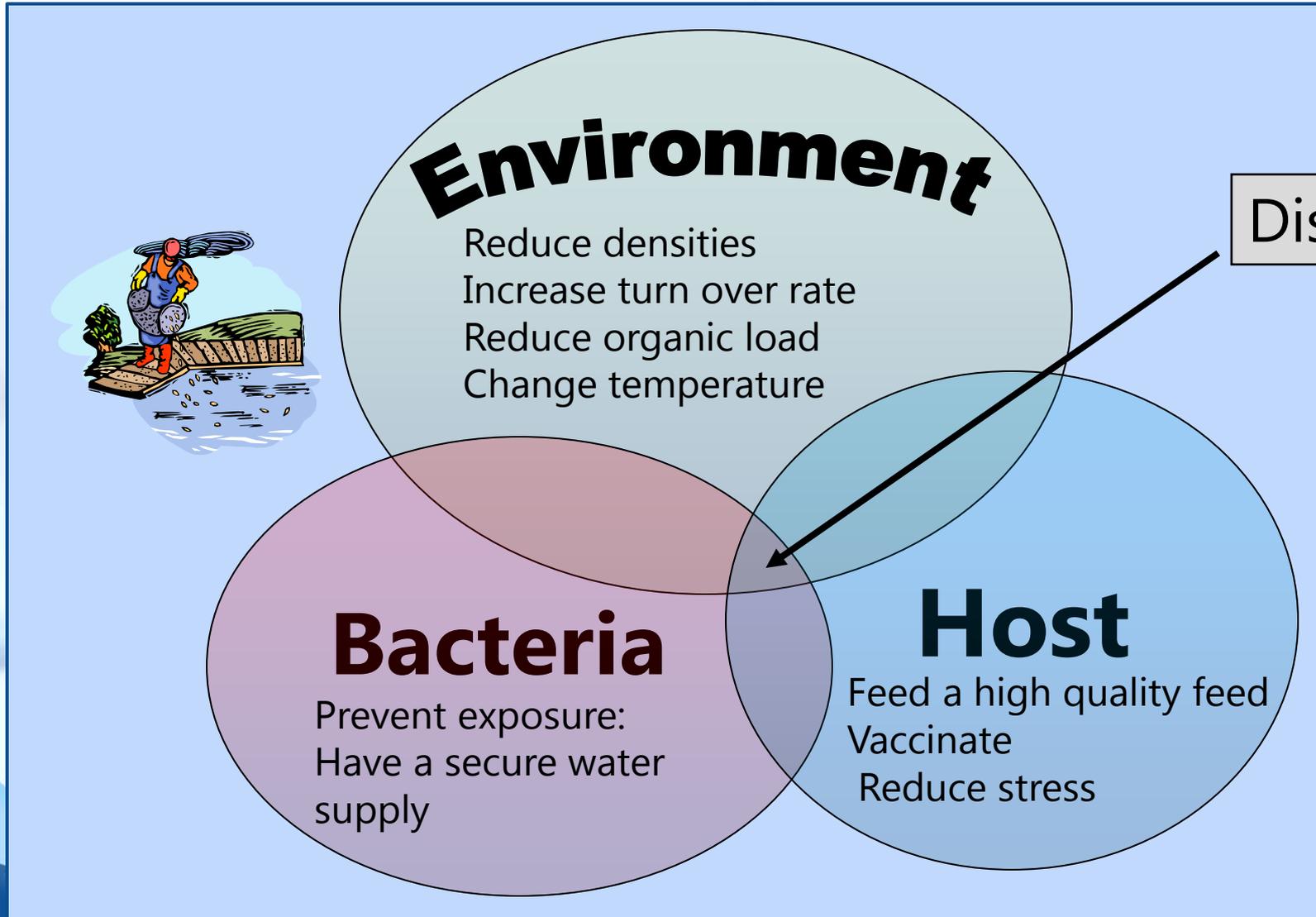
Oxytetracycline

Erythromycin

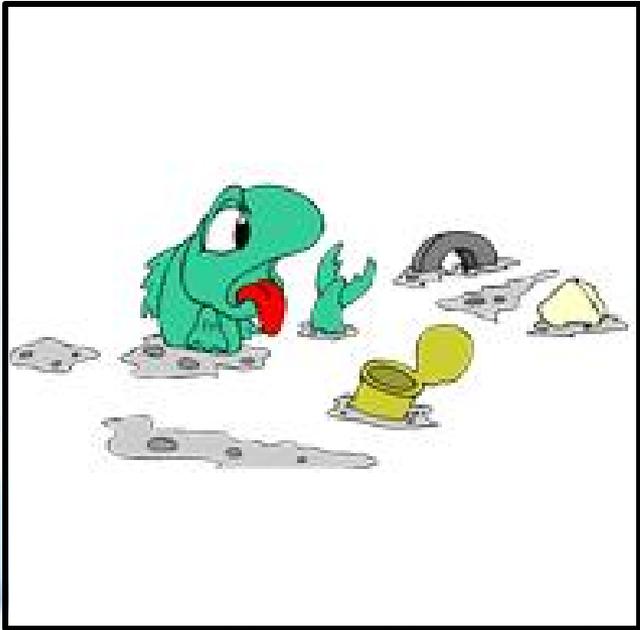
In addition to biological considerations, we must consider the appropriate regulations when using antibiotics.



# How to avoid using antibiotics...

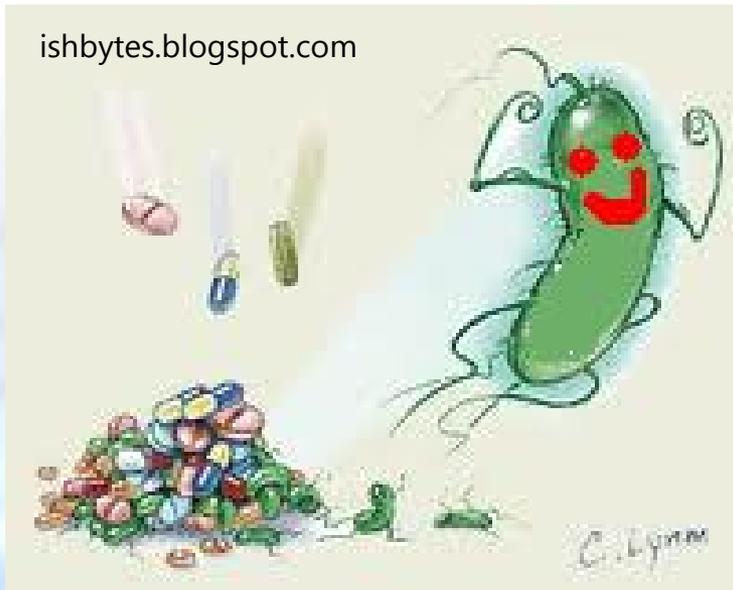


# When should we use antibiotics?



- A diagnosis of a bacterial disease has been made
- The bacteria is susceptible to the antibiotic
- An adequate dose and duration of treatment can be given
- AS A LAST RESORT!**

# Why use antibiotics as a last resort



- We only have 3 antibiotics approved for food fish
- Bacteria are constantly evolving and sharing genetic information
- It took a **MANY YEARS** to get the last antibiotic approved for food fish
- No new antibiotics for food fish in the horizon

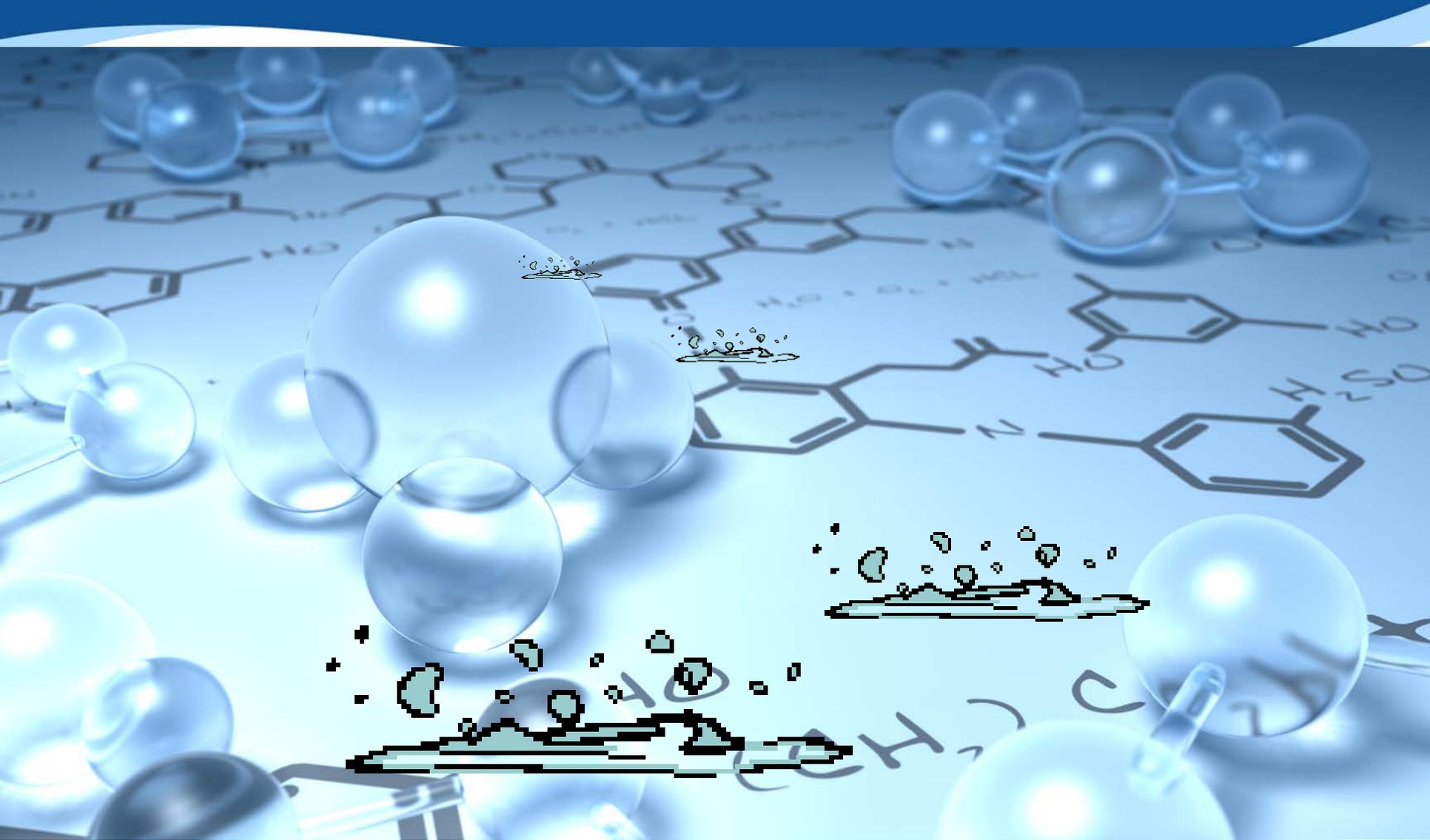
# Strategies for delaying resistance



Treat only when there are no other viable options

Do not treat when disease is not present

Continue to improve fish cultural practices



**QUESTIONS???**

www.doi.gov



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