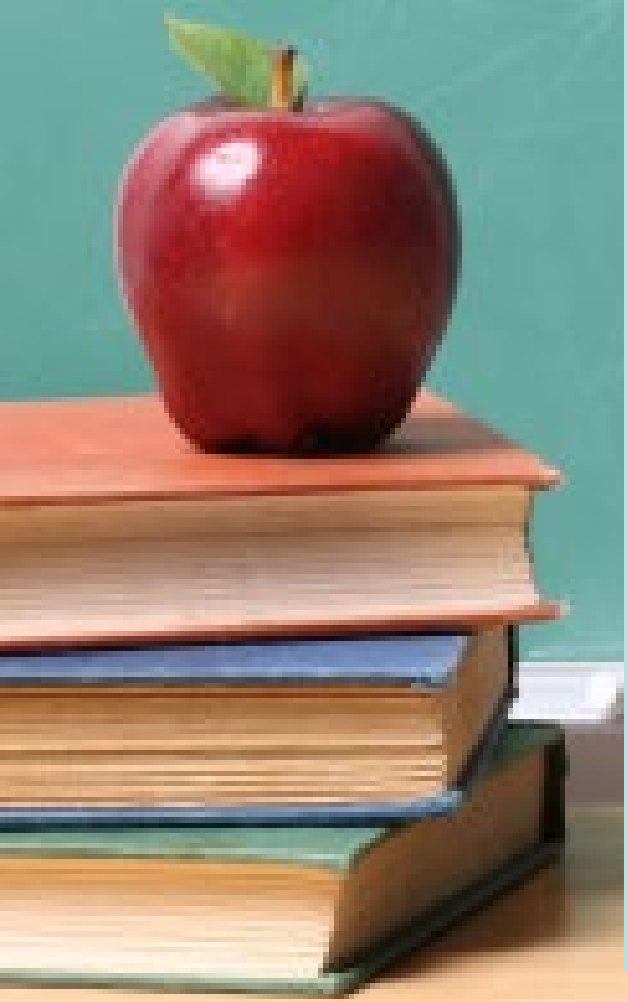
Bacteria, Antibiotics, & Resistance

Indiana AWARE: Indiana Alliance Working for Antibiotic Resistance Education

Overview: What Will We Learn?



- How do bacteria cause disease?
- When are antibiotics needed?
- What is the history of antibiotic use and resistance?
- How do bacteria become resistant?
- What has led us to the problem of antibiotic resistance?
- How do we prevent and combat resistance?

Scenario 1

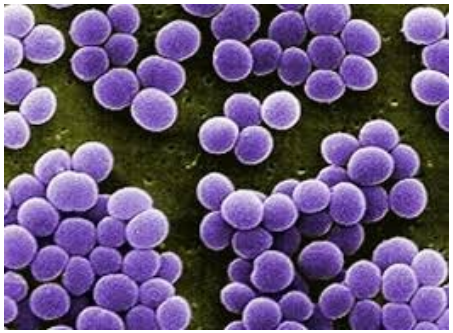
- A woman comes into the ER with a high fever and is diagnosed with a bacterial infection.
- She is prescribed intravenous antibiotics, and put under observation
- The infection does not respond to the drugs, and the patient worsens
- A new course of drugs is used, but the patient goes into shock and dies from the infection

Scenario 1

- Why do you think the drugs used to treat the patient did not eliminate the infection?

What are bacteria?

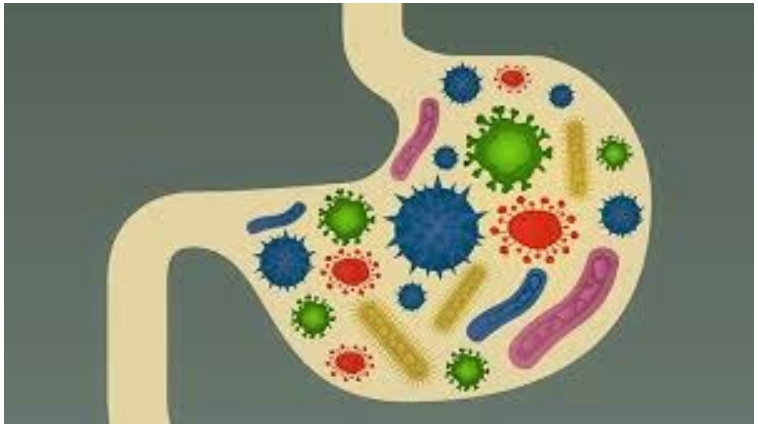
- Bacteria are microscopic, single-celled organisms
  - Prokaryote
  - Have no nucleus
  - Cell structure is different from that of human cells



- Other types of microorganisms
  - Virus (common cold)
  - Fungi (athletes foot)
  - Parasite (tapeworm)

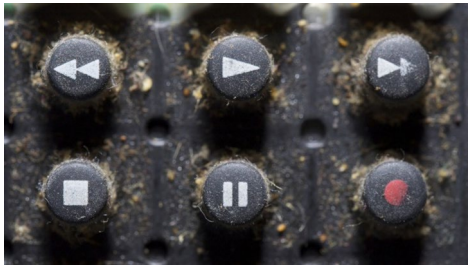
Where are Bacteria Found?

- Bacteria are everywhere
  - In nature
    - soil, water
  - In and on humans
    - Skin
    - Upper airway and mouth
    - Gastrointestinal tract
    - Genitourinary tract



Bacteria in the Environment

- Many bacteria can survive on other surfaces that have come in contact with a person
  - toilets
  - sinks
  - cell phone
  - desks
  - remote controls
  - food
  - computers



Spread of Bacteria

- Direct contact with infectious particles
  - Computer keyboards, money, doorknobs

- Fecal/oral spread
  - From eating or drinking contaminated food or water
  - Food handler with diarrhea who doesn't wash hands well after using bathroom

Blood-borne spread
  - Transfusion or injection (syphilis, brucellosis)

Spread of Bacteria

- Respiratory contact
  - Inhaling infectious particles in the air from someone coughing or sneezing (Examples: whooping cough, anthrax, bacterial meningitis)
- Sexual contact
  - Examples: syphilis, chlamydia
- Vector-borne examples
  - Tick bite—Rocky Mountain Spotted Fever, Lyme Disease
  - Fleas/rodents—Bubonic Plague

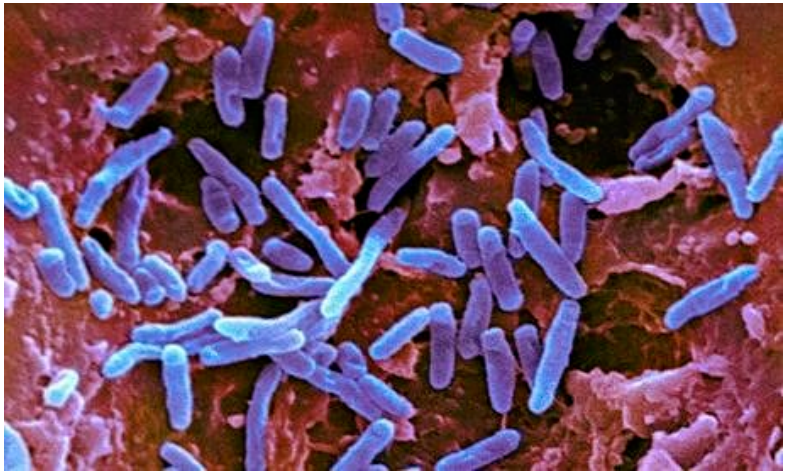
The Power of a Sneeze

- Did you know that a sneeze can blast microbes into the air at 100 miles per hour?!
- The spray from a sneeze can travel up to 30 feet from the person who sneezed!

www.discovery.com/tv-shows/mythbusters/mythbusters.../**sneeze**-travel-100-mph/

Most Bacteria are Beneficial

- Aid in digestion
- Provide essential nutrients (vitamin K)
- Occupy (colonize) sites that might otherwise be invaded by harmful (pathogenic) bacteria



Some Bacteria are Harmful

- Some are harmful (pathogenic):
  - Damage tissues or produce toxins that cause disease
- Opportunistic pathogens
  - Do not cause disease in most healthy people, take advantage of already weakened host
- True pathogens
  - Cause infection in otherwise healthy people
  - Have mechanisms to evade the immune system

Battle Between Bacteria and Host

- When a pathogenic (disease-causing) bacteria attacks healthy host, there are three potential outcomes:
  - Host wins and bacteria are removed
  - Host and bacteria live together
  - Bacteria win and infect host
- Under which situation would antibiotics be needed?

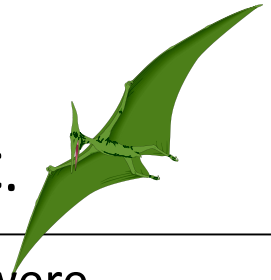
What is an Antibiotic?

- A chemical that kills bacteria or stops them from growing
- Antibiotics work only against **bacteria**, not **viruses**

Why Use Antibiotics

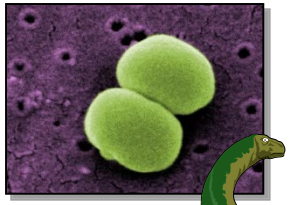
- When bacteria infect the host and cause damage, antibiotics are necessary to fight the infection

Antibiotic Timeline



Way B.C.

Bacteria were present before the dinosaurs



Millions of years later

1940s

The first antibiotics are mass produced for humans and work well

1950s

Antibiotic resistance begins as soon as the first antibiotics are used

Early 2000s

Current teenagers are born!

Today

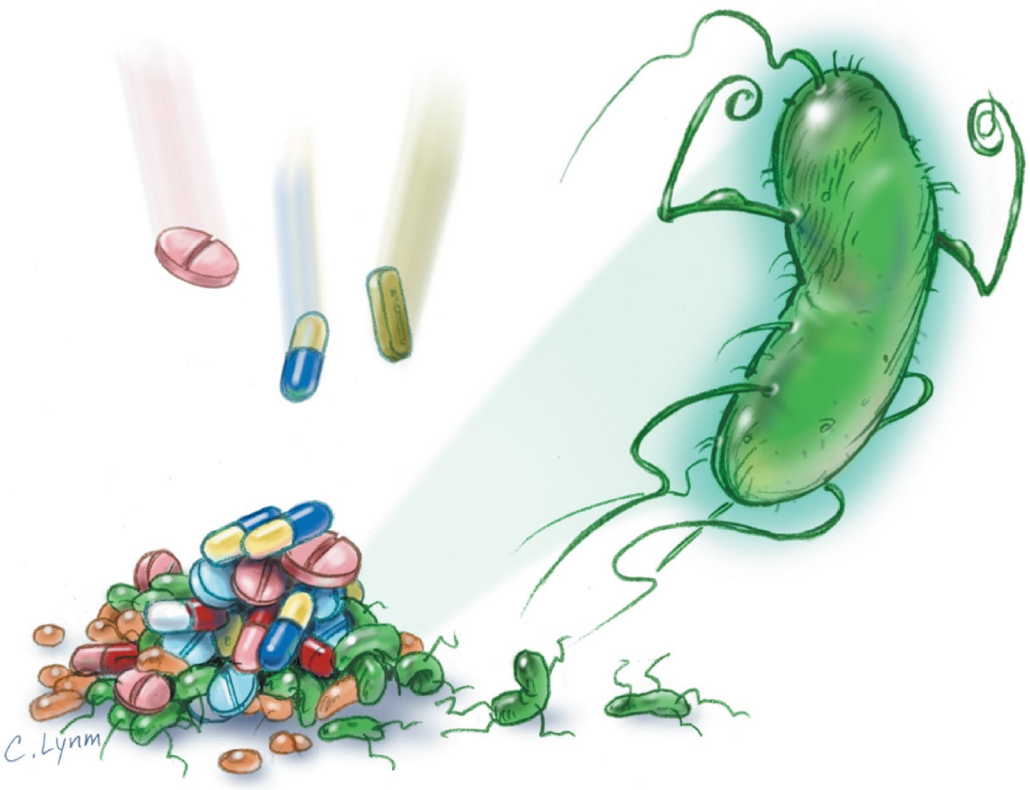
Some antibiotics no longer work and few new ones are in the pipeline

2030

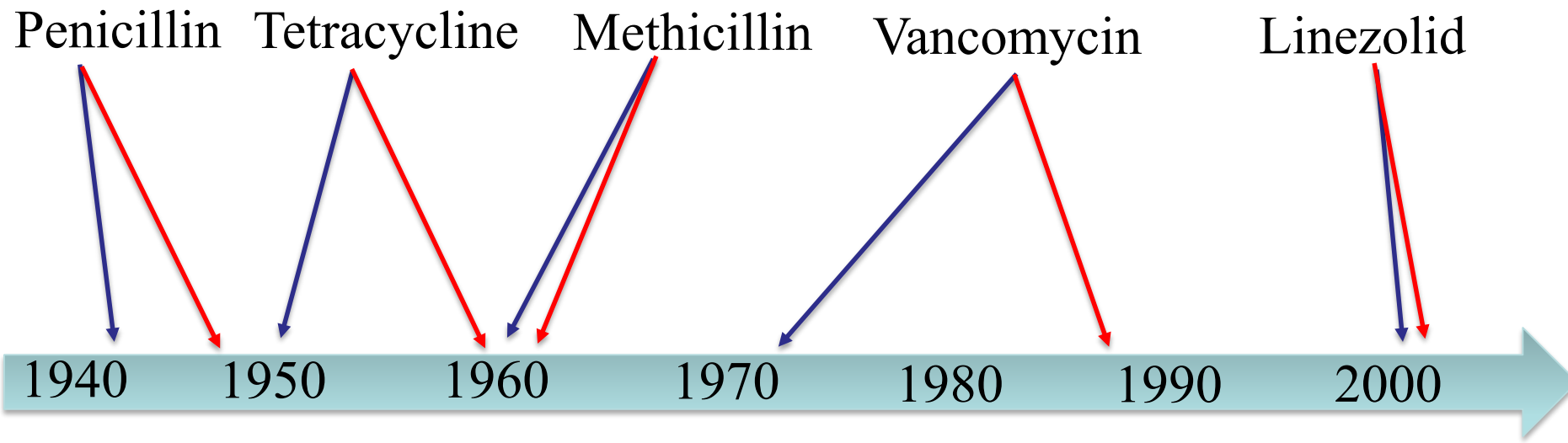
Will we have antibiotics that work?

What is Antibiotic Resistance?

- Decreased effectiveness of an antibiotic against a particular type of bacteria
- Bacteria evolve rapidly, and develop ways to prevent drugs from working

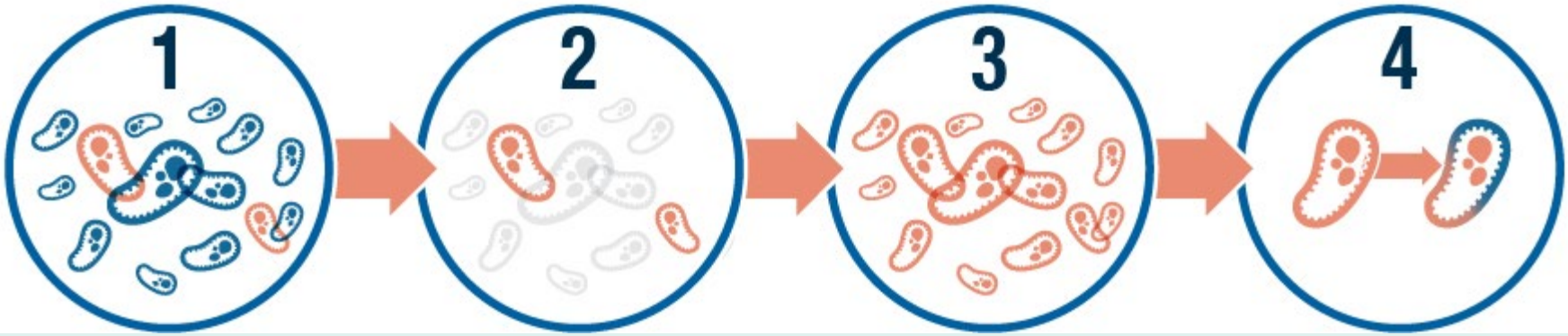


Timeline of Resistance



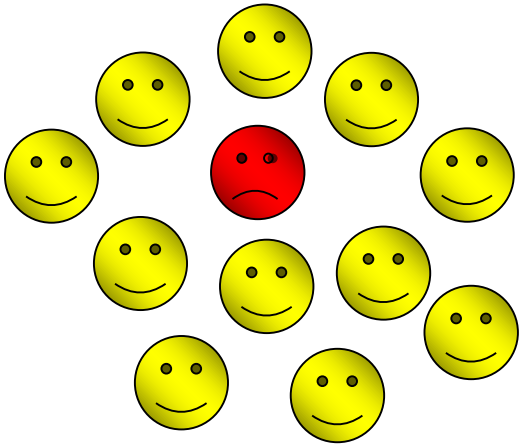
Selection for Resistance

- Example of Natural Selection
  - Bacteria either have gene or do not have gene for antibiotic resistance
  - Bacteria are exposed to drug; susceptible bacteria (no resistance gene) die, while resistant bacteria (the ones with a resistance gene) survive
  - Over time, resistant bacteria multiply, and the infection becomes resistant to that drug



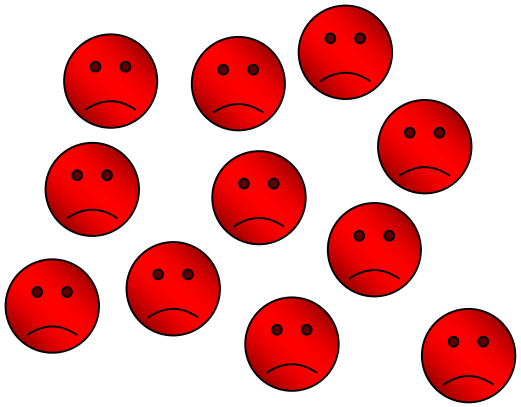
Drug Use Selects for Resistance

Sensitive and resistant bacteria live together.

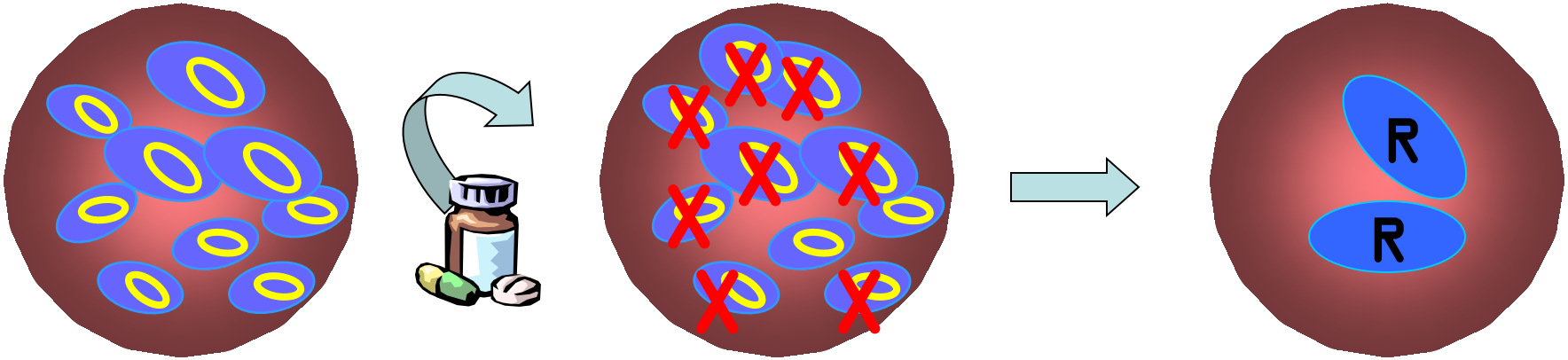


Antibiotics kill sensitive bacteria.

The resistant bacteria are left to multiply.



Unnecessary Antibiotics Cause Resistance



Jane takes penicillin.

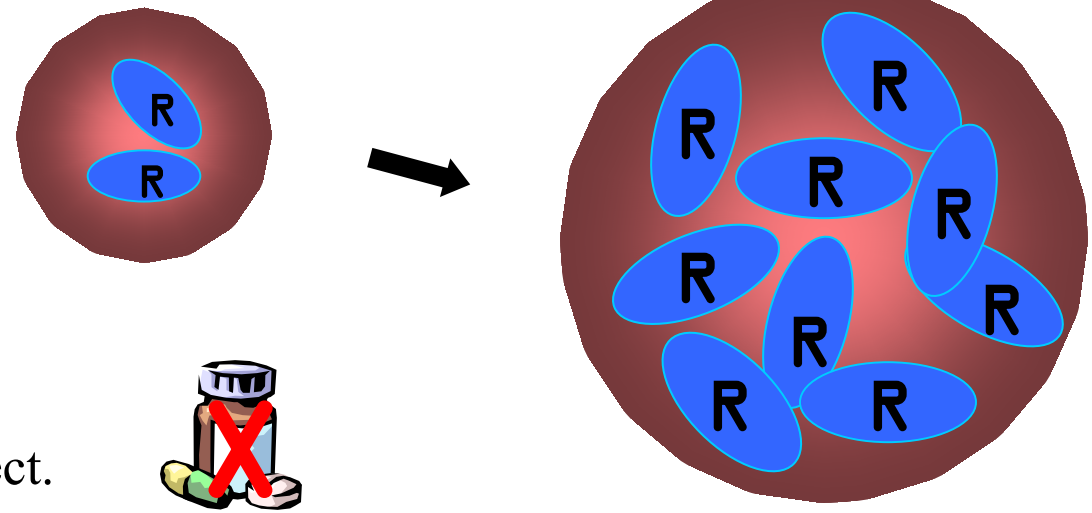
Susceptible bacteria are killed off.

A few hardy survivors are left behind.

The survivors can withstand penicillin.

Resistant Bacteria Can Multiply and Spread

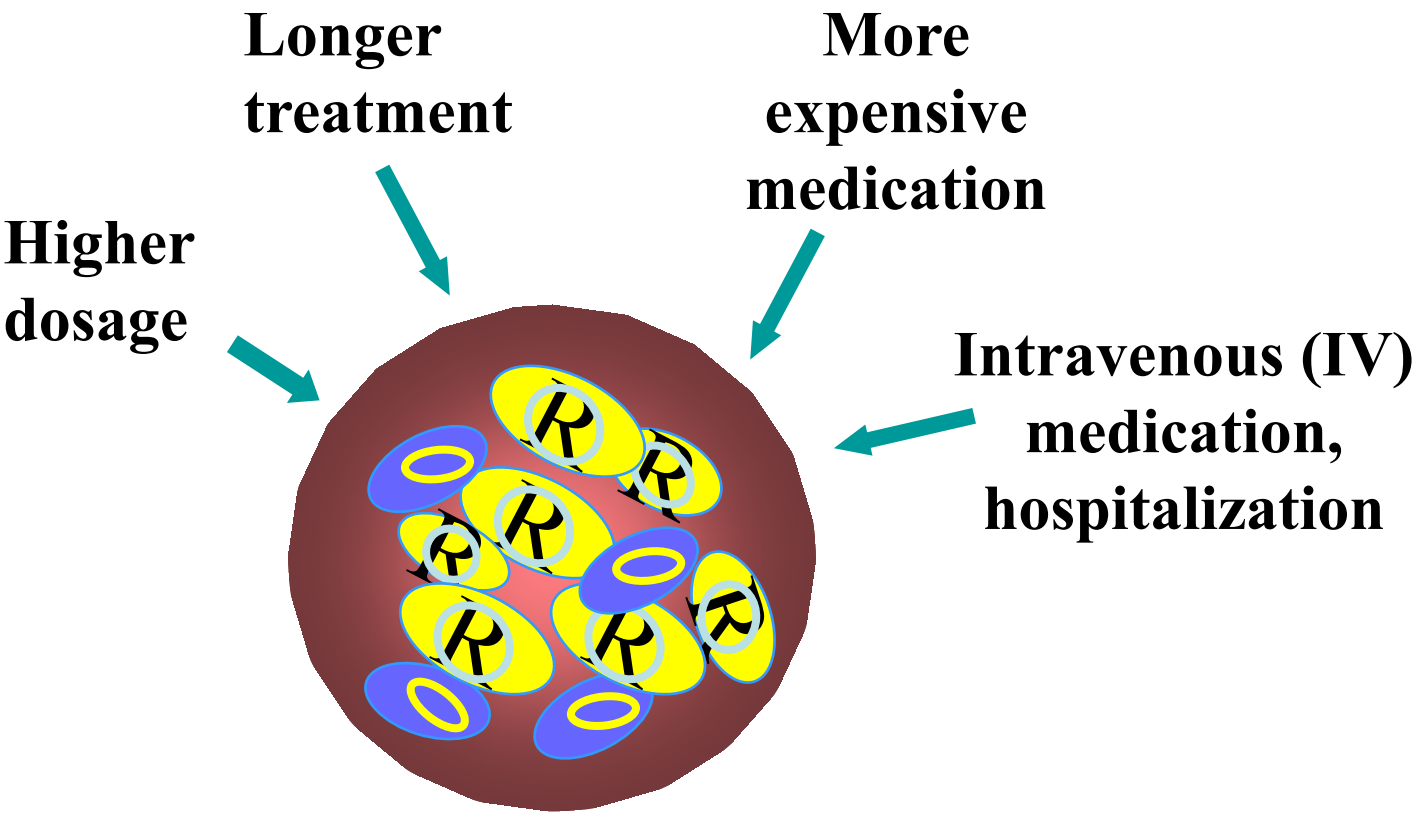
The resistant survivors multiply.



Treatment with penicillin has no effect.

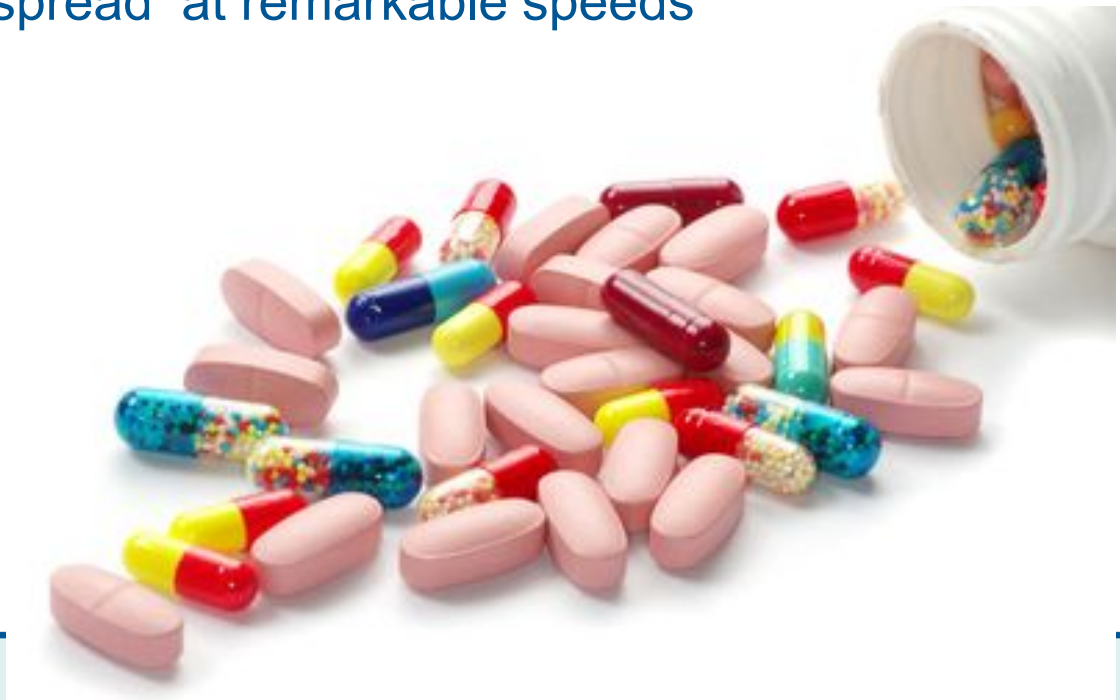
Jane is now a carrier of penicillin-resistant bacteria.

Resistant Infections Require Special Treatment



What contributes to Resistance?

- The misuse and overuse of antibiotics in agriculture and health care has led to the current state of widespread antibiotic resistance at both national and global levels.
- Travel has led to spread at remarkable speeds



Agriculture

- Antibiotic use in animals and crops can lead to resistance
- Resistant bacteria found in fertilizer contaminates crops
- Resistant bacteria can be transmitted to humans through animal products and crops

Health Care

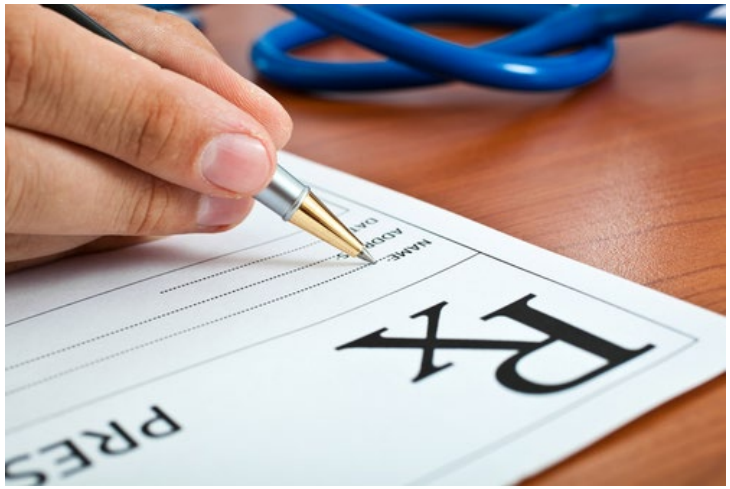
- Antibiotic use in health care is problematic at many levels
  - Patient
  - Provider
  - Pharmaceutical Industry

Health Care

- Patient
  - Antibiotic administration
    - Skipping doses
    - Stopping early
    - Timing issues
  - Antibiotic Seeking
    - Requesting for common viral infections
  - Self-prescribing
    - Taking old antibiotics
    - Sharing antibiotics
    - Buying foreign antibiotics
  - Improper Disposal
    - Flushing → environmental damage
  - Inaccurate Allergy Reporting (most specifically penicillin)

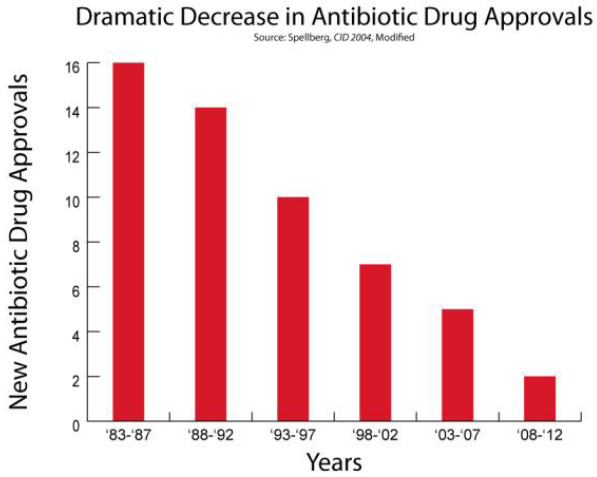
Health Care

- Provider
  - Prescribe unnecessary antibiotics
    - Patient pressure
    - Incorrect diagnosis (viral vs. bacterial)
  - Prescribe broad spectrum
    - Collateral damage to normal flora
    - Promotes resistance



Health Care

- Pharmaceutical Industry
  - Very little development of new antimicrobials over last three decades
  - Medications for chronic conditions such as high cholesterol, diabetes, etc. more profitable than antibiotics



Travel


One billion people cross through international borders each year. This includes
350 million travelers arriving in the United States through more than 300 points of entry.
A resistant threat anywhere can quickly become a threat at home.
Global capacity is needed to slow development and prevent spread of antibiotic resistance.

Penicillin (PCN) Allergy—5 Facts

1. PCN Allergy Reporting: ~10% of general population and up to 20% in-patient-reported prevalence
2. When evaluated, <1% of the entire population is truly allergic

Penicillin (PCN) Allergy—5 Facts

3. Approximately 80% of patients who did have a true PCN allergy lose this sensitivity after 10 years (due to changes in immune system)
4. Many reported “allergies” are actually side effects (examples: nausea/diarrhea)
5. Many reported “allergies” are secondary to symptom confusion (a rash or other symptoms that develop may be due to the illness itself instead of caused by the penicillin)

Penicillin (PCN) Allergy—Why does it matter?

- **Most appropriate treatment**
  - PCN or PCN-related antibiotics are most often the most effective treatment and with the least amount of side effects
- **Cost**
  - Alternate antibiotics are often much more expensive than penicillins (on average, PCN-allergic patients pay 60% more for treatment than those without the reported allergy)
- **Resistance!**
  - PCN allergy labeled patients are prescribed more broad spectrum antibiotics, which leads to higher incidence of development of resistant bacteria

Think you have a PCN allergy?—What can you do?

Get Tested!

Ask your physician if a referral to an allergy specialist is right for you (or your friends or family members)

- Penicillin Skin Testing
- Penicillin (Amoxicillin) Oral Challenge Testing

Consequences of Resistance

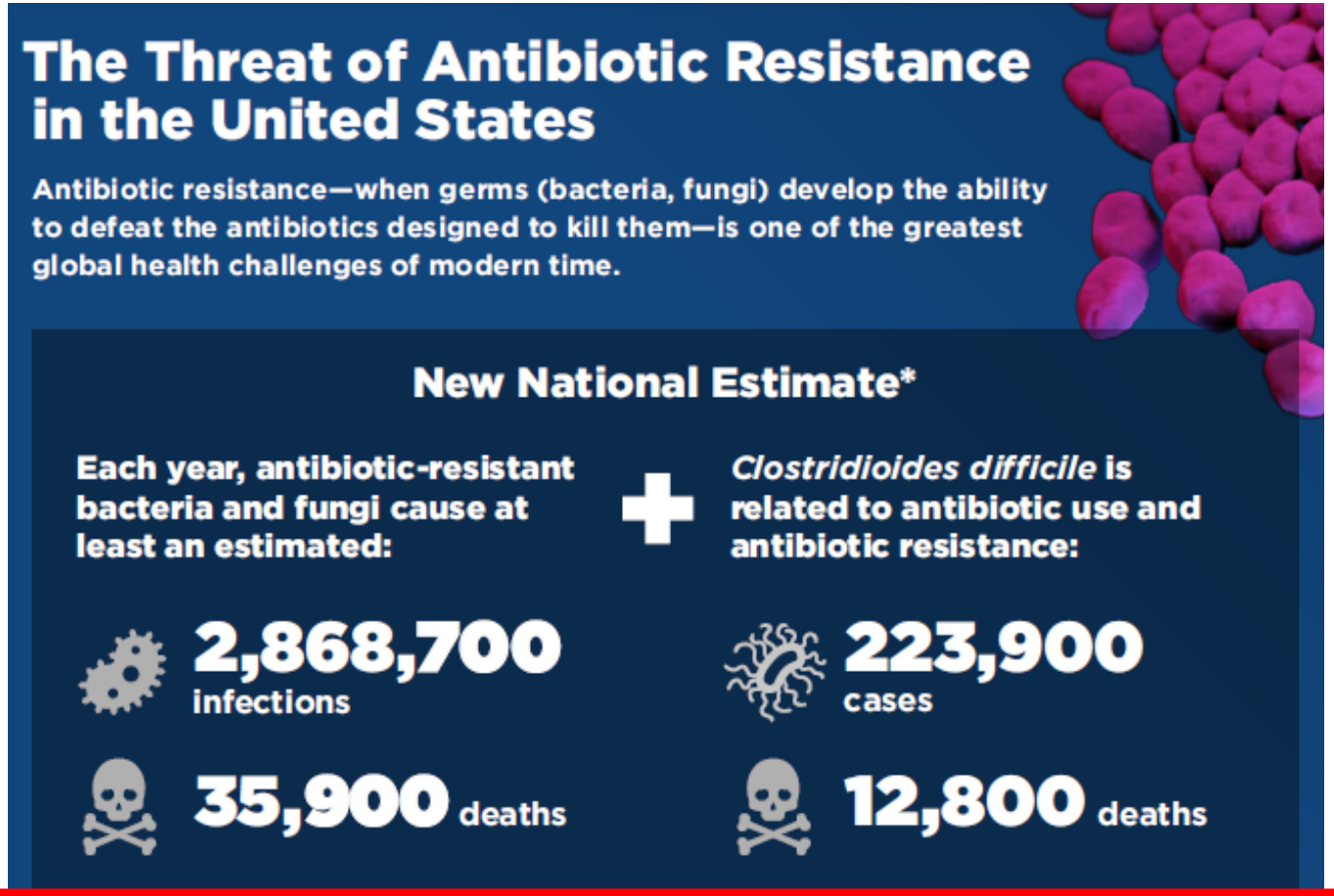
- Number of appropriate antibiotics decreasing
- Number of infections that cannot be treated with known antibiotics is increasing

Limited number of antibiotics available for use

Drugs with greater cost, toxicity and side effects must be used

Resistant infections increasingly difficult to treat

Antibiotic Resistance



In 2050, Antimicrobial Resistance is expected to be the #1 cause of death

Combating Resistance

- Prevent Infection
  - Hand-washing and proper hygiene
  - Immunization
  - Healthy lifestyle: proper nutrition, exercise, regular sleep habits
  - Handle and prepare food properly

Combating Resistance

- Proper antibiotic use
  - Take for prescribed time and as directed
  - Do not share antibiotics
  - Dispose of properly
  - Only take for bacterial infection
  - Limit use in agriculture
  - Use narrow spectrum drugs after infective agent has been identified
  - Know true allergies vs adverse reactions (and get tested for penicillin allergy if unknown!)

- Every time someone takes an antibiotic, resistant bacteria may be selected for and multiply
- Resistant bacteria may then spread to others, compromising the effectiveness of treatment for future infections
- Share what you have learned with your friends and family members


YOU
CAN
MAKE A
DIFFERENCE
I WILL
I WILL
I WILL
I WILL
I WILL
I WILL
I WILL
I WILL
I WILL

Credits

- Oregon Health Authority: Oregon AWARE
- CDC website: https://www.cdc.gov/drugresistance/index.html
- CDC. Antibiotic Resistance Threats in the United States, 2019. Atlanta, GA: U.S. Department of Health and Human Services, CDC; 2019.