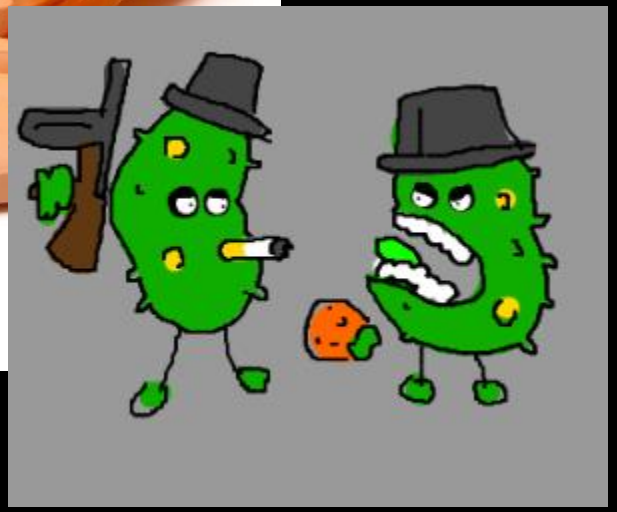
Drug Problems



The Set-up

- Introductory biology
- Majors-level
- 400-student lecture (so 250 show up)
- Fixed seating lecture hall (IH 100)
- TAs to help facilitate small group discussions

Learning Goals

- Understand evolution by natural selection
- Explain bacterial genetics (gene transfer, gene expression, mutation)
- Understand modern applications of biology to society
- Develop scientific literacy

Learning Outcomes

Students should be able to:

- Identify molecular targets of antibiotics
- Explain what roles mutations and natural selection play in antibiotic resistance
- Explain how resistance in one bacterial species can be acquired by another
- Predict how changes in antibiotic use will affect the frequency of resistance
- Formulate hypotheses and interpret scientific graphs

Public Health History

Prior to 1945

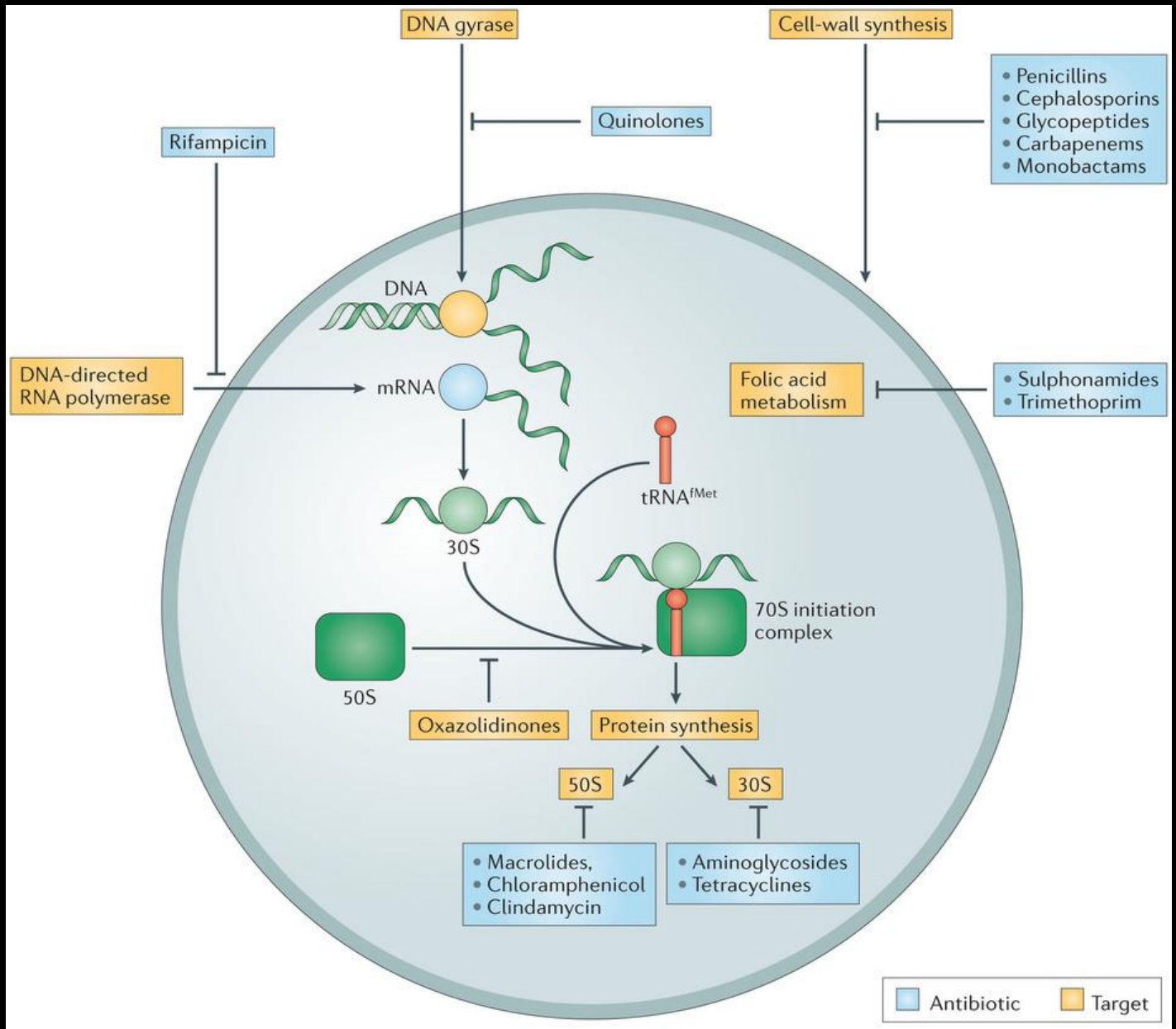
- 90% of children with meningitis died
- Strep throat was frequently fatal
- Tuberculosis, pneumonia, and whooping cough were serious public health concerns

After 1945

- Human life expectancy increased by 8-10 years
- Are the above diseases still life-threatening?

Public Health History

Hooray, antibiotics!



Targets of Antibiotics

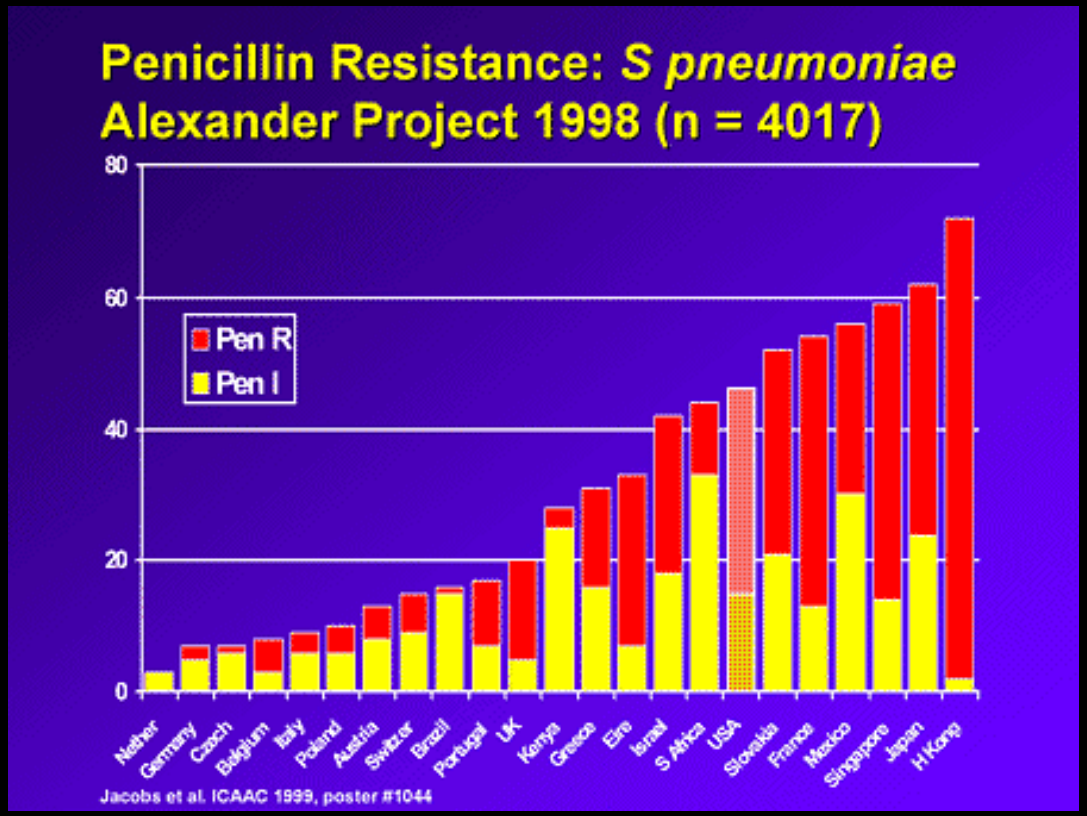
Nature Reviews | Drug Discovery

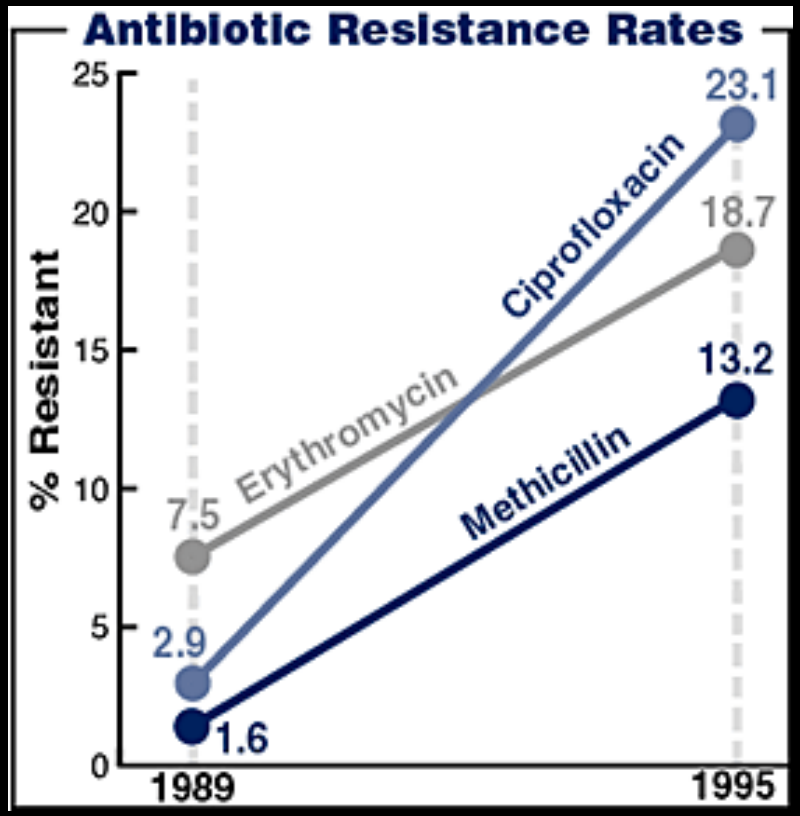
You develop drug X, which blocks protein synthesis by binding an essential part in the bacterial ribosome.

Two years after introduction onto the market, it became ineffective.

What happened?

Trouble in Paradise





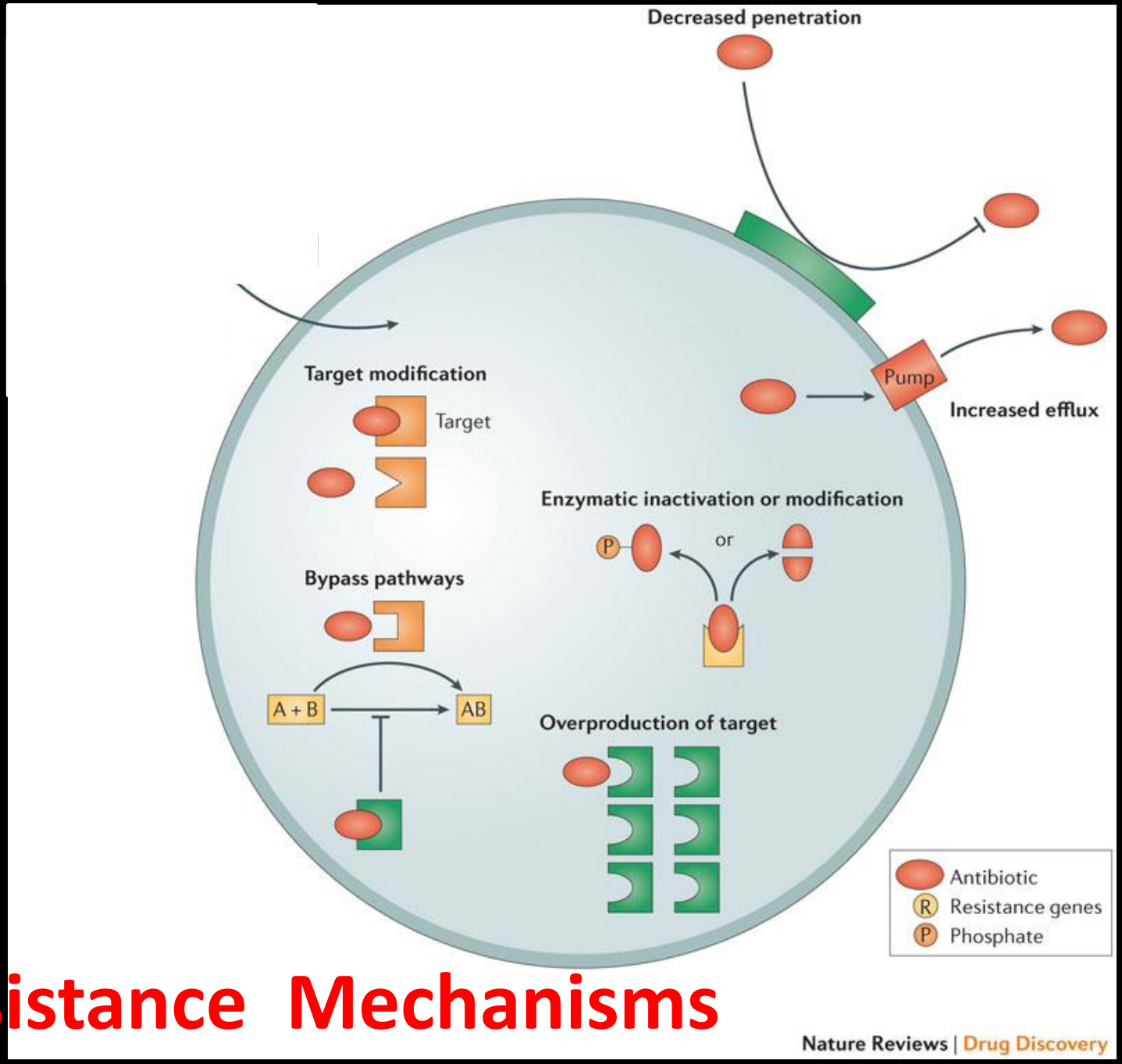
How do bacteria develop antibiotic resistance?

a) They evolve in order to overcome the antibiotic and survive
b) Antibiotics cause genetic mutations over time that protect the future generations of bacteria
c) Some bacteria are naturally resistant to antibiotics, and they're the ones that reproduce
d) This is a common misconception– people just use the wrong antibiotic, or the dose is too weak

Antibiotic Resistance

- What does it mean to “resist” an antibiotic?

- Is it something the bacteria chose to do?

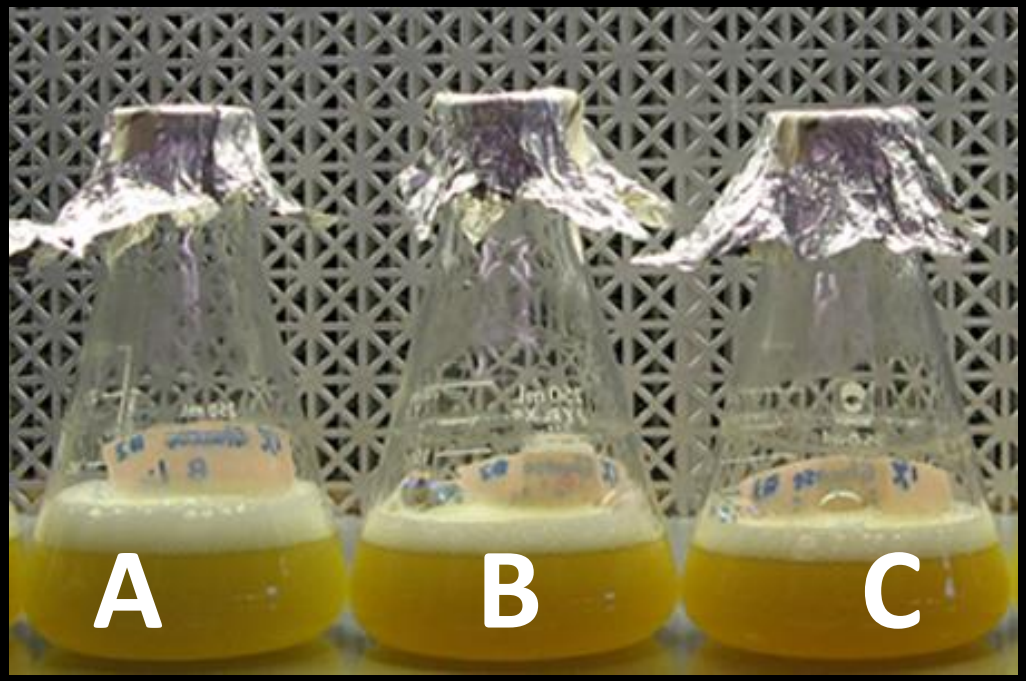


Resistance Mechanisms

Superbug Origins

- How do “superbugs” become “super”?
- i.e. Where do traits that confer resistance come from?
  - Mutation

Sample Experiment



3 flasks of *E. coli* (all the same strain):

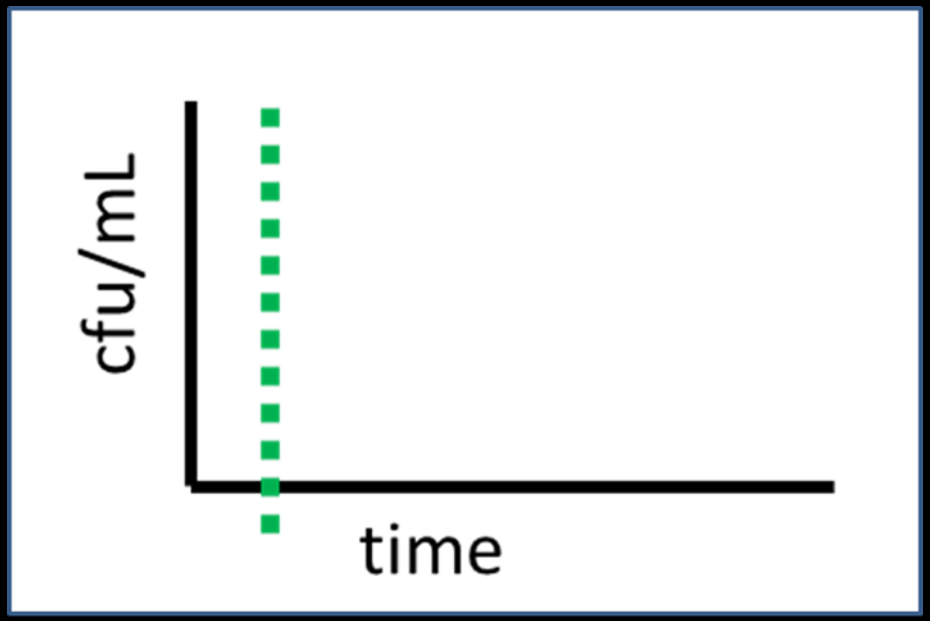
- A – no antibiotic added
- B – treated with vancomycin
- C – treated with chloramphenicol

Conclusions about this strain:

- Contains resistance to chloramphenicol
- Did not contain resistance to vancomycin

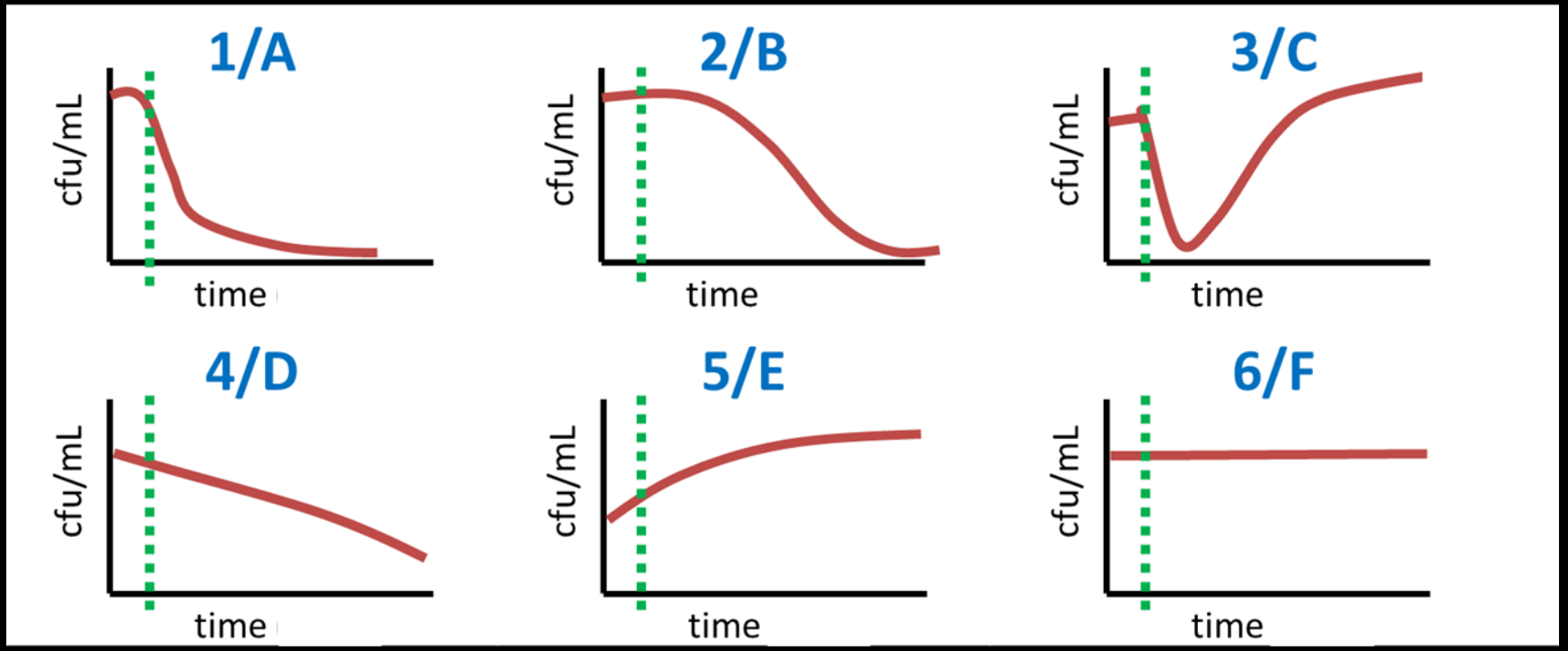
Sample Experiment

- What results would support the scientist's conclusions?
- Work with a small group (4-5) to create graphs showing the changes in population density in Flask A, B, and C



Flask A: control, Flask B: vancomycin, Flask C: chloramphenicol

What did the scientist see?
(pick the closest approximation)



Flask A: control, Flask B: vancomycin, Flask C: chloramphenicol

Sample Experiment

- When did the *E. coli* develop resistance to chloramphenicol?
  - Before or after the chloramphenicol was added to the flask?
- How would you explain that the *E. coli* did not develop resistance to vancomycin after it was added to the flask?

Sample Experiment

- Does the introduction of a selective pressure ***cause*** the adaptive mutation to occur?
- Does the misuse of antibiotics cause the mutation that leads to resistance?
- What is a better way to explain the link between antibiotic misuse and resistance?

How do bacteria develop antibiotic resistance?

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Activity 2

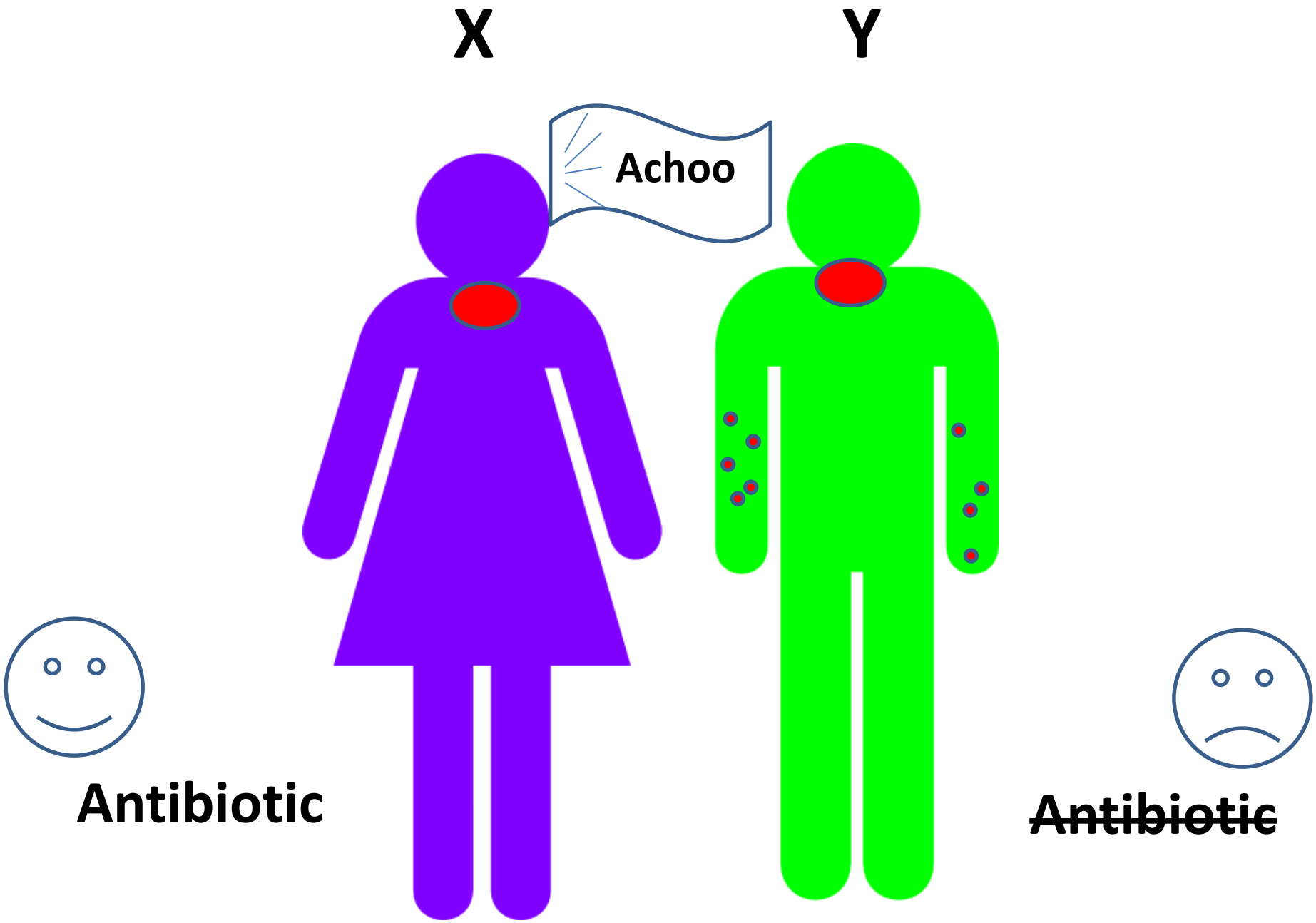
- We need 3 brave volunteers…
- Follow the story
- Keep track of the important events
- Solve the mystery!

X

Y

Antibiotic

Antibiotic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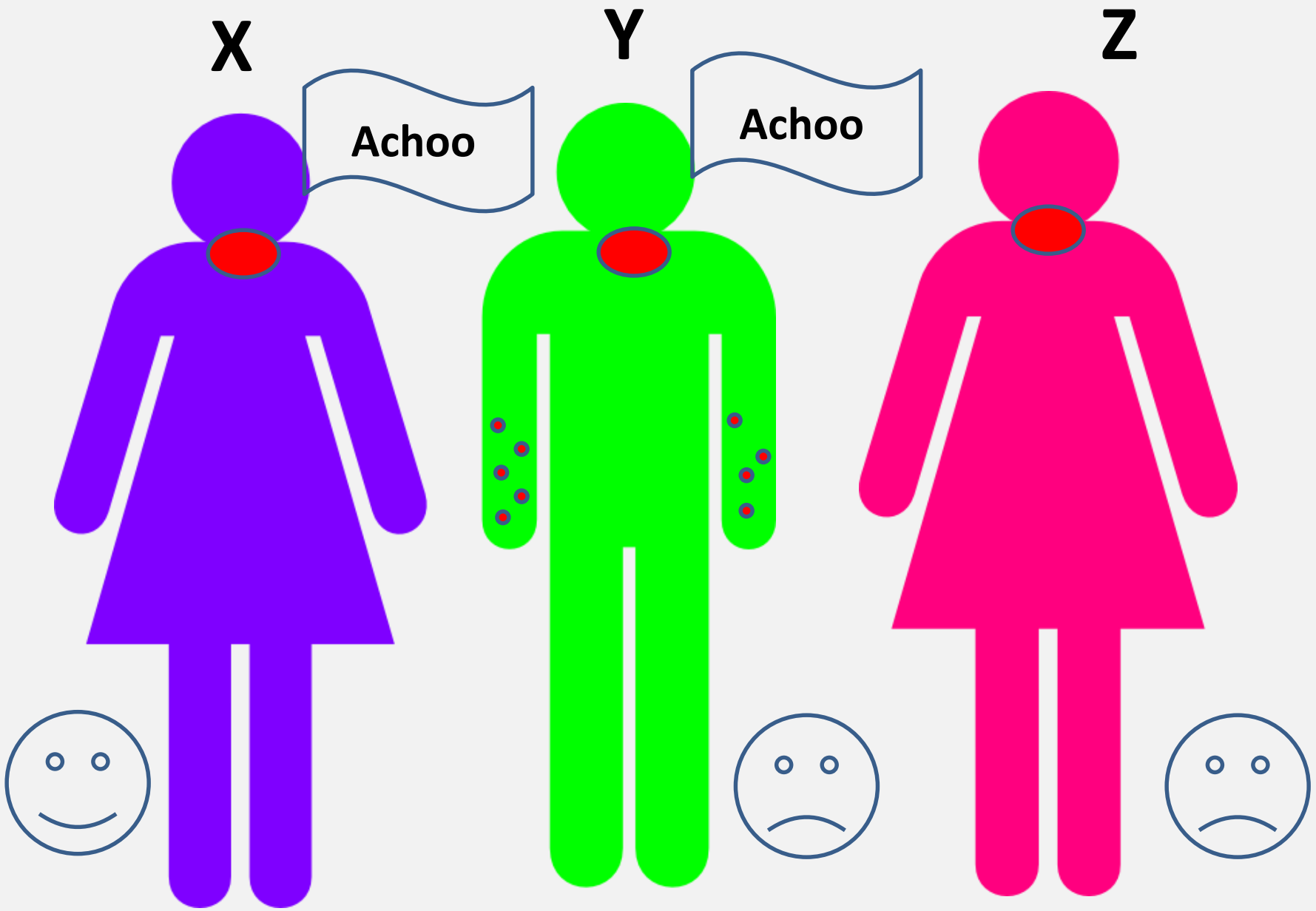
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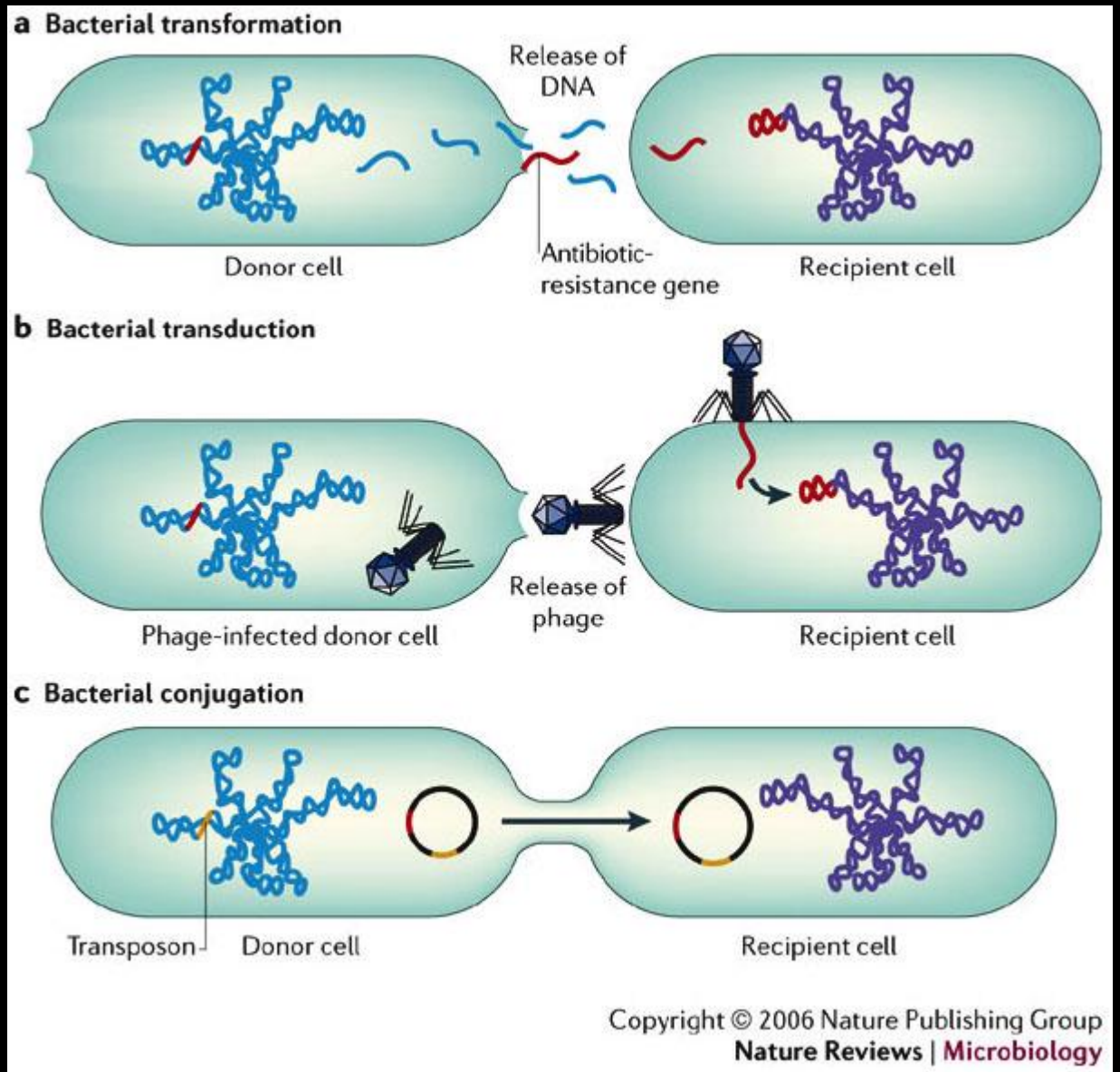
Bacterial Gene Transfer



Public Health Policies

- What human behaviors contribute to increased antibiotic resistance?

- What changes would you propose to mitigate antibiotic resistance?