Name_____Date_____Sec:_____

Worksheet—ID Case Study 4: Does antibiotic use on farms contribute to resistant infections in humans?

Learning Objectives. At the end of today's lesson, you will be able to:

- Draw a picture to illustrate the effect of antibiotics on a population of bacteria.
- Distinguish between antibiotic resistance and an antibiotic-resistant infection.
- Analyze and make predictions using data on antibiotic resistance.
- Develop a model to explain how human antibiotic resistant infections may be linked to antibiotic use on animal production farms.

Discussion: Understanding the evolution of antibiotic resistance

1) Describe or draw a picture to explain how a population of bacterial cells develops resistance to an antibiotic.

Cells or organisms with a better change of survival have an advantage over other organisms in the same population. The selection pressure exerted by the environment (e.g. presence of an antibiotic) leads to those with the advantage becoming the majority of the population; others are lost from the population. This is the basis for natural selection.

A common misconception is that the circumstances present in the environment put pressure on an organism to change, but this is incorrect. A cell or organism does not change (e.g. become resistant to antibiotic) as a result of environmental pressures.

In the case of bacterial resistance to antibiotics, the cells that survive contain genes encoding proteins that enable the bacterial cell to be impervious to the action of the antibiotic. These genes might encode pumps that push the antibiotic out of the cell or they might encode slightly modified target proteins such that the antibiotic cannot bind effectively to its target (targets include proteins involved in DNA replication, protein synthesis, cell wall synthesis, etc.).

Activity: Developing a model to link antibiotic use on farms with human infections.

2) The amount of antibiotics used on meat producing farms in the U.S. is much greater than that prescribed for human infection. What might you predict about the bacteria isolated from those farm animals?

Since presence of antibiotics selects for growth of bacteria resistant to the antibiotic, we would expect that bacteria isolated from farm animals exposed to antibiotics might contain higher levels of resistant bacteria (when compared to animals not exposed to antibiotics).

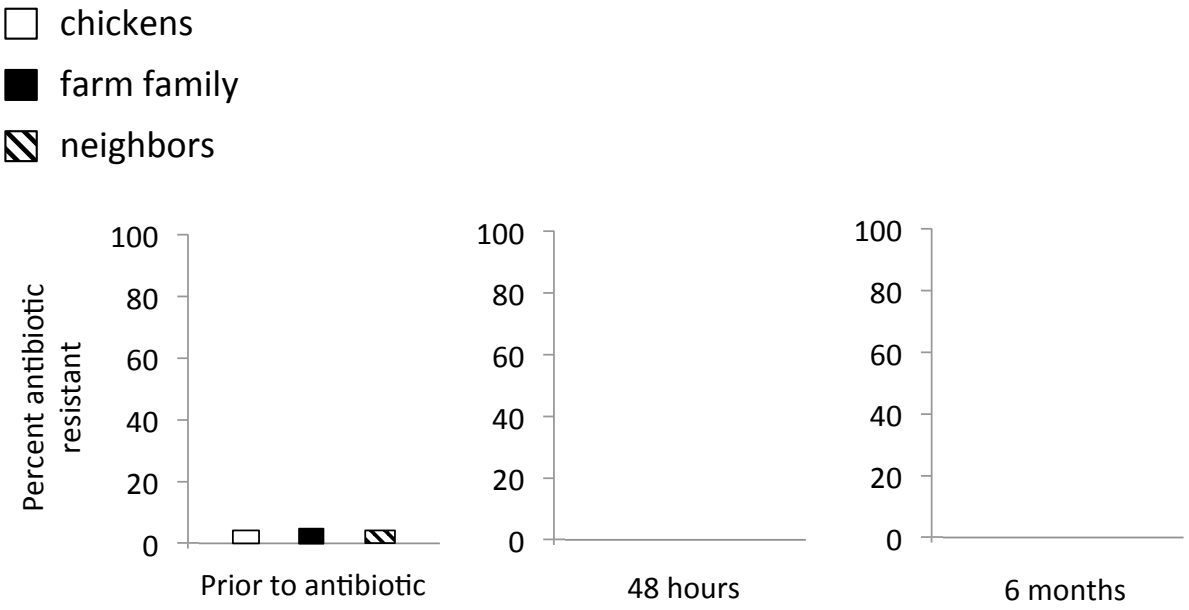
3) Researchers sampled the intestinal microbes present in feces of healthy chickens on farms that did or did not use antibiotics in the daily feed. Analyze the data in the table. Do they support your prediction? Explain.

Farm type	Number of antibiotic-resistant samples	Total number of samples tested	Percent resistant
Conventional (antibiotics (Ab) used)	10	13	77%
Organic (no antibiotics)	0	16	0%

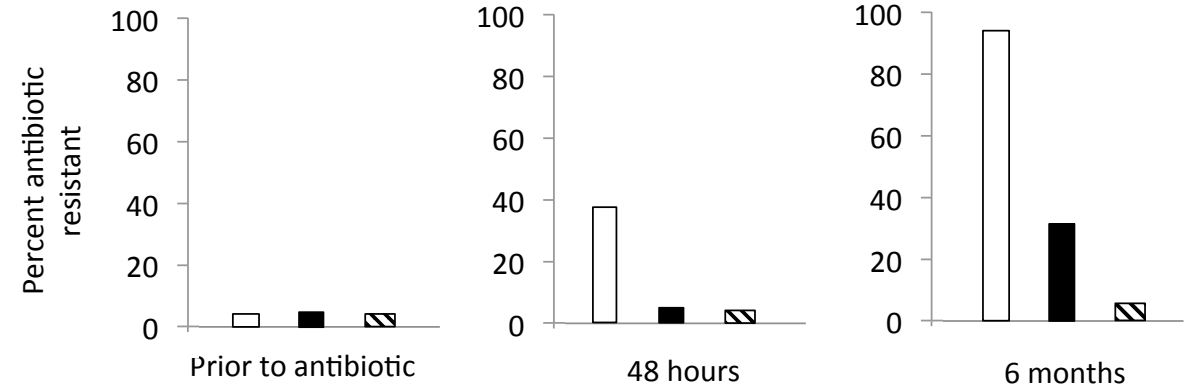
The data clearly support the hypothesis/prediction that levels of antibiotic resistant bacteria will be higher on farms that use antibiotics than farms that don't

In a revolutionary study in 1976, scientists ran an experiment on a farm in western Massachusetts. Prior to the start of the study, fecal samples of family members, chickens and neighbors were tested for the presence of antibiotic-resistant microbes. The result is shown in the graph on the left. Then, the chickens were given a low dose of antibiotic in their daily feed.

4) Predict the results of the stool sampling 48 hours and 6 months after start of antibiotic feeding.



Actual data:



5) Does having antibiotic-resistant bacteria on your skin or in your intestinal tract make you sick? Explain.

Antibiotic-resistance, per se, only refers to the ability of a bacterial cell to survive in the presence of antibiotic. Organisms that are resistant could be commensal organisms, normally present on your skin or in your body. If, however, you become infected because these organism cross the immune barriers, then treatment can be difficult because they won't be killed by antibiotics to which they are resistant.

6) Choose the best answer

A) Humans can become resistant to antibiotics

B) Humans can get infected with bacteria that are resistant to antibiotics

C) Both are true

D) Neither is true.

Antibiotics work by killing bacteria. They have little or no direct effect on human cells.
Humans do not become resistant to antibiotics, but they can acquire bacteria that are resistant.
Humans can harbor antibiotic-resistant bacteria as part of their normal flora (e.g. on skin or in their intestinal tract) and they may never become sick because of them.
Or humans can acquire antibiotic-resistant bacteria through infection in which case the infection will not respond to treatment with that antibiotic.

7) Provide a model to explain how a deadly Salmonella strain (in the background reading) became resistant to the antibiotic ciprofloxacin?

A plausible model:
Cipro or a related antibiotic could have been used on the farm.
It would have provided selection pressure such that pigs carried *Salmonella* resistant to the antibiotic
The resistant bacteria remained on the pork product after slaughter and delivery to market.
Patients ingested the *Salmonella* either through handling or consumption of raw pork.
The strain is pathogenic and usually causes disease when ingested, but in this case wasn't treatable using the normal antibiotic prescribed.