**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Partner: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**How bacteria gain resistance to antibiotics?**

**Tuesday morning you wake up with a mild sore throat, but you figure it will probably be better in a few days. Unfortunately, you end up staying up really late the next few nights studying for a test and you wake up feeling very sick the morning of the test. You stay home for the day, but you agree to go to the doctor.**

**1.** The doctor prescribes you an antibiotic. This leads you to conclude that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are causing you to feel sick?

**2.** What is an example of a sickness that an antibiotic would not help?

**3.** Can you ever think of a time when you had to take antibiotics? Does it make sense why your doctor prescribed you antibiotics?

**On the way home from the doctor you pick up your prescription from the pharmacy and immediately take the recommended dose. Now let’s think about what is happening in your body after taking the antibiotic.**

**Materials:** Toothpick, mini-marshmallows, M&Ms, stop watch or phone, paper.

The mini-marshmallows represent the bacteria that are causing you to feel sick. Start by putting 25 marshmallows on the paper.

**4**. The toothpick represents the antibiotic your doctor prescribed. Name your toothpick after an antibiotic \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

You now have 5 seconds to pick up as many marshmallows as possible using the toothpick (i.e. kill as many bacteria as possible). But before you begin list two ways that antibiotics kill bacteria?

**5.**

**6.**

***Dose 1***: Now start the clock for 5 seconds (one person time and one person use the toothpick) **GO!**

How many marshmallows were you able to grab in 5 seconds? This is representative of how many harmful bacterial are still alive in your body. Record your results in the table below.

**Certain bacteria may not have been killed by the antibiotic because the dose was not strong enough or because they are resistant to the antibiotic. Many bacteria are naturally resistant to bacteria and others develop resistance through beneficial mutations that prevent the antibiotic from working. *To represent mutated bacteria, take one marshmallow away and replace it with an M&M*. Then to represent binary fission (asexual reproduction), double the number of marshmallows and M&Ms!**

***Dose 2***: Now it is time for the second dose of antibiotics. This time the antibiotic is stronger and you will have 10 seconds to pick up as many marshmallows and M&Ms as possible with the toothpick.

Switch off who was timing. Set the clock for 10 seconds. **GO!**

Record below how many marshmallows and M&Ms are still in the population. If there are no M&Ms at the end of a dose, a new mutation will arise and you should add one M&M. **Now double the number of marshmallows and M&Ms.**

***Dose 3:*** Apply a third dose of antibiotics that is the strongest yet. This time you have 15 seconds to pick up marshmallows and M&Ms with the toothpick.

Record how many marshmallows and M&M’s are left in the population after the third dose of antibiotics? You can keep going for 3 more doses, but do not extend the time limit any longer as you are already taking the strongest legal dose of antibiotics.

 **M&M**

**Marshmallow**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Start | Finish | Start | Finish |
| Dose 1 | **25** |  | -- | -- |
| Dose 2 |  |  | **2** |  |
| Dose 3 |  |  |  |  |
| Dose 4 |  |  |  |  |
| Dose 5 |  |  |  |  |
| Dose 6 |  |  |  |  |

Below graph the number of marshmallows and M&Ms *at the end of each dose (before doubling)*. Before you begin determine what to plot on the X and Y axes.

X axis: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Y axis: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Label which line in your plot represents non-resistant bacteria and resistant bacteria. Use this information to answer the questions below.

**7.** What can you conclude about the influence of the antibiotic on the population of bacteria?

**8.** How effective will this same antibiotic be when prescribed to this patient again?

**9.** What is one human practice that increases the prevalence of antibiotic resistance?

**10.** Name one medical treatment that will result in a lower human survival rate if antibiotics cannot kill harmful bacteria anymore?

**11.** What is one way we can work to prevent antibiotic resistance?