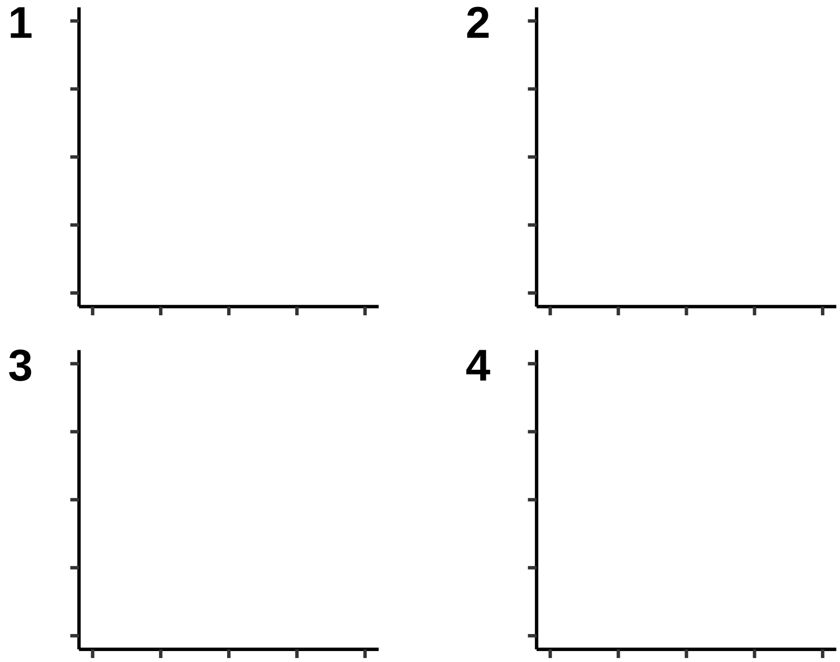
Dice and dose-response relationships

Dose-response relationships frequently show up in biological (and other) systems. Indeed, I bet you can think of at least four *different* ways some *response* changes with the dose of some *cause*. Let's write those down:

1.
2.
3.
4.

In fact, draw graphs of those relationships. Add labels (including units if you can) and put reasonable numbers on the two axes.



It's good to keep this diversity in mind if only so that you don't make the mistake of assuming every dose-response relationship means the same thing.

Dice as pathogens

To develop a more intuitive sense of at least one way we can get a dose-response relationship, let's roll some dice. I like thinking about pathogens, so let's imagine that we are the hosts and each die is a single pathogen. A pathogen/die only causes an infection if it comes up a "6", otherwise you fight it off. We are going to simulate exposures to different doses of pathogens/dice to see how the probability of infection changes with the dose.

Of course a single host is either infected or uninfected, so a single person's data would like a series of zeros and ones. We want to determine what the *probability* of infection is at different doses, which we can estimate as the *proportion* of hosts[1]

[1] Students rolling dice.

that are infected[2] at each dose.

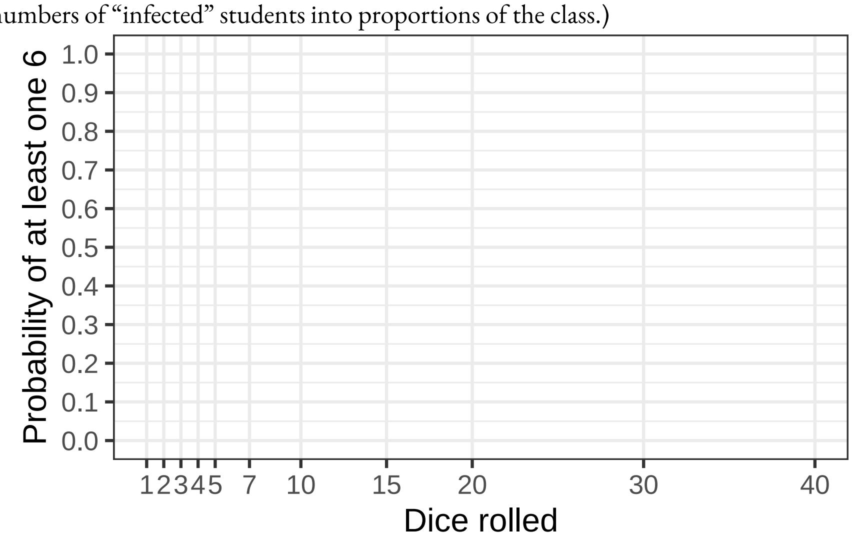
We will also consider two other scenarios: one where *two* sixes in a roll are needed to cause an infection and one where *four* are needed.

Before we start rolling our dice, I would like you to sketch out on the axes below your expectation for what these data are going to look like for each criterion for a successful infection. Be sure to think about what you will see for each of our criteria for success.

Number of students: ______

Dice rolled	Students with ≥ 1	Students with ≥ 2	Students with ≥ 4
1			
2			
3			
4			
5			
7			
10			
15			
20			
30			
40			

Then let's plot these data on the axes, below. (And yes, you will have to turn numbers of "infected" students into proportions of the class.)



Do your data look like what you expected? Why? What fits your expectation and what is a surprise?

[2] Roll at least one 6.

Now plot the same data on the *logarithmic* x-axis, below. Note that distance along the x-axis now reflects *proportional* increases (e.g., doubling is always the same) rather than the increases in number.

Does this pattern fit your expectations better? Worse?