

## **REMNet: A Student's Guide to Microbiome Experimental Design**

By Jessica Lee Joyner

So now you're curious about the microbiome of our built environment, but how do you address that curiosity? How do you design an experiment or a research project to learn more about this microbiome around us everyday?

I'm Jessica Lee Joyner, and I do research and I teach at the City University of New York. And today, I want to guide you through: how do you design that experiment? What do you need to consider to be able to do research about the built microbiome?

What are the variables you need to address? How do you have a precise question and a testable hypothesis? When and how much replication do you need for your project and to overall be confident in what you have done, and to report these results.

When it comes to deciding what your projects going to be about, what microbiome are you going to explore and to learn more about, the best place to start is your experience. What are your everyday observations about your everyday environment? Those observations are the foundation for developing your question.

Once you have your good question, the key thing is what, what do you think's going to happen? What is your hypothesis? And that hypothesis comes from your background experiences. What are you able to predict would happen? Key thing, it doesn't have to be right. It doesn't have to absolutely be certain to happen.

That's the goal of a hypothesis: to set a framework for what you're going to be doing, but if you truly already knew the outcome, you wouldn't be doing the experiment. You wouldn't be doing this project. So be confident in your question and the hypothesis as your framework for the project.

Now that you have your hypothesis, you need to identify what factors are those variables that could influence the outcome. These variables are classically temperature, light, moisture, water, but for your question and your hypothesis, there may be other factors to consider. Do you need to think about the plant life and the animal life? Or how they're disturbing the environment? These all come together to create your unique project.

The next step is to identify which ones will be constant regardless of what happens in the course of your experiment. Others could you change and hold them control? But most importantly which one are you testing? What is the central variable that's part of your question, and how are you going to be sure that is what you're going to be collecting results about?

When you're designing your experiment, and you have all your variables outlined, you need to consider how the experiment is going to proceed. Are you going to do a comparison taking a sample as a before and as an after, or are you going to do a

treatment? So not just looking at a time difference of a before and after, but actually doing something to change? Maybe you plant a tree!

These are your treatments. This is what's going to directly influence the variable you are interested in testing. You now have your question, your testable hypothesis, and the variables that you're going to hold control—constant—or you're testing, but how are you going to be confident in the results of your experiment being true to what you are actually designing it to do? That's replication.

The more you do the project, the more times you go to a site, or you visit multiple sites, that is how you know that what you have designed—what you set out to do and explore this microbiome—is true to what is there.

So with replication, you have confidence in your results. When you've completed your project, now you get to evaluate: do your results support your hypothesis? Some things may have surprised you.

We have an answer to your hypothesis, but in exploring that, you have so many more questions, and that's because when it comes to looking at a microbiome, regardless if it's even in our everyday environment, there's so much more that needs to be considered.

So when you look at your project, what additional elements did you need to consider? That's worthy of reporting. That's how we can decide how to go on, how to proceed and do the next experiment. So looking back at your question and your hypotheses and what you did.

All of those experiences are incredibly valuable, and they help us for all studies that are deciding to do a microbiome research or understanding our built environment a bit little more. That's where we want to go. That's what it means to be doing research and to contributing to understanding our own microbiome and the microbiome that we create by designing our built environments.