**Collective task 1: Exploring microbial diversity in different environments**

**Key questions:**

* How many microbial species can coexist in one microbiome?
* Why are some microbiomes more diverse than others?

**Thought experiment:**

Imagine you are a scientist on a mission to collect as many biological samples as possible from every corner of the biosphere. You gather samples from diverse environments, including:

* Different zones of the ocean
* Forest soil
* Leaf surfaces, roots, and flowers
* Various human body sites
* Sewage and wastewater treatment plants
* Rivers and freshwater sources
* Farm animals and insects

Taking care to avoid cross-contamination, you bring tens of thousands of samples back to your lab and extract their DNA. Utilizing the bioinformatics skills acquired in previous lectures, you develop a method to count how many different microbial species are present in each sample.

After completing this herculean, you observe a few patterns:

* The number of different species on each sample is finite
* Similar environments tend to have a similar number of species, which can be represented by a Gaussian-like distribution, characterized by a mean and variance.
* Some environments have very different number of species. One gram of soil contains almost 1,000 times more species than one gram of animal stool. Even within host body-sites, you observe very large differences. For example, the human skin hosts an average of 40 species, while samples from inside the mouth contain an average of 500 species.

(note: these number are illustrative and may not reflect actual data).

**Your task:**

Based on these empirical observations, your assignment is to:

Explain the patterns: Provide possible explanations for why environments have characteristic (average) numbers of microbial species.

Formulate a general hypothesis: develop a general hypothesis of nature that accounts for why some environments harbor many more species than others. If true, your hypothesis should account for the observations and be applicable to a wide range of environments.

Describe an experiment to test your hypothesis.