

There has been numerous guides on "what Biohacking is (the DIYbio bit)" but i haven't actually seen a layman's term guide on how to start, ie, how to structure your learning in a fun and goal-orientated fashion. One where you could literally go from "step 1" to "step 2". So here we go.

If you've never heard of DIYbio or Biohacking (not the nutrition/nootropics/redlight therapy stuff) then i suggest you read this excellent intro by Elliot Roth ["A guide to DIYbio" which he has updated yearly](#).

There is so much you could jump into right now to start learning. There are kits, books, equipment builds, experiments, that all sound amazing, may even be marketed as being beginner friendly but still can feel daunting to just jump into. Maybe you'd like a basic run through of some every day essentials/fundamentals in life sciences before getting into some more specific fields. If so, this guide should be quite helpful. Expect updates throughout the year, and if you'd like to contribute to this get in touch u/SciencePeddler on reddit.

The goal for this guide is not to re-write everything that has already been done, but rather, curate everything into a one stop shop. Links to videos, documents, and other guides helping you go from zero to one.

Please keep an eye out for warnings. Some of the recommended skills or techniques could be illegal in your country, especially when it comes to moving DNA into an organism, also referred to as "Gene Technology". We'll try to create a link to relevant regulations for each country, eventually

calculating concentrations for solutions

One of the most basic skills you'll have to become familiar with on your journey is calculating how much mass of a certain something to add to a volume of liquid.

There may be a paper that says the authors used "0.1N NaCl solution" or similar, you might know that NaCl is salt but wth is 0.1N? There may be percentage signs ie "a 1% solution" or "a 0.8% gel" there may also be descriptions of grams per liter or g/L when you're preparing media to grow bacteria and many other ways of describing basically the same thing, ie a certain amount of a substance called a solute, into a certain amount of liquid or a solution.

This may be easy to come to grips with but if not, don't fret, there are tons of guides on how to do this and with practice you'll be able to do most of this in your head, until then, grab a calculator.

[This is a really helpful guide on the various ways of calculating concentration](#)

Today you'll learn: how to calculate concentration by making a 0.9% saline solution, used for a wide variety of medical purposes from cleaning wounds to intravenous purposes. Just be aware,

if you intend to use this, it needs to be refrigerated after being prepared and should be used within 24 hours.

Fundamentals

Lets start with some background, units written in science are primarily written in the **metric** system, so if you're not familiar with Kilo's Micro, and nano, then it's time.

Factor	Prefix	Symbol	Examples
10^9	giga	G	1 Gm = 1 gigameter = 10^9 m 1 Gb = 1 gigabyte = 10^9 bytes
10^6	mega	M	1 Mm = 1 megameter = 10^6 m 1 Mb = 1 megabyte = 10^6 bytes
10^3	kilo	K	1 Km = 1 kilometer = 10^3 m 1 Kg = 1 kilogram = 10^3 g
10^{-1}	deci	d	1 dm = 1 decimeter = 0.1 m
10^{-2}	centi	c	1 cm = 1 centimeter = 0.01 m
10^{-3}	milli	m	1 mg = 1 milligram = 0.001 g 1 ms = 1 millisecond = 0.001 s
10^{-6}	micro	μ	1 μ m = 1 micrometer = 10^{-6} m 1 μ s = 1 microsecond = 10^{-6} s
10^{-9}	nano	n	1 ns = 1 nanosecond = 10^{-9} s
10^{-12}	pico	p	1 pg = 1 picogram = 10^{-12} g

There are only four areas you'll need to really be familiar with, but the rest could be helpful in a trivia session. These four are **kilo**, **mili**, **micro**, and **nano**. Have a look at their relation to one another. They increase or decrease from one another is by multiples of 10 to the 3/-3. What is not on here is the 10 to the 0. This is because 10 to the 0 is one, ie, 10 to the 0 grams is one gram while 10 to the 3 grams is 1kg and 10 to the -3 grams is a milligram. This is the same for liters. ie 10 to the -3 is a milliliter, while 10 to the 0 liters is one liter, etc.

The above table has a few different measurements like seconds, bytes, grams, and is missing liters

Percentage Concentration

Right so for this example we're preparing a concentration based off percentage. IE the relation of the solute (the thing we're mixing into the solution, in this case the solute is salt, also written as NaCl, 1 sodium 1 chloride) to the volume of the solution.

So for a 0.9% we first have to divide by 100, which gives us 0.009, then we just need to figure out the volume (ie the amount of liquid) we're adding to. The trick here is to know that we always use mls when it comes to volume for percentage calculations, not liters. So even if we wanted to make up a liter of 0.9% saline, we're not going to say okay $0.009 \times 1\text{L}$, we would convert that to milliliters and say $0.009 \times 1000\text{ml} = 9\text{g}$ (9grams). If we only wanted to make 100ml of 0.9% saline solution then we would multiply $0.009 \times 100 = 0.9\text{g}$ or 900mg.

Equipment you'll need

- Scale
- Small container of some sort, weighing in
- Mixing container of some sort, mixing in
- Scooping tool; spoon, spatula, ladle, or just free hand it
- Salt
- Pot for boiling water or a kettle
- 1L of water
- Measuring cup in metric units L, ml, etc...

Method

1. Place your weighing container on your scale, and zero the scale, ie make sure that the scale reads zero with your container on it so it doesn't impact how much you're weighing
2. Use your scooping device to weigh out 9 grams of salt
3. Add 9 grams of salt to 1000ml of boiling water
4. Stir to dissolve, put a lid on it, and remove from heat
5. Cool down and store away until use in a refrigerator for up to 24 hours.

Mass per Volume

[Preparing DIY nutrient agar plates for bacteria plating \(will come in handy later for plating bacteria\)](#)

In this experiment you'll understand how to make a solution based on g/L or mg/L

This is probably the easiest of all the methods of doing concentrations. You're literally told how much to add per liter. That's right, g/L means grams per liter, or mg/L is milligrams per liter or even mg/ml is milligrams per milliliter. So if something says you need a concentration of 5 g/L that means you add 5 grams per liter, that's simple. It follows a simple formula C (concentration) = $M(\text{mass})/V(\text{volume})$ or $C=M/V$

So if you click on the link you'll see they have everything in teaspoons and cups, while cooking is science, let's convert kitchen measurements to metric measurements to stay in theme with the guide.

1 teaspoon = 4.2 g

1 cup = 236.5 ml

So if we wanted to make 1L of this solution we'll need to multiply this recipe by 4.22 as there are 4.22 cups in 1L and currently the recipe is for 1 cup.

1 teaspoon of beef stock powder = 4.2g for 1L we'll need $4.22 \times 4.2\text{g}$ = around 17g

1 teaspoon of sugar = 4.2g for 1L we'll need $4.22 \times 4.2\text{g}$ = around 17g

1 teaspoon of gelatin = 4.2g for 1L we'll need $4.22 \times 4.2\text{g}$ = around 17g

Now it's good practice to always be as precise as possible, but when operating in a DIY environment, and you don't have access to a scale that can measure down to 4 decimal places, it will always be a best guess. There will be times where this impacts you more than others, but for now let's just try our best to be as close as possible.

So as far as grams per liter or g/L go the recipe or "protocol" calls for

- 17g/L of beef stock
- 17g/L of sugar
- 17g/L of gelatin or Agar Agar

Doing Dilutions

Following how to calculate concentration is the need to know how to dilute something. It would be a right pain to have to prepare solutions everytime we wanted to do an experiment or re-try

an experiment, be prepared for re-trying, don't ever assume you'll get it right on the first go in science and especially in DIYbio! SO we generally prepare stock solutions. A stock solution is basically a super concentrated amount of a particular solution you may

preparing buffers,

microscopy,

plating bacteria,

transforming bacteria,

PCR

Gel electrophoresis

Restriction digest

Ligation

Plasmid design

etc,