Explanation of Dye Concentration Scaling

Here's how the number of drops of food coloring per volume of distilled water was calculated to represent the relative concentrations of mRNA and DNA:

Scaling Assumptions Based Upon Quantified Findings in Research:

- 1 drop of dye represents a base concentration (e.g., 10^9 copies/ml).
- Each 10-fold increase in concentration = 10× more dye drops (or 10× less water).
- Lower concentrations use more water to simulate dilution and reduced intensity.

Application to Experiment:

- Moderna mRNA 10^9 = 1 drop green in 100 ml; 10^10 = 10 drops in same volume.
- Pfizer mRNA 10^10 = 1 drop yellow in 10 ml; 10^11 = 10 drops in 10 ml.
- Moderna DNA 10^7 = 1 drop red in 100 ml; 10^9 = 100 drops in 100 ml.
- Pfizer DNA 10^8 = 1 drop blue in 10 ml; 10^9 = 10 drops in 10 ml.

Purpose of Visualization:

- This method offers a visual, hands-on demonstration of exponential differences in mRNA and DNA concentrations.
- Color intensity reflects concentration, and blending (e.g., mRNA + DNA) simulates molecular admixtures/interactions.

Conceptual Basis: Logarithmic Scale of Concentration

Biological substances like mRNA and DNA in vaccines are often measured in copies per mL, such as:

- 10^9 copies/ ml (1 billion molecules per milliliter)
- 10^{10} copies/ ml (10 billion molecules per milliliter), etc.

Food coloring can't represent actual molecular quantities, but we can use it to simulate relative concentration changes by assigning drops to each log scale of concentration.

Assumptions and Scaling Logic

We can use a simple logarithmic proxy:

- 1 drop = base level (represents 10^9 concentration)
- Each 10-fold increase in concentration = add 10× the drops (or reduce the water volume proportionally)

How Drops Were Assigned

Target Concentration	Representation	Drops of Dye	Water Volume
10^7	Very dilute DNA	1 drop	100 mL
10^8	10× higher than 10^7	1 drop	10 mL
10^9	High for DNA / baseline mRNA	1 drop	1 mL or 100 mL
10^{10}	10× higher than 10^9	10 drops	Same volume
10^{11}	100× higher than 10^9	100 drops	Same volume or smaller volume

We can scale volume and drop count such that the visual intensity of color matches what you'd expect from increasing nucleic acid concentration.

Why Use This Method?

- Drops are tangible and easy for audiences to visualize.
- Log scaling helps show the exponential differences in nucleic acid content.
- Color blending (in the DNA + mRNA experiments) simulates molecular admixtures/interactions and content shifts.