How to do the Food Dye Experiment at Home

Here is a demonstration experiment using food coloring to represent the quantitative and qualitative visual differences between mRNA and DNA from Moderna and Pfizer products, using concentration and color intensity as analogues. The experiment will visually simulate increasing concentration and interactions between DNA and mRNA components.

Materials Needed:

- Food coloring (4 colors):
    - Green = Moderna mRNA
    - Yellow = Pfizer mRNA
    - Red = Moderna DNA
    - Blue = Pfizer DNA
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- Clear plastic cups (at least 10)
- Eyedroppers or pipettes
- Measuring spoons or droppers for water (ml level)
- Water (preferably distilled for clarity)
- Notebook for observations

Instructions & Observations

Materials Needed:

- Food coloring (Green = Moderna mRNA, Yellow = Pfizer mRNA, Red = Moderna DNA, Blue = Pfizer DNA)
- Clear plastic or glass cups (at least 10)
- Eyedroppers or pipettes
- Measuring spoons or droppers for water (ml level)
- Distilled water (to prevent impurities in water from obscuring color changes)
- Notebook or space below for observations

Experiment Steps:

1. Prepare individual dye solutions as described on the next page, matching drops to concentrations.
2. Observe and note the color intensity changes with increasing concentration (log-scale proxy).
3. Mix Moderna DNA with Moderna mRNA solutions and observe resulting color (should become olive-brown).
4. Mix Pfizer DNA with Pfizer mRNA solutions and observe resulting color (should become various shades of green).
5. Record observations of any unexpected changes or layering effects. [Many of our scientific discoveries come from what we didn't expect to find. Telling us to look deeper.]

Observations:

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Part 1: Individual Representations by Concentration

Each dye will represent nucleic acid concentration. More drops = higher concentration (log scale proxy).

1. Moderna mRNA

- Concentration: 10^9 [1 billion molecules/milliliter (ml)]
    - Mix 1 drop of green dye in 100 ml water. Label: "Moderna mRNA 10^9".
- Concentration: 10^{10} [10 billion molecules/milliliter (ml)]
    - Add 9 more drops of green dye (total 10 drops) to same volume or another 100 ml. Label: "Moderna mRNA 10^{10}".

2. Pfizer mRNA

- Concentration: 10^{10} [10 billion molecules/milliliter (ml)]
    - Mix 1 drop of yellow dye in 10 ml of water (more concentrated base). Label: "Pfizer mRNA 10^{10}".
- Concentration: 10^{11} [100 billion molecules/milliliter (ml)]
    - Add 9 more drops of yellow dye (total 10 drops) to same or another 10 ml water. Label: "Pfizer mRNA 10^{11}".

3. Moderna DNA

- Concentration: 10^7 [10 million molecules/milliliter (ml)]
    - Mix 1 drop of red dye in 100 ml water. Label: “Moderna DNA 10^7”.
- Concentration: 10^9 [1 billion molecules/milliliter (ml)]
    - Add 99 more drops (total 100 drops = 100x increase) of red dye in 100 ml. Label: “Moderna DNA 10^9”.

4. Pfizer DNA

- Concentration: 10^8 [100 million molecules/milliliter (ml)]
    - Mix 1 drop of blue dye in 10 ml water. Label: “Pfizer DNA 10^8”.
- Concentration: 10^9 [1 billion molecules/milliliter (ml)]
    - Add 9 more drops of blue dye to same water volume. Label: “Pfizer DNA 10^9”.

Part 2: Interaction Experiment — DNA added to mRNA

These mixtures simulate the interaction of added DNA with mRNA solutions. Each Pfizer vaccine was 0.3 ml volume and each Moderna vaccine was 0.5 ml total volume injected.

5. Moderna mRNA + Moderna DNA

- Use the Moderna mRNA 10^{10} solution (green, 100 ml).
- Add 10 ml of Moderna DNA 10^{9} (red) drop by drop while stirring.
- Expected outcome:
    - The solution will turn olive-brown (green + red), showing mixing of mRNA and DNA elements.
    - Intensity of color shows additive interaction.

6. Pfizer mRNA + Pfizer DNA

- Use the Pfizer mRNA 10^{11} solution (yellow, 10 ml).
- Add 10 mL of Pfizer DNA 10^{9} (blue).
- Expected outcome:
    - The solution will turn shades of green, depending upon dominance.
    - Intensity of color shows additive interaction.