AMGEN® Biotech Experience

Scientific Discovery for the Classroom

Exploring Tools of the Biotechnology Lab

Pipetting

STUDENT SCIENCE NOTES

AMGEN® Foundation

Science Note 1.1

Welcome to the Amgen Biotech Experience (ABE)! ABE was created to introduce young people to the world of biotechnology, which is the use of biological systems to create products. Humans have been using biological organisms for thousands of years, but the science of biotechnology is pretty new. It was not until the 1970s that biotechnology took off when scientists made two big discoveries about bacteria: (1) bacteria contain DNA (which contains genetic information), and (2) bacteria also contain proteins called restriction enzymes that can cut DNA at very specific places.

With these discoveries, scientists have been able to use bacteria and other microorganisms to generate products, like fuels to power the world, systems for the production of food, and medicines to improve human health.

For the next few days, you will explore how biotech scientists measure the tiny amounts of materials that they use in their experimentation (remember, they work with *micro*organisms) and the importance of accuracy and precision in their work.

Science Note 1.2

Investigate the importance of accurate measurements in your everyday life by making play dough from the recipe below. As you're making your recipe, think about whether the tools you've been given to measure your ingredients are reasonable and how your tools help or hurt your ability to make your play dough.

INGREDIENTS

- 2 cups (240 g) flour
- 0.5 cup (144 g) salt
- 1.5 cups (360 mL/350 g) hot water
- 2 T (30 mL/27.5 g) cooking oil
- 2 T (21 g) cream of tartar
- Food coloring

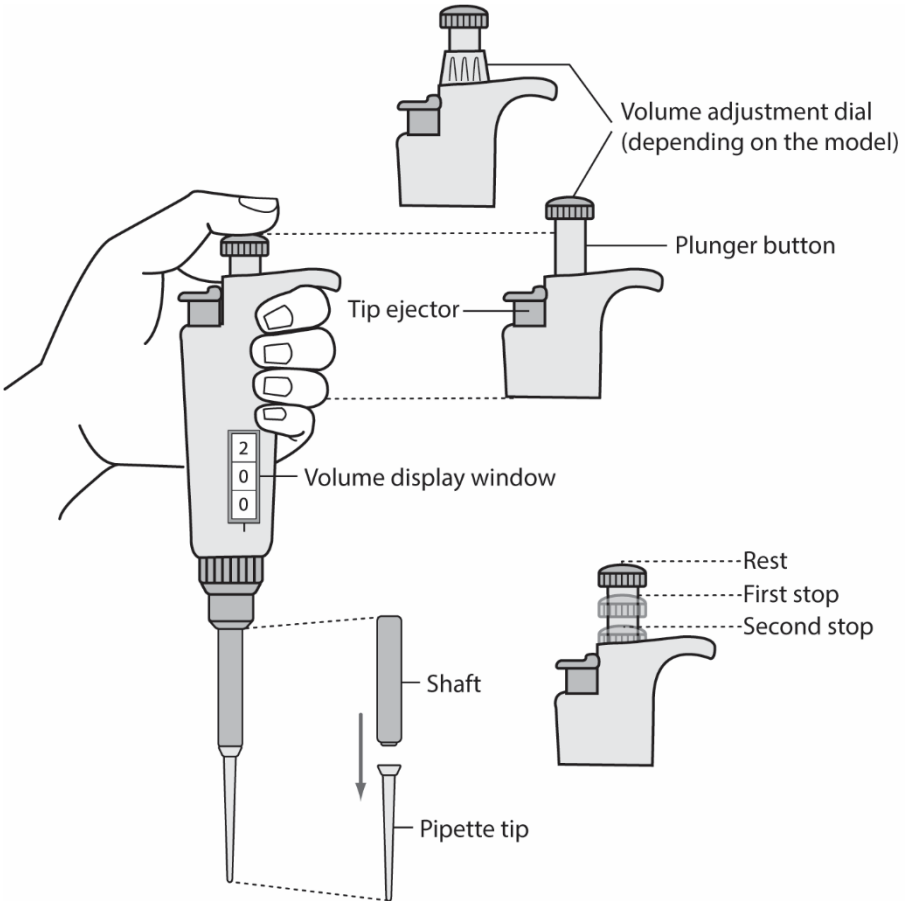
RECIPE

1. Combine all the dry ingredients in a bowl and form a well in the center.
1. Add the cooking oil and food coloring to the dry ingredients and stir.
2. Add water and stir.
3. Allow the mixture to rest for a few moments. This will give the salt a chance to absorb the extra moisture.
4. Now feel your play dough—if the dough is sticky, add an additional 0.5 cup (32 g) flour. Keep adding 0.25 cup (32 g) flour until the dough feels like the play dough you are familiar with.

Science Note 2.1

Today you will be using a very accurate science tool called a micropipette. Micropipettes are used to measure small volumes of liquids accurately and precisely. Before using these micropipettes, you need to understand how to handle them appropriately.

Explore the parts of a micropipette in the diagram below.



PROPER MICROPIPETTE HANDLING

- Be gentle.
- Hold a micropipette in one hand. With the other hand, turn the volume adjustment dial until the volume reads slightly above the desired volume setting, and then slowly adjust the volume down until the correct volume shows in the display window.
- Add a pipette tip by pressing the pipette shaft firmly into the wide (not pointed) end of the tip to create an airtight seal. Do not bang the pipette or tips together!

- Depress the plunger to the first stop. Holding the micropipette vertically, immerse the tip approximately 2 mm into the sample liquid. Slowly release the plunger to return it to the rest position.
- To dispense the liquid inside the pipette tip (either back into the sample tube or into a new tube), place the pipette tip so that it touches the wall of the tube, and depress the plunger to the second stop.
- While still holding the plunger in the second-stop position, move the pipette tip up and out of the (sample or new) tube, and slowly release the plunger to return it to rest position.

NOTE: If you release the plunger too quickly, you may not withdraw or dispense the correct volume. It could also cause the liquid to "jump" and get into the micropipette. This can result in cross-contamination of solutions and damage to the micropipette.

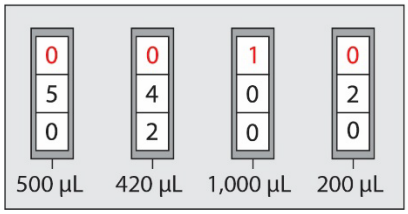
- Discard the tip into a waste container by depressing the tip ejector button. Use a fresh tip for the next sample to avoid contamination.

NOTE: In these activities, you will be using the same tip repeatedly to minimize waste.

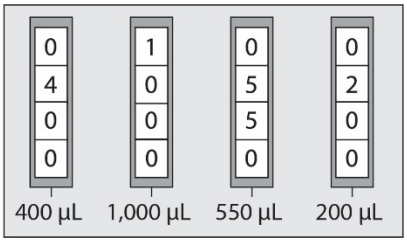
- Never try to set the volume outside of the micropipette's range. A P-1000's limits are 200 to 1000 microliters (µL) and a P-200's limits are 20 to 200 µL.

SETTING THE VOLUME ON A MICROPIPETTE

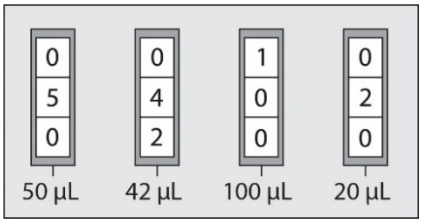
P-1000 Volume Setting



Alternative P-1000 Volume Setting



P-200 Volume Setting



ADDITIONAL IMPORTANT INFORMATION

- NEVER use the micropipette without a disposable tip in place. Moisture will cause internal damage to the pipette
- NEVER lay a liquid-loaded micropipette down. Moisture can run back inside, similarly causing damage to the micropipette.
- Do not allow the plunger button to snap back after pushing it. Always control the release of the plunger to return to rest position gradually.

Science Note 2.2

You are going to explore and compare the accuracy of inexpensive microchemistry pipettes with the accuracy of more-expensive micropipettes. To do so, you're going to test these two measuring devices to see how accurate and precise they are. To do that, you will use each type of pipette to draw up a small amount of water and then weigh that water to see how accurate the measurement was.

MATERIALS

- 1 P-1000 micropipette
- 1 box P-1000 micropipette tips
- 1 plastic microchemistry pipette
- Distilled water
- 1 100-mL beaker
- 1 thermometer
- 1 weigh boat
- 1 scale that can accurately weigh to hundredths of a gram
- Paper towels

PROCEDURE

1. Fill your beaker with distilled water.
2. Measure the temperature of the water and make note of it. The weight of a volume of water is dependent on its temperature. Why do you think that is?
3. Go to the website Water Weight Calculator – How Much Does Water Weigh? and enter 0.5 mL as your water's volume and the temperature of your distilled water.
4. Place the weigh boat on your scale and press "Zero." That will cause the scale to set itself to zero even though the weigh boat is on it.
5. Use the plastic microchemistry pipette to draw up 0.5 mL of water from your beaker.
6. Expel the water into the weigh boat and note its mass in the table below.

	Mass (g)	
Trial	**Microchemistry Pipette**	**Micropipette**
1		
2		
3		
4		
5		
Average		

7. Use a paper towel to dry the weigh boat, and repeat Steps 4–7 five times with the plastic microchemistry pipette.
8. Next, follow Steps 4–7 using the micropipette.
9. Calculate the average mass for each instrument.
10. Using the data you gathered, determine if your plastic microchemistry pipette is accurate. Is it precise? Is your micropipette accurate? Is it precise? Explain your thinking about accuracy and precision for these two devices below.

Science Note 3.1

You are going to use your micropipette to combine small amounts of blue-, red-, and yellow-colored water to make a variety of other colors: orange, purple, green, and brown. Your job is to work with your team to make color recipes and keep track of the volumes of colored water you add to make them. You will then share your recipes with your class.

MATERIALS

- 2 or more P-200 micropipettes
- 1 box of P-200 micropipette tips
- 4 prepared 50-mL centrifuge tubes filled with red, blue, yellow, and plain water
- 1 centrifuge tube rack
- 2 96-well micropipette plates
- Paper towels

PROCEDURE

1. With your team, discuss the colors you need to make and what combinations of red, blue, and/or yellow make those colors.
2. Each well of your 96-well plate will hold 150 µL of liquid, so your recipes should all have 150 µL or less of liquid in them.
3. After you have discussed your possible recipes, write the names of the colors you will be making to the left of the rows on the chart on the second page of this science note. Then enter the volumes of each color (remember, you can use plain water [W], too) in the cells. Each row should contain only one color. There is one cell on the chart for each well of the 96-well plate.
4. After you have entered one or more of your recipes in the table, try them out by using the micropipette to pipette the exact volumes you decided on into each well. To reduce waste, you will use one pipette tip for each color rather than a new one for each time you pipette. Keep track of each tip so that you know which tip was used for which color.
5. Once you have mixed a few of your recipes for a color, decide whether you need to try different recipes or if you are happy with the color that you have made.
6. Once you have come up with a recipe for each color, write down your recipes below and be prepared to share them and show the wells that they are in to the rest of the class.

Orange
B: _____ µL
Y: _____ µL
R: _____ µL
W: _____ µL
Coord:

Purple
B: _____ µL
Y: _____ µL
R: _____ µL
W: _____ µL
Coord:

Green
B: _____ µL
Y: _____ µL
R: _____ µL
W: _____ µL
Coord:

Brown
B: _____ µL
Y: _____ µL
R: _____ µL
W: _____ µL
Coord:

			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
COLOR		**A**	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL
		B	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL
		C	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL
		D	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL
		E	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL
		F	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL
		G	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL
		H	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL	B: ___ µL Y: ___ µL R: ___ µL W: ___ µL

Science Note 4.1

You've had a chance to experiment with micropipetting and making different colors by mixing small volumes of colored water together. While you are working on making class Mystery Designs, you are going to make your own design. YOU decide what colors to use! YOU decide how to fill the wells to make your design!

MATERIALS

- 1 P-200 micropipette
- 1 box of P-200 micropipette tips
- 4 prepared 50-mL centrifuge tubes filled with red, blue, yellow, and plain water
- 1 centrifuge tube rack
- 1 96-well plate
- Paper towels
- Colored pencils or pens in a variety of colors

PROCEDURE

1. Use the template below and colored pencils or pens to decide on your design:

	1	2	3	4	5	6	7	8	9	10	11	12
A												
B												
C												
D												
E												
F												
G												
H												

2. Depending on the colors you've chosen for your design, decide on the recipes that should be used for your colors by mixing colors with your micropipette.
3. Create a clue card for your design that specifies the wells that should be filled with each color and includes your color recipes.