

Soft Lithography: Making a pH Sensor Microfluidic Device

Pre-Lab Preparations

Before the lab, 3 solutions must be made, an acid solution, a basic solution, and an unknown solution per lab group.

Pre-Lab Materials

- 3 vials
- Vinegar solution or HCl
- Antacid and water or NaOH
- Labels (tape and marker)

Pre-Lab Procedure

1. Prepare and label three 10 mL solutions in glass vials
 - a. Acid Solution: vinegar solution or HCl
 - b. Basic Solution: water and antacid solution or NaOH
 - c. Unknown: use either the acid or base solution (You might want to make an unknown of the acid solution for half of the lab groups and the basic solution for the other half of the groups.)



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Materials

Per every 3 lab groups:

- 170 g of lemon-flavored Jell-O (2 small boxes or one large box)
- 1 pouch (7 g each) of unflavored (the Original) Knox Gelatine
- Hot plate
- Stirring rod
- 500 mL beaker
- 250 mL beaker
- Water

Per lab group

- Drinking Straw
- Metal pan
- Three disposable 3 mL syringes with labels
- Four small pieces of pH paper
- 5 Coffee stirrers (~3" long)
- 2 petri dishes
- PAM no-stick cooking spray
- Single- and double-sided tape
- Acid Solution
- Basic Solution
- Unknown Solution



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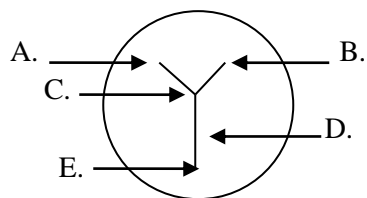
Pre-Lab Questions

What is the difference between an acid and a base?

Why is it important to know if fluids in the body are the correct pH?

When an acid and base are mixed in Y shaped chip (see below) with the acid inserted at A and the base inserted at B., what do you think the pH (approximately) will be at certain places along the path?

- A.
- B.
- C.
- D.
- E.

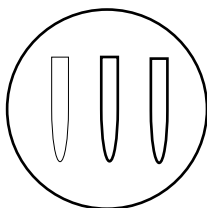


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Procedure – Day 1

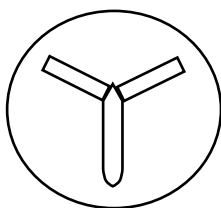
Preparing the parallel channel mold

1. Prepare the mold by dabbing the inside rim of a petri dish with cooking spray.
2. Tape 3 coffee stirrers to the plate using double-sided tape about 1” apart as shown below.



Preparing the Y-mold

1. Prepare the mold by dabbing the inside rim of a petri dish with cooking spray.
2. Cut coffee stirrers as follows:
 - a. Cut one coffee stirrer about 3” long with a dagger edge on one end.
 - b. Take a second coffee stirrer and cut into two 1” pieces
3. Tape the long coffee stirrer down the middle of the plate using double-sided tape as shown below.
4. Tape the two smaller stirrers at the dagger-shaped end of the longer stick using double-sided tape.



Preparing the gelatin

1. Heat 120 mL of water to a boil in a 500mL beaker.
2. Dissolve 170 g of Jell-O in the boiling water and stir.
3. In a 250 mL beaker, dissolve one pouch of Knox Gelatine powder in 120 mL of water and stir with a stirring rod.
4. Once the Jell-O solution has come to a boil, remove from the heat and add the gelatine solution.

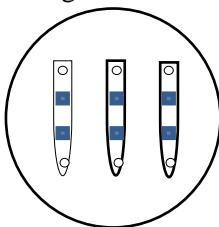


5. Heat the mixed solution to a boil, and then remove from the heat.
6. Pour the solution into 6 molds.
7. Keep the molds at 4 °C at least overnight (best for at least 2 days).

Procedure – Day 2

Parallel Analysis

1. Obtain a parallel-channel Jell-O mold and an aluminum pan.
2. Peel the Jell-O pattern out of the mold and press (channel side down) onto an aluminum plate.
3. Have one person carefully lift up one end of the mold. You should be able to lightly see where the channels were on the plate.
4. Using double sided tape, a different person should tape two small pieces of pH paper in each channel as shown below. Carefully replace the Jell-O so as to create a good seal between the Jell-O pattern and the pan. There should be no air bubbles and the pH paper should be contained within the channel.
5. Puncture two inlet holes and two outlet holes at the top and bottom of the channels using a drinking straw and a gentle twisting motion.

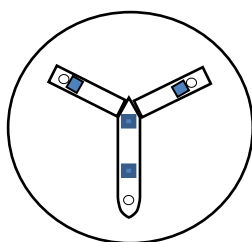


6. Label the 3 disposable syringes: acid, base, and unknown. Fill each syringe with the appropriate liquid.
7. Hold the syringes perpendicular to the mold so that they do not let any air into the channel. Slowly release the solutions at the same time into the channels. Do not remove the syringes until the solutions reach the outlet hole.
8. Record the pH of each solution at each position of the pH papers in the data table.



Laminar Flow

1. Obtain a Y channel Jell-O mold and an aluminum pan.
2. Peel the Jell-O pattern out of the mold and press (channel side down) onto an aluminum plate.
3. Have one person lift up one end of the Jell-O pattern off the plate. You should be able to lightly see where on the channels were on the plate.
4. Using double sided tape, a different person should tape two small pieces of pH paper in each channel as shown below. Carefully replace the Jell-O so as to create a good seal between the Jell-O pattern and the pan. There should be no air bubbles and the pH paper should be contained within the channel.
5. Puncture two inlet holes and one outlet hole at the top and bottom of the channels using a drinking straw and a gentle twisting motion.



6. Fill the acid and base syringe with the appropriate liquid.
7. Hold the syringes perpendicular to the mold so that they do not let any air into the channel. Slowly release the solutions at the **same time and speed** into the channels. Do not remove the syringes until the solutions reach the outlet hole.
8. Record the pH of each solution at each position of the pH papers in the data table.



Data

What was the pH of the solutions at each of the following points?

Mold 1

	Inlet	Outlet
Acid Solution		
Basic Solution		
Unknown Solution		

Mold 2

	pH
Acid inlet	
Base Inlet	
1 st pH indicator	
2 nd pH indicator	
Outlet	

Discussion Questions

Describe the flow of the liquid through the parallel-channel mold.

What do you think parallel analysis means? Why might it be important to compare two samples at one time?

Why would parallel analysis be useful on a lab in a chip?



What does the parallel channel tell you about the unknown solution?

Why is it important to obtain a good seal between the molds and the pan?

Why is the outlet hole needed? Why do you have to keep the syringe against the mold until the solution reaches the outlet hole?

Describe the flow of the solution in the Y-channel mold. Why do you think this happens?

