ASCP STRONGERTOGETHER

Lo-Fi Laboratory Engagement

A Guide for Getting the Lab Out of the Laboratory

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ASCP Negotiation & Advocacy Toolbox
A roadmap to advocating for the needs of your laboratory
supportcdconelab.org/toolbox

This project is supported by Cooperative Agreement number CDC-RFA-OE22-2202 (CFDA No. 93.322), funded by the Centers for Disease Control and Prevention. Its contents are solely the responsibility of the American Society for Clinical Pathology and do not necessarily represent the official views of the Centers for Disease Control and Prevention or the Department of Health and Human Services. This project was funded, in part, with federal funds to the American Society for Clinical Pathology (NU47OE000107).

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Introduction

Recruiting for laboratory professions is hard.

Let's say you've been invited to attend a career fair on behalf of the laboratory professions. You have a small table, maybe a tablecloth, and some pamphlets - what do you bring to demonstrate the clinical laboratory?

Automation? Impossible.

Microscopes? Delicate. Expensive.

Bacteria? Stinky. Dangerous. Explicitly forbidden.

Blood? You get my point here...

How can we increase the visibility of laboratory professions when so much of what we do is stuck behind a biohazard sign with required PPE?

When you think of laboratory career engagement, you may think of hosting participants in a real laboratory, testing simple, but realistic samples. This is high fidelity or Hi-Fi Engagement, as it is the truest representation of the medical laboratory. While still an important step towards gaining interest in the laboratory professions, Hi-Fi Engagement isn't without its problems. For one, it requires an available laboratory. Specimens can be difficult to procure, grow, or mock-up. Time and effort are required of the hosting staff to recruit, register, prepare, and run the event. For these reasons, Hi-Fi Engagement events tend to be less frequent and their audiences carefully targeted.

But what if we were to let go of the notion that laboratory engagement had to be exactly true to life? By taking the concepts of laboratory testing and reimagining them as a simulation using non-biohazardous props, we create low fidelity or Lo-Fi Engagement. Once built, these low-cost props can travel to career fairs and into classrooms. They can be used by themselves to demonstrate a single concept or compiled for more complex case studies. Most never expire and can be used again and again for a standardized experience for multiple audiences.

This booklet contains several Lo-Fi Engagement props and activities that have been constructed and used to demonstrate the concepts of the medical lab outside of the laboratory. While these activities were written with other laboratory professionals in mind, they can be adapted by anyone who wants to share and promote the laboratory professions with others!

Lo-Fi Props & Activities

In this section you will find a list of Lo-Fi props and activities that can simulate laboratory testing concepts. Activities are divided into four main subjects: Immunohematology, Hematology, Microbiology, and Chemistry / Urinalysis.

Each activity is listed with the following format:

Activity Name Example

A short description of the activity and the laboratory testing it mimics.

COST: The relative cost of all required materials for the activity's construction

Scale: **$** ≤ $10 **$$** = $11-20 **$$$** = $30-40 **$$$$** ≥ $40

DIFFICULTY: Approximately how difficult the activity prop is to construct

Scale: ★☆☆ - ★★★

SHELF LIFE: Approximately how long the activity will last after creation

MATERIALS REQUIRED:

A list of materials required to assemble and use the activity. If unfamiliar with the listed material, please see the Material Glossary for further information.

Instructions for Prop Assembly

Step-by-step instructions to create the prop(s) necessary for the activity.

Suggestions for Activity

A simple example procedure for how to use the activity to demonstrate a particular laboratory test or concept. It may contain possible scripts or questions to ask participants. Use these ideas to springboard your own activities to meet the needs of your audience or classroom setting!

Immunohematology Activities

Blood Typing Agglutination Activity – Glitter Method

This activity simulates how a laboratory professional would perform blood type testing via the slide method. Participants are asked to gently swirl petri dishes of "large chunk red glitter" and observe the concept of agglutination. This is simulated with chunky/super chunky red glitter. The dishes of glitter look unassuming when lying flat, but the agglutination is revealed after swirling, allowing participants to declare each dish-reaction either "positive" or "negative," correlate that result with a found antigen, and declare the simulated patient's blood type.

COST: $

DIFFICULTY: ★☆☆

SHELF LIFE: ∞

MATERIALS REQUIRED:

- 3 Petri dishes (100x15mm, non-sterile)
- Wax paper
- Chunky/super chunky red glitter
- Clear-drying liquid glue of choice
- Optional: Toothpicks

Instructions for Prop Assembly

1. Lay out a section of wax paper to protect your working area from glue and glitter.
2. Set out 3 petri dishes.
3. To each petri dish, add enough large chunk red glitter so that the back of the petri dish is coated when lying flat, but can still be easily swirled when the petri dish is rocked.
4. With your petri dish as a reference, assess approximately how large you would like your glitter-agglutination clumps to be.
5. On the wax paper, pour the desired amount of glitter for the agglutination size.
6. Add a dollop of glue to the glitter.
7. Optional: Take a toothpick and spread the glue to allow for even coating.
8. Add additional glitter to coat the glue dollop and use a wax paper shred with your finger or a toothpick to press the dot into a flat shape.
9. Repeat until you are satisfied with the number and quality of your glitter-agglutination clumps.
10. Allow glitter-agglutination clumps to fully dry, then add to your petri dish(es) of choice.
11. Glitter should look unassuming while sitting flat with the agglutination easily revealed when the petri dish is swirled gently.

Suggestions for Activity

- Pre-determine what blood type result you would like participants to obtain, using the following chart as a guide:

POSSIBLE BLOOD TYPES									
Antisera		O-	O+	A-	A+	B-	B+	AB-	AB+
	Anti-A	-	-	+	+	-	-	+	+
	Anti-B	-	-	-	-	+	+	+	+
	Anti-D	-	+	-	+	-	+	-	+

  - Keep plates in order of Anti-A, Anti-B, and Anti-D to prevent confusion.
  - For "positive" result(s): place a petri dish with glue-glitter agglutination clumps.
  - For "negative" result(s): place a petri dish with only loose glitter.

- Use paper or masking tape to create labels for Anti-A, Anti-B, and Anti-D that can be easily rearranged, if needed.
  - Do not label the individual petri dishes if you plan to reuse the plates for multiple activities.

- Explain to participants:
  - the basics of antigen-antibody reaction and agglutination
  - the 3 antigens being tested for during blood typing and their 3 anti-sera reagents
  - how these 3 antigens determine human blood types

- Explain that on the table are "patient red blood cells" that require blood typing

- Have participants gently swirl each petri dish to check for glue-glitter agglutination

- After each petri dish is swirled, ask or lead participants through the following questions
  - Did they see agglutination?
  - Did an antibody find its antigen?
  - Based on the antisera reagent, which antigen is present on the "patient red blood cells"?

> **Example:** "So you see clumps? That's agglutination! That means an antibody has found its specific antigen. We know what antibody we added because it's right in the name, Anti-A. So, based on your results, what antigen do you think they have? Yes, they have the A antigen!"

- After swirling all 3 petri dishes and talking about the results, ask participants what the patient's blood type is.

- If desired, extrapolate further on this activity by exploring what blood types this patient could or could not be transfused with, how blood transfusions work, or what disease states may cause someone to need blood products.

Blood Typing Agglutination Activity – Milk and Vinegar Method

This activity simulates how a laboratory professional would perform blood type testing via the slide method. Participants are asked to combine and gently swirl a simulated blood-like mixture (red-dyed reconstituted powdered milk) with simulated antisera reagents (dyed water or white distilled vinegar). The powdered milk in the simulated blood will curdle when exposed to vinegar reagent, mimicking the appearance of agglutination and producing a "positive" result, while exposure to a water reagent will produce no curdling and simulate a "negative" result. By using a combination of vinegar and water reagents, participants will be able to determine the blood type of the simulated patient.

COST: $

DIFFICULTY: ★★☆

SHELF LIFE:
Water & White Distilled Vinegar Reagents: ∞

Blood-like Mixture: Refer to Powdered Milk label and instructions

MATERIALS REQUIRED:

- 3 dropper bottles, one each labeled Anti-A, Anti-B, and Anti-D reagents
- Water
- White distilled vinegar
- Toothpicks
- Food coloring – red, blue, and yellow
- Wax paper
- Powdered milk
- Small container, bowl, or cup for mixing
- Disposable pipettes
- EDTA vacutainer or test tube with cap
- Paper towels or disposable bench protectors
- Glass slides

Instructions for Prop Assembly

Creating the Antisera Reagents

1. Determine the desired blood type result for the activity, as this cannot be changed and is bound by the materials used for each reagent! Consider the following chart for expected positive and negative reactions for each blood type:

	POSSIBLE BLOOD TYPES								
Antisera		O-	O+	A-	A+	B-	B+	AB-	AB+
	Anti-A	-	-	+	+	-	-	+	+
	Anti-B	-	-	-	-	+	+	+	+
	Anti-D	-	+	-	+	-	+	-	+

   - If a reagent is expected to test POSITIVE: Fill the reagent bottle with vinegar.
   - If a reagent is expected to test NEGATIVE: Fill the reagent bottle with water.

2. On a small piece of wax paper, disperse a drop of blue food dye and a drop of yellow food dye.
3. Take a toothpick and gently swirl into the blue food dye droplet, then mix into the Anti-A reagent bottle containing either vinegar or water. Repeat until the liquid is a light-blue color.
4. Take a new toothpick and gently swirl into the yellow food dye droplet, then mix into the Anti-B reagent bottle containing either vinegar or water. Repeat until the liquid is a light-yellow color.
5. Leave the Anti-D reagent bottle containing vinegar or water as is (do not mix with food dye).

If creating multiple sets of reagent bottles all with the same result, you may choose to color your reagent liquids in bulk, then pour them into individual bottles.

1. Pour a desired amount of vinegar into a clear cup, then add a single drop of the desired food coloring, diluting with more vinegar or adding more dye as necessary.
2. Repeat with water and the desired food coloring.
3. Pour dyed liquids into their corresponding reagent containers.
4. Label containers (if not already labeled).
5. Save any leftover dyed liquid for future activities.

Creating the Blood-like Mixture

1. In a small mixing container, combine approximately 10mL of water, a tablespoon of powdered milk, and 5 drops of red food dye. Continue to add to the mixture until it has the appearance of milky blood.
2. Test the mixture on a glass slide or piece of wax paper by using a disposable pipette to add 1 drop of the blood-like mixture followed by 1 drop of vinegar.
3. Gently rock and swirl the slide or paper. The blood-like mixture must produce easily identifiable clumps when exposed to vinegar. If not, add more powdered milk to the container of blood-like mixture, remix, and re-test.
4. Once tested successfully, pour the desired amount of blood-like mixture into your vacutainer(s) or test tube(s). Label with mock “patient” information, if desired.

Suggestions for Activity

- Pass out the following items per participant or per pair of participants:
  - Paper towel or benchtop protector
  - A set of antisera reagents (Anti-A, Anti-B, and Anti-D)
  - A vacutainer or capped test tube of blood-like mixture
  - 3 glass slides (one for each reaction)
  - 1 disposable pipette
- Optional: Ask participants to label one slide each: Anti-A, Anti-B, and Anti-D.
- Explain to participants:
  - the basics of antigen-antibody reaction and agglutination
  - the 3 antigens being tested for during blood typing and their 3 corresponding antisera reagents
  - How these 3 antigens determine human blood types
  - The “patient blood sample” in front of them requires typing
- Instruct participants to carefully open their vacutainer or test tube of blood-like mixture, then use their disposable pipette to distribute 1 drop onto each of their 3 slides.
- Instruct participants to then add 1 drop of their Anti-A reagent to the liquid on their first slide (or slide labeled Anti-A).
- Demonstrate to participants how to rock their slide, gently mixing the liquids.
- Ask participants if their result is positive or negative for agglutination and have them record their result on paper, answer out loud, or commit to memory until the end of testing.
- Repeat testing and resulting with Anti-B on second slide and Anti-D on third slide.
- Ask participants for their final interpretation of the “patient” blood type and what blood types could be transfused into their “patient” if a transfusion was required.

Hematology Activities

White Blood Cell Differential – Card Method

This activity simulates performing a white blood cell differential without the need for a microscope or blood smears. Participants are asked to sort several cards of high-quality white blood cell photos based on morphology. Complexity can be added with the addition of malignant cells or by skewing the number of each cell line to correlate with a disease state, allowing participants to correlate a hematological picture and a most probable diagnosis.

COST: $

DIFFICULTY: ★☆☆

SHELF LIFE: ∞

MATERIALS REQUIRED:

- High-quality hematology photos (such as from **Cell Wiki©**)
- Image editor of choice
- Cardstock
- Printer
- Scissors
- Optional: Laminator or Self-Adhesive Laminating Sheets

Instructions for Prop Assembly

1. Find and save your desired hematology images to a computer file.
2. Use an image editor of your choice to array your chosen photos in a format that meets your desired image size and cutting needs.
3. Print your images onto cardstock and carefully cut out into cards.
4. Optional: Array cards in a laminate sheet, leaving some space in between each card, then feed the sheet through the laminator and cut after cooling.

Suggestions for Activity

- Create a 10 to 20-cell differential (depending on your audience and space), mix the cards around or pass them out to participants, and ask them to sort the cells based on their appearance.
- Possible differential activities:
  - Normocytic: All cells have normal morphologies.
  - Leukemia: Add a single blast card and ask participants to sort them based on morphology – will they notice the cancer cell? Use this as a talking point about the importance of laboratory professionals working the hematology department of the laboratory to identify leukemias and lymphomas.
  - Case Study: Print cards with cell morphologies that match a given clinical presentation such as a viral, bacterial, or parasitic infection. Talk participants through a simulated patient's symptoms before having them sort the cards, then discuss what conclusions they can come to regarding the patient's diagnosis.

White Blood Cell Differential – Ball Method

This activity simulates performing a white blood cell differential test without the need for a microscope or blood smears. Participants are asked to sort several painted 2” balls representing cells into containers based on their colors and characteristics, similar to how laboratory professionals or a clinical analyzer would sort cells. If desired, complexity can be increased with the addition of a painted malignant morphology or by skewing the number of each painted ball type to correlate with a disease state, allowing participants to correlate a hematological finding with the most probable diagnosis.

COST: $ - $$ (depending on quantity of items)

DIFFICULTY: ★★☆

SHELF LIFE: ∞

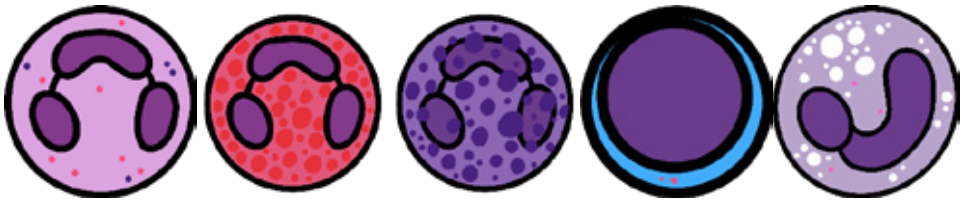
MATERIALS REQUIRED:

- 2” plastic balls in pink, blue, white / grey, and purple
- Acrylic paint in purple, pink, red, and white (if using grey balls)
- A small palette, dish, lid, or protected surface for paint
- Paintbrushes, small
- A small dish of water
- Paper towels
- Egg carton or similar disposable structure to hold drying balls

Instructions for Prop Assembly

Because this activity relies on simple colors and shapes to define complex white blood cell morphologies, you may refer to the graphics below as an artistic guideline:

WHITE BLOOD CELL COLOR AND SHAPE GUIDE



Neutrophil Eosinophil Basophil Lymphocyte Monocyte

Assemble your desired number of plastic balls with the following color assignments:

- Pink: Neutrophils & Eosinophils
- Purple: Basophils
- Blue: Lymphocytes
- White / Grey: Monocytes

Painting the Nucleus

Refer to the graphical guide above and the following list for cell-specific nuclear shapes:

- **Neutrophils, Eosinophils, & Basophils:** Create 3 to 4 small, ovular or bean-shaped segments, then connect the segments with a contiguous line
- **Lymphocytes:** Create 1 circle, taking up much of the space seen with a straight-on view
- **Monocytes:** Create a 1 horseshoe shape, but can add some ovals for complexity

1. Dispense a small amount of purple craft paint onto your palette, dish, lid, or surface, adding more paint as needed throughout the process.
2. Take your paintbrush and wet it in the dish of water, dabbing it lightly on a paper towel afterwards.
3. Dip your paintbrush into the purple paint and stipple the brush in the following patterns to mimic each cell type's nucleus shape.
4. Place each freshly-painted ball face up in an egg carton or similar holding structure until completely dry before moving on to additional painting.

Painting the Granules / Vacuoles

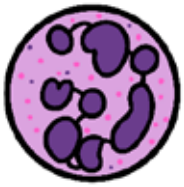
Refer to the graphical guide above and the following list for cell-specific granule/vacuole colors:

- **Neutrophils:** Many tiny pink and some tiny purple granules
- **Eosinophils:** Numerous large red granules
- **Basophils:** Numerous large purple granules that may cover the nucleus
- **Lymphocytes:** None necessary, but may add rare tiny pink granules to one or two lymphocyte balls as an example
- **Monocytes:** Some small to large white vacuoles

1. Starting with a single color, dispense a small amount of purple, pink, red, or white craft paint onto your palette, dish, lid, or surface, adding more paint as needed throughout the process.
2. Take your clean paintbrush and wet it in the dish of water, dabbing it lightly on a paper towel afterwards.
3. Carefully paint the granules/vacuoles on roughly half of each ball's surface, leaving the unpainted surface area for storing the ball to dry.
4. Place each freshly-painted ball face up in an egg carton or similar holding structure until completely dry.
5. Once dry, finish painting granules/vacuoles on the unpainted portion of the ball.
6. Repeat this process for each desired granule/vacuole paint color for each cell type.

Painting Abnormal Morphologies

There are many abnormal morphologies, from reactive to malignant, that can be added to this activity for additional complexity. These diverse cases require additional research into their correlated white blood cell differential and morphologies but can still be broken down into simple shapes and colors. The following are only a few examples:



Hypersegmented Neutrophil

Reactive Neutrophil with Bacteria

Malignant Blast Cell

Malignant Lymphoid Cell

Suggestions for Activity

- A classroom-wide introduction to white blood cells
  - Give each student a single ball and ask them to self-sort into groups based on the colors and shapes they see.
  - Explain the different types of white blood cells and their roles in the immune system, pointing out each student group or having student groups guess their identity.
  - For added complexity, explain what a normal distribution would be based on the classroom size and ask the class if their "patient" is normal or abnormal.
  - For added complexity, add an abnormal morphology, such as a malignant cancer cell, and ask the class to double-check their groups for a cell that doesn't belong. Once found, explain how the immune system checks itself for cancerous cells continuously.
- A career fair tabletop activity
  - Using 2" clear acrylic drawer organizers or any similar transparent container for sorting, ask participants to sort a "sick patient's cells" based on their colors and shapes.
  - Provide a reference flyer such as the "Meet Your Blood!" Flyer (Appendix 2).
  - Ask participants to correlate their differential findings with what could possibly be making a patient feel sick.

Microbiology Activities

Agar Plates – Resin Method

This activity simulates the look of various agar plates used in the speciation of bacteria by combining a resin with either mica powder or dye. Once fully cured, the prop-agar can be built upon with different materials to simulate different types of bacteria.

COST: $$

DIFFICULTY: ★★★

SHELF LIFE: ∞

MATERIALS REQUIRED:

- Silicone mat for work area protection
- Nitrile gloves
- Optional: Mask or respirator approved for epoxy resin work
- Epoxy resin kit (containing both resin and curing reagent)
- Disposable clear plastic cups
- Disposable wooden stir sticks OR silicone stir sticks
- Coloring agent
- Mica powder for opaque agars
- Resin dye for translucent agars
- Petri dishes (100x15mm, sterile not required)
- Optional: Denatured alcohol and paper towels for resin spills

Instructions for Prop Assembly

1. Read the instructions for your epoxy resin kit as exact instructions may vary.
2. Prepare your working surface and lay down a silicone mat.
3. Have all materials prepped on the silicone mat and keep a trashcan nearby.
4. Don PPE.
5. Warning: Throughout the process, change gloves immediately if soiled using a glove-in-glove technique, tossing gloves directly into a trashcan.
6. Warning: Epoxy resin will solidify on surfaces. Keep all epoxy resin work over the silicone mat. Paper towels and denatured alcohol may be used to clean up resin spills.
7. Pour an amount of resin in a disposable clear plastic cup, then pour an approximately equal volume of curing agent in another disposable clear plastic cup. Approximately 5 oz of each will make ~11 agar plates.
8. Combine the liquid into one cup and begin to stir.

9. Refer to epoxy resin kit for exact mix times.
10. If color is desired, add a small amount of either mica powder or resin dye and remix.
11. Continue adding small amounts and remixing until desired color is achieved, working quickly as resin will begin to cure.
12. Pour resin mixture into petri dishes until approximately half full or at desired fullness.
13. Leave resin-filled petri dishes to cure and refer to epoxy resin kit for exact cure times.
14. Dispose of plastic cups in trash.
15. Spills of liquid resin or curing agent can be absorbed with paper towels and disposed of in the trash, then wipe contaminated areas with paper towels and denatured alcohol.
16. Spills of the fully mixed resin on the silicone mat can be left to harden. After full cure time, the silicone mat can be flexed to dislodge the hardened resin bits. Dispose in trash.

Adding Bacteria

Simulated bacterial growth can be added to fully cured agar props in numerous ways, depending on time, skill, and desire to experiment! Regardless of materials used, try to pour or pipe your material into 3 or 4 quadrants of decreasing "growth," similar to how real agar would be struck.

This example uses puffy paint in several different colors.

The left side of the plate serves as the primary quadrant, where bacterial growth is the thickest and the paint "growth" runs into itself without much differentiation.

Out of the primary is a slightly less dense secondary quadrant. Much of the "growth" is still in solid lines of paint, but there are standalone circles representing single colonies of bacteria.

Out of the secondary quadrant is the tertiary quadrant, which is represented here with only circles dotted in straight lines, as the bacterial "growth" diminishes.

Other materials to experiment with for simulated bacteria:

- 3D / Puffy / Fabric Paint (pictured)
- Resin
- Silicone
- Letter-Sealing Wax

Suggestions for Activity

- Create sets of simulated blood, chocolate, and MacConkey agar. Add simulated bacteria that would match the expected morphologies found on the plates. With guided help or an additional flyer, ask participants to identify the organisms based on their patterns of growth. For example:
    - *Staphylococcus* species
        - » Blood Agar: Pure white growth and colonies
        - » Chocolate Agar: Pure white growth and colonies
        - » MacConkey Agar: No growth
    - *Escherichia coli*
        - » Blood Agar: Pure grey growth and colonies
        - » Chocolate Agar: Pure grey growth and colonies
        - » MacConkey Agar: Pure pink colonies (lactose fermentation)
    - *Neisseria* species
        - » Blood Agar: No growth
        - » Chocolate Agar: Pure tiny growth and colonies
        - » MacConkey Agar: No growth
- Compare an agar plate with 3-4 different "bacteria" types present on the plate versus an agar plate with only 1 "bacteria" present. Ask participants if more bacteria implies a patient is more sick, then explain normal human flora.
- Case Study: Create sets of simulated blood, chocolate, and MacConkey agar and add simulated bacteria of an obvious morphology or that of normal flora.

Agar Plates – Soap Method

This activity simulates the look of various agar plates used in the speciation of bacteria through the use of a dyed soap base. Once fully set, additional dyed soaps can be added to simulate bacterial colonies.

COST: $-$$

DIFFICULTY: ★☆☆

SHELF LIFE:

Months to years, if protected from humidity

MATERIALS REQUIRED:

- Optional: Wax paper or workspace protector
- Optional: Washable knife for cutting soap base
- Microwave-safe mixing container
- Disposable large stir stick or washable metal spoon
- Microwaveable soap base
    - » White glycerin soap base for opaque agars
    - » Clear glycerin soap base for translucent agars
    - » Can experiment with other soap bases, if desired
- Soap-making colorants in desired colors
- Petri dishes (100x15mm, sterile not required)

Instructions for Prop Assembly

The following instructions are approximate. Carefully read the instructions provided for the chosen soap base and always defer to temperatures and times provided.

1. Using a knife, cut soap base into small cubes for easier melting.
2. Using provided soap base instructions, heat the soap base in the microwave for small increments at a time, stirring frequently.

WARNING: Do not overheat the soap base, as this can cause the soap to reach scorching temperatures that may cause injury.

3. Add a small amount of soap colorant and mix, adding more and remixing until desired color is achieved.
4. Pour melted soap into petri dishes until approximately half full or until desired fullness.
5. Let cool according to soap base instructions.

Adding Bacteria

1. Following the above instructions for heating and coloring the soap base.
2. Take a disposable pipette or similar piping mechanism and add the melted, colored soap base.
3. Distribute the melted soap base back and forth across the top of the soap-agar, doing your best to mimic the quadrant pattern used to streak bacteria.

For an example of a quadrant pattern, see Agar Plates – Resin Method.

a. Primary quadrant: The area of the thickest growth where soap may run together.
b. Secondary quadrant: An area of thinning growth in a zigzag line from the primary quadrant.
c. Tertiary quadrant: An area of only individual dots (bacterial colonies) in a zigzag line from the secondary quadrant.

Suggestions for Activity

See Resin Method for suggestions.

Chemistry / Urinalysis Activities

Chemistry Activity – Printout Method

This supplemental activity simulates how a laboratory professional would review chemistry results as provided by an automated analyzer. While it does not simulate actual clinical chemistry methodology, as a handout it can be a useful addition to other activities such as a classroom case study.

COST: $

DIFFICULTY: ★☆☆

SHELF LIFE: ∞

MATERIALS REQUIRED:

- Spreadsheet Program (e.g. Microsoft Excel)
- Printer
- Optional: Laminator

Instructions for Prop Assembly

1. In a Spreadsheet Program, label the following 6 columns (as in the example shown below):
   a. Chemical Analyte
   b. Purpose (Simplified)
   c. Reference Low
   d. Reference High
   e. Patient Values
   f. Units

Chemical Analyte	Purpose (Simplified)	Reference Low	Reference High	Patient Values	Units
Sodium	Important Electrolytes	136	145		mmol/L
Potassium	Important Electrolytes	3.5	5.1		mmol/L
Chloride	Important Electrolytes	98	107		mmol/L
CO2	Important Electrolytes	22	32		mmol/L
Osmolality	Blood Concentration	275	295		mOsm/kg
Anion Cap	Acid-Base Balance	4	15		
BUN	Kidney Function	6	20		mg/dL
Creatinine	Kidney Function	0.44	1.03		mg/dL
BUN/Creatinine Ratio	Kidney Function	10.0	20.0		
GFR	Kidney Function	>59			
Glucose	Blood Sugar	70	139		mg/dL
Calcium	Important Mineral	8.6	10.4		mg/dL
Total Protein	Protein	5.8	8.2		g/dL
Albumin	Liver Function	3.5	5.1		g/dL
Total Bilirubin	Liver Function	0.3	1.0		mg/dL
ALP	Liver Function	32	91		IU/L
AST	Liver Function	15	41		IU/L
ALT	Liver Function	7	52		IU/L
Phosperous	Important Mineral	2.4	4.7		mg/dL
Magnesium	Important Mineral	1.8	2.5		mg/dL
CHFP	Heart Function	0	100		pg/mL
Troponin	Heart Function	<0.04	>0.04		ng/mL
UTSH	Thyroid Function	0.400	4.300		mcIU/mL

2. Under Chemical Analyte, create a list of chemical analytes you would like your participants to consider, one per cell.
3. Under Purpose (Simplified), write a very simple 1-to-3-word description of why each chemical analyte is important or would need to be analyzed, such as "Important Electrolyte" or "Kidney Function."
4. Under Reference Low, list the expected cutoff value that would flag a patient result as lower than normal for each analyte.
5. Under Reference High, list the expected cutoff value that would flag a patient result as higher than normal for each analyte.
6. Under Patient Values, list the analyte values of the patient as needed for the example or case study.
7. Under Units, provide the units of measure for the analyte.
8. Format the spreadsheet as desired, possibly including bolding row and column headers, adding a grid / cell border, or changing text color.
9. To print, select all cells used from the top left Chemical Analyte to the bottom right final Unit cell, then click on File > Print.
10. If using Microsoft Excel, be sure to change the Print setting from "Active Sheet" to "Current Selection" to print only the cells you are using and not any unused cells.
11. Optional: Laminate the printed document.

Suggestions for Activity

- This printout is not intended to be used as an activity by itself, but to discuss clinical chemistry results in a larger case study:
    - Describe a simulated patient's symptoms, then hand them a chemistry result printout and ask them to circle or highlight any result that is either low or high. Based on the Purpose (Simplified), what could be wrong with the patient?
    - For larger classrooms, consider cutting the chemistry results into smaller subsections and handing out a single subsection to each participant. You may want to name these subsections, such as the "Electrolyte Group," so that you can verbally address each group for any high or low results.

Putting It Together

In this section you'll find an example on how to combine multiple Lo-Fi prop activities with some provided flyers (See Appendix 1) to create a cohesive, slightly more complex engagement experience.

Clues in the Blood – A Tabletop Case Study

This tabletop presentation is a highly simplified, 2-step case study that focuses on Hematology, Microbiology, and Immunohematology laboratory tests. With a fictional feverish patient in the Emergency Room, participants perform a white blood cell differential activity to discover the cause of the patient's symptoms –infection of the blood! Participants then perform a blood type activity and select units for a life-saving transfusion.

Note: While this activity example is intended to introduce the work of a medical laboratory scientist (MLS), the activity, language, and references in it can be adapted, as necessary, to suit other laboratory professionals. Informational flyers available from ASCP's What's My Next website, or other vetted sources can be used in service of these modifications. The activity shown here serves as an example and framework, designed for MLS career visibility.

SUGGESTED AUDIENCE:
High school or college students

SUGGESTED ENVIRONMENT:
Career fair booth, 3" table or longer

ESTIMATED RUN TIME:
5 minutes, depending on engagement level

ACTIVITIES USED IN THIS PRESENTATION
- White Blood Cell Differential – Card Method
- Blood Typing – Glitter Method
- Agar Plates - Resin Method

TABLE FLYERS USED IN PRESENTATION
- We Are MLS (Appendix 1)
- Meet Your Blood! (Appendix 2)
- Blood Types (Appendix 3)

Presentation Setup

Preparing the Table

- Roughly divide your space for each activity and their flyer materials, with the White Blood Cell Differential – Card Method on the presenter's right and the Blood Typing – Glitter Method on the presenter's left. Reserve a small space for a resin-blood agar plate "growing" *Staphylococcus aureus*. This keeps activities in sequential order for the participant.
- Place the "We Are MLS" (Appendix 1) or similar material (e.g. the ASCP Medical Laboratory Career Roadmap, etc.) in a visible space.
- If handing out informational pamphlets (e.g. those available on ASCP's What's My Next website, etc.), place these on an outermost corner of the table.
- Optional: Consider bringing table props that may draw in participants or add professional flair, especially if given a larger table for your booth.

Preparing the White Blood Cell Differential – Card Method Activity

- Follow the instructions for the White Blood Cell Differential – Card Method.
- Print 10 –15 cards with the following quantity skew:
  - Neutrophils > lymphocytes > eosinophils ≥ monocytes > basophils
  - For Example: 15 total cards printed
    - 11 Neutrophils, 2 Lymphocytes, 1 Monocytes, 1 Eosinophils, 0 Basophils
  - Note: The differential is not intended to be realistic. It is intended to display how a differential works and what information can be gained from its result.
- Give the cards a good mix and redistribute to your liking on the table.
- Have one or two copies of the "Meet Your Blood!" Flyer (Appendix 2) or similar material available to help participants sort the cards based on morphology and to correlate their findings with a most probable diagnosis when complete.
- Optional: You may choose to print a single copy of each type of normocytic white blood cell to serve as place markers for where participants should sort each type of cell, keeping the table organized. Do not mix these in with the other case cards or lightly secure them to the table or tablecloth.

Preparing the Blood Agar Culture Plate - Resin Method

- Prepare a blood agar plate using the Resin Method and red mica powder or resin dye. Allow to cure.
- Add white "colonies" to resemble *Staphylococcus aureus* using a quadrant streaking pattern.

Preparing the Blood Typing – Glitter Method

Place printed labels for Anti-A, Anti-B, and Anti-D in left to right order from the participant's view and place one glitter dish at each, remembering the expected glitter-agglutination reaction of each dish and overall blood type.

- Have a single copy of the "Blood Types" flyer (Appendix 3) or similar material available to help guide participants through what an antigen is, how it interacts with antibodies, and what antibodies are present in certain blood types.

Running the Presentation

Introduction to the Case

- Gesture to the "We are MLS" flyer, the ASCP Medical Laboratory Career Roadmap, or other informational flyers (like those available through ASCP's What's My Next website) about laboratory professions.
- Explain briefly what MLS do and that the profession has variety, mobility, and stability.

> "Medical Laboratory Scientists are a bachelor's degree level laboratory professional who work behind the scenes in clinical laboratories. We wear a lot of hats! We can work in many areas of the laboratory including chemistry, hematology, microbiology, blood banking, and more, so our degree is very versatile! And since patients can't be treated on vibes, you can find MLS all over the U.S. in clinical laboratories helping the healthcare team with our results!"

- Explain that MLS may work with their hands, microscopes, and automated analyzers.
- Tell participants this activity only covers 3 of the possible fields: Hematology, Microbiology, and Blood Banking, which may also be called Transfusion Medicine.
- Describe the following scenario:

> "A patient is admitted to the ER with a fever, describing that they 'just don't feel very well.' Can the provider tell what is making a patient sick just by these symptoms? No! We will need more data, which is where laboratory results can help!"

Case Study Test 1 - The White Blood Cell Differential

- Referencing the "Meet Your Blood!" flyer and the optional printed placeholder cell cards, invite participants to try sorting a mixed pile of cell cards.

> "Blood was drawn in the ER and sent to the MLS in the hematology department to test the patient's blood cells. Inside a person's blood we have red blood cells, which deliver oxygen from the lungs to our tissues, we have platelets, which help our blood clot, and we have white blood cells that fight disease. As you can see, there are different types of white blood cells! By counting and sorting the patient's white blood cells into types, we can figure out what might be making them sick."

- Guide participants with helpful comments such as explanations of morphology or assuring them they have placed a cell correctly.
- When all cells are sorted, assess the participant's differential and move around any cells that are not correctly sorted.
- Give reassurance to participants:
    - If they find it easy or did well, congratulate them on their skill and tell them they may be budding MLS hematologists!
    - If they find it difficult, let them know that MLS must go through their schooling to learn hematology, and even then, not every MLS goes on to work in the hematology department.

- Briefly re-explain the simulated situation: there is a patient in the ER who is feeling sick, so we are performing this differential to give us results that will serve as clues.
- Go over the simulated differential results.

> "So, what cell type did we find the most of? Correct – neutrophils! But actually that may not help us, because neutrophils are actually the most plentiful of all our white blood cells. Let's keep checking.
>
> Our next most common white blood cell are lymphocytes – do we have fewer lymphocytes than neutrophils? Yes!
>
> The next most common are monocytes – do we have fewer monocytes than lymphocytes? Yes!

- Gesture again to the "Meet Your Blood!" flyer and ask participants what conclusion they can come to based on these results.

> "Our patient's body is producing even more neutrophils than normal and the increase in these cells means they are there to fight something. What do you think they're fighting – a virus, bacteria, or parasite? Yes, a bacterium!"

- Reveal that this patient is infected with a bacterium and that it is so small it is not normally seen in the blood when there is infection.

> "We can also culture the blood and find what is causing the infection. In this case our patient has an infection with a common bacterium called "*Staphylococcus aureus*". You may have heard of a Staph infection."

- Show the blood agar plate with *Staphylococcus aureus* growing on it.

> "This is what *Staphylococcus aureus* looks like when we grow it on a petri plate in the laboratory to diagnose the cause of the infection. This helps the doctor know what antibiotic to use for treatment."

- Explain that the patient has revealed to their provider that they also have a rash on their legs that has been red, itchy and warm.

> "Our patient has a fever and chills and also has a bad rash on their legs. The rash is red and warm to the touch and this area is a little swollen. These are signs of an infection. This infected rash is probably caused by the *Staphylococcus aureus* that has caused the fever and infection in the blood. The laboratory was able to determine the exact cause of the infection and now the patient can be given the right antibiotic to treat the rash and infection in the blood.
>
> Unfortunately, our patient was hoping they would "just get over" being sick but they also learned that they have less red blood cells than normal, making them feel even worse. How can this patient be treated?"

- Explain that not having enough red blood cells, also called anemia, can be very dangerous, so the patient will need to receive a blood transfusion.

Case Study Test 2 - Blood Typing

- Referencing the "Blood Types" flyer (Appendix 3), use the chart's top row to explain red blood cell antigens.

> "You might have heard about blood types before, such as A, B, AB, and O, and that they can be positive or negative. This is related to the combination of antigens on a person's red blood cells.
>
> Type O red blood cells are a little naked with no antigens,
>
> Type A red blood cells are covered in the A antigen,
>
> Type B red blood cells are covered in the B antigen,
>
> And type AB red blood cells are covered in both A antigens and B antigens.
>
> But what about positive or negative blood types? That's also an antigen – the D antigen. If a person has any positive type, they also have the D antigen on their red blood cells. If they're a negative type, they don't have the D antigen."

- Referencing the "Blood Types" flyer, use the chart's middle row to explain how antibodies only react with their specific antigen and how we can see that reaction.

> "So how can we tell what antigen a person has on their red blood cells? By introducing antibodies! Antibodies will only bind to their very specific antigen and so they're named that way too. The antibody Anti-A will only bind to an A antigen.
>
> When Anti-A meets A antigens, it locks in and holds on tight, grabbing any other A antigens it can find. This reaction is called agglutination and it's so strong we can see it with our naked eyes! It looks like clumping forming in the blood."

- Explain that an MLS in blood bank will take the patient's red blood cells and introduce them to 3 reagents (Anti-A, Anti-B, and Anti-D) to look for agglutination.

> "The MLS in the blood bank department will take the patient's blood and introduce it to 3 antibodies, checking for agglutination or clumping each time. These antibodies are Anti-A to check for the A antigen, Anti-B to check for the B antigen, and Anti-D to check for the D antigen."

- Starting with the glitter dish labeled "Anti-A," have the participants give it a gentle swirl and describe what they see.

> "Do you think you saw any agglutination clumps? Based on that, do you think an antibody found its antigen?"

- Repeat this step with the Anti-B glitter dish and the Anti-D glitter dish, re-explaining the D antigen's relationship to positive blood types, if needed.

- Ask the participant what they believe the patient's blood type is based on the results, referencing back the "Blood Types" flyer top row, if needed.
- Explain how the patient's blood type will influence the transfusion process.

> "Now that we know what the patient's blood type is, we can determine what type of blood they may receive. Since our immune systems make their own antibodies against blood types that aren't our own, we need to be very careful about what type of blood we transfuse. The wrong choice can be fatal!"

- Referencing the "Blood Types" flyer top row, have the participant find the patient's blood type.
- Referencing the "Blood Types" flyer bottom row, explain that the patient would be producing the shown antibodies and therefore cannot receive blood products with the corresponding antigens.

> "What type was our patient? O+, so their immune system is making antibodies to all the antigens they don't have on their red blood cells. They're making Anti-A and Anti-B antibodies. So, we can't transfuse any blood that has the A or B antigens."

- Ask participants what type of blood they think their patient should receive and why, guiding them as needed and explaining the correct answer(s).

Case Study Conclusion

- Review the case and emphasize how the laboratory results, performed by MLS professionals, influenced the patient's diagnosis and treatment.

> "We started with a sick ER patient who just wasn't feeling well.
>
> In one test, an MLS discovered our patient was producing white blood cells to fight a bacterium and the laboratory was able to grow the bacterium by culturing the patient's blood. Because of this find, the healthcare team can begin the specific drugs to fight the Staph infection right away.
>
> We also found out that our patient was anemic, which wasn't even what we were expecting from a patient whose only complaint was feeling sick!
>
> Our second test let the MLS know the patient's blood type, so that the correct red blood cells could be chosen for a life-saving transfusion and help in our patient's path to recovery."

- Hand out any stickers, swag, or pamphlets, as desired.
- Ask the participants if they have any questions and thank them for their time!

Materials Glossary

This glossary contains entries for materials that may be required by the projects listed within this book. Entries are listed alphabetically by name. All entries contain the following format and scales:

Material Name

WHERE TO FIND: The most common type of store the item can be purchased from

PROCUREMENT DIFFICULTY: The relative difficulty of finding the item to purchase on a scale of 1 to 3 possible stars (★☆☆ - ★★★)

COST: The average cost to purchase the item at its most common level of bulk on a scale of 1 to 4 dollar signs ($ - $$$$): **$** ≤ $10 **$$** = $11-20 **$$$** = $30-40 **$$$$** ≥ $40

Below these details you can find a short description of the item here. This section may also contain any suggestions for item purchase or use, as well as any potentially hazardous material warnings users should expect to follow.

3D / Puffy / Fabric Paint

WHERE TO FIND: Craft Stores, Online Retailer

PROCUREMENT DIFFICULTY: ★☆☆

COST: **$**

A thickened form of paint suitable for creating slightly raised structures and textures.

Acrylic Craft Paint

WHERE TO FIND: Craft Stores, Online Retailer

PROCUREMENT DIFFICULTY: ★☆☆

COST: **$$**

A versatile fast-drying, water-based paint. Stores may present acrylic paints in tiers of quality, such as "craft" versus "professional." For the projects within this book cost-effective versions are encouraged.

Clear Gloss Spray

WHERE TO FIND: Craft Stores, Hardware Stores

PROCUREMENT DIFFICULTY: ★☆☆

COST: **$**

An aerosol-based gloss spray dispensed from a pressurized cannister in a fine mist allowing for even, smooth coats with no brushstrokes. Provides some protection to painted layers beneath it, especially for well-handled objects.

Potentially Hazardous Material Warning: Clear gloss sprays may contain volatile compounds known to be hazardous to human health. Users should read all individual product instructions and warnings, wear suggested PPE, and work in a well-ventilated area.

Disposable Pipette

WHERE TO FIND: Laboratory Equipment Stores, Online Retailers

PROCUREMENT DIFFICULTY: ★☆☆

COST: **$**

A plastic, disposable, cost-effective pipette. May come in calibrated and non-calibrated varieties, but for the projects within this book non-calibrated is suggested.

Dropper Bottles

WHERE TO FIND: Laboratory Equipment Stores, Online Retailers

PROCUREMENT DIFFICULTY: ★☆☆

COST: **$ - $$** (based on bulk)

Small plastic or glass bottles with lids that function as a dropper bottle, similar to those used with laboratory reagents. May come in clear, frosted, or amber colors.

Food Coloring

WHERE TO FIND: Grocery Stores, Baking Stores, Online Retailers

PROCUREMENT DIFFICULTY: ★☆☆

COST: **$**

Common food coloring packet. May contain a variety of colors, but for the projects within this book red and yellow are most used.

Image Editor

WHERE TO FIND: Direct Sale from Developer, Online Retailers

PROCUREMENT DIFFICULTY: ★☆☆

COST: **$ - $$$$**

A computer program capable of editing images such as cropping, resizing, recoloring, and general format changes. Different programs may use different commands to perform image editing, so seeking a program manual or additional tutorials for in-depth editing instructions is recommended. For the projects within this book cost-effective versions are encouraged.

Laminator

WHERE TO FIND: Craft Stores, Office Stores, Online Retailers

PROCUREMENT DIFFICULTY: ★☆☆

COST: **$$$ - $$$$**

A machine used to heat-seal paper documents. Waterproofs, grants mild protection from wear and tear to paper products, and allows for the use and reuse of dry erase markers.

Lamination Sheets (Self-Adhesive)

WHERE TO FIND: Craft Stores, Office Stores, Online Retailers

PROCUREMENT DIFFICULTY: ★☆☆

COST: **$$ - $$$**

A set of laminating sheets that self-seals paper documents without the need for heat or machinery. Waterproofs, grants mild protection from wear and tear to paper products, and allows for the use and reuse of dry erase markers.

Mica Powder

WHERE TO FIND: Craft Stores, Online Retailers

PROCUREMENT DIFFICULTY: ★★☆

(dependent on color needed)

COST: **$ - $$**

Finely ground, colored powder used to add color and texture to a variety of craft products, such as resin.

Microwaveable Soap Base

WHERE TO FIND: Craft Stores, Online Retailers

PROCUREMENT DIFFICULTY: ★☆☆

COST: **$ - $$$** (based on bulk)

Easy-to-use soap base that can be melted and reshaped using only a microwave. Comes in a wide variety of types and qualities that may affect the color and texture of the final product. For projects requiring a clear finish, use a clear glycerin soap base. For products requiring an opaque finish, use a white glycerin or shea base. For the projects within this book cost-effective versions are encouraged.

Petri Dish

WHERE TO FIND: Laboratory Supply Stores, Online Retailers

PROCUREMENT DIFFICULTY: ★☆☆

COST: **$ - $$** (based on bulk)

A flat plastic dish with lid that is commonly used in laboratories to contain agar for bacterial growth; can be sterile or non-sterile in a variety of sizes. For the projects within this book, sterile laboratory-quality petri dishes are not required, so cost effective versions are encouraged.

Plastic Balls, 2” Diameter

WHERE TO FIND: Online Retailers

PROCUREMENT DIFFICULTY: ★★☆
(due to necessary colors)

COST: **$$ - $$$** (based on bulk)

Plastic balls used for children’s ball pits that come in a wide variety of colors. For the projects within this book look for mixed-color sets containing pink, blue, purple, and white.

Powdered Milk

WHERE TO FIND: Grocery Stores, Online Retailers

PROCUREMENT DIFFICULTY: ★☆☆

COST: **$**

Canned powdered milk. When reconstituted and mixed with vinegar it will produce a reaction similar to agglutination seen in some laboratory tests.

Epoxy Resin

WHERE TO FIND: Craft Stores, Hardware Stores, Online Retailers

PROCUREMENT DIFFICULTY: ★☆☆

COST: **$$ - $$$$** (based on bulk)

A 2-part mixture of resin and a curing agent that forms a clear, hard surface after a dedicated time of reagent mixing and curing. It can be enhanced with resin dyes or powders for color as well as sanded, polished, or molded (in silicone) for a desired shape. For the projects within this book cost-effective versions are encouraged.

Potentially Hazardous Material Warning: Uncured epoxy resins can cause eye and skin irritation. Users should read all individual product instructions and warnings, wear suggested PPE, and work in a well-ventilated area.

Spray Paint

WHERE TO FIND: Craft Stores, Hardware Stores

PROCUREMENT DIFFICULTY: ★☆☆

COST: **$$**

An aerosol-based paint dispensed from a pressurized cannister in a fine mist allowing for even, smooth coats with no brushstrokes.

Potentially Hazardous Material Warning: Spray paints may contain volatile compounds known to be hazardous to human health. Users should read all individual product instructions and warnings, wear suggested PPE, and work in a well-ventilated area.

Spreadsheet Program

WHERE TO FIND: Microsoft, Google, Online Retailers

PROCUREMENT DIFFICULTY: ★☆☆

COST: **$**

A computer program capable of editing spreadsheets, commonly available with a computer’s operating system (Excel) or provided for free online (Google Sheets), allows for easy, clean formatting for certain printable documents.

Vacutainer Test Tubes

WHERE TO FIND: Laboratory Supply Stores, Online Retailers

PROCUREMENT DIFFICULTY: ★★☆

COST: **$$**

Test tubes used for blood collection and blood-based laboratory testing. Color-coded stopper tops correlate to a type of chemical additive found within the tube. While vacutainers may add realism, they can also be substituted with capped test tubes or other easy to procure sample containers.

Potentially Hazardous Material Warning: Opened vacutainer test tubes may contain chemical additives that should be handled with caution. Users should read all individual product instructions and warnings, and wear suggested PPE.

Vinegar

WHERE TO FIND: Grocery Stores, Online Retailers

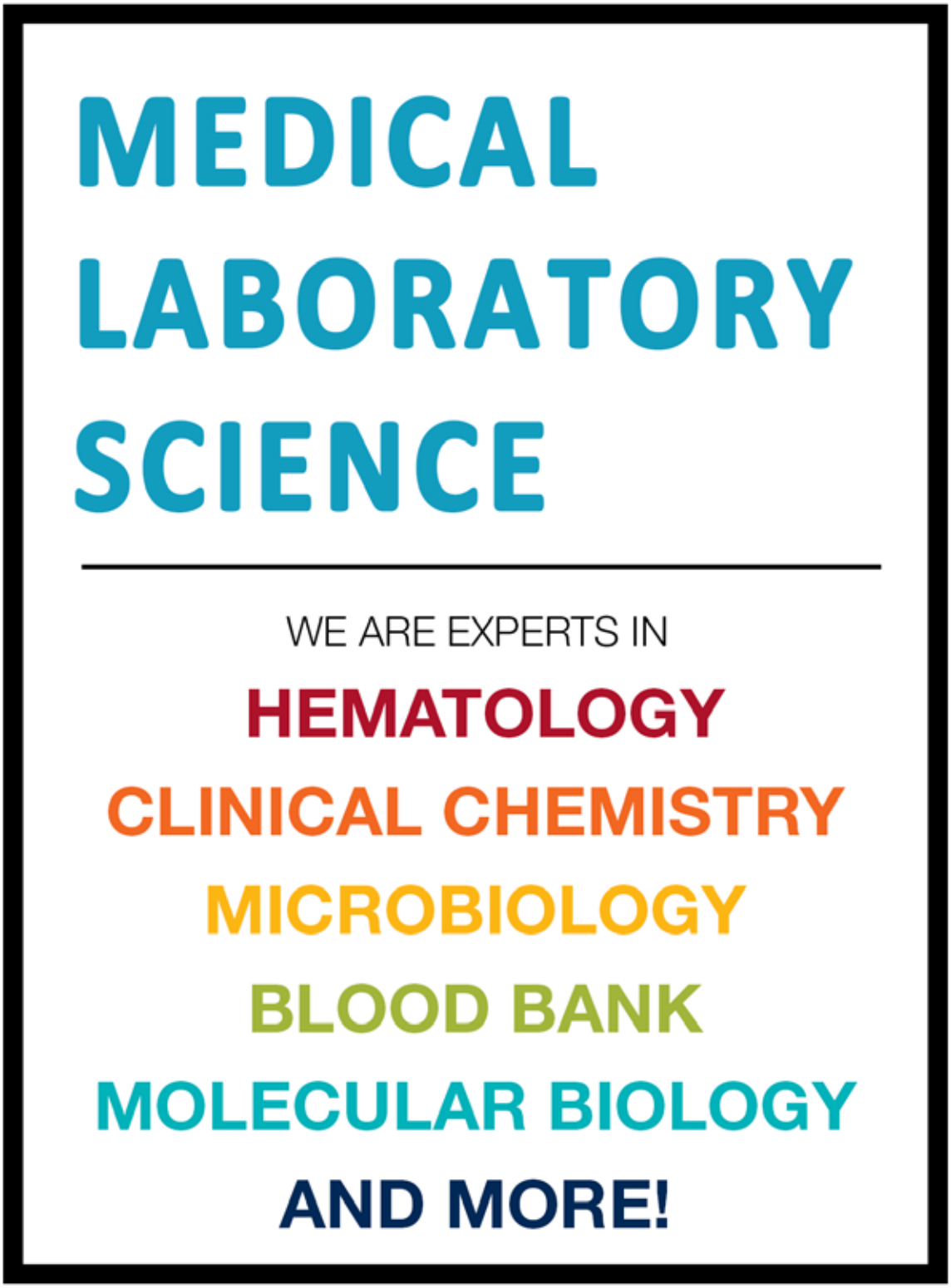
PROCUREMENT DIFFICULTY: ★☆☆

COST: **$**

Household white vinegar. When introduced to milk-based products will produce a reaction similar to agglutination seen in some laboratory tests.

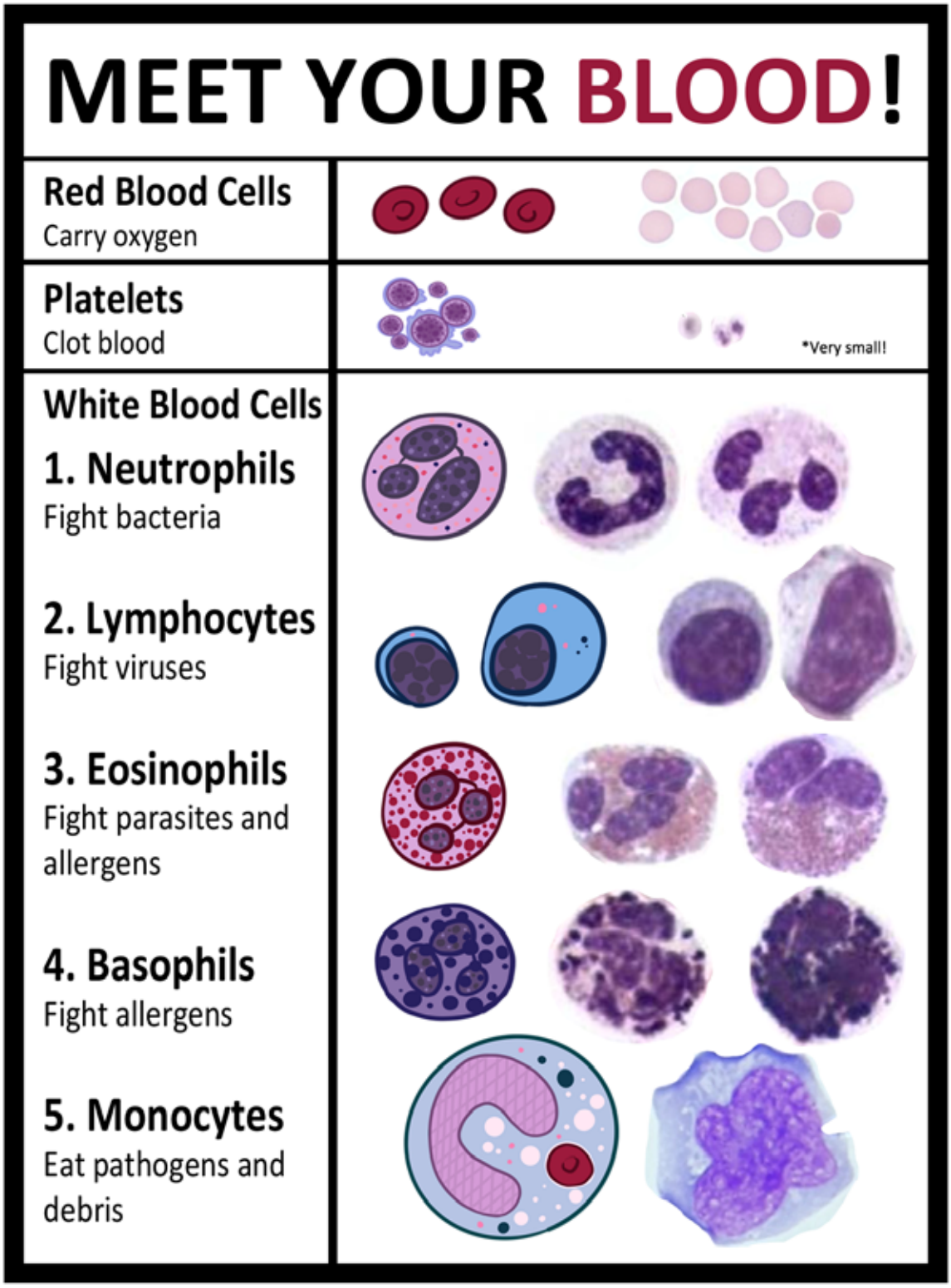
Appendix 1

We Are MLS Flyer

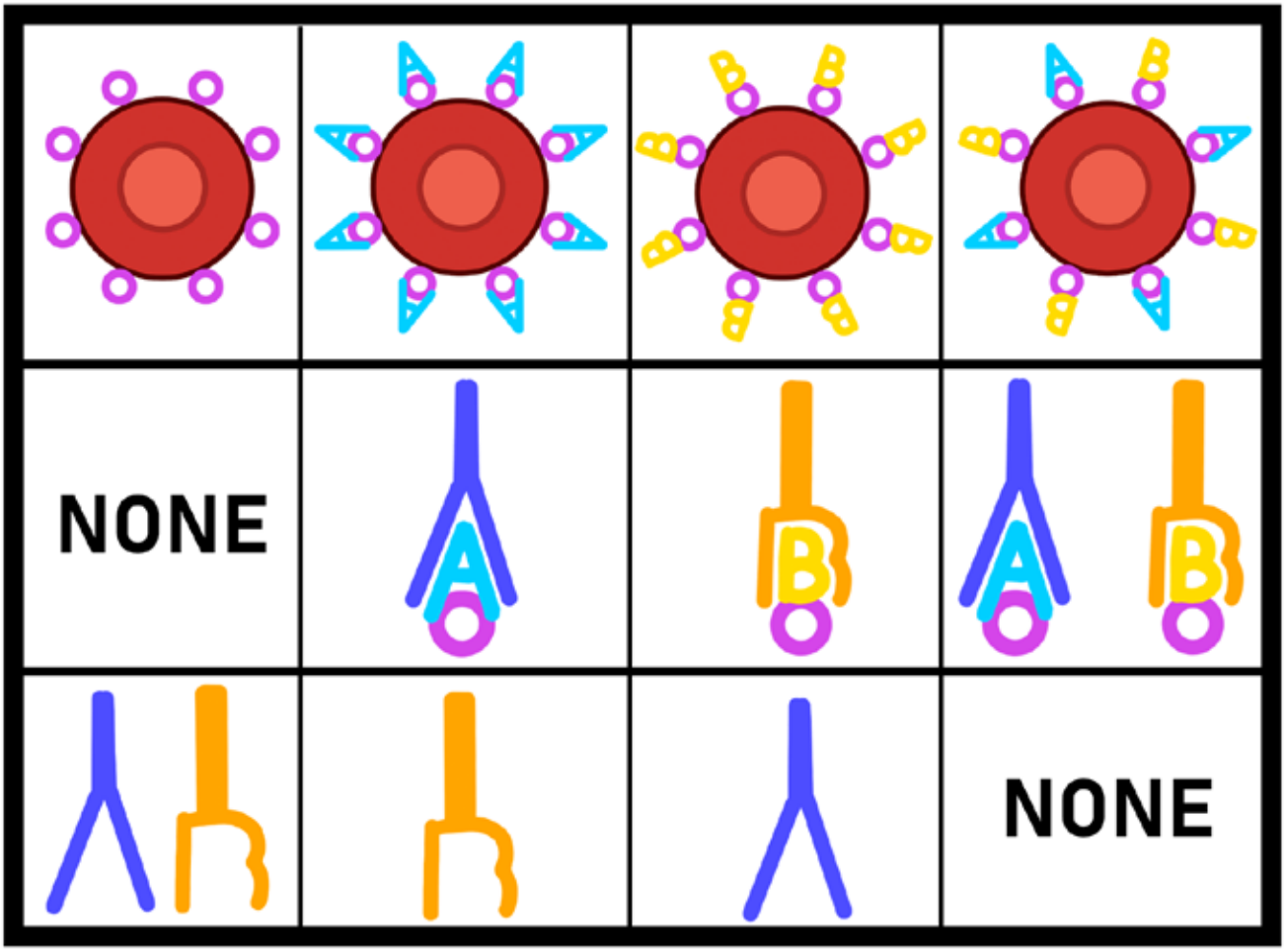


Appendix 2

Meet Your Blood! Flyer



Appendix 3 — Blood Types Flyer



Meet the Author

These materials were developed entirely by Lauren Schiefelbein, MLS(ASCP)^{CM}. Ms. Schiefelbein currently serves as the MLS Education Coordinator for the University of Nebraska Medical Center's Medical Laboratory Science program. In this role, she has leveraged her skills as an artist and medical laboratory scientist to bring creative and innovative laboratory outreach activities to high school students in the communities she serves.

Ms. Schiefelbein has presented her career trajectory as a laboratory scientist and educator at ASCP's Building Bridges Across the Laboratory Community webinar series. She has shared her concept of "Lo-Fi Engagement for the Laboratory" in both ASCP's Critical Values publication as well as at ASCP's Annual Meeting 2024.

Acknowledgments

This project is supported by Cooperative Agreement number CDC-RFA-OE22-2202 (CFDA No. 93.322), funded by the Centers for Disease Control and Prevention. Its contents are solely the responsibility of the American Society for Clinical Pathology and do not necessarily represent the official views of the Centers for Disease Control and Prevention or the Department of Health and Human Services. This project was funded, in part, with federal funds to the American Society for Clinical Pathology (NU47OE000107).

The ASCP would like to further recognize the ASCP Laboratory Workforce Steering Committee for their support and review of these materials. Michelle R. Campbell, MS, MLS(ASCP)^{CM} MB^{CM},SC^{CM}, Michelle Lamendola-Essel, DrHSC, MS, MB(ASCP)^{CM}, and Susan Harrington, PhD provided review of the resource. Debby Basu, PhD, Edna Garcia, MPH, and Jenny Diaz, MSHI, MLS provided program oversight and editing of this resource. Jeff Jacobs, MA provided executive-level support for the project. ASCP Creative Team, Liz Skokna, Martin Tyminski, MFA, and Jennifer Brinson designed and managed the layout of this document.

For additional materials in support of elevating the visibility of medical laboratory professions to students, educators, and school counselors, visit: What's My Next | Learn About Career Opportunities in the Medical Laboratory.