LESSON: FIRST DAY

1. Setting up syringes, syringe couplers, gels, ice box, napkins
2. Intro to my gels and what they'll be doing
    a. Remember my research and I work with gels, today, will get to do hands-on experiments with these gels
    b. Two different experiments and will need to take notes, so get out sheet of paper
3. **Instructions on the experiment**
    a. Safety!! Everyone wear goggles at all times and gloves, no opening syringes/vials, no squirting/eating gels
    b. Groups of 4 will be dividing tasks: 2 mixers, one time keeper and one note-taker
    c. NHA→ everyone gets to play with the vial, hold in hand and place in ice and observe what happens, write down all observations/questions
    d. For chemical gel, show how to connect syringes
    e. PPODA/QT → division of tasks, mixer 1 mixes PPODA + QT for 30sec, mixer 2 mixes PPODA/QT + Conray for 1min, note-taker maybe makes table for time points and gel status, time-keeper tracks mixing and squirting times
    f. Every minute squirt little of gel to note what is happening (pH 10.9 should gel in ~9min and pH 11.4 gels around ~4min)
    g. Write down all observations/questions/theories
4. With everyone, ask what they observed with NHA and the mixing of PPODA/QT/Conray
5. Any theories on what is happening? Differences between the two experiments?
6. Intro to physical and chemical changes: with NHA, do you think a chemical reaction is happening? Is it reversible? With PPODA/QT, do you think a chemical reaction is taking place? Is a new substance formed?
7. Address student misconceptions

Student Misconception #2 – Chemical Reactions:
Students do not see chemical changes as interactions and do not understand substances can be formed by recombination of atoms in the original structures. To address this misunderstanding, students will see firsthand how chemical changes occur when they will be mixing the two polymer solutions together to form a gel. They will be asked to comment on what they think is happening. What did you start off with? What happened when you mixed the two components together? What did you end up with, after mixing? Are the solutions that you started off with the same as the final solution? What do you think allowed for this change to take place (liquid to gel)? We will talk about how two different solutions (both liquids), when mixed together, undergo a chemical reaction to form a new substance, completely different from the initial solutions (a gel). We will also discuss how this happens due to recombination of the atoms in the original structures to form a new structure.

Student Misconception #1 – States of Matter:
Students have difficulty understanding the motion of particles in solids, liquids and gases. To address this issue, students will be asked to note the changes in the properties of the polymer solutions (solid vs. liquid) during the experiment. How does the liquid solution behave or look differently than its solid counterpart? What do you think attributes to that difference? If you were put in a tub filled with water vs. if you were in a tub filled with jello, how would your movements be different? And why? We will then discuss how this can relate to particles in the different states and their respective motion (solid, liquid, gas). A particle in a liquid (tub of water), can easily move around, whereas a particle in a solid (tub of jello) is constricted in movement.

8. Pass out worksheets
9. Go through **powerpoint presentation** and ask them to fill out definition of terms, signs and examples
    a. Size and shape: crushing soda can, tearing paper
    b. Density: ice cube lighter than water so float, but same substance; hot air lighter so goes up
    c. Solubility: salt or sugar dissolved in water, sugary water and sugar changed from solid to solution form but can be gotten back by evaporating water
    d. Melting/Boiling/States: changing from solid to liquid to gas, just changing state not substance
    e. Color: iron rusting, copper rusting (statue of liberty from copper to green), gels not changing color but state (liquid to solid/gel)
    f. Absorption/release of heat: absorption in baking a cake (baking soda decomposes when heated and releases CO2 making cake expand), release in sodium reaction in water
    g. Precipitate: mixing two different solutions and get a third that is a solid (silver nitrate + potassium chloride → white solid silver chloride
    h. Gas: Alka-Seltzer tablets in water give CO2 gas
10. Ask if they can think of any other examples of physical and chemical changes around them
11. Go through exercise of **examples** and ask them to guess physical or chemical:
    - Blowing up a balloon (PHYSICAL)
    - Stomach digesting food (CHEMICAL)
    - Liquid water boiling and turning into steam (PHYSICAL)
    - Burning a piece of paper (CHEMICAL)
    - Salt dissolved in water (PHYSICAL)
    - Breaking a bottle (PHYSICAL)
    - Plant going through photosynthesis (CHEMICAL)
    - Baking a cake (CHEMICAL)
12. **Instructions for design-a-gel**

a. Intro to gels: do you remember in my research what these gels are used for?
b. Discuss Grand Challenges and I'm working on "engineer better medicines" using hydrogels
c. Gels can be used for many medical applications
d. In the same groups, brainstorm diseases/medical conditions in which gels can be used for treatment
e. Also think of how you'd want to change the gel and its properties to better serve the purpose
f. Tomorrow, will have to report on poster and present

<u>Day 1, Part A: Gel Experimentation</u>

- In groups of 4, students will investigate physical change with thermosensitive polymer solutions (10min)
- They will also investigate chemical change by mixing two polymer solutions, which will undergo a chemical reaction to form a gel (15min)
- Students will take notes on the experiment conditions, record observations and data, and formulate questions
- We will then go through the definitions and examples of physical and chemical changes with a powerpoint presentation, accompanied by a worksheet (5-10min)
- We will discuss the physical and chemical changes observed in the gel experiment and relate to definitions (5-10min)
- Video about physical and chemical changes, and examples

<u>Day 1, Part B: Design-a-gel</u>

- We will discuss the use of gels and what similar gels can be used for (related to medical applications) (5-10min)
- We will also talk about what changes/alterations can be made to the gels to optimize them or to result in different properties or to be used in other medical applications (5min)
- Students will identify (in groups of 4) a medical condition/application for which gels can be used as a treatment method, and design a gel for that purpose (brainstorm diseases/conditions, ideas on the gel properties needed, addition of components to the gel, what want gel to do and how to accomplish task) (10-15min)

LESSON: SECOND DAY

1. Finishing up notes from yesterday
2. What do you remember from yesterday? About gels? Physical and chemical changes?
3. Remember what I use the gels that we worked with yesterday for? Lots of uses for gels in the medicine so will be designing your own gels
4. Instructions on Design-A-Gel
    a. Work in your table groups
    b. Brainstorm diseases/medical conditions and how gel can be used to treat/help it
    c. You can change the gel to have whatever properties you want, add anything, make it any way you want…no restrictions/limitations
    d. Once all agree on one medical condition and gel/properties to use, grab poster and put ideas down/drawings/schemes (include disease, treatment with gel, properties gel)
    e. Present to class
5. Powerpoint on hydrogels and uses
    a. My temperature-sensitive and chemically reactive gels for treatment of aneurysms
    b. Gels in drug delivery: sensitive to some signal (temperature, pH, etc.) changes form and releases drug, can be orally or injected at site, used for cancer research also loaded with particles to make tumor visible
    c. Gels for creating an environment for cells and seeding them in the body when repair needed
    d. Tissue regeneration/repair: make the scaffolds for the cells to live in or make the synthetic tissue
    e. Bone cement: keeping implants in place
    f. Put on flasks and grow cells on it to better understand cell behavior
6. Video
    a. Make sure to pay attention to it and recognize things that we saw/discussed in class (cells images, bone gels,…)
    b. If have any questions, keep them until the end
    c. Link research seen in video with projects that the kids came up with and presented on posters, and talk about how great they are since they think like scientists/researchers
7. Wrap-up: questions, comments, thoughts