Glue Making

Steps, Content & Hints

Main directions and content for the activity are in the boxes to the left with the orange border, like this one.

In a classroom setting, you will lead the students through the activity with a series questions, the students' own responses and brief explanations.

Whenever possible, find and affirm what's right about the students' answers.

Questions in Context:
Do you remember something better when you are asked to think about it?

On the right, in the conversation bubble outlined in yellow, are guiding questions that you should ask the students during the associated step.

Each question should be asked separately – and a short amount of time should be allowed for responses.

Green Chemistry Introduction:
Defining Green Chemistry

Have students work in pairs for 30 seconds to come up with a definition for green chemistry. Break down the meaning of both words.

Establish that Chemistry is the science of making products.

Eco-friendly, good for the environment, sustainable.

What is Chemistry? What does chemistry mean to you? Do you think of good things or bad things? Who has heard of companies going green? What does that mean?

Green chemistry is pollution prevention at the molecular level, the basic design stage. So what is it that chemists do?

What do Chemists do?

Use wait time . Build off of their prior knowledge. Acknowledge student responses and prompt them for more information. Control the conversation by asking for a certain number of answers.

Chemists are inventors. They help to design just about every product out there.

Traditionally chemists were not taught about the environmental impact or toxicology. We have had many advances and helpful inventions but we have also had inventions that have caused harm to the environment. Green chemists design products taking into account the entire process, energy efficiency, renewable resources, the product itself along with the end-of-life impact of the product.

Is there anything in this room that a chemist invented? What about the desks, paint, floor, etc.

Who has taken medicine? Does anyone use an iPod or an mp3 player? What about a computer or a cell phone?

Set the Scene**:**
Connect the Dots & Introduce the Activity Topic

Connect the dots for them: they are the future scientists who will help to discover and invent the solutions to the environmental challenges.

Introduce Biomimicry.
Scientists have figured out that the natural world has the most efficient processes on Earth. Learning how to manufacture or create products that mimic how nature operates is called biomimicry.

How can we learn from the natural world?

What does “bio” mean?
Like in biology the study of life.
And mimic, who can tell me what that means?
If you mimic something you are copying.

Yes, biomimicry is learning from nature how to design products that are sustainable. This aligns with green chemistry closely because that is what green chemists are trying to do.

Can you identify any links between green chemistry and biomimicry?

Could we consider animals and plants to be green chemists?

How do spiders catch their food? Spiders use a “glue” to coat their webs and catch their prey. Scientists are studying the process of this natural glue for human use.

We are going to break the class into groups of 4 students. Each group will receive a set of flashcards.

Match the images of the technology or product with corresponding the animals or plants it was inspired by.

Ask each group to share out one match and why they matched them. Guide them as they answer and review the points of lessons learned from nature for each technology briefly.

What do you know about the animals? What traits may be useful for any of the items? Think about shape, function or special abilities.

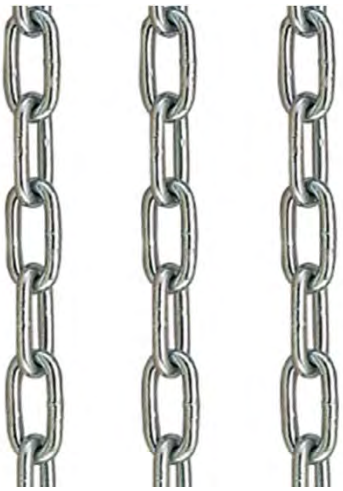
Biomimicry Matching Game Key	
Kangaroo	Landfill
Blue Mussel	Toxin-free waterproof glue
Termite	Electrcity-free air-conditioned buildings
Gecko	Velcro
Chimpanzee	New sources of natural medicines
Shark	Faster boats and submarines
Blue Morpho Butterfly	Toxin-free paints

How else could we learn from nature? There are so many techniques and processes that we can learn from. Which creature is already making an incredibly strong natural glue? That's right the blue mussel.

What is the purpose of glue?
To create a bond between two materials.

Explain that synthetic is human made.

Introduce polymerization using the analogy of chain. Each section represents the monomer.



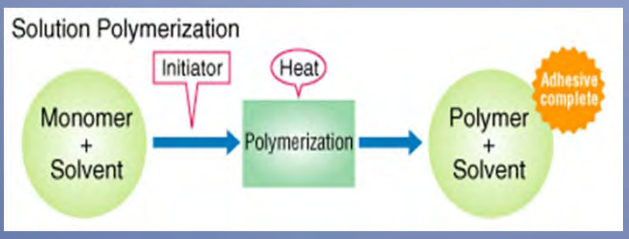
As green chemists today you will create your own glue. What do you know about glue or adhesives?

Can you identify any products that use adhesives? How about the windows? How does the glass stay in place?

Synthetic adhesives are made by people and found in tape, shoes, assembling cars, airplanes, houses. There are three processes when making adhesives. Let's think about them briefly.

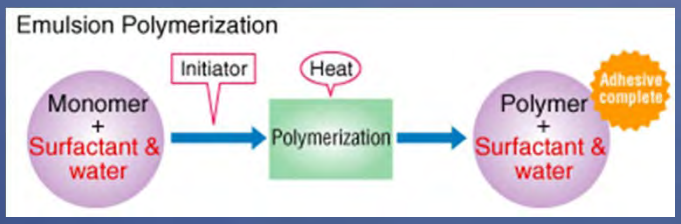
Solution polymerization. (Show image)
Uses hazardous solvents/chemicals called VOC's or volatile organic compounds they can escape into the air and harm the animals, plants and people. VOC's also stay in the groundwater or air for a long time.
Uses high amounts of energy.

Is there anything about this process that doesn't fit with green chemistry? There are better processes. Let's look at them.



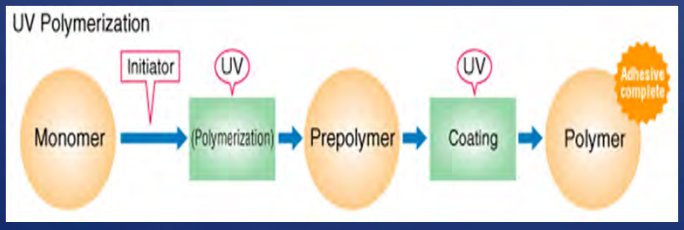
Emulsion polymerization: (Show image)
Uses soap and water.
Uses much safer chemicals.

Soap and water is this a safer process? Is the process energy intensive?



UV polymerization: (Show image)
Doesn't use any solvents.
Uses much safer chemicals.

Where have you heard the term UV before? That is right! Ultra violet rays come from the sun. How does this process compare to the others?



Improvements can still be made with adhesives.
Let's think the biomimicry lessons could help us as green chemists. What do we need to consider?

Green chemistry technology considers 3 criteria: Safety, Cost and Performance

Which animal from the game is helping scientists design a better glue?
Is the blue mussel using safe materials?
Does the blue mussel hold up against strong waves?
The blue mussel isn't spending any money but it uses its own resources wisely.

1.Let's make our own glue!
2. Pass out supplies. Ask students to help with the process. This activity works best with groups of 2 students.
3. Start by adding 2 tablespoons of powdered milk to the cup. (Instructors may pre-measure the amount in a small baggie)

Do you recognize any of the materials in front of you? Powdered milk, vinegar etc. Would you consider that safe? What about the cost?

4. Measure ¼ cup of hot water into measuring cup. (Instructors may use a hot pot and have one or two stations at the front of the class for students to measure the hot water.)
5. Add the water to the cup with the powdered milk.
6. Add one tablespoon of vinegar to the mixture and stir.
7. Stir with the spoon until the milk is separated well.

Vinegar is used to curdle the milk (or cross-link in chemical terms). When something speeds up the reaction in science what term do we use? Vinegar is the catalyst in this step.

8. Now that the milk has started to separate we are going to remove the curd from the whey.
9. Place 2 coffee filters together an fold them for increased drying and filtering ability.
10. Place the curd on the coffee filters and squeeze any of the excess liquid back into the cup. Dry the curd ball as much as possible.

Who can make an observation about what is happening? Yes, you are noticing a separation of the milk into the curd and whey. What do we call the white chunky part?

11. Collect all of the whey waste for the students in a waste container.
12. Reuse the empty cup and place the curd ball into the cup.

13. Use the fork to break the curd into small pieces. (This is an important step make sure to check each group)
14. Add one tablespoon of hot water (use the water stations again).
15. Add ¼ teaspoon of baking soda.

What can we do with this whey waste? Perhaps there is another product that could use our waste. We will reuse all of the materials that we can creating less waste.

16. Mix curd, water and baking soda thoroughly.

What is happening to the mixture? Are you seeing any foaming? Great! You have successfully made natural glue. It looks a little like a glue stick doesn't it?

17. Pass out scrap paper and encourage the students to make an environmental themed collage.

Who can tell me the 3 criteria for a green chemistry technology?

Let's test the performance of our glue.

18. Students can save the leftover glue or use it all on their collage. Be creative so there is little to no waste in the end.

What will happen to the glue waste? Where will the waste go? Will that degrade? Yes it is biodegradable. Remind them that solution polymerization does not create biodegradable adhesives.

Reiterate the 3 criteria of safety, cost and performance.

Great Job! Scientists ask questions and seek out answers.

Reinforce how biomimicry can help scientists to create solutions.

Who here asks questions about how products are made or why we have certain problems? Sounds like we have some green chemists in the room. Who thought that this was easy? Who had fun doing this? Do you think that science is something that you can do?

In Closing:

You made a green glue that was not only cost efficient, safe for you and the environment but it also worked.

Green chemistry provides the tools needed for creating solutions to environmental challenges.

As a green chemist you can be a part of the solution by inventing better technologies for the future. Also remember that you do not need to be a scientist to make a difference in this world. As an informed citizen you have the power to influence change with your decision making, voting power and purchasing choices.

Any questions? Wrapping up is always a good time to talk a little more about why you are in the classroom, what you are studying, researching or pursuing as a career.