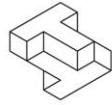


# Chemistry of Plastination

## Teacher Resource Guide



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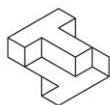
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### How to use this Document

The resources provided in this document are not required to be used in preparation for your lab. They are simply resources that we thought might be helpful to you and engaging for your students in preparation for your lab. It is your choice to use them, you may pick as few or as many to implement as you like.

*\*If you are receiving a Title 1 scholarship for your lab, you are required to implement a vocabulary or journal activity prior to your lab visit.*

### Lab Summary

*"More than just anatomy, Body Worlds Decoded is also a display of advanced chemical processes. In this lab students investigate and experiment with some of the chemistry behind the preservation process of Body Worlds."*

Grade Levels: 8-12

#### Student Outcomes:

- 1) Students will be able to model and explore the chemical process of defatting in the plastination process (i.e. polar and non-polar characteristics that allow for solutes to dissolve in solvents)
- 2) Students will be able to model and explore the depressurization process that leads to forced impregnation of polymers in the plastination process (i.e. relationship between atmospheric pressure and boiling point)

#### State and National Standards Connections:

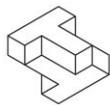
##### Next Generation Science Standards

	Disciplinary Core Ideas	Crosscutting Concepts	Science and Engineering Practices
8 <sup>th</sup> - 12 <sup>th</sup> Grade	PS1.A PS1.B	Structure and Function Systems and System Models	2, 3, 7, 8

#### Common Core Language Arts Standards:

##### *Speaking and Listening*

- Grades 8-12: SL.8.1.b-d



### Related Links and Games

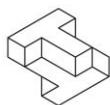
The following links provide additional information on Body Worlds and the plastination process as well as the science behind other human preservation processes. We are not endorsing the following organizations, but feel that the information provided by said organizations may be of benefit to your students and may help enhance the learning experience of the lab.

#### Plastination and other Human Preservation Processes

- *Body Worlds*: Body Worlds is one of the most successful travelling exhibitions in the world. Created by Dr. Gunther von Hagens, Body Worlds exhibitions were created to educate the public about the human body and help visitors visualize the inner workings and fragility of their bodies. For more information on Body Worlds exhibitions around the world, the chemical and physical processes behind plastination, and more visit [www.bodyworlds.com](http://www.bodyworlds.com)
- "The Right Chemistry: Silicone and the Wonders of Plastination" : This article from the Montreal Gazette discusses the importance of silicon polymers in the plastination process as well as other important uses for silicone polymers throughout history. <https://montrealgazette.com/opinion/columnists/the-right-chemistry-silicone-and-the-wonders-of-plastination>
- "Five Crazy Ways Humans Have Preserved Their Bodies Throughout History": This list/article from popular website gizmodo.com lists five methods for human preservation used throughout different periods of history. Each listed method also links to other resources on each method. Great for a short read and introduction to human preservation. <https://gizmodo.com/five-crazy-ways-humans-have-preserved-their-bodies-thro-1737362333>

#### History of the Study of Human Anatomy

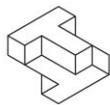
- *Dream Anatomy*: This website by the National Institutes of Health accompanied a previous exhibition on the art of anatomy. This online module reviews the history of anatomical representation through art and science with a focus on how the visualization of anatomy has evolved throughout human history. <https://www.nlm.nih.gov/dreamanatomy/index.html>
- *The Science of Anatomy*: This site by the National Center for Biotechnology Information gives a brief historical timeline of the study of human anatomy, from the Stone Age to present day. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5380415/>



## Gallery and Exhibit Connections

### Body Worlds Decoded Gallery (Upper Level)

- *Body Worlds Decoded*: Students use augmented reality and other emerging technologies to examine organs and body systems through immersive 3D models.
  - Connection to the lab:
    - Students can view bodies preserved through plastination, a process which begins with an acetone bath to remove water and body fats, followed by the impregnation of a silicone polymer into all the cells of the body, and ends with the specimen being hardened by gas, light or heat.
  - Activities to complete at the exhibit:
    - Use our custom AR system, Iris, to view and interact with 3D models of the body.
    - Students can view the chemical signals of neurons, X-ray and SEM (Scanning Electron Microscope) images of internal organs and external influences on the human body (pollen grains), none of which would have been possible without Chemistry.
    - Students will also use Iris to view kidney stones, which are made of mineral and salt deposits.
  - Questions to guide student learning:
    - How do you think chemistry might be involved in the process of developing specimens for Body Worlds?
      - *Plastination is a process in which the cells of a cadaver are impregnated with a flexible polymer, preserving the body and the internal organs and systems indefinitely.*
    - Has anyone ever heard of acetone? What are some of the common uses of acetone?
      - *Nail polish remover; paint thinner*
      - *Acetone is a chemical solvent that dissolves grease (fats) and other chemical compounds such as paint and plastics (polymers).*
      - *After being treated with formaldehyde to kill bacteria, the cadaver is submerged into an acetone bath to remove all the water and fats. Acetone replaces the water within the cells so that they maintain their physical structure and shape.*
    - What type of plastics do they use for the plastination process?
      - *Polymers – large molecules that consist of repeating chains of similar chemical units. Polymers are both natural and synthetic, the latter consisting of plastics, resins, rubber, and many others.*
    - Apart from plastination, how has Chemistry influenced advances in medical technology that we see in Body Worlds?
      - *Without the discovery of atoms or electrons, we would not been able to get images from inside the human body using X-rays.*
      - *A scanning electron microscope (SEM) is a type of electron microscope that produces images of a sample by scanning the surface with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that contain information about the surface topography and composition of the sample. The most common SEM mode is detection of secondary electrons emitted by atoms excited by the electron beam.*



### Writing Prompts

The following writing prompts and questions are just a few examples of journal topics to incorporate writing into your students' lab experience. If you feel that one of the below prompts does not meet your needs, you are welcome to use your own, but please make sure it is related to the chosen lab experience. If you have a related writing prompt you would like to share with The Tech and other teachers, please let us know on our teacher survey that will be available in the lab.

Most of the writing topics could be used as either pre-lab or post-lab writing. You may choose the prompts that work best for your class and schedule.

#### Pre-Visit Writing Topics/Prompts

##### *Generic*

- We will be attending \_\_\_lab name\_\_\_ at The Tech Museum of Innovation; what do you think we will learn about in the lab? What do you want to know about this topic? What do you already know about this topic?
- We will be attending \_\_\_lab name\_\_\_ at The Tech Museum of Innovation; what are you looking most forward to in this lab? Why?

##### *Specific to Chemistry of Plastination*

- Take a look at a few samples of plastinated human remains at [bodyworlds.com](http://bodyworlds.com). How do you think Chemistry might be involved in the process of creating these plastinated human remains?

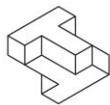
#### Post-Visit Writing Topics/Prompts

##### *Generic*

- We learned a lot in our \_\_\_lab name\_\_\_ lab. What were your two favorite things you learned in the lab? Why?
- The principal is excited to hear all about your lab experience. Explain what you did and learned about in the lab since she or he was unable to attend the lab.

##### *Specific to Chemistry of Plastination*

- Plastination is one of several forms of preservation of human remains. How do you think the chemical processes of plastination compare to the chemical processes behind other preservation processes such as embalming, mummification, or cryogenics?
- The future of Body Worlds exhibitions and plastination is dependent on people donating their bodies to the project upon their death. Would you consider donating your body to the Body Worlds project, why or why not?



### Pre-Visit Vocabulary

*These are words and concepts that we will discuss in the lab. Your students' experience will be enhanced if they are familiar with these terms prior to your visit. Below you will find several graphic organizers and games to aid in your vocabulary review.*

#### Terms and Definitions

- Human preservation: the process of keeping human tissue free from damage or decay
- Molecule: a group of atoms bonded together; represents the smallest fundamental unit of a chemical compound that can take part in a chemical reaction.
- Polar molecules: a molecule that has uneven electric charges across the molecule - one side has a slight positive charge (fewer or no unbonded electrons), the other a slight negative charge (unbonded electrons). Water is an example of a polar molecule
- Non-polar molecules: a molecule that has even distribution of electric charges across the molecule
- Solvent: a liquid that has the ability to dissolve a substance (or solute)
- Solute: a compound that can be dissolved in a liquid (of solvent)
- Solution: the resulting compound of a solute dissolved in a solvent
- Polymer: a substance that is made up of many repeating chains of similar molecules; many synthetic plastics and resins.
- Pressure: the physical force exerted on an object by something in contact with it
- Atmospheric pressure: the pressure exerted by the atmosphere

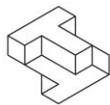
#### Vocabulary Activities:

##### *Vocabulary Review Games*

- *Quiz, Quiz, Trade*: This is a fun cooperative game for students to review vocabulary terms. For more details and to see an example of Quiz Quiz Trade in action, please visit the following link:  
<http://www.theteachertoolkit.com/index.php/tool/quiz-quiz-trade>
  1. Create questions or vocabulary cards. On one side of an index card, write the question or vocabulary term; on the other, the answer or definition. Pass out the cards to students. If there are not enough terms for everyone to have a different card, try using different "back" sides to the same cards (e.g. instead of the definition again, have a drawing, a question about the term, characteristics of the term, or an example of the term).
  2. Pair up. When all cards have been passed out, students find a partner to quiz with their card.
  3. Hands up. When both partners have completed the quizzes correctly, they put their hand up to show other students that they are ready for a new partner to quiz.
- *Back-words*: This game is part Charades part 20 Questions. In this review game, students have to guess the vocabulary term that is on their back by asking questions of a partner or having the partner act out the term.
  1. Write your vocabulary terms on index cards. If there aren't enough terms for each student to have a different one, you can make two sets and divide the class into two groups. You may also add in other related vocabulary terms that you have been studying in class.
  2. Tape one term onto the back of each student so that he or she cannot see the word.
  3. Have students pair up. Each partner should look at the word on their partner's back. Partners take turns asking questions or acting out or gesturing about the term that is on their back. (e.g. "Am I an element? Am I part of an atom? Do I make up all matter? Etc.) Partners must ask at least 2 questions before guessing their word.

# Chemistry of Plastination

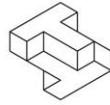
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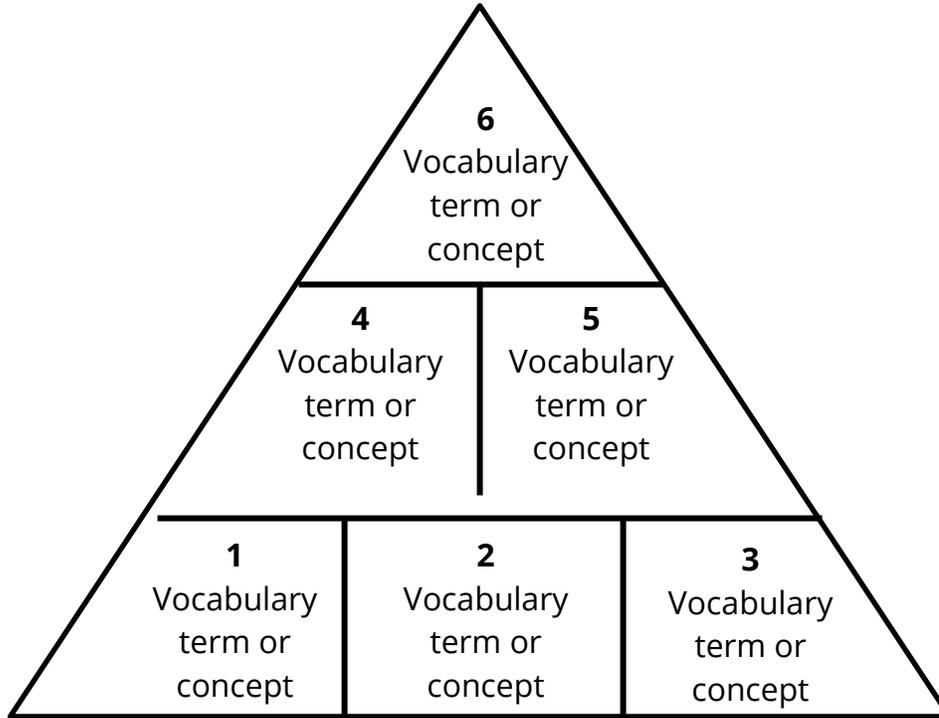
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4. When both partners have correctly guessed their word, they put a hand up to signal that they are in need of a new partner. Continue game play until everyone has guessed their word.
- *\$10,000 Pyramid*: This review game is exactly like the classic game show. Students will work in pairs, taking turns to describe the words and to guess the words.
    1. Break up the terms into two groups. Each partner will take on one group of words.
    2. Have each partner fill out the worksheet on the next page with their group of words.
    3. For the first round, Partner A will be the one describing the term and Partner B will be the one guessing the term. Partner A will describe the term (starting with 1) using the words he or she wrote down on the worksheet. From the description, Partner B will guess what the term is.
    4. When Partner B guesses the word correctly, Partner A moves on to the next word.
    5. When Partner B correctly guesses all the words in Partner A's pyramid, they switch places and Partner B will describe the terms on his or her pyramid while Partner A guesses the terms.
    6. You can time this activity like on the quiz show, but it may intimidate some students



Student Name: \_\_\_\_\_

## \$10,000 Pyramid



Write descriptive clues about each vocabulary term or concept

1. \_\_\_\_\_  
\_\_\_\_\_
2. \_\_\_\_\_  
\_\_\_\_\_
3. \_\_\_\_\_  
\_\_\_\_\_
4. \_\_\_\_\_  
\_\_\_\_\_
5. \_\_\_\_\_  
\_\_\_\_\_
6. \_\_\_\_\_  
\_\_\_\_\_