“A New War Weapon to SAVE Lives”

Blood Plasma

A Lesson Plan from
The Education Department

The National WWII Museum
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www.nationalww2museum.org

A New War Weapon to SAVE Lives: Blood Plasma

Major advances in medical technology were made during WWII, including the use of blood plasma transfusions to save lives on the battlefield. Investigate the three major antigen types present on the surface of human red blood cells. Relate the complexity of blood typing prior to transfusion and the solution of using blood plasma to treat trauma on the front lines during WWII.

OBJECTIVES: Students will:

- Learn about blood transfusion by analyzing a photograph and interpreting the meaning of print materials.
- Think critically about the challenges collecting, preserving and transporting blood for transfusions and recognize the role of collaboration in scientific undertakings.
- Recognize the three human blood antigens, the determination of blood type and the phenomenon of agglutination during transfusions.

GRADE LEVEL: 9-12

STANDARDS:

Next Generation Science Standards
NGSS HS-LS1-2: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

Common Core ELA Anchor Standards for Literacy
CCSS.ELA-Literacy.CCRA.R.2: Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

CCSS.ELA-Literacy.CCRA.R.7: Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.

CCSS.ELA-Literacy.CCRA.R.9: Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

National Center for History in the Schools
Historical Thinking Standard 2D: Differentiate between historical facts and historical interpretations.

TIME REQUIREMENT: 75 to 90 minutes

MATERIALS: Copies (paper or digital access) of the primary sources, the fact sheet, and the student activity sheet.

4 clear plastic cups filled with water, blue and red food coloring.

PRIOR KNOWLEDGE:
This lesson can correspond with the exploration of the anatomy and physiology of the circulatory system, specifically the composition of blood and red blood cell antigens. During a genetics unit, this lesson can be used to explore the real-life application of the inheritance of blood types.

INTRODUCTION:
Show students the primary source, obscuring the caption. Display on a video projector, overhead projector or make copies for students to share. Use some or all of the questions to lead an introductory discussion about the history of the development of blood donation, blood transfusions and the use of

blood plasma in treating shock. Hints are given after some questions in parentheses to help move the discussion forward.

Primary Source:

Private Roy Humphrey of Toledo, Ohio, is being given blood plasma by Private First Class Harvey White of Minneapolis, Minnesota, after he was wounded by shrapnel on 9 August 1943 in Sicily. Image courtesy of National Archives and Records Administration.

Leading Discussion Questions:

- Take a look at the photograph. What is happening in the picture? (Hints for students: notice the helmeted soldier, the patient's shirt is open, the men's positions, the worried expressions of the women in the background, and the discarded helmet on the left of the image.)
- Who are these men? (Look at the clothing and equipment, the medic's arm band and dog tags.)
- When and where do you think it was taken? (In a village, notice the children and women's clothing, lack of shoes, the dirt pathway.)
- What so you think is in the bottle held up by the soldier second from the left? (The liquid is clear and a large volume connected to the injured soldier through a tube. Students may think that this is medicine which would likely be dosed by syringe, not a drip line.)
- Describe what you see in the background of the photograph. (Notice the discarded helmet at the far left, explore the presence of civilians including women and children during war.)

DIRECTIONS:

1. Reveal the caption. Have students read and discuss their reactions to the photograph before and after reading the caption.

2. Distribute copies of the Owens-Corning Fiberglas advertisement, "A new war weapon to save lives." You may choose for your students to read individually, as a small group or as a class. Stop periodically to answer questions and clarify any terms from the reading.

3. Demonstrate blood type compatibility using the four cups of water. Label cups with the four human blood types, A, B, AB, and O. Add blue food coloring to represent type A blood. Add red food coloring to represent type B blood. Add blue and red to represent type AB blood. Add no food coloring to the type O cup.

4. Ask your students to predict what will happen when each blood type is donated to the other three types. You may choose to do this as a whole group activity, small group activity, or individual activity. Discuss the predictions as a class.

5. Combine the colored liquids to see the results. You may want to use additional cups during the demonstration.

6. Discuss the results on the demonstration, focusing on the antigen/antibody reaction. Ask students to differentiate between the transfusion of whole blood and the transfusion of plasma.

7. Distribute the Fact Sheet for students to read. You may choose for your students to read individually, as a small group, or as a class. Stop periodically to answer questions and clarify any terms from the reading.

8. Give the Student Activity Sheet to assess understanding of the reading and demonstration.

ASSESSMENT: Components for assessment include the student activity sheet, classroom discussion, and formative assessment.

ENRICHMENT: Listen to WWII oral histories about segregated medical treatment and blood storage at http://ww2online.org, especially Segment 4 of Daniel Inouye's interview at http://ww2online.org/view/daniel-inouye/segment-4.

Debate discriminatory blood banking policies and conduct additional research to determine when these practices came to an end. Does discriminatory medical treatment still exist?

RESOURCES: The National WWII Museum's Digital Collections site
http://ww2online.org

The Blood Typing Game
http://www.nobelprize.org/educational/medicine/bloodtypinggame/

American Red Cross
http://www.redcrossblood.org/learn-about-blood/blood-types

FOR THE FIRST TIME in military history, lives can be saved with blood plasma transfusions right on the field of battle. This triumph of modern medicine was worked out by doctors and scientists in the Army, Navy, private hospitals, and universities. The portable blood plasma transfusion kit is one of medicine's newest resources.

A new war weapon to save lives

In past wars, hundreds of thousands of lives have been lost because of inability to give the wounded quick and effective treatment.

Today, to our boys on land, at sea, and in the air, modern medicine says:

"Because of the many advances made in medical science, your chances in battle will be immeasurably greater."

Among these important advances is the modern blood plasma transfusion—a new weapon that helps overcome the wounded fighter's grimmest adversary . . . shock due to hemorrhage or injury.

The new plasma transfusion kit can be moved right into the field of battle. It is the one transfusion that needs no "typing" or "matching" with the patient's blood. It can be administered to *any* wounded man at once. The time saved often prevents shock and hemorrhage from getting in their deadly work.

Remarkable as it was, the new plasma transfusion needed development. The need for refinement was in the apparatus. It concerned one of the simplest things . . . a tiny filter in the tubing leading from the plasma bottle to the wounded man's vein.

Originally, sterile gauze filters were used. These swelled when wet and slowed up the plasma flow so much that emergency use in battle was almost out of the question. Then, fine-mesh, stainless-steel filters were tried. But they were so bulky that they interfered with the compactness of the transfusion apparatus.

The medical and laboratory men set out to overcome these shortcomings. Eventually, they discovered in *glass fibers* the filter material that gave them what they wanted.

Now, the vital filters are made of tightly woven Fiberglas* cloth. Because these filters are *pure glass*, they do not swell when wet. They are not weakened by moisture—the individual fibers are non-absorbent. The filters are not bulky, but small and compact.

Fiberglas is proud to have helped science perfect this new life-saving technique.

And now, this plasma transfusion is being used not only on the battle fronts but also for civilians and among workers in "Arsenals of Democracy."

Thus it is that modern medicine, in perfecting a new weapon of war, has given new hope to all mankind in time of injury.

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The role of Fiberglas in portable transfusion kits is an unusual and dramatic use of this modern basic material. It spotlights the versatility of a product which makes the physical properties of glass available in many new and useful ways. *Owens-Corning Fiberglas Corporation, Toledo, Ohio. In Canada, Fiberglas Canada, Ltd., Oshawa, Ontario.*

OWENS-CORNING

FIBERGLAS

*T.M. Reg. U. S. Pat. Off.

Fact Sheet: Blood Plasma

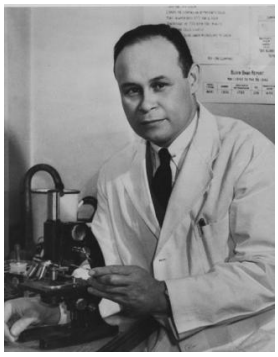
The Composition of Blood

Blood is a mixture, made up of four components: red blood cells that carry oxygen to the body, white blood cells that that defend the body against disease, platelets that assist in the clotting of wounds and plasma. Blood plasma is a clear, sticky liquid composed mainly of water. It carries nutrients to the cells of the entire human body. Replenished by the body every four months red blood cells are covered with antigens, markers that determine blood type. Humans have two possible antigens, A and B, which in different combinations determined by inheritance, make up the four human blood types, A, B, AB, and O. If certain blood types mix when a person receives a blood transfusion, life-threatening complications might occur. Type O carries no antigens and is considered the universal donor because any person can receive a transfusion of type O blood safely.

Blood Transfusion on the Battlefield

During WWII the use of blood plasma was an essential component of treating wounded soldiers. When a soldier is critically wounded, blood loss is extremely dangerous. Rather than the loss of oxygen carrying red blood cells, the greatest concern is the loss of fluids which results in low blood pressure. By transfusing casualties with plasma, blood volume is maintained and blood pressure remains at a normal level, preventing shock. Because the red blood cells are removed from plasma, the need to match the blood type of the donor to the recipient is unnecessary. In addition, dried plasma can be stored for long periods of time without refrigeration and transported across great distances. Medics on the battlefield simply reconstituted the dried plasma by adding water before transfusion.

Dr. Charles Drew



Dr. Charles R. Drew, surgeon and researcher, developed techniques for preserving plasma, the liquid portion of blood. The first African American to receive a Doctor of Science degree, Drew proved that plasma could be stored significantly longer than whole blood. He supervised the “Blood for Britain” program which met the desperate need for blood to treat those wounded during the Blitz. To encourage donation Drew first devised the use of bloodmobiles, trucks with refrigerators serving as donation centers.

On the heels of his successful “Blood for Britain” campaign, Drew was asked to direct New York’s American Red Cross blood bank, tasked with the massive blood drive for the U.S. military. Outraged by the policy to separate donated blood according to the race of the donor, a practice he denounced as unfounded by science, Drew resigned from the project. Howard University appointed him professor of surgery and in 1943 he was asked to serve on the American Board of Surgery, the first African American to do so. Drew died tragically in an automobile accident while traveling to the annual free clinic in Tuskegee, Alabama. Despite his untimely death at only 45 years of age, Dr. Charles Drew is credited as a pioneer in the field of blood transfusion, developing techniques that have saved many lives around the world.

Blood Plasma
Student Activity Sheet

Part 1: Read "Fact Sheet: Blood Plasma." Respond using complete sentences.

1. List the four human blood types. _____ _____ _____ _____

2. Which component of blood determines blood type? Describe.

3. Which blood type can be safely transfused into any patient? Explain.

4. Does blood plasma have a type? Why or why not?

5. How did medics administer plasma transfusions on the battlefield?

6. Contrast the benefits of using plasma for blood transfusions with the benefits of using whole blood.

7. Summarize Dr. Charles Drew's contribution to the field of emergency medicine.

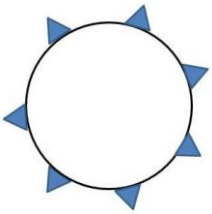
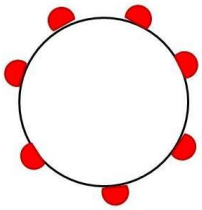
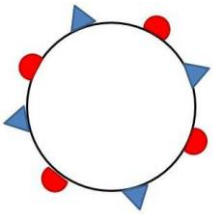
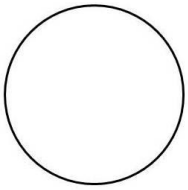
8. How did the development of blood plasma revolutionize the treatment of injured soldiers on the battlefield?

9. What did Owens-Corning develop to improve plasma transfusion?

10. Evaluate the plasma advertisement heading, "a new war weapon to save lives." Do agree or disagree? Explain.

Certain blood types do not mix because of antibodies carried in our blood stream. Antibodies are part of our immune system which defends our bodies from invading substances like viruses and bacteria. If incompatible blood is transfused, the donor red blood cells are treated as foreign invaders and the recipient's immune system mounts a huge response. This response and the associated blood clotting that results can be life threatening.

Part 2: Observe the patterns in the table below and use the information to predict if a blood transfusion is safe or dangerous. Circle your choice and respond using complete sentences, when appropriate.

	Type A	Type B	Type AB	Type O
Red Blood Cell with Antigens				
Recipient Antibodies			none	

Circle one

11. A patient with blood type B receives a transfusion of type O blood. **SAFE** or **UNSAFE**

12. A patient with blood type AB receives a transfusion of type A blood. **SAFE** or **UNSAFE**

13. A patient with blood type O receives a transfusion of type B blood. **SAFE** or **UNSAFE**

14. A patient with blood type A receives a transfusion of type AB blood. **SAFE** or **UNSAFE**

15. A patient with unknown blood type receives a transfusion of type A blood. Luckily, no complications occur. Which two blood types could the patient have? _____ _____

    Explain your choices.

16. Type O blood is called the "universal donor" because it can be safely donated to anyone, regardless of the recipient's blood type. Why is this safe? Include the terms antigen and antibody in your answer.

17. On the other hand, type AB blood is called the "universal recipient." Explain why, including the antigen/antibody response.

Blood Plasma
Student Activity Sheet KEY

Part 1: Read "Fact Sheet: Blood Plasma." Respond using complete sentences.

18. List the four human blood types. A B AB O

19. Which component of blood determines blood type? Describe.
Antigens covering the surface of red blood cells determine blood type.

20. Which blood type can be safely transfused into any patient? Explain.
Type O can be safely transfused into any patient. Because type O blood carries no antigens, the immune system does not recognized the transfused red blood cells as foreign.

21. Does blood plasma have a type? Why or why not?
No. Blood plasma does not have a type because it does not carry antigens.

22. How did medics administer plasma transfusions on the battlefield?
Medics reconstituted dried plasma with water before administering a transfusion.

23. Contrast the benefits of using plasma for blood transfusions with the benefits of using whole blood.
Plasma can be stored for long periods without refrigeration. It is highly portable in dried form and can be transported long distances. Whole blood, on the other hand, must be refrigerated and stored in its liquid form making transportation difficult.

24. Summarize Dr. Charles Drew's contribution to the field of emergency medicine.
Dr. Charles Drew pioneered the use of plasma as an alternative to emergency blood transfusion.

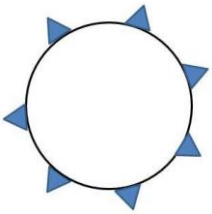
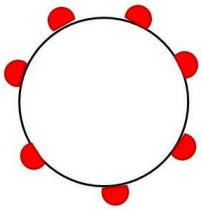
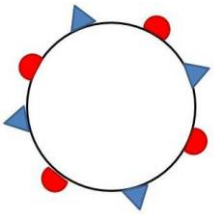
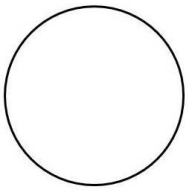
25. How did the development of blood plasma revolutionize the treatment of injured soldiers on the battlefield?
Blood plasma was used to treat blood loss in injured soldiers. By replacing lost fluids, transfused blood loss prevented low blood pressure and the danger of shock.

26. What did Owens-Corning develop to improve plasma transfusion?
Owens-Corning developed tiny glass filters for the transfusion apparatus to replace gauze filters, allowing plasma to pass through the filter quickly.

27. Evaluate the plasma advertisement heading, "a new war weapon to save lives." Do agree or disagree? Explain.
Responses will vary.

Certain blood types do not mix because of antibodies carried in our blood stream. Antibodies are part of our immune system which defends our bodies from invading substances like viruses and bacteria. If incompatible blood is transfused, the donor red blood cells are treated as foreign invaders and the recipient's immune system mounts a huge response. This response and the associated blood clotting that results can be life threatening.

Part 2: Observe the patterns in the table below and use the information to predict if a blood transfusion is safe or dangerous. Circle your choice and respond using complete sentences, when appropriate.

	Type A	Type B	Type AB	Type O
Red Blood Cell with Antigens				
Recipient Antibodies			none	

Circle one

28. A patient with blood type B receives a transfusion of type O blood. **SAFE** or **UNSAFE**

29. A patient with blood type AB receives a transfusion of type A blood. **SAFE** or **UNSAFE**

30. A patient with blood type O receives a transfusion of type B blood. **SAFE** or **UNSAFE**

31. A patient with blood type A receives a transfusion of type AB blood. **SAFE** or **UNSAFE**

32. A patient with unknown blood type receives a transfusion of type A blood. Luckily, no complications occur. Which two blood types could the patient have? A AB

    Explain your choices.

Because the patient must have no anti-A antibodies, the recipient must carry the A antigen. The two human blood types with the A antigen are type A and type AB.

33. Type O blood is called the "universal donor" because it can be safely donated to anyone, regardless of the recipient's blood type. Why is this safe? Include the terms antigen and antibody in your answer.

Type O is the universal donor because no antigens are carried on the red blood cells. Therefore, there is no antigen to bind with antibodies and trigger an immune response.

34. On the other hand, type AB blood is called the "universal recipient." Explain why, including the antigen/antibody response.

Type AB is the universal recipient because no antibodies are present in the plasma. No antibodies mean no immune response, regardless of the type of blood transfused.

