I. Proposal Cover Page

Proposal Title: Will Microgravity Have a Significant Affect on Packed Synthetic HBOCs?

Grade Level(s) of Submitting Student Team: Grade 11

Submitting School: Montachusett Regional Vocational Technical School

Submitting School District: Montachusett Regional Vocational Technical School District

Submitting Teacher Facilitator:

Name: Mrs. deDiego
Position: Chemistry Instructor
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Proposal Summary:

Our project proposal revolves around one central concept: How does microgravity affect Synthetic Hemoglobin Based Oxygen Carriers? Due to their extreme medical potential, Synthetic HBOCs are favored in emergency medical conditions where it is difficult to get donated human blood. On the International Space Station, as well as any other spacecraft, it is next to impossible to keep a supply of donated blood on hand to use in emergency situations. Synthetic HBOC’s, on the other hand, last an extremely long time, have the ability to adapt to any person in need and can be stored without the complex conditions required for human blood. The only problem is: nobody knows how these cellular components will react when taken up into space. Through this experiment, we are trying to figure out just how Synthetic HBOCs will react among each other when stored in microgravity. Will they stick together and become unviable? Will allowing them to float free affect their ability to transport oxygen throughout body tissues? Will their protein membranes disintegrate? Our experiment can address all of these issues. To obtain these answers, we plan to place two samples of synthetic HBOCs in identical containers, immersed in a preservative, under controlled conditions. One sample will be sent into space, the other will remain here on Earth. By analyzing both of these samples simultaneously after the flight, we will be able to address all of the afore-mentioned issues and more.
II. Student Team Members Page

Co-Principal Investigators

Name: Nadia Machado
Grade level: Grade 11
Trade: Health Occupations

Name: Tiffany Nguyen
Grade level: Grade 11
Trade: Health Occupations

Name: Ryan Swift
Grade level: Grade 11
Trade: Machine Technology

Collaborators

Name: Yeniffer Araujo
Grade level: Grade 11
Trade: Health Occupations
III. Experiment Materials and Handling Requirements Pages

Type 1 FME

LIST YOUR PROPOSED EXPERIMENT SAMPLES BELOW:

**FME Main Volume (all FME Types):**

<table>
<thead>
<tr>
<th>Sample Description (List each fluid/solid to be used and proper concentration)</th>
<th>Source of Sample (Confirm with the source that you can obtain the sample in time for the experiment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synthetic HBOCs (Hemopure) Filled to capacity</td>
<td>OPK Biotech Cambridge, MA</td>
</tr>
</tbody>
</table>

3. **Special Handling Requirements During Transportation**

There are no special handling requirements.

4. **Timeline for Experiment Aboard International Space Station**

T = 0: S = 0 SSEP payload is transferred to ISS  
(There are no handling instructions or requirements.)

5. **Certification by Teacher Facilitator**

By signing this section of the proposal, the Teacher Facilitator certifies that the samples list and the special handling requests listed above are accurate and conform to the requirements for SSEP Mission 1 to ISS. The Teacher Facilitator also certifies that the team, after reviewing 1) their procedure for obtaining the samples for the experiment, and 2) their budget, is certain that they will be able to obtain the necessary samples for their experiment, and in time to meet the deadline for FME shipping to Houston. Finally, the Teacher Facilitator certifies that the student team will have access to the proper facilities to prepare the Fluid Mixing Enclosure for flight and to analyze the samples after the flight.

Paula deDiego  
Teacher Facilitator  
signature
IV. The Question to be Addressed by the Experiment

Description of the basic question:

Will Microgravity Have a Significant Affect on Packed Synthetic HBOCs? While in storage, the HBOCs will still be held at the same temperature as here on earth and they will still have the same oxygen concentration in the air. The only change is the lack of gravity pulling them to one side of their container. We are trying to figure out if the lack of gravity will affect the solubility of the oxygen bound to the HBOCs.

Discussion of current scientific understanding that is relevant to the question:

Due to their necessity in the medical field, certain information has been gathered about blood components and their synthetically made equivalents. Real blood, when used in transfusions, has several risk factors that have to be taken into consideration and a few drawbacks to the process. The first of these factors is blood type. Since these components would be transferred from another human, they would carry their blood type with them, thus posing a problem if the recipient did not have the same blood type. The second and most serious risk factor is the chance that the components could also be carrying a disease or foreign body as they are transfused. The third and final risk factor is, if the recipient rejects the transfer, they could suffer through a bodily change similar to an extreme allergic reaction. A couple minor drawbacks to the process are that the actual extraction of the blood is a painful procedure and that once extracted, the blood is only viable for around 42 days.

On the other end of the spectrum, Hemopure has very few risk factors and there are practically no drawbacks. Synthetic blood, otherwise known as Synthetic HBOCs (Hemoglobin Based Oxygen Carriers), is manufactured in Cambridge, Massachusetts as the product Hemopure. This is a synthetic substitute for red blood cells and has the ability to carry oxygen through the body extremely efficiently. Also, this product is in stage three of clinical trials and will soon be cleared for any person to accept. HBOCs are the body’s natural oxygen transports and contain hemoglobin which bonds to oxygen reversibly to transfer the oxygen throughout body tissues. The hemoglobin in HBOCs is natural hemoglobin that has been sterilized and placed in a synthetic membrane made of lipids. Having been cultured in a lab, synthetic blood has no chance at contracting a foreign body or disease, has no specific blood type and is able to go to any recipient. Hemopure is stable without refrigeration for 36 months at 2 degrees to 30 degrees centigrade, for 18 months at the elevated temperature of 40 degrees centigrade, and is acceptable by all blood types. These properties permit the product to be stocked well in advance of anticipated use. Consequently, when blood is not available, Hemopure could be used to provide temporary oxygen-carrying support to a patient until the needed type and quantity of red blood cells arrive, until the patient can be transported to a hospital or until a patient's body replenishes its own red blood cells. Currently, the maximum one-time dose of Hemopure (10 units) will not be a permanent cure for anemia or a long term fix for massive blood loss, but it will keep a patient stable long enough to receive proper care.
Hemopure has certain disadvantages when compared to red blood cells. Transfused red blood cells have a longer duration of action and can persist in the body for an estimated 60 to 90 days. Hemopure has an average half-life of 19 hours once inside the body and, depending on the degree of the patient's anemia, may require repeat administration.

Hemopure’s small molecular size permits it to oxygenate through the plasma and thereby act as a potential therapeutic in ischemic (blood flow constricting) conditions, where red blood cell transfusions are generally not useful. These factors have contributed to the focus on the treatment of cardiovascular ischemia and out-of-hospital trauma.

**Description of the insight that will be gained from the experiment:**

By sending the samples of synthetic HBOCs into space, we are testing to see if their ability to carry oxygen is affected by floating in a microgravity environment. In addition to these results, experimenting with synthetic HBOCs can lead to thousands of implications in the world. By figuring out what type of environments these synthetic substitutes can survive in, we can figure out all the different places we can use them. With a shelf life of up to two years, these HBOCs are ideal for storage in spacecraft. If there was an emergency situation involving an astronaut in space, synthetic blood would be perfect for treatment and replenishing a person's blood supply. Because there is no risk for immunologic reactions and the blood can be given universally, it is extremely practical to use it in an area where many people need the blood. There is no need for matching blood type because there is no antigen in the synthetic HBOCs and they are good for use with any natural blood type. They are also extremely well adapted for trauma injuries because they can easily access swollen and constricted tissues.
V. Experiment Design

The experimental rationale:

Our experiment is identifying the affects on synthetic HBOCs when stored in microgravity. By doing this we can figure out if synthetic HBOCs can be stored in space to help solve emergency medical problems. Since the HBOCs can be used in any person in the world, they are ideal to have in any emergency kit that would be traveling with the astronauts into space.

The experimental materials:

The materials were chosen for this experiment based on availability and we have contacted researchers that will assist us to perform our analysis.

The experimental procedure:

The procedure consists of one simple step. All that needs to be done is to place the synthetic HBOCs in an ampoule and send them into space for storage during the flight.

Ground elements:

We will leave a sample of synthetic blood here on Earth as well as send one into space. The sample left on Earth will be our ground truth to compare with the sample that will be sent to space. Both samples will come from the same lot of Hemopure and will be analyzed simultaneously. This is important because it will reveal the differences between the samples and determine if microgravity affected the oxygen carrying abilities of the synthetic blood.

Experimental analysis:

Upon return, the actual procedure can initiate. As a group, we will analyze both of our samples; synthetic blood exposed to microgravity and the same type of sample left here on Earth. In order to do this, we will need to subject the samples to several tests determining their consistency and oxygen-carrying abilities. Both samples are under the same quality control measures and will undergo the same tests to check the integrity of the synthetic samples. The recommended tests include but are not limited to: P-50 test, size exclusion chromatography, total hemoglobin, and MET Hemoglobin test. The compared results of these tests will determine if there was any change between the two samples. We will also examine the structure of the individual HBOCs to see any direct physical change.
Works Cited


VI. REQUIRED Letter of Certification of a Student-Directed Effort

May 10, 2012

I certify that the student team designed the experiment described herein and authored this proposal, and not a teacher, parent, or other adult. I recognize that the purpose of this letter is to ensure that there was no adult serving to lead experiment definition and design, or write the proposal, and thereby provide content and/or professional expertise beyond that expected of a student-designed and student-proposed experiment.

I also understand that NCESSE recognizes that facilitation of thinking across the student team by the team’s Teacher Facilitator, and other teachers, parents, and local area researchers, is not only to be encouraged but is absolutely vital if students are to receive the necessary guidance on the process of scientific inquiry, experimental design, how to do background research in relevant science disciplines, and on writing the proposal.

Paula deDiego
Teacher Facilitator