Human Immune Complex Formation Rates in Microgravity

Team Name
The Weightless Lumbees

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* flew in April, 2008

As the faculty advisor for an experiment entitled "Human Immune Complex Formation Rates in Microgravity" proposed by a team of undergraduate students from UNC Pembroke, I concur with the concepts and methods by which this experiment will be conducted. I give my full support for these individuals in this program. I understand that any default by this team concerning any program requirements (including submission of final report materials) could adversely affect selection opportunities of future teams from UNC Pembroke.

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Timothy M. Ritter
Professor of Physics

I. Overview

A team consisting of seven undergraduate students from four different academic disciplines (Biology, Chemistry, Education and Nursing) have joined together to submit this proposal to NASA's Reduced Gravity Student Flight Opportunities Program (RGSFOP). The team represents The University of North Carolina at Pembroke (UNC Pembroke). The team name is "The Weightless Lumbees". This name was chosen several years ago by the first team to submit a proposal to RGSFOP to identify its American Indian history. The team proposes to perform one microgravity experiment and one outreach demonstration on board the aircraft. It is our hope to 1) gain a better understanding of the effects of gravity on the human immune system and 2) excite the next generation of science students with our outreach experiment.

1. Purpose/Introduction

It is our intention to conduct one experiment and one demonstration onboard the Zero-G aircraft, one for research and the other to be incorporated into our outreach program. The first experiment will investigate the effects of microgravity on immune system by looking at the binding rates of antigens and antibodies found in the human body. The demonstration will be the classic oil and water mixture in a bottle, showing what occurs when two fluids of different densities are mixed together and the effects of gravity on their interface. The proposal has been endorsed by the administration of The University of North Carolina at Pembroke.

2. Background

The Lumbee Tribe has occupied the lands around the Lumber River for the last 300 years. The first Indian community observed in this area was in 1724 on Drowning Creek (Lumber River) in what is present day Robeson County, North Carolina. Today the Lumbee Native Americans still occupy this area. The Lumbees gained tribal recognition by the state of North Carolina in 1885. Along with this recognition, the Lumbee Tribe gained state-provided educational assistance and other services. Although the Federal Government and the state of North Carolina recognize the Lumbee Native Americans, the tribe is excluded from most services provided by the Bureau of Indian Affairs. However, because of state recognition, some federal services and assistance from the Department of Labor, Office of Indian Education, and the Administration for Native Americans are rendered. The Lumbee Tribe holds no treaty with the federal government. However, in 1956, the Congress of the United States passed the Lumbee Act, which officially recognized the Native American Indians of Robeson and adjoining counties as the Lumbee Native Americans of North Carolina.

3. North Carolina Space Grant

North Carolina Space Grant (NCSG) was established in 1991 and continues to promote aeronautics and space-related science, engineering, and technology programs. This is accomplished through forming partnerships with all levels of educational institutions, industry, and government within the state of North Carolina.

NCSG membership currently consists of ten of the sixteen UNC campuses and one private university (Duke University). UNC Pembroke is one of the original members of NCSG and continues to work closely with them to promote space science awareness across North Carolina. Two members of The Weightless Lumbees currently receive individual support from the NC Space Grant and they have been very helpful to our program in the past.

4. The University of North Carolina at Pembroke

In 1887, the state established an American Indian training school for the Lumbee Native Americans. Over time, this training school grew into a comprehensive university that today still serves the southeast region of the state. This school is now known as The University of North Carolina at Pembroke (UNCP) and is the fastest growing campus among the sixteen institutions comprising the North Carolina system for public coeducational and higher learning. UNCP has always been a diverse institution and has the largest enrollment of Native Americans east of the Mississippi River. UNCP boasts a very racially diverse population of students. Approximately 17 percent of UNCP's student body is American Indian and 22 percent African American. Many American Indian student organizations, such as NASO, the American Indian Science and Engineering Society (AISES), and several Native American Greek organizations are actively represented at UNCP.

5. Organization of the student teams

The 2008-09 Weightless Lumbees team consists of seven student members, four of which are members of the Lumbee Indian tribe. The members were selected via an interview process conducted by the faculty advisors. The initial selection began in the spring of 2008 and was concluded this fall. Work on the research topic was begun last year as part of the 2007-08 campaign and continues with this year's project. The senior member of the team, Lisa Walters, took the initiative to serve as the team leader. Lisa was a flyer on last year's team and is a dual Biology/Chemistry major preparing for medical school.

Two faculty advisors have also been selected for the team. Dr. Tim Ritter, Professor of Physics at UNCP, is the supervising faculty advisor. Dr. Siva Mandjiny, Professor of Chemistry, serves as the team's biochemistry advisor.

Members of the student team and their responsibilities

Name	**Classification**	**Academic Major**	**Team Responsibility**
Branyun Bullard	Sophomore	Biology	Procedures, Data Analysis, Immunology Experiment
Michelle Godwin	Sophomore	Biology	Ground Crew, Procedures, Outreach Experiment
Lane Guyton	Senior	Biology/Chemistry	Procedures, Data Analysis, Outreach Experiment
Clinton Haywood	Senior	Education/History	Outreach Coordinator, Ground Crew
Tamra Henderson	Sophomore	Nursing	Procedures, Data Analysis, Immunology Experiment
Lisa Walters	Senior	Biology/Chemistry	Team Captain, Procedures, Data Analysis
Lindsay Willis	Senior	Biology	Procedures, Data Analysis, Immunology Experiment

In addition, all team members will actively participate in our outreach program (see Outreach section of this proposal for further details).

II. Technical

A. Synopsis

The NASA mission statement expands upon the idea of how technology gives insight into ones own self. Throughout one's life, the human body has encountered various environments including zero gravity and hyper gravity. In order to prepare for the future life on Mars, astronauts are currently spending more time in space. As a result of the increased time period in space, the immune system has been of great interest to flight surgeons, as well as, the astronauts. In order to understand how the immune system is affected through gravitational fields, one must understand the factors relating to the immune system (Borchers 2002; Sonnenfeld 2002 & 2003). NASA has shown interest in the immune system by exploring the immune system through research in cellular biotechnological areas. According to Sundaressan, it is believed that researchers will eventually develop a therapy that will allow the increase of antigen and antibody interaction during zero gravity (Sundaresan, 2004). The immune response will ultimately increase as a result of antigen and antibody interaction. Therefore, our research goal is identify the significance of gravitational forces on the human immune system by in-vitro antigens and antibodies.

B. Test Specifics

1. Test Objectives

Our intent in 2008-2009 is to determine the rate of formation of immune complexes at varying gravitational forces; zero, Lunar, Martian, and 2 g. We hypothesize there will be varying rates of formation depending upon the gravitational forces applied. We believe there will be a decreased rate of formation during microgravity and an increased rate during hyper-gravity. We also believe the immune complexes will have slightly varying rates of formation under Lunar and Martian gravity. In order to confirm our hypothesis we will measure the absorbance rates due to the formation of immune complexes during 0, 2, Lunar and Martian gravities and then compare them to rates determined by the 1-g ground truth samples. Data obtained from this experiment will be analyzed for its research value as well as being used in our outreach program.

2. Test Description

By observing the reaction between human Immuno Globulin G (IgG) and goat derived Anti-Immuno Globulin G (A-IgG) in a Sodium Phosphate Buffer, we will be able to study the in-vitro formation of immune complexes under varying degrees of gravity. To catalyze the rate of reaction, the buffer solution will contain polyethylene glycol (PEG). Prior to flight, solutions will be prepared and stored separately. The solutions are to be combined during 0-g, 2-g, Lunar and Martian g's. A spectrophotometer will be utilized to record the absorbance of the first 20 seconds of the reaction. Absorbance rate data collected during flight will be compared to rates obtained in the lab for a solution containing the same concentrations of IgG and A-IgG within the Sodium Phosphate and PEG buffer.

Initial Experiments

Due to the compressed timeline of this special flight, no initial experiments have been run at this time. Pre-flight experiments are to be preformed over the next several months. However, we are repeating our previous experiment from the 2007-08 campaign and we have 1-g data collected prior to and after the April 2008 flight. Last year data was lost post flight and no analysis was preformed, therefore we would like to repeat our experiment and include Martian and lunar gravities to strengthen the results of our data set. Prior preliminary measurements were

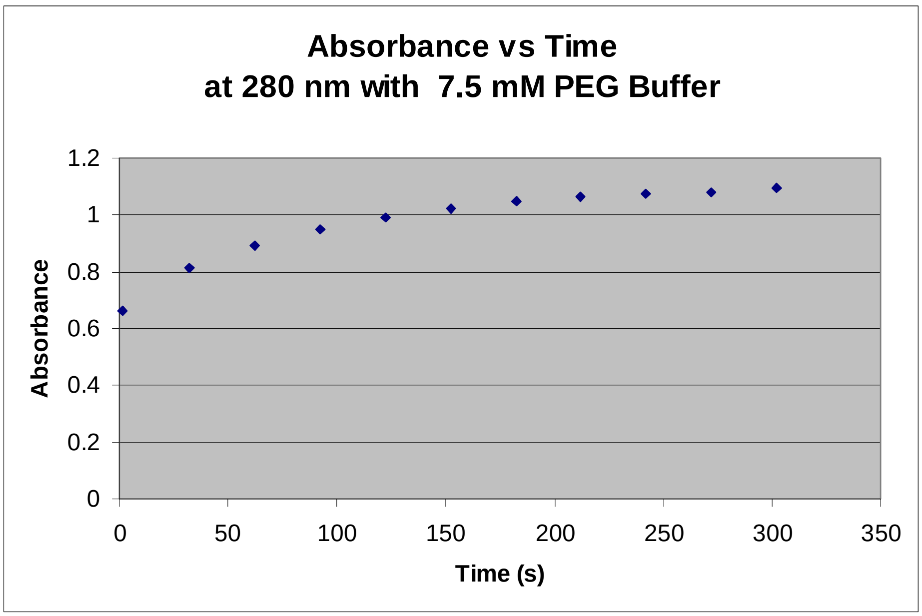

Fig. 1: The absorbance increase depicts the time required to form and immune complex in a 7.5 mM PEG Buffer using technical grade IgG.

preformed in the laboratory last year. Numerous trials were preformed enabling us to determined optimal concentrations for the PEG buffer solution as well as the IgG and A-IgG solutions. Based on the time limitation faced during the parabolic flight path our goal was to demonstrate an absorbance increase within 20 seconds of mixture. After several months of experimentation last year, a PEG concentration of 7.5 mM added to the sodium phosphate buffer has been determined to give optimal absorbance during the 20 second interval using a wavelength of 280 nm. Consequently a 7.5 mM solution of PEG and Sodium Phosphate will be used to create the buffer solution in which the technical grade IgG and the A-IgG will react to form immune complexes. The rate of absorbance for our optimal concentration is shown in figure 1.

C. Equipment Description

1. Description

The Immune Complex experiment has several pieces of equipment associated with it. The primary components are the spectrophotometer, the PASCO datalogger, and the Immune Complex Formation devices. The outreach demonstration, or the Density Demonstrator is rather simple. Both experiments will be housed inside a double Lexan walled glove box and all of the above are explained in detail below.

Spectrophotometer

An Agilent 8453 DAS spectrophotometer was originally used in the laboratory to measure the absorbance of light. However, this is a large bench top sized piece of equipment and it cannot be used inside the glove box. In its place, an Ocean Optics USB4000 Spectrophotometer and USB-ISS-UV-VIS Integrated Sampling System will be used during flight. The USB4000 Spectrometer and its mating light source are both relatively small and easy to contain in the glove box (see Fig. 2). When the system is properly connected, it consists of a Spectrometer and light source that is approximately 290 mm x 168 mm x 40 mm and under 400 g. The USB-ISS-UV-VIS Integrated Sampling System has a Deuterium tungsten light source that requires 1.8 A while the USB4000 spectrometer requires 250 mA at 5 DCV. The USB4000 and USB-ISS-UV-VIS Integrated Sampling System can be controlled with either a laptop computer or a handheld datalogger, the Xplorer GLX™ (described below). When the spectrophotometer and light source are connected together the system allows for the insertion of a standard 1cm cuvette for measurement purposes. The absorbance spectrum can be measured using light ranging from 200 nm to 1100 nm.

Fig. 2 Manufacturers photo of the Ocean Optics spectrophotometer. Device will be controlled by a laptop computer within the glove box. Overall dimensions given in the text.

Pasco's Xplorer GLX™

The Xplorer GLX™, see figure 3, is a device that allows the experimenter to take precise measurements sent from the spectrophotometer. This mini computer (GLX™) stores and prints data and controls all the functions of the spectrophotometer system. The inner most components of the GLX™ include universal sensor ports, 10MB internal memory for maximum data storage and a graphing calculator for trend analysis.

Fig. 3 Manufacturers photo of the Pasco Xplorer GLX™ datalogger.
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Density Demonstrator Containment

The Density Demonstrator consists of oil and water to show the variations between the density dependent gravitational affects on each substance. The containers which will be used for the outreach portion of the experiment are certified nonpyrgenic clear polystyrene bottles. These corning containers are capped with high-density polyethylene caps that form a liquid tight seal. The containers are completely transparent, which will allow for through observation during the experiment. Each container will contain equal amounts of clear mineral oil and colored water. The containers will be secured inside the glove box by Velcro strips.

Glove Box

The equipment needed for both experiments will be located in a glove box to provide additional safety, see figure 4. The experiments will be secured inside the glove box using a mounting system consisting of bolts and velcro. The glove box is double walled Lexan and held together with an industrial style aluminum frame. The front of the glove box has a mounting bar on which

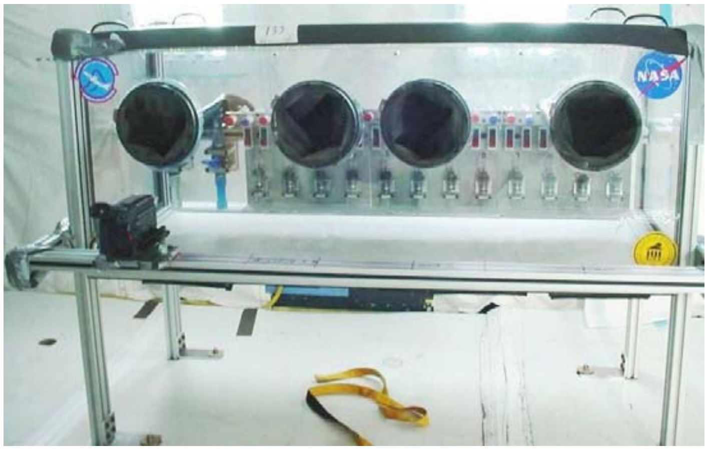

Fig. 4 Double-walled Lexan glove box with two sets of industrial strength rubber gloves. The glove box is shown in this picture with a previously flown experiment and only one camera mounted.

to hold two cameras in place during flight. The legs of the glove box are equipped with mounting brackets which are compatible with the bolt pattern of the C-9 aircraft. These mounting plates are detachable and can be easily redrilled to match the existing pattern on the floor of the Zero-G 727. Furthermore, access into the glove box is accomplished through two sets of industrially tested gloves that are mounted to one side of the glove box. As a security precaution against a leak through the gloves, Lexan covers have been made which fit the glove openings and can be quickly secured in place. For further protection during the flight, foam padding will be applied to the edges and corners of the glove box prior to the loading on the aircraft.

2. Data Acquisition

Antigen Antibody Experiments

Prior to flight, a 7.5 mM PEG Sodium Phosphate buffer solution will be mixed and will contain the antigen IgG. The IgG solution will be stored in thirty standard 1cm cuvettes until flight. Two syringe needles will be pushed through the cap of each cuvette. See figure 5 for an example of the Immune Complex Formation (ICF) apparatus. The first syringe will contain the A-IgG and the second will be empty to allow for the compensation of overpressure during the insertion of the A-IgG into the cuvette. During flight, the experiment will begin by moving the entire ICF over to the spectrophotometer and inserting the cuvette portion into the opening prior to entering 0-g/2-g. Upon entering g forces, the A-IgG will be manually injected into the cuvette from the syringe. The spectrometer will then begin measuring the absorbance rate through the formation of immune complexes. Once in process, the spectrophotometer will record readings for the rate of reactions in 20 second increments. To allow preparation for the next set of g forces, the cuvettes will be removed from the spectrophotometer after completion and before entering "dirty air". As part of the post flight analysis, the recorded data and video will be analyzed for further reference.

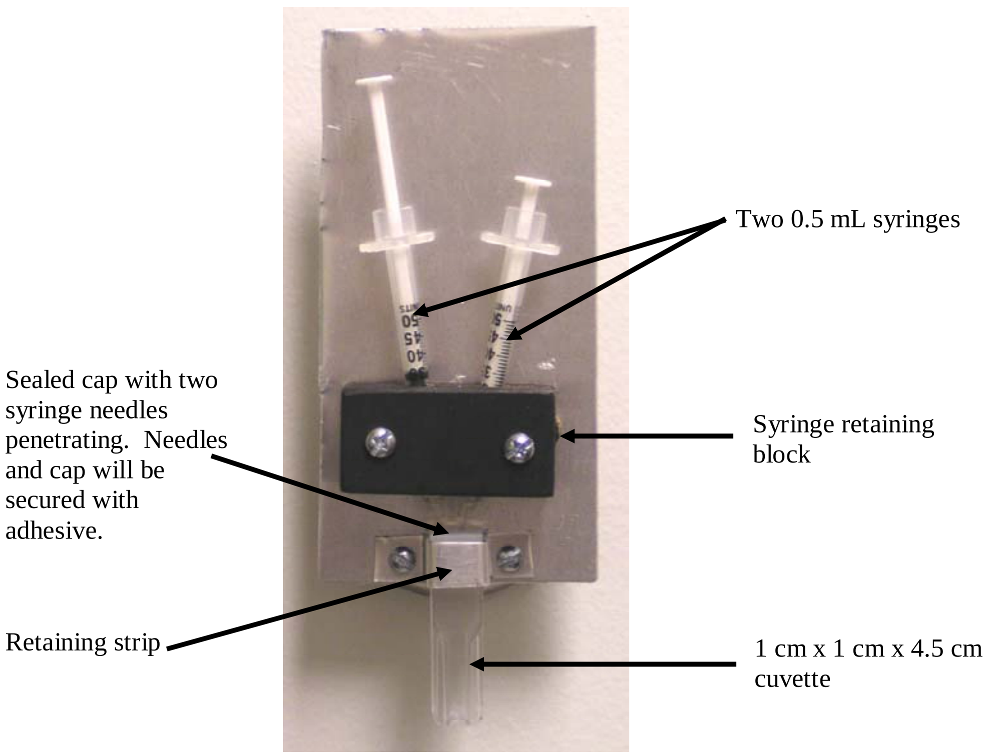

Fig. 5 Immune Complex Formation (ICF) apparatus.

The Density Demonstrator

The oil and water demonstration requires little preparation and operation while in flight. The observation containers will be pre-filled with oil and water. During flight, the operator will remove one of the bottles from its mounting and simply rotate the bottle inside the glove box. One of the cameras will be strategically placed to capture the effects of gravity on the solution.

If need be, the camera will be refocused after each parabolic flight. This video footage will be analyzed once the flight has concluded. The footage obtained will be incorporated into our outreach presentations.

3. Parabola Requirements

Each experiment will begin when the aircraft enters either 0-g or 2-g and conclude prior to exiting the reduced/hyper gravity portion of the parabola. We will have 30 ICFs in the glove box and will distribute their usage through the various reduced/hyper gravity potions of the parabolas. The density demonstration will be performed during all gravitational environments experienced during the flight.

4. Structural Load Analysis

All major pieces of equipment will be stress tested before the flight. This will ensure that all design requirements and guidelines are met. In our Test Equipment Data Package (TEDP) there will be greater details on the testing. The structural design will be in compliance with all regulations that NASA has for frame attachments, assembly design, frame attachment to the aircraft floor, and floor surface area load analysis. A 9-g load in all directions will be analyzed for takeoff and landing configurations. The frame will also go through a series of pull tests in the laboratory to simulate the g-load forces that will be present.

5. Electrical Load Analysis

The laptop and the video cameras will be powered by their own battery packs, while the light source on the spectrophotometer will require an external 120 V power supply connection. The glove box has been designed with a single power cord passing through the walls and a multiple outlet surge protected power strip mounted internally.

6. Pressure Vessel Certification

The Antigen and Antibody, as well as the Density Demonstrator, fall under Category C for the Pressure/Vacuum System Requirements. The 7.5mM buffer will be preloaded into the cuvettes prior to flight in a 1-g environment. In addition to the buffer solution, the IgG will be loaded into the cuvette also on the ground approximately one hour before flight. During flight, the A-IgG will be added to the solution through a syringe into the cuvette to observe and measure the rate of interaction through the absorbance. The containers located within the glovebox should only experience pressure changes if the aircraft experiences pressure changes as a result of change in altitude. Therefore, the containers within the glove box will be able to withstand the slight change in pressure due to altitude changes.

7. Hazard Summation

For safety precautions, our team will attach instructions to the exterior portion of the glove box to advise team members on responsibilities if an accident were to occur. In the case of an emergency, team members will be advised on proper safety procedures to be preformed.

The Antigen Antibody Experiment and the Density Demonstrator are not free floating and will be completely contained within the glove box throughout the entire flight.

8. Test Operating Limits and Restrictions

Before arriving in Houston, preliminary trials will be performed using the GLX™ and the spectrophotometer to record the interaction between the IgG and A-IgG. These initial experiments will serve as a guide for the team members in order to understand the step by step procedure during flight. In addition to completing preliminary trials, the trials data will be evaluated to conclude the average absorbance for the experiment. To ensure the flight experiment will be as safe as possible, the preliminary trials will be performed inside the glove box to in order to replicate flight conditions.

9. Requested Flight Dates

January 8 – 17, 2008

10. Support Requirements

Our team will require refrigeration for the storage of the A-IgG and IgG solutions prior to flight, but not during flight. The PEG buffer solution must also be prepared the day before to enhance the interaction between IgG and A-IgG. As a result of small volumes used, all containers will be relatively small in size and should not take up much space. In addition to storage requirements, basic tools will be required for assembly of apparatus. These tools will be checked out according to the Reduced Gravity's office procedure and returned prior to flight.

11. Request for JSC Engineer

To provide our team with a professional individual who can answer questions directly to our team throughout the various phases of our experiment, we would like to request a JSC Engineer; Mr. Wesley Tarkington of Lockheed Martin Space Operations. A prior team from our institution worked with Mr. Tarkington and he has shown interest in working with our university as part of the 2008-2009 campaign. Mr. Tarkington would serve as an invaluable source of information throughout our construction phase and provide knowledge that would enhance the success of our experiment.

D. Test Procedure

1. Proposed Flight Profile

Ground Operations

Preceding lift off, all equipment will be cleaned and readied for flight. Subsequent to this procedure, the apparatus will be inspected to assure that there are no unfastened materials present. In addition to the apparatus, the cuvettes and syringes will be examined for leaks. All preparations listed above will take place at Ellington field prior to lift off.

Pre-Flight

The PEG buffer solution will be prepared the night preceding the flight to limit degradation. On the actual flight day, the IgG and A-IgG will be loaded into either the cuvette or syringe. The spectrophotometer and the Density Demonstrators will be mounted inside of the glove box. The cuvettes comprised of the IgG along with both syringes will be mounted securely on the support bar. The video cameras will be stowed in a cruise box until the team is given permission to mount them on the camera mounting bar. Once the experiments are completed, the cameras will be returned to the cruise box for the return flight. Additionally, Material Safety Data Sheets will be posted along the side of the glove box in compliance with NASA's prerequisites.

In-Flight

Once the students have become accustomed to the weightless feeling, the individuals will begin work on the specific experiment. One individual will be responsible for the Antigen-Antibody experiment and one for the density demonstration. The person working the density experiment will have primary responsibility for the cameras. The cameras will be turned on before the first experiment takes place. The first camera will remain stationary throughout the flight to monitor the density demonstration while the second camera will be moved along the mounting bar to record the Antigen and Antibody experiment. During "dirty air" the team member will place a new cuvette containing IgG and PEG buffer solution in the spectrophotometer. Upon entering reduced/hyper gravity, the individual will inject the A-IgG into the cuvette and begin to measure the absorbance for twenty seconds. After the first twenty seconds, the cuvette will be removed from the spectrophotometer, placed securely back on the mounting bar and replaced with another cuvette to prepare for the next reduced/hyper gravity. This experiment will take place approximately ten times for each gravitational field.

Post-Flight

The solutions used during the first flight will be removed from the cuvettes and placed into a waste container for storage. Preparation for the second flight will include cleaning the equipment, refilling syringes and cuvettes with the specific solutions. In addition to exchanging the solutions, we will install new batteries for the camera and replace the used video tapes with new ones. Upon completion of the experiments on board the aircraft, the waste products and the equipment will be packaged to ensure safety during travel back to North Carolina.

Justification for Follow-Up Flight

The 2007-2008 Weightless Lumbees team performed the Antigen-Antibody reaction on board the C-9 aircraft in April, 2008. While in flight, the GLX™ malfunctioned and data was deleted. In addition to the deletion of some data during the flight, all remaining data was lost due to an equipment malfunction with the GLX™ during the return trip to North Carolina. Another unexpected difficulty encountered was keeping the ICF securely mounted in the spectrophotometer. It was found that the ICF would begin to "float away" if it was not held in by the experiment operator. This resulted in unusable data for several reactions. In order to address these lessons learned, the team is designing a new platform for the spectrophotometer which will include a mounting surface for the ICF. This will hold the cuvette firmly in place inside the spectrophotometer. The team will also be making multiple copies of our data to avoid any loss due to unexpected equipment malfunctions. Finally, we are expanding the number of ICFs mounted in the glove box to take advantage of the extra Martian and Lunar parabolas. This will expand the range of our data to include five gravitational environments (0-g, $\frac{1}{6}$ -g, $\frac{1}{3}$ -g, 1-g, and 2-g).

III. Safety Evaluation

A. Hazard Analysis

To ensure that the Antigen Antibody experiment is performed as safely as possible, the team will rehearse the experiment extensively prior to arrival at Ellington Field. Before departure, team members will inspect all equipment thoroughly, as well as have a full understanding of the emergency procedures. In the case of an accident, NASA staff will be advised of the situation at hand and the proper procedure will be initiated. Throughout the research process, our team will be mindful of safety for our team members, as well as fellow flyers aboard the aircraft.

1. Tool Requirements

Our experiment does not require tools during flight. We only request the usage of ground tools supplied through the reduced gravity office. These ground tools will be used only for the assembling of the glove box and equipment within the glove box. In compliance with the reduced gravity office, basic ground tools will be checked out during use and checked in when the tools have been returned. Upon completion of flight preparation, team members will reassess their area to verify all tools have been returned.

2. Ground Support Requirements

Ground support and hardware required for our experiment will be requested through the reduced gravity office. In order to stabilize our experiment during flight, our glove box has been designed to allow for the attachment to the floor of the aircraft. Additional support will be used during takeoff and landing portions of the flight provided through support harnesses.

3. Hazardous Materials

In this experiment, the chemicals used do not express significant hazards to ones health. In addition to the low toxicity of the chemicals, the volumes used are extremely small measuring less than 3mL of a single solution. Material Safety Data Sheets will be provided for all chemicals abroad the aircraft and accessible at all times. Also, emergency procedures will be discussed with team members prior to flight.

IV. Outreach

A. Background and overview of activities

Found in the middle of the second largest county in the state is the University of North Carolina at Pembroke. Robeson County is rich in diversity, and houses roughly 50,000 members of the Lumbee Indian tribe. The Lumbee Indian tribe has encountered many problems in the past few years. One such problem is the unemployment rate which has been on a constant increase since 1991, and with significant dropout rates among the Lumbee population the future does not look too bright. In the last year, American Indian drop out rates has passed those of the Hispanic population, which lead in last years report (NC Annual Report on Dropout Events and Rates 2007). The dropout rate for American Indians is nearly double the average of all ethnicities.

Of the Lumbees that graduate high school and pursue college, the common degree path is that of education; a very small percent decide to study the sciences. We tend to believe that the primary reason for these horrible statistics is that few understand the benefits and rewards of studying science. It is the goal of this team to reach out into our surrounding area, as well as into much of the state, to demonstrate how exciting and rewarding science can be. We as group intend to travel to the surrounding counties of Richmond, Cumberland, Hoke, and Scotland. Furthermore, we will travel to the most western county in the state in an effort to illustrate our mission to another large American Indian tribe in North Carolina, the Cherokee. If our efforts only affect a few individuals, it will most certainly be worth it. Hopefully we can inspire these children to pursue their goals, and more importantly view the area of science as a rewarding option.

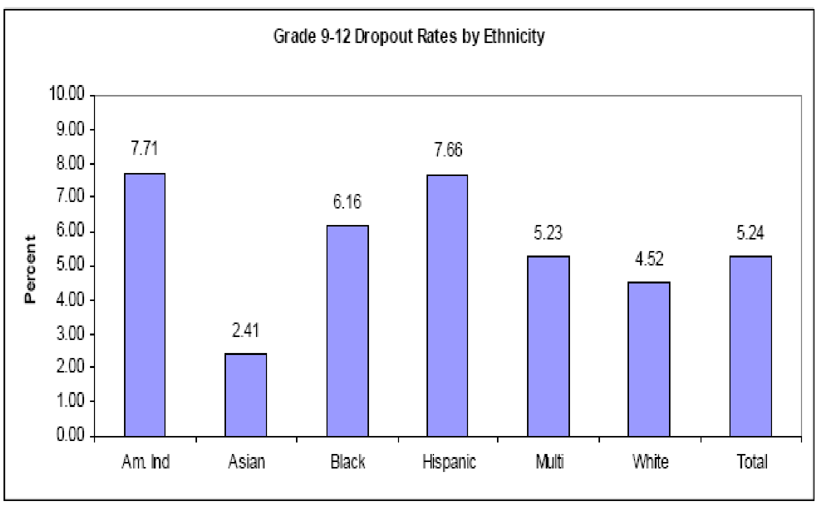

Fig. 6 Hispanic and American Indian students were over-represented in 2006-2007 dropout rates in the state of North Carolina. This is consistent with the rates from previous years reporting. (Taken from the NC Annual Report on Dropout Events and Rates, 2008)

B. Outreach activities

When growing up as a young person, prominent role models made a great impact in the life of the young people. Now looking back as a team, we the “Weightless Lumbees” now see the effect it had on our lives. This has led us to be the role models that we once had and to give the disadvantaged children, not only the knowledge of microgravity but also a better understanding of life.

In order to perform sufficient outreach throughout the state, we will make presentations and be represented at such venues as local schools, after school programs, science museums, youth centers, YMCA/YWCA, and Boys and Girls Clubs to name a few. We will also take our message to our peers through local, state, national, and international conferences.

Topics such as density, gravity, and the concept of weightlessness will be presented as an overview via PowerPoint presentation, which will also include information about the Reduced Gravity Student Flight Opportunities Program. We will also include video clips of flights taken in prior years, which will show "Weightless Lumbees" while performing microgravity experiments. Hands on demonstrations will also be used for younger children, such as making their own oil and water bottles. This will demonstrate the gravitational effects on a mixture of fluids with different densities. CDs will also be handed out and will include our presentation as well as several educational NASA documents, to further aid teachers in their curriculum.

The Education System

As young role models trying to reach this new generation of children in the areas of science and math, we as a team attend many school conferences across the state, spreading our outreach message. We hope that through our hard work and dedication we will be able to set and example for young students as well as the community. We want the children to look up to us and realize that we were once in their shoes and that dreams really can come true if you work hard.

Our team will also indulge in the Parent-Teacher Association, because we know that a great education and superb learning skills begin in the home. We feel that by presenting to the parents, we can educate them in being a primary role model in their child's life by getting them excited about the opportunities NASA has to offer.

Although public schools are our primary focus, there are other organizations we try to target. As a group we plan on reaching out to the American Indian population in the Western part of North Carolina. Most of the reservations accumulated throughout our state, support their own school system through the Bureau of Indian Affairs. We would like to target this group of students and educate them about the opportunities that NASA has to offer.

Youth Organizations

We will be outreaching to children in a non-academic environment by coordinating with many youth organizations. Examples of such organizations we will be reaching out to are the Boys and Girls Clubs, Boy Scouts and Girl Scouts, summer enrichment programs, weekend "Mr. and Mrs. Wizard" type events, the Native American Youth Organization, and after school programs. We will also attempt to involve the community through outreach in Pow-Wow's and through organized church groups.

Conferences

In order to reach our peers team members will participate in many conferences on the local, national, and even international level. Some of these conferences are: the American Indian Science and Engineering Society (AISES) national conference, the Southeastern Regional American Chemical Society's meeting, and the State of North Carolina Undergraduate Research Symposium, to name a few. When presenting at these conferences the outreach will take a new twist. Instead of being a mentor to a younger audience we will be targeting people of various ages, education and socio-economic levels.

Media Coverage

One of the most important aspects of our research is to expand our message to the community. We will accomplish this responsibility by means of local radio, television, and newspapers. In addition, our team will prepare presentations and deliver them to surrounding schools in attempt to encourage youth to pursue science and the benefits thereof.

Since the establishment of the Weightless Lumbees a website has been maintained and continues to grow and be improved upon. This website, (which can be located at the following URL: http://www.uncp.edu/home/ritter/kc135/kc135home.html), is a source for students and faculty to access information on current experiments, as well as past experiments. In addition to the website, a brochure will be published to be used in conjunction with the outreach presentation (a copy can be found on website) to distribute to community members and at public conferences.

Previous Activities:

The following list highlights our various outreach activities. Note the presentations range from small local schools to the state level science museum to national level conferences.

1. October 18, 2007: Presented to 50 high school students and two teachers at Cherokee High School in Cherokee, NC.

2. October 27, 2007: Participated in the North Carolina celebration of National Chemistry Day at the North Carolina Museum of Natural Sciences. Approximately 500 persons came by our table.

3. December 14, 2007: Presented to 250 middle school students and 4 teachers (4 presentations in one day) at West Pine Middle School in Pinehurst, NC.

4. December 18, 2007: Presented to 100 8^{th} grade students and 1 teacher at Rockingham Junior High School in Rockingham, NC.

5. January 26 and 27, 2008: Set up an informational table and demonstrations at the North Carolina Museum of Natural Sciences' annual Astronomy Days event. We had approximately 1000 persons come by our table and speak with us.

The Weightless Lumbees have also delivered their message through conference presentations. The following presentations were made at conferences during the applicable time period.

1. "The Influence of Micro- and Hypergravity on Immune Complex Formation", presented by Lisa Walters, *22^{nd} National Conference on Undergraduate Research,* Salisbury, MD, 2008.

2. "Microgravity: A Down to Earth Approach to Science for Today's Youth", presented by Clinton Haywood and Samantha Schrock, *3rd Annual State of North Carolina Undergraduate Research Symposium,* Greensboro, NC, 2007.

3. "The Influence of Micro- and Hypergravity on Immune Complex Formation ", presented by Tala P. Smith and Lisa Walters, *3rd Annual State of North Carolina Undergraduate Research Symposium*, Greensboro, NC, 2007.

4. "Microgravity: A Down to Earth Approach to Science for Native American Youth", presented by Clinton Haywood, *AISES National Conference*, Phoenix, AZ, 2007.

5. “The Effects of Varying Gravitational Fields on Immune Complex Formation”, presented by Tala P. Smith, *AISES National Conference,* Phoenix, AZ, 2007, (awarded third place prize for all oral presentations).

6. “Flame Dynamics in Microgravity”, presented by Samantha Schrock, *Summer Undergraduate Research Symposium,* Pembroke, NC, 2007.

V. References

Borchers AT, Keen CL, Gershwin ME. Microgravity and Immune Responsiveness: Implications for Space Travel. *Nutrition*, **18** (2002) 889–898.

Sonnenfeld G. The Immune System in Space and Microgravity. *Med Sci Sports Exerc.,* **34** (2002) 2021–2027.

Sonnenfeld G, Butel J.S., Shearer W.T., Effects of the Space Flight Environment on the Immune System. *Rev Environ Health.*, **18** (2003) 1–17.

Sonnenfeld G, Shearer WT. Immune function during space flight. *Nutrition.,* **18** (2002) 899–903.

Sundaresan, A., Risin, D., and Pellis, N.R., *J. Appl. Physiol.*, **96** (2004) 2028-2033.

North Carolina Annual Report on Dropout Events and Rates, Department of Public Instruction, 2008.

VI. Administration

A. Institution Letter of Endorsement

To be included with print copy.

B. Statement of Supervising Faculty

To be included with print copy.

C. Funding and Budget Statement

Funding for the equipment and supplies has already been secured though an award received by one of the team members from the North Carolina American Chemical Society (NC-ACS). The funding for the travel portion of this project is projected to come from several sources to include the North Carolina Space Grant, The University of North Carolina at Pembroke administration, and several on campus organizations.

Estimated Budget

Line Item	***Estimated Amount***
I. EQUIPMENT	
I.1 Syringes	$60.00
I.2 Cuvettes & caps	$120.00
I.3 Video Tapes	$40.00
I.4 Mineral Oil	$20.00
I.5 Glass ware and fluid containers	$30.00
I.6 I-gG and A-IgG	$750.00
I.7 Other Fluids/Chemicals	$500.00
I.8 Bulk wood and metal	$300.00
I.9 Miscellaneous	$250.00
Section I Sub Total	**$2070.00**
II. TRANSPORTATION	
II.1 Rental Cars: Two Vans @ $650.00/week for 2 weeks	$1300.00
II.2 Fuel for Vans: 5200 Miles @ $4.00/gallon	$1400.00
Section II Sub Total	**$2700.00**
III. LODGING/MEALS	
III.1 Hotel: 4 rooms @ $100.00/room for 10 days	$4000.00
III.2 Meals: $36.25/day for 8 persons for 10 days	$2900.00
Section III Sub Total	**$6900.00**
IV. OUTREACH	
(Cost of supplies, demonstration equipment, materials to distribute)	**$1000.00**
TOTAL ESTIMATED BUDGET FOR 2008-09	**$12,670.00**

D. Institutional Review Board

This proposal, entitled “Human Immune Complex Formation Rates in Microgravity”, does not incorporate any human, animal, or biological matter as a test subject. Therefore, no Institutional Review Board (IRB) endorsement is submitted.