**TEST EQUIPMENT DATA PACKAGE**

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**The Behavior of Slime Molds (Physarum) in Microgravity**

TEDP Completion Date: 1 October 2013

**IMPORTANT THINGS TO NOTE:**

**Avoid permanent magnets if possible**

**Avoid Shaterable materials if possible (e.g. class) However there are ways to secure these items, just be sure Mentor and NanoRacks are aware so that they can be packaged appropriately.**

**Avoid pressure vessels**

**Avoid substances with toxicity higher than 2 on MSDS’s**

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**QUICK REFERENCE DATA SHEET**

Team Name: Cristo Rey Jesuit College Preparatory Seniors

Principal Investigator: Fr. Brian Reedy, SJ

Contact Information: 6700 Mount Carmel Street, Houston TX 77087

Experiment Title: The Behavior of Slime Molds in Microgravity

Work Breakdown Structure (WBS):

Flight Date(s): Thursday 8 May 2014

Overall Assembly Weight (lbs): TBD

Assembly Dimensions (L x W x H): 10cm x 10cm x 10cm

Equipment Orientation Requests in reference to NanoRack: TBD

Proposed Mounting to NanoRack: TBD

Does Experiment need to be located next to fan on NanoRack: (Yes or No) NO

Power Requirement (Voltage 9and Current Required): TBD

Camera or Video Requested? (Yes or No): NO

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Section\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Page Number

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**BASIC MISSION OBJECTIVE:**

The goal of this project will be to investigate the behavior of slime molds in microgravity. Slime molds have an ability to self-assemble into cooperating organisms and learn from external stimulus. We will provide a series of well documented stimuli, observe their response, and quantify the differences produced by a microgravity environment.

**EXPERIMENT BACKGROUND**

Slime molds have unique behavior. At times the behave like isolated single-celled organisms, at other times they assemble into slug-like multi-cellular organisms, and when they are under duress they can form fruiting bodies and sporulate. This behavior, in itself, is interesting but the behavior could be even more interesting when it occurs in microgravity. Will the single-celled organisms still be able to self-assemble into the multi-celled organism? Upon induction of sporulation, will the fruiting body be able to develop without the spatial organizing principle of gravity? When a slime mold “slug” is physically separated, the cells find their way back to re-unite. Studies on *Physarum* have even shown that they have ability to learn and predict periodic stimuli (<http://discovermagazine.com/2009/jan/071>). Will this ability transfer into a microgravity environment? Professor John Tyler Bonner of Princeton University, has spent a lifetime studying slime molds. In his book *The Social Amoebae: The Biology of Cellular Slime Molds* he states that they are "no more than a bag of amoebae encased in a thin slime sheath, yet they manage to have various behaviours that are equal to those of animals who possess muscles and nerves with ganglia – that is, simple brains." The simplest statement of our project is that we intend to investigate whether or not slime molds can learn to adapt to a completely new environment. In addition, we have some anecdotal evidence (gathered from a personal conversation with Dr. Don Pettit) that slime molds already exist on the ISS, having arrived there accidentally, but that they have not been studied. It is possible that our research could be helpful in understanding how slime molds function on the ISS and, perhaps, be applied to eliminating them or reducing their negative effects.

**EXPERIMENT DESCRIPTION**

We plan to grow slime molds and visually observe their behavior with a microscopic camera. Slime molds have been very heavily studied and have predictable behavior in response to various chemical and mechanical stimuli. We will have 6 different environments (measuring 5cm in diameter) in which the slime molds are growing. We will chemically and mechanically induce various behaviors in the colonies and observe their behavior. The responses that slime molds give to various stimuli are observable and quantifiable. We predict that in a microgravity environment their responses will be measurably different as functions of time and spatial relationship. We also hypothesize that the slime mold behavior will be qualitatively different (i.e. it will vary in kind, not just amount). We will track their behavior through time lapse photography and video.

**OPERATIONAL SCENARIO**

1. *High Level Summary of Payload Operations, general overview*
2. *Specific constraints for payload (ie. Activation requirements, temperature requirements to/on/from ISS, orientation requirements during transport to ISS)*
3. *How long does the experiment need to operate for? Does the experiment require any crew interaction?*

**We need a minimum of 20 days of experimentation.**

1. *Will payload need to be returned or disposed of once ops complete*

**Yes, we would like for the payload to be returned to us.**

1. *What kind of data needs to be collected during the mission and will ground operations be required (ie. Downlinking to NanoRacks mission control?)*

**The ardulab will be fully automated and it will collect all data. The data will need to be downlinked to NanoRacks mission control.**

**EQUIPMENT DESCRIPTION**

1. Ground-Based and Flight Equipment (if there is no difference just reference the flight Equipment. Please make excel spreadsheet for all categories of the equipment.)
	1. Pictures
	2. Descriptions of each piece of equipment
	3. Dimensions
	4. Mass
	5. Hardware Class (different classes based on toxicity of material)
2. Equipment Layout for Take-off, in Flight, and Landing (some of this information provided by NanoRacks. Equipment may be stowed in flight stowage bag during liftoff and landing. Show how the ardulab should be interfacing the NanoRack with orientation. Diagrams are helpful.
3. Special Handling/Special Hazards/Special Requirements

*Crew handling during mission? Will crew be handling toxic materials?*

1. Bio/Chemical Contents :

*Complete JSC form 27472 if applicable and provide MSDS . Avoid substances with toxicity higher than a 2 on MSDS form.*

1. Inventory of In-flight Items

*Any extra materials that will need to be stowed outside of the ardulab? If you have items that are going to be operated by the crew outside of the module provide a sketch or enough details to create a drawing. Photographs are great if available.*

**ELECTRICAL ANALYSIS**

1. Schematic drawing with all current and voltage draws
2. Load Table
3. Stored Energy
4. Electrical Kill Switch

*How will experiment be turned off in event of an emergency?*

1. Loss of Electrical Power (Fail-Safe)
2. TRY TO DESIGN without Batteries and just use the NanoRacks platform with USB power. If Batteries cannot be avoided, please include the following information and specifications:
	1. Schematics of entire unit must include the batteries (if batteries are rechargeable, include the schematics of the battery charging circuits).
	2. Protection circuit
		1. Manufacturer, details, and model number
		2. Schematics
		3. Voltage and current cutoff levels
	3. Battery type and configuration
	4. Battery manufacturer
	5. Battery history
		1. Testing history, including reports
		2. Previous NASA use, if any.
		3. Lot and cell Data
	6. Specifications on any active thermal system (N/A if no heater internal to Module experiment.)

**INSTITUTIONAL REVIEW BOARD**

*Only for human or vertebrate animal test subjects.*

**HAZARD ANALYSIS**

1. General Hazard Identification Checklist

[*http://jsc-aircraft-ops.jsc.nasa.gov/Reduced\_Gravity/docs/NS-STO-CH01.pdf*](http://jsc-aircraft-ops.jsc.nasa.gov/Reduced_Gravity/docs/NS-STO-CH01.pdf)

**TOOL REQUIREMENTS**

1. Additional Tools that will be required in flight for crew monitoring of the project.

**PHOTO REQUIREMENTS**

1. Camera/Video required? How often during mission required?
2. Downlink Requirements
3. Still/Video Photographer Special Requests

**HAZARDOUS MATERIAL**

*List any hazardous material being used and it hazard number associated with it. Include MSDS sheet for that material in section below.*

**MATERIAL SAFETY DATA SHEETS (MSDS)**

**EXPERIMENT PROCEDURES DOCUMENTATION** *This section is to include procedures for all aspects of the experiment from shipping to KSC to unloading and return to Houston. Please be specific about all procedures, especially those procedures that need to take place while on the Space Station. If there are not specific aspects to consider then please put N/A*

1. Equipment shipment to KSC
2. Ground Operations while at KSC
3. Loading/Stowing
4. Pre-Flight
5. Ascent (Launch)
6. On-Orbit
7. Descent (Return/landing)
8. Post-Flight
9. Off-Loading
10. Emergency/Contingency

**BIBLIOGRAPHY**

Bonner, John Tyler, *The Social Amoebae: The Biology of Cellular Slime Molds,* (Princeton University Press, 2009).

Saigusa, Tetsu, “Amoebae Anticipate Periodic Events,” Physical Review Letters, 11 January 2008, **100**.018101, 1-4.

**DEVIATIONS/EXCEPTIONS/WAIVERS**

*Include any waivers or exceptions documentation from CASIS, NanoRacks, or NASA JSC if applicable.*