Rationale and Guidelines for A Healthy Space Contest.

This Year's Theme: **Healthy Humans in Healthy Places**,

What right stuff would you eat to become the "right stuff" in Space?

Revision: 2023.4.1 1/2/2023

Introduction

The winners of the first three years of the Contest produced candidate food, nutrition, and nutrition timing plan solutions to reduce or eliminate adverse reactions to conditions of deep space flight. The 2023 "A Healthy Space Contest" outcome will integrate these with the agricultural and food production modules in the G.K. O'Neill Space Settlement Design Contest (ONSSDC).

Contestants are asked to develop food and nutrient timing plans to the format of the Mars-Moon Astronautics Academy and Research Science (MMAARS, Inc.) analog missions conducted by MMAARS, Inc. in the Mojave Desert. The effectiveness of the proposed Contest Cumulative Nutrition Plan (CNP, defined further below) guidance will be tested at the MMAARS site. The CNP will be implemented by MMAARS enrollees prior to and during the analog missions. In the Fall of 2023, the winning CNP will form an essential element of the food production guidelines provided to the students applying to the ONSSDC Contest agriculture/food production module design.

Goal

Provide the CNP guidance to be used for the ONSSDC agricultural and food production modules that may best reduce the potential for space flight injury from the principle health challenges of space flight: space ionizing radiation., micro-gravity and long confinement.

Background

Multiple investigations conducted by NASA's Nutritional Countermeasures (NCM) Branch at the Johnson Space Flight Center have identified issues regarding the health of International Space Station (ISS) astronaut crews. Space health researchers have recommended interventions to reduce adverse reactions to deep space flight conditions. Data analyses has identified factors correlated with Spaceflight Associated Neuro-ocular Syndrome (SANS) and other conditions. These factors include mitochondrial injury and insulin resistance in astronauts. Research on nutrition and intermittent fasting warrant further study to help identify potential strategies to improve health outcomes. Currently, NASA's nutrition guidelines for astronauts remain based on the 1980 USDA nutrition guidelines adopted for the Space Shuttle program. These guidelines include high carbohydrate content (50-55% calories), minimal fats and proteins, and about 2,700 calories daily.

Insulin resistance, metabolic syndrome, is when sugar-saturated cells can no longer import and store additional sugar. Mitochondrial injury initiates insulin resistance. [D. C. Wallace, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2821041] NASA's diet guidelines, similar to the standard American diet (SAD), likely initiates insulin resistance prior to space flight. Many medical conditions are correlated with insulin resistance in the American population. Dr. Douglas Wallace, research medical doctor at Children's Hospital in Philadelphia, finds after many years of study that many common medical conditions, such as heart disease and cancer, result from mitochondrial injury. NASA researchers in a November, 2020 issue of CELL report that *mitochondrial injury* has become the "hub" of their investigations for space flight

health injury. We will conduct analog Mars missions to simulate sac flight to some more or less high degree of fidelity.

The Contest hypothesis to be tested:

If participants exhibit mitochondrial injury/insulin resistance prior to analog MMAARS missions then their health and performance outcomes will be significantly less than participants without.

Pre-flight insulin resistance can be evaluated in scheduled participants while engaging in a controlled diet, physical and mental health study monitoring blood insulin and glucose. The analog mission studies will evaluate this mitochondria injury hypothesis in this manner. Lipid and metabolic panels will be collected prior to and following missions. There will be no collections within the missions

The consequences of metabolic syndrome/insulin resistance and some possible nutrition countermeasures are described by Dr. Paul Mason of Sydney, Australia, at https://youtu.be/LRHir1k9jmE.

Dr. Jason Fung of Toronto has proposed that intermittent fasting, or "time-restricted eating," helps address metabolic syndrome and reports many successful case studies. For mild conditions or maintenance, Dr. Fung recommends intermittent fasting 16-18 hours per 24-hour day. Type 2 diabetes, a common outcome of metabolic syndrome, even in advanced cases, seems reversible by fasting and carbohydrate reduction. For milder conditions and for maintenance, Dr. Fung recommends diets that combine low carbohydrate, suitable fats, and moderate protein intake. Examples are variants of mildly "ketogenic" nutrition plans, such as Mediterranean, South Beach and Paleo. The addition of time restricted eating helps address metabolic disorders by supporting natural recovery systems and metabolic flexibility. These diet and fasting modifications may also enhance resistance to radiation, chemical, and physical stressors present both in space and on Earth. Nutrition and behavioral changes that improve health enough to survive on Mars can also improve health for those who stay on Earth.

Contest Multi-Year Theme

Food selection, nutrition, and nutrient timing promotes a healthy life any place where humankind lives.

The Challenge

Detail an eating plan with meals and timing of meals that supports the goal.

Cumulative Nutrition Plan

The first three years have provided thoughtful and well-researched food, nutrition and nutrient timing plans. Individual contestants in prior years referred to their recommendations as Food and Nutrition Plans (FNPs). From these we have now drawn together their best supported recommendations to develop the guidelines below, named the Cumulative Nutrition Plan (CNP).

White Paper

Explain how your meal and meal timing plan will address the Contest goal. Specify nutrition and nutrient timing making use of intermittent fasting and time-restricted eating. Use the standard International Space Station (ISS) eating pattern as a control and apply your own plan as the test design.

Requirements:

- Describe a 90-day period prior to a MMAARS analog mission using the CNP to maintain or restore metabolic health using a two-week repeating diet plan
- List markers used to indicate initial and final measures of metabolic health (see recommended)

- Explain how the markers determine the effectiveness of the CNP
- Provide a food diary with: name of food, source, quantity by volume or weight, and preparation (for example, raw or cooked)
- Specify meal times and intervals of fasting and eating, including daily or prolonged intervals

Optional: Briefly discuss exercise, meditation and socialization

Optional: Write a paragraph or an original poem and a sketch, cartoon or artwork about yourself in any healthy place. Invite a historical figure, departed loved one or pet.

Judging will not apply to your response to these optional features of your White Paper.

Preparation for Analog Mission

Medical personnel will conduct at the beginning and end of the MMAARS on-site mission a broad panel of tests and performance markers to evaluate the mitochondria injury hypothesis. Contestant(s) and instructors will evaluate changes in these markers over the duration of their analog mission and in mission follow-up.

Contestants should allow for their own known food preferences and intolerances, allergies and medical prescriptions needed throughout the study and analog mission period.

Contest Outcomes

Contest Winners will:

- Be awarded scholarships in an introductory analog mission subject to meeting MMAARS medical standards (vitals, etc)
- Perform metabolic health markers and performance tests at mission start-up
- Implement their full plan and agree to provide their metabolic data to the MMAARS medical staff with a signed HIPAA release.
- Report their 90-day pre-mission study

Paper Layout Guidelines

Titles:

Print as the Contest title: “Healthy Humans in a Healthy Place”

Print your own sub-title under the Contest title.

Content:

Sections:

Abstract

Introduction

Background

Plan

Results

Conclusion/s

Background section questions:

- How do you describe the basic benefits claimed for your implementation of the CNP (food, nutrition, and fasting plan) and why?

- How does your CNP implementation resolve the mitochondrial stress hypothesis from common toxic terrestrial exposures and improve metabolic health and ability to respond to healthy food, nutrition, and nutrient timing?

- Why would you expect the mitochondrial and nuclear damage from space ionizing radiation to be reduced or eliminated by your CNP implementation? If there is no mitochondrial or nuclear damage, can cancer be avoided or eliminated?

Combined Nutrition Components Summary:

- Separately list the actual percentages of the nutrition components in your mean plan.
- State the sources (processed and/or fresh, grown on-board) of the food.
- Include the types of fats and proteins such as insects, synthetic proteins, 3D printed foods, and plant extracts, if any.
- Provide a repeating two-week detailed food, nutrition and fasting plan for the 90-day pre-mission study and the analog mission.

Table 1a. Test/Demonstration/Intervention CNP supports the working Mitochondrial Hypothesis –

Nutrient description and ranges (low% -high%)

Contributed by Zsuzsanna Benyo, 2021 Contest Winner

- Percentage of proteins (all kinds) 21%- 37%
- Percentage of Non-Vegetable Fats (all kinds)54% -75%
- Percentage of Carbohydrates (all kinds) 5% - 11 %
- Carbohydrates classified by Glycemic Index (GI)
    - High GI: 70 and higher: sugars, starches
    - Medium GI: 56 to 69: potatoes, corn, white rice
    - Low GI (1 to 55): fruits, vegetables, nuts, beans, resistant starches
- Glycemic load (GL) Dietary Fiber (indigestible carbohydrates)
    - Soluble
    - Insoluble
- Micronutrients and supplementation
    - Vitamins
    - Minerals
    - Probiotics and prebiotics

- Food intake interval choices
    - Intermittent fasting e.g. 16/8 alternating days

- Alternate day fasting
- Prolonged fasting

- **Table 1b. Control CNP -Nutrient description and ranges (low% -high%) Search on NASA Nutrition Standards 12/11/22 quoting 8/11/20 NASA posting-**

- Percentage of proteins (all kinds) 15%
- Percentage of Fats 30%
- Percentage of Carbohydrates (all kinds) 55 %

Format Requirements

Generate the paper in Microsoft Word and electronically submit it in Adobe portable document format (PDF).

Paper guidelines:

1. Double-spaced on a 8 ½" x 11" page with 1" margins on all sides, using 12-point Times New Roman font.

2. 10 – 20-page limit, not including the title, table of contents, abstract, appendices (7 pages maximum) or reference pages.

3. Pages must be numbered consecutively beginning with the Introduction. Diagrams and tables may be included either within the paper or as part of the Appendices.

4. The contents of the paper shall be organized as follows:

    a. *Title page:* Include the Contest title and your sub-title. Your sub-title should consist of the minimum number of keywords necessary to portray accurately the contents of the paper. The author's name must **NOT** appear on the title page, nor should any other persons or schools.

    b. *Table of Contents:* The table of contents should consist of a list of the parts of the paper and the page numbers, in the order in which they occur.

    c. *Abstract:* The abstract should not describe the paper, but should briefly give the essential facts of its contents; for example, a brief of the problem or objective and a concise summary of the results or conclusion, touching upon methods or other details only if they are unique or if they are of some particular significance. The abstract should be no longer than 100 words.

    d. *Introduction:* The introduction should lead to the development of the subject so that the reader may obtain a clear understanding of the significance of the content, data presented, and/or conclusion. This can often be done by briefly giving the current understanding of the subject matter and then bring out the added advantages of the method of approach and emphasizing the importance of the results and conclusion/s.

    e. *Background:* The main argument is clearly stated with supporting references. The argument should proceed in a logical sequence according to a prepared outline. The writing should be in the

third person. Support data and results can be presented most effectively as graphs, charts, or tables.

i. Standard graphical symbols and abbreviations should be used on all drawings. Well-known abbreviations may be used in the text but should be defined where used the first time followed by the abbreviation in parentheses. The use of abbreviations are most appropriate for tables and illustrations.

ii. Illustrations and tables should supplement and complement each other, not duplicate, text materials.

f. *Plan:* Provide all information as described in the white paper guidelines.

g. *Results:* *Expected* results from monitoring the subject "before" and "after."

h. *Conclusion/s:* The conclusion/s should be stated concisely in a separate section at the end of the paper. If there are three or more conclusions number or label each conclusion and set them off in separate paragraphs.

i. *Tables:* Generally, each table should be typed on a separate sheet in an appendix and numbered consecutively using Roman numerals: Table I, Table II. However, they can be inserted as part of the main body. Small tabulations or listings may be made in the text where necessary for continuity. Each table should be titled by a brief descriptive heading following the table number at the top. Ditto marks should not be used in tabled data, but brackets may be used to group information on several lines.

j. *Figures:* Figures should be numbered consecutively using Arabic numerals: Figure 1; Figure 2, etc. Three types of figures may be used: photographs, biochemical pathways, and line drawings. The reading material on illustrations should be kept to a minimum and included in the captions. Portions of the illustrations may be identified by letters and explained in the captions. Whenever feasible in graphs, several trend lines or regression curves should be combined on the same coordinate axes. Their identifying letters or numbers should be in clear spaces between cross section lines. Readers generally prefer having the figures distributed through the paper, although they may be bundled in an appendix.

k. *Appendices:* There may be no more than 7 pages of appendices. Main graphs as they are developed in the text should be numbered consecutively in the appendix/s. The graphs, figures, and tables in the appendix/s should be numbered consecutively, following the numbers used for the graphs, figures, and tables if used in the text (such as, if table IV were last in the text, table V would be first in the Appendices.)

l. *References:* To enable the reader to consult important works used by the author incidental to the preparation of the paper and other related literature that might be helpful, a suitable reference list should be appended. References should be numbered consecutively. Examples are shown below:

Formatting Examples:

A related periodical: R.N. Hall, "Power Rectifiers and transformers," Proc. IRE, Vol 1, pp. 1515-1518, November 1952.

For a book: W.A. Edison, "Vacuum Tube Oscillators," John Wiley and Sons,

Inc., New York, New York, pp. 170-171, 1948.

A related article: B. Lawrence, B.H. Weil, and M.H. Graham, "Making online search available in an industrial research environment," Journal of the American Society for Information Science, pp. 364-369, Nov- Dec. 1974.

YouTube presentations:

Jason Fung, Published on 3/5/17, YouTube Video “Jason Fung: ‘The Complete Guide to Fasting (& how to burn fat)’”. https://youtu.be/n3dwizlGaRI.