“A FOOD AND NUTRITION PLAN FOR SPACE FLIGHT TO MARS”

IF is not an “if”, but a MUST

with Ketogenic-Mediterranean Diet

to prepare and safeguard astronauts and humanity

for deep-space missions

CONTENT

ABSTRACT

The National Aeronautics and Space Administration (NASA) is planning missions that will put the first woman and next man on the moon this decade and will send humans to Mars next decade. Hence, providing food and nutrition in deep space becomes a significant challenge.

Therefore, if we aspire to send people to distant planets, space food research has never been more important. In these deep space missions besides physiological adaptation to the new circumstances, changes in the human body can be also experienced, more precisely in the cardiovascular and musculoskeletal systems, metabolic and neurobehavioral health and immune function.

To keep astronauts healthy on their trip to Moon, Mars and beyond and their return to Earth, a variety of precautionary measures before and during the space flights need to be taken. Nutrient supply must be optimized for exploration missions. Moreover, disease risks need to be mitigated as well.

Food intake is linked to changes in the gut microbiome composition. "Most of the microbes that inhabit our body supply ecosystem benefit to the host-microbe system, including production of important resources, bioconversion of nutrients, protection against pathogenic microbes, regulating the processes of energy storage and appetite perception, and influencing immune and neurobehavioral function."(Turroni et al., "Gut Microbiome and Space Travelers' Health: State of the Art and Possible Pro/Prebiotic Strategies for Long-Term Space Missions")

INTRODUCTION

In this study I am outlining an innovative nutritional strategy based on intermittent fasting, ketogenic-Mediterranean diet with phytotherapy and nutrigenomics to combat this pressing issue of reducing markers of metabolic syndromes both in space and on Earth. I have prepared recommendation for a dietary plan for participants to a long-term space flight and/ or analog mission preparing them for deep-space. Besides, I am summarizing the changes in the gut microbiome experienced in space and analog models, especially on the effects on metabolism, the musculoskeletal and immune systems and neurobehavioral disorders in order to justify my plan. My objective in creating this study is to serve the establishment of a deep space food system mitigating disease risks. Moreover, it can be implemented also in terrestrial life to safeguard the wider population across the world.

NUTRITION STRATEGY FOR LONG-DURATION MISSIONS

The main direction, that I recommend for solving the challenging conditions of long-duration space flight's health risks and combat metabolic syndromes, is a Ketogenic – Mediterranean Diet with various tools of intermittent fasting and the holistic view of involving phytotherapy mainly with seasonings and teas plus personalized nutrigenomics.

More precisely, I have put together a plan of a 4:1 (75-80% fat) proportion ketogenic diet mixed with Mediterranean. On top of that a Calorie Restricted (CR) 20-hour intermittent fasting 2 times a week is included, while on the other 5 days a week the eating pattern involves restricting food intake to a specific time period of the day, with a daily 16-hour intermittent fasting and thus with an eating window of 8 hours between 11.00 am to 07.00 pm. This way you will be sleeping through the majority of your fast, making it relatively painless. And to make it more effective a low-carbohydrate diet is set as part of the overall plan.

Intermittent fasting

Intermittent fasting (IF)—the practice of alternating periods of eating and fasting—has emerged as an effective therapeutic strategy for improving multiple cardiometabolic endpoints in rodent models of disease, ranging from insulin sensitivity and ectopic fat accumulation to hard endpoints such as stroke and diabetes incidence (Antoni et al., 2017; Harvie and Howell, 2017; Mattson et al., 2017; Patterson and Sears, 2017). The first clinical trials of IF in humans began about a decade ago (Catenacci et al., 2016; Heilbronn et al., 2005a, 2005b). "Studies on IF demonstrate its effectiveness in improving glycemic control and other metabolic parameters, including reduction in visceral fat, blood pressure and markers of oxidative stress and inflammation. The available human data for IF show marked benefit in pre-diabetes and type 2 diabetes. In a case report of three patients with long-standing type 2 diabetes each requiring at least 70 units of insulin per day, the implementation of 24 hours fasts either three times per week or on alternate days, combined with a recommended low- carbohydrate diet resulted in the complete discontinuation of insulin in all three patients; reductions in HbA1c, BMI and waist circumference were also demonstrated". "Significant improvements in biomarkers, including HbA1c, weight, fasting glucose, fasting insulin, blood pressure, cholesterol profile, high sensitivity C- reactive protein and a reduced need for type 2 diabetic medication. By contrast, the control arm consisting of patients with type 2 diabetes receiving 'usual care' with counselling on lifestyle interventions by a registered dietitian showed no significant change in any of the biomarkers measured. Weight and body mass index improve during treatment with intermittent fasting and ketogenic diet."(Lichtash et al.)

As the incidence of Chronic Non-Communicable Diseases (CNCDs) increases, preventive approaches become more crucial. Special emphasis was placed on reducing insulin resistance (IR), as it reduces metabolic syndrome (MS), a known risk factor for CNCD, and is predictive of MS diagnosis. Calorie Restriction (CR) is the most robust intervention known to increase lifespan and health span, with high evidence and known biochemical mechanisms. Now we know CR is most effective, if the hi-glycemic carbs are reduced relatively more than the fat and protein proportion of the diet. Studies with non-human primates are also contributing to support the benefits of CR. One investigation shows how 30% CR drastically reduces the incidence of glucose intolerance, cardiovascular disease, and cancer in primates.(Ibrahim et al.) CR improves cardiometabolic risk parameters, boosts exercise insulin sensitivity response, and there may be benefits of implementing moderate CR on healthy young and middle-aged individuals. However, there is insufficient evidence to support long-term CR. However, CR is effective for weight and MS management, and may have additional benefits such as prevention of muscle loss and appetite control. "Spanish Ketogenic Mediterranean diet" (SKMD) has extreme significant benefits for all the metabolic parameters studied. Studies show inconsistent benefits of IF compared to classic CR.(Ibrahim et al.)

Studies in normal and overweight subjects have shown efficacy of IF, primarily foreweighing loss and improvements in several health indicators, including IR and reductions in risk factors for cardiovascular disease. A study with three patients referred to the Intensive Dietary Management clinic in Toronto, Canada, for insulin dependent type 2 diabetes, showcased reversed IR and improved glycemic control, leading to discontinuation of insulin therapy. Previous studies that compared intermittent calorie restriction (ICR) to continuous calorie restriction (CCR) in overweight women showed a greater benefit of ICR in comparison to CCR on hepatic insulin sensitivity (fasting insulin and IR).(Napoleão et al.)

In terms of timing the optimal strategy is eating the largest meal in the midday, sometime between noon and 3 p.m., and only a small amount in the evening hours. Interestingly, this is the traditional Mediterranean eating pattern. They eat a large lunch, followed by a siesta in the afternoon, and then have a small, almost snack-sized dinner. While we often think of the Mediterranean diet as healthy due to the type of foods in it, the timing of meals in the Mediterranean may also play a role. On top of that, this type of day routine is just ideal also for ketogenic diets (especially for carnivore type). This practically means, that on these days two times a week the 4-hour eating window is between 3 pm – 7 pm., so you fast 20 hours from the previous day of 7:00 pm till the following day 3 pm. Within this period a substantial lunch is included and one snack before 7 pm.

This will allow the astronauts to concentrate without interruptions on their core tasks at least for 8 hours or longer and will be also in line with their circadian rhythm during their space flight, meaning that they go to bed early, and get up early morning.

Another reason for this timing is the fact that just before awakening (around 4:00 a.m.), the body secretes higher levels of growth hormone, cortisol, glucagon, and adrenaline. Together, these are called the counterregulatory hormones—they counter the blood-sugar-lowering effects of insulin, meaning that they raise blood sugar. These normal circadian hormonal surges prepare our bodies for the day ahead. After all, we are never quite so relaxed as when we're in a deep sleep. Glucagon tells the liver to start pushing out some glucose. Adrenaline gives our bodies some energy. Growth hormone is involved in cell repair and the synthesis of new protein. Cortisol, the stress hormone, increases as a general activator. All these hormones peak in the early morning hours and then fall to low levels during the day.

When you are following a regular fasting regimen that involves longer fasts, it's best not to deliberately restrict calories after your fast. You should still remain on a low-carbohydrate, high-fat, unprocessed- food diet, but you should eat until full. The fasting period ensures that you burn through quite a bit of your stored energy, and deliberately trying to cut calories further is often difficult in the long term. Extended fasting rarely causes electrolyte abnormalities. Calcium, phosphorus, sodium, potassium, chloride urea, creatinine, and bicarbonate levels in the blood remain within the normal limits and are virtually unchanged by the end of the fast. Blood magnesium levels occasionally go low. This seems to be especially prevalent in diabetics. Most of the body's magnesium is intracellular and not measured by blood levels.(Cameron et al.)

Incorporating intermittent fasting (16:8 and 20:4) and resistance interval training (to preserve muscle mass and drain those glucose stores) help to get into ketosis faster and lose fat more efficiently than using a well-formulated ketogenic diet alone. Diet alone takes about

3+ weeks to get past hunger, but fasting and exercise with keto cuts time in half.(Lichtash et al.)

Furthermore, whilst the data are "incomplete", there is some evidence to suggest that fasting and caloric restriction might play a protective role with respect to ionizing radiation in rodents. „The radio-protective effect (i.e., lower cancer incidence and greater survival) with caloric restriction was only seen if implemented before and after irradiation whereas the benefits of fasting were seen regardless of timing. The potential application and mechanisms of radioprotection provided by dietary changes could have various benefits in both terrestrial and space medicine. However, the transferability of knowledge from animal (rodent) models to humans is questionable and given the paucity of research in the field, these observations are only hypothesis generating. Future research should focus on the role of fasting and reduced caloric intake in humans, in particular examining clinical outcomes in patients undergoing radiotherapy. Apparently, there is no animal model of accurately mirrors the preexisting load of toxins and parasites in humans. Furthermore, included studies employed a range of radiation types, doses, and locations which require evaluation and further optimized standardization in future research for the potential benefit in radiotherapy patients and astronauts."(Valayer et al.)

Ketogenic – Mediterranean Diet

In 2008, researchers from Spain explored the potential impact of combining the ketogenic diet with the Mediterranean diet. Their diet plan featured these primary characteristics:(Pérez-Guisado et al.)

- Unlimited calories (no calorie counting).
- Olive oil as the major source of added fat, with over 2 tablespoons consumed per day.
- Green vegetables and salads as the primary carbohydrate source.
- Fish was the major source of protein.

- Participants also drank a moderate amount of daily wine (200-400 ml/day). I need to highlight already here, that I have substituted alcohol with daily resveratrol.

The researchers called this a "Spanish Ketogenic Mediterranean diet" (SKMD) and it resulted in significant decreases in body fat, blood pressure, glucose, and triglycerides.

„The most noteworthy finding, however, was what happened to each subject's cholesterol numbers. On average, there was a reduction in LDL cholesterol (114.52 mg/dl→105.95 mg/dl) and an increase in HDL cholesterol (50.10 mg/dl→54.57 mg/dl)." This indicates that consuming more unsaturated fat-rich foods like fish and olive oil and less saturated fat from other animal foods while restricting carbs may be a suitable strategy for those who struggle with unhealthy cholesterol levels.

In 2011 a similar study was conducted, exploring the effects of a six-week Mediterranean ketogenic diet with the addition of herbal extracts. Once again, the change in cholesterol levels was remarkable:(Pérez-Guisado and Muñoz-Serrano, "The Effect of the Spanish Ketogenic Mediterranean Diet on Nonalcoholic Fatty Liver Disease: A Pilot Study")

- Significant reductions in total cholesterol (204 mg/dl to 181 mg/dl); significant decreases in LDL cholesterol (150 mg/dl to 136 mg/dl); increases in HDL cholesterol (46 mg/dl to 52 mg/dl)

The above studies suggest that the combination of the Mediterranean and keto diet may provide more significant health benefits than either diet on its own. These benefits are:

- Decreased inflammation and IR, oxidized (damaged) cholesterol, triglyceride, blood sugar, insulin, blood pressure, and hbA1c levels
- Increased HDL cholesterol levels
- Significant loss of fat

There are further potential benefits of the combined diet, but these are to be confirmed by further trials:

- Reduce cardiovascular disease incidence and mortality (as discovered through research on Mediterranean diets).
- Provide us with the unique benefits of ketosis and carb restriction

The current data show us that the Mediterranean keto diet has the potential to optimize at least ten key biomarkers associated with heart disease, type 2 diabetes, and overall health all at once.

To maximize these benefits, however, I have selected the primary principles responsible for the health improving results. By this, I have formulated a simple, safe and effective Ketogenic - Mediterranean diet plan, that I will showcase in the meal plan.

Having all the benefits of ketogenic diet, this could also put other aspects of the mission at risk (e.g., the life-support systems may be unable to remove exhaled ketones from the air). (Zwart et al.; Scott M Smith et al.)

As a result of this, it must be carefully considered if and how ketogenic diet should be used also during spaceflight or only in analog missions preparing for deep space. To make sure, that the astronauts are fully prepared for their space flight from their nutrition status point of view, IF and SKD are recommended for their analog missions. Chemical absorbs can be used to remove ketones from the air, but in case the life support system might be at risk due to ketones I highly recommend still IF and low-carb diet even during spaceflight.

Nutrigenomics

Genomics and genetics are vital for the development of preventive medicine and health of astronauts. Studies confirm that a comprehensive genetic test is recommended to set personalized nutrition. Though in missions the food system needs to be easy to use, thanks to ultra-modern technology like 3D food printing, it is realistic to prepare food for everyone's individual needs based on their genetics. The DNA is analyzed using a simple saliva or cheek swab sample, then personalized recommendations are developed based on your unique genetic profile. The study of epigenomics is showing us, how gene expression is variable and effected by external influences and factors like endosymbionts.

"The link between diet and health is well established, but renewed interest in which dietary components are biologically active and how they exert their effects is being fuelled by the development of nutritional genomics." (*Role of Macronutrients and Micronutrients in DNA Damage: Results From a Food Frequency Questionnaire*; Ladeira et al.; Rana et al.)

The food we eat contains thousands of biologically active substances, many of which may have the potential to provide substantial health benefits. Indeed, several food derived compounds—such as sulphoraphane, curcumin, lycopene, and tea polyphenols—are among the most promising chemopreventive agents being evaluated.(Rana et al.)

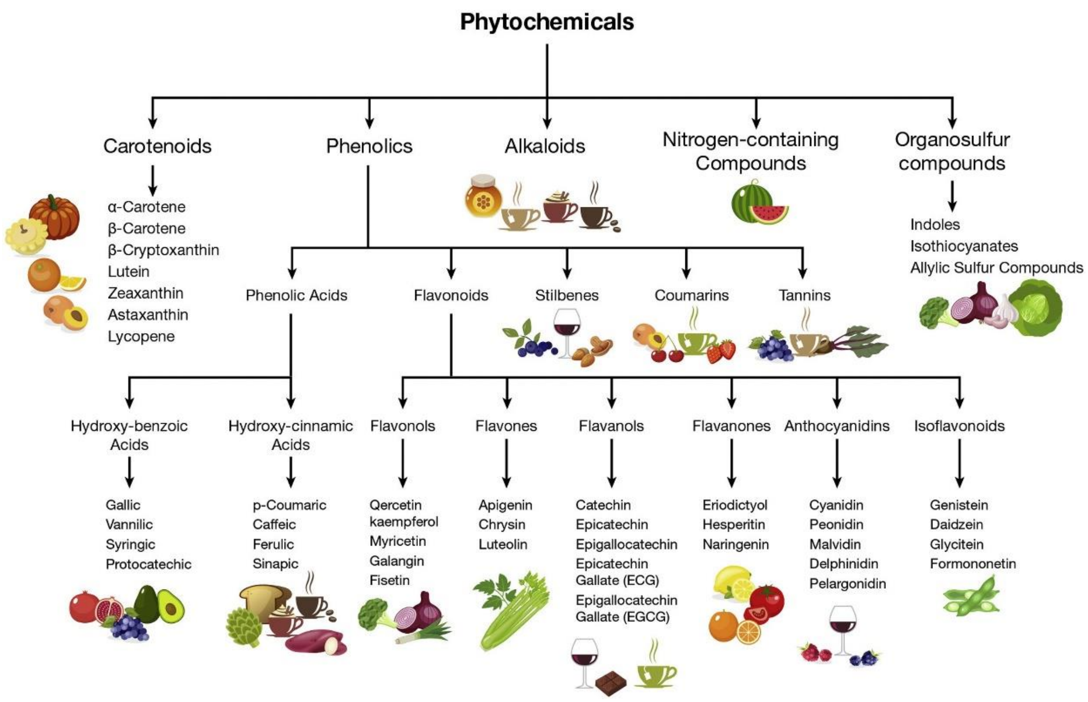


Illustration 1.: Phytotherapy
(Scott M Smith et al.)

The BioNutrients investigation, shown during Expedition 61, demonstrates a technology that enables on-demand production of human nutrients during long-duration space missions. The process uses engineered microbes, like yeast, to generate carotenoids from an edible media to supplement individual needs and, or potential vitamin losses from food that is stored for very long periods.(Hindupur et al.; *Bionutrients-1, On-Demand Production of Nutrients in Space - NASA Technical Reports Server (NTRS)*)

RATIONALE BEHIND NUTRITIONAL BENEFITS IN SPACE

Many countermeasures, mainly different training regimes and modification in nutrient supply, have been tested so far but none of them fully maintains the physiological condition in microgravity. Food intake and appetite are intrinsically linked to the composition and function of the gut microbiome. (Lam et al.) Reduced insulin sensitivity has been demonstrated in various short- and longer-term space missions. (Wood et al.) Since diet is recognized as a pivotal determinant of gut microbiome composition and function, changing general food habits on Earth to space food or the respective space travelers' selection might – beside other environmental factors – deeply affect the gut microbiome structure and functionality with repercussions on the space traveler's health. Extending the countermeasure portfolio by supplementing pre- and or probiotics might be of interest to support health maintenance of space travelers on exploration missions. Since the early 1960s, some of these stressors have been shown in both animal and human studies, to promote gut microbiota dysbiosis. This may drive gastrointestinal disease and metabolic imbalances, as well as changes in bacterial physiology in the spaceflight environment and ground-based analogue studies. Impaired glucose and lipid metabolism would be resulting in insulin resistance and glucose intolerance, and these are also frequently observed in both spaceflights and ground-based microgravity analogs. These conditions represent a serious concern for the general health of space travelers. (Turroni et al., "Gut Microbiome and Space Travelers' Health: State of the Art and Possible Pro/Prebiotic Strategies for Long-Term Space Missions")

As a countermeasure, providing crewmembers with balanced diets, optimized to reduce nutrient deficiency, along with functional foods/bioactive compounds might help improve energy supply and prevent nutritional imbalances. This counteracts the potential downstream dysregulation of the immune system. Such diets should be rich in fibers, possibly delivered through Biological Life Support Systems (BLSSs). Non-digestible carbohydrates are well known to exert multiple benefits on human health mediated by the gut microbiome, fermentation by short chain fatty acids (SCFAs). (Kolodziejczyk et al.) Acting as signaling molecules (e.g., through G protein-coupled receptor binding or inhibition of histone deacetylase), these microbial byproducts are recognized to be variously involved in energy extraction and storage. More generally, SCFA maintain metabolic homeostasis. Some of them, especially butyrate, are potent immune modulators. (Cai et al.)

A healthy-like gut microbiome, low in pathobionts, can produce SCFAs, especially butyrate. This could be decisive in ensuring a fine regulation of host energy metabolism by maintaining a balance between orexigenic (appetite stimulating) and anorexigenic signals. Especially in long-term missions this balancing act could limit energy deficits when they are no longer tolerable. It should also be remembered that microbial metabolism of fiber has additional SCFA-independent beneficial effects, ranging from increased availability of ferulic acid and macro/micronutrients to the regulation of bile acids levels. Of note, the use of fibers for preventive, therapeutic application has shown variable results in human intervention studies. Thus**,** personalized nutritional approaches that evaluate space travelers' responses will have to be anticipated on the ground, based on enterotype/metabolotype identifications. In addition to the design of balanced diets enriched in prebiotics, probiotics-based countermeasures could also be taken into consideration. The supplementation of Bifidobacterium spp. suppressed endotoxemia and liver inflammation, and improved glucose tolerance. It has been extensively reported that low high-glycemic carbohydrates cause

Bifidobacterium to become dominant over Firmicutes, reducing carbohydrate absorption. (Turroni et al., "Gut Microbiome and Space Travelers' Health: State of the Art and Possible Pro/Prebiotic Strategies for Long-Term Space Missions")

As summarized above for bones, there is a growing number of publications pointing to a relationship between gut microbiome and skeletal muscle physiology.

Other important gut microbiome derived compounds able to affect skeletal muscles are SCFAs. Among SCFAs, butyrate was shown to increase ATP production and improve the metabolic efficiency of myofibers (Leonel and Alvarez-Leite). In aged mice, the administration of butyrate prevents muscle mass loss (Walsh et al.). It has also been found in mouse models of cancer that L. reuteri in drinking water can prevent the development of cachexia (Varian et al.). Interestingly, in a study, the authors demonstrated that probiotic supplementation can also protect wild-type mice from age-associated sarcopenia given adequate dietary protein. A recent interesting intervention study with older patients involved the administration for 13 weeks of a prebiotic formulation containing fructooligosaccharides and inulin in a randomized controlled trial with 60 volunteers. In the treatment group, the subjects experienced a significant improvement in muscle function as estimated by exhaustion and handgrip strength tests. (Martínez-Arnau et al.) SCFAs, especially butyrate, derived from fermentation of dietary fibers maintain intestinal barrier integrity and protect from intestinal inflammation. (Lewis et al.)

Indeed, the modulation of the intestinal microbiome enhances immune response of immunotherapies in the anti-cancer response. SCFAs are also able to control T cells, especially butyrate. For example, butyrate promotes the generation of regulatory T lymphocytes, thus shifting the immune system to a more tolerogenic phenotype. (Turroni et al., "Gut Microbiome and Space Travelers' Health: State of the Art and Possible Pro/Prebiotic Strategies for Long-Term Space Missions")

It is accepted that intake of fruit and vegetables-derived dietary fiber in astronauts is rather low, and this results in low SCFA production. In humans, it is commonly accepted that a healthy and balanced diet, with a regular intake of dietary fiber through fruits and vegetables, allows the prevention of several diseases with immune deficiencies such as cancer, and a better immune response against pathogens. In view of the effects on immunity, the use of prebiotics and probiotics to stimulate the production of SCFAs would thus increase nutrient and metabolic resources and the eliminatory capacity of lymphocytes, which may limit the re-emission of latent viruses.

To test this, Castro Wallace has assessed the behavior of the probiotic strain L. acidophilus ATCC 4356 in a microgravity environment. They did not observe differences in growth, survival in simulated gastric or small intestinal juices, or in bacterial gene expression in comparison to control cultures. This suggests that the strain will behave similarly during spaceflight and consequently will maintain its beneficial properties (Shao et al.). Recently, Sakai (Sakai et al.) specifically developed a freeze-dried probiotic product for space experiments using the Lactobacillus casei Shirota probiotic strain and tested its stability over 1 month of storage on the ISS. For the study, a SpaceX/Dragon spacecraft for the 8th commercial resupply mission (SpX-8) was used for the launch to the ISS and return of probiotic samples. (Turroni et al., “Gut Microbiome and Space Travelers’ Health: State of the Art and Possible Pro/Prebiotic Strategies for Long-Term Space Missions”)

Having said that supplements (vitamins or minerals) should be used only when the nutrient content of the nominal food system does not meet the requirements for a given nutrient, or when data show that the efficacy of single (or multiple) nutrient supplementation is advantageous. To date, one supplement has met this standard during space flights: vitamin D. Vitamin D supplements have been provided to all U.S. crewmembers on the ISS. More recently, 1000 IU vitamin D3 supplements have been provided for crews to take daily. This level allows maintenance of serum 25-hydroxyvitamin D around 75 nmol/L (Scott M. Smith et al.)

Although these results are very encouraging, additional mechanistic studies under microgravity and simulated space environment are still needed, especially to directly test the health benefits of probiotics in space. Once the best bacterial strains are identified and selected, clinical trials or intervention studies in space travelers should be rapidly carried out to validate their potential during long-term stay in space.

CONSLUSIONS

More and more studies proved, that gut microbiota of astronauts can be influenced during space exposure. Since intestinal microbes play a crucial role in maintaining metabolic, immunological and neurological health, as well as of muscles and bones, I recommend a nutritional strategy of recovering and preserving a eubiotic microbiota profile to avoid the unwanted effects and symptoms or even long-term damages to astronauts' health, and thus serve the overall success of deep space missions. The optimal diet to achieve these goals is to ensure adequate energy and fiber supply for SCFA production, while avoiding nutritional imbalances. **The ideal way to reach this is Ketogenic - Mediterranean Diet coupled with intermittent fasting, since this is the most efficient way of securing metabolic health during long-term space missions.**

Besides the supplementation of prebiotics, bioactive compounds, both traditional and new generation probiotics during spaceflights should be introduced as a non-invasive alternative –given that safety is assured- to protect space travelers against altered metabolism, satiety impairment, immune dysregulation, circadian rhythm changes, bone and muscle loss, neuro-ocular syndrome, as well as neurobehavioral disorders. (Turroni et al., "Gut Microbiome and Space Travelers' Health: State of the Art and Possible Pro/Prebiotic Strategies for Long-Term Space Missions")

Having said that, further microgravity research (Akiyama et al.; Matsuda et al.) is required to gain additional evidence of previous observations related to ketogenic diet with IF and usage of pre-, probiotics, before employing them in the real practice of space exploration journeys.

Earth-independent and self-sustainable food system is of utmost importance for future deep-space missions or settlements. Growing crops and producing/ 3D printing even cultured fish and/ or meat must be further researched with a special focus of taking into account the special circumstances and mitigating the side-effects of microgravity and radiation. Food technology innovation grows just as exponentially as Artificial Intelligence, and its result will be seen and enjoyed not only by astronauts but also in our everyday life within the next decade.

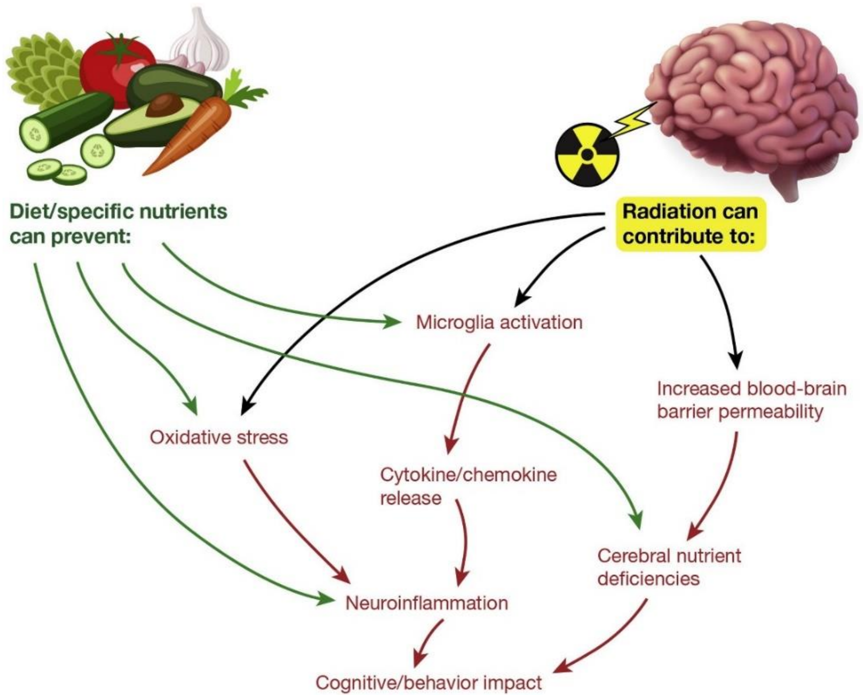


Illustration 2.: Diet/ specific nutrients can prevent diseases.
(Scott M Smith et al.)

APPENDIX

This appendix includes a diet plan for seven days prepared with myfitnessplan.com. Please note, that this is only a sample, and I recommend using alternative menus for the different weeks, so that no meals are repeated more often than every 2nd or 3rd week. Thus, we can make sure, that the meal is more attractive, and nutritional needs are covered.

In terms of sources, I have calculated with organic food and wherever possible with "fresh" products or crops/ cultured fish/ meat "grown" on board. In order to make sure that sufficient animal protein with all necessary amino acids is secured, besides fish I highly recommend also insects (Mehlwurm flour and dried seasoned crickets) as part of the dietary intake. Besides they are both possible to be grown even on board of a spaceship.

3D printing is included in the production of food on board especially due to the special features of long-term deep space travel. Moreover, this enables us to provide participants with personalized menus based on nutrigenomics.

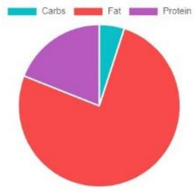
1. Table_ IF Plan timetable

- Monday - 16 hour fasting with 8-hour eating window between 11 am - 7 pm
- Tuesday - CR with 20 hours fasting
- Wednesday - 16 hour fasting with 8-hour eating window between 11 am - 7 pm
- Thursday - 16 hour fasting with 8-hour eating window between 11 am - 7 pm
- Friday - CR with 20 hours fasting
- Saturday - 16 hour fasting with 8-hour eating window between 11 am - 7 pm
- Sunday - 16 hour fasting with 8-hour eating window between 11 am - 7 pm

2. Table_ Sample diet plan

Monday

Breakfast	Calories kcal	Carbs g	Fat g	Protein g	Sodium mg	Sugar g
Boiled egg (large) - Egg, 4 large	312	2	20	24	248	2
Marketside - Lettuce, 1 1/2 cup	15	3	0	1	15	2
Add Food | Quick Tools	327	5	20	25	263	4
Lunch						
Keto - Ham and Cheese Keto Stromboli, 1/2 stromboli	646	10	44	45	0	0
Radish - Radish (Nc), 50 g	8	2	0	0	20	1
Generic - Goose Greaves (Libatepertő), 50 g	412	0	42	6	0	0
Add Food | Quick Tools	1,066	12	86	51	20	1
Dinner						
Cod fillet - Tesco, 210 g	173	0	2	38	0	0
Butter, 2 pat (1 inch sq, 1/2 inch high)	72	0	8	0	1	0
oliva - oliva , 150 gram	216	0	23	1	0	0
Add Food | Quick Tools	461	0	33	39	1	0
Snacks						
Fresh from Hawaii Macadamia nuts - Macadamia Nuts, 0.75 cup	690	12	72	6	285	3
Add Food | Quick Tools	690	12	72	6	285	3
Totals	2,544	29	211	121	569	8



When you're finished logging all foods and exercise for this day, click here:

Complete This Entry

Water Consumption

Today's Water Total 3000 ml

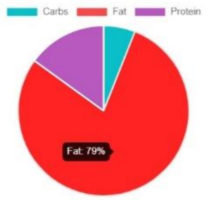
Aim to drink at least 1920 milliliters of water today. You can quick add common sizes or enter a custom amount. Change Units

Today's Food Notes

Prepared with mayfitnesspal.com

Tuesday

Breakfast	Calories kcal	Carbs g	Fat g	Protein g	Sodium mg	Sugar g
Bhg - Htc, 100 gram	523	1	49	21	0	0
Add Food | Quick Tools	523	1	49	21	0	0
Lunch						
Homemade - Low-carb Cloud Bread, 1 cloud	63	2	42	4	55	0
Loch Fyne - Salmon Fishcakes With Spinach and Lemon Butter, 1 main course	655	26	57	18	830	7
Avocado, 1 medium	240	13	22	3	11	1
Vegan butter - Butter, 1 tbsp	100	0	11	0	0	0
Add Food | Quick Tools	1,058	41	132	25	896	8
Dinner						
Maple Leaf - Fatty bacon, 2 slices	320	1	31	9	0	0
Mexican Cheese - Cheese, 0.33 cup	110	1	9	6	180	0
Rio mare - Tuna, 3 can	330	0	21	36	930	0
Butter, 2 pat (1 inch sq, 1/2 inch high)	72	0	8	0	1	0
Add Food | Quick Tools	832	2	69	51	1,111	0
Snacks						
String Cheese - Cheese Stick, 2 stick	160	2	12	12	400	0
Hazelnut (Each), 15 nut	135	3	13	3	0	1
Add Food | Quick Tools	295	5	25	15	400	1
Totals	2,708	49	275	112	2,407	9



When you're finished logging all foods and exercise for this day, click here:

Complete This Entry

Water Consumption

Today's Water Total 2500 ml

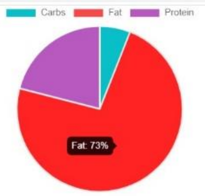
Aim to drink at least 1920 milliliters of water today. You can quick add common sizes or enter a custom amount. Change Units

Today's Food Notes

Prepared with mayfitnesspal.com

Wednesday

Breakfast	Calories kcal	Carbs g	Fat g	Protein g	Sodium mg	Sugar g
Boiled egg (large) - Egg, 4 large	312	2	20	24	248	2
Marketside - Lettuce, 1 1/2 cup	15	3	0	1	15	2
Add Food | Quick Tools	327	5	20	25	263	4
Lunch						
Keto - Ham and Cheese Keto Stromboli, 1/2 stromboli	646	10	44	45	0	0
Radish - Radish (Nc), 50 g	8	2	0	0	20	1
Add Food | Quick Tools	654	12	44	45	20	1
Dinner						
Cod fillet - Tesco, 210 g	173	0	2	38	0	0
Butter, 2 pat (1 inch sq, 1/2 inch high)	72	0	8	0	1	0
oliva - oliva , 150 gram	216	0	23	1	0	0
Add Food | Quick Tools	461	0	33	39	1	0
Snacks						
Fresh from Hawaii Macadamia nuts - Macadamia Nuts, 0.75 cup	690	12	72	6	285	3
Add Food | Quick Tools	690	12	72	6	285	3
Totals	2,132	29	169	115	569	8



When you're finished logging all foods and exercise for this day, click here:

Complete This Entry

Water Consumption

Today's Water Total 3000 ml

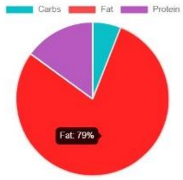
Aim to drink at least 1920 milliliters of water today. You can quick add common sizes or enter a custom amount. Change Units

Today's Food Notes

Prepared with mayfitnesspal.com

Thursday

Breakfast	Calories kcal	Carbs g	Fat g	Protein g	Sodium mg	Sugar g
Keto Coffee - Keto Coffee, 8 oz Coffee	590	2	67	2	0	0
Add Food | Quick Tools	590	2	67	2	0	0
Lunch						
Keto Tuna Mornay - Keto Tuna Mornay, 1.5 serve 250 grams	948	14	77	51	1,113	2
Add Food | Quick Tools	948	14	77	51	1,113	2
Dinner						
Certainlyketo - Keto Stromboli, 6 Slice	564	12	42	36	510	6
Add Food | Quick Tools	564	12	42	36	510	6
Snacks						
Hazelnut (Each), 40 nut	360	9	34	8	0	2
Add Food | Quick Tools	360	9	34	8	0	2
Totals	**2,462**	**37**	**220**	**97**	**1,623**	**10**



When you're finished logging all foods and exercise for this day, click here:

Complete This Entry

Water Consumption

Today's Water Total 3000 ml

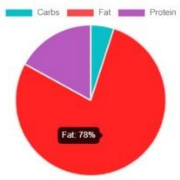
Aim to drink at least 1920 milliliters of water today. You can quick add common sizes or enter a custom amount. Change Units

Today's Food Notes

Prepared with mayfitnesspal.com

Friday

Breakfast	Calories kcal	Carbs g	Fat g	Protein g	Sodium mg	Sugar g
Ketodietapp - Cheese-stuffed Portobello Mushrooms (Keto), 2 musshroom	334	8	29	14	0	0
Rita Keto Coffee - Keto Coffee, 1.5 cups	320	1	35	0	10	0
Add Food | Quick Tools	654	9	64	14	10	0
Lunch						
Gemüse - Mangold Roh, 200 g	32	1	1	4	426	2
Bacon - Maple Bacon, 7 slice	630	0	49	35	1,890	0
Add Food | Quick Tools	662	1	50	39	2,316	2
Dinner						
Keto Salmon - Salmon Cakes, 3 oz	459	3	37	26	0	0
Keto cauliflower - Keto cauliflower, 4 cup	152	4	12	6	0	0
Add Food | Quick Tools	611	7	49	32	0	0
Snacks						
Almonds, 40 almond	278	10	24	10	0	2
Add Food | Quick Tools	278	10	24	10	0	2
Totals	**2,205**	**27**	**187**	**95**	**2,326**	**4**



When you're finished logging all foods and exercise for this day, click here:

Complete This Entry

Water Consumption

Today's Water Total 3000 ml

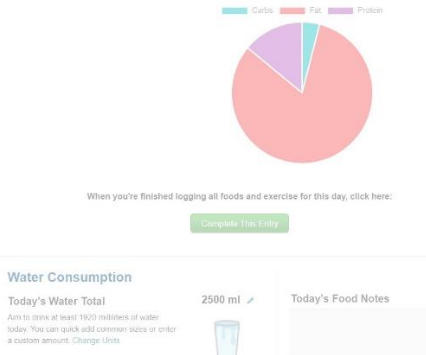
Aim to drink at least 1920 milliliters of water today. You can quick add common sizes or enter a custom amount. Change Units

Today's Food Notes

Prepared with mayfitnesspal.com

Saturday

Breakfast	Calories kcal	Carbs g	Fat g	Protein g	Sodium mg	Sugar g
Simply Keto - Chocolate Avocado Pudding, 0.67 Cup	175	3	16	2	0	0
Upgraded Bulletproof - Bulletproof Coffee, 2 cup	500	1	54	0	15	0
Add Food | Quick Tools	675	4	70	2	15	0
Lunch						
Bajcshal - Halászlé, 700 gram	504	3	35	48	0	1
Add Food | Quick Tools	504	3	35	48	0	1
Dinner						
Marisa's - Keto Egg Cup - Bacon Spinach, 2 cup	308	4	24	18	0	2
Konscious Keto - Macadamia Nuts, 28 g	210	2	21	2	100	2
Add Food | Quick Tools	518	6	45	20	100	4
Snacks						
NUT EXPERT - Brazilian nut, 100 gram	659	12	67	14	0	2
Add Food | Quick Tools	659	12	67	14	0	2
Totals	2,356	25	217	84	115	7



Prepared with mayfitnesspal.com

Sunday

Breakfast	Calories kcal	Carbs g	Fat g	Protein g	Sodium mg	Sugar g
Keto Vanilla Berry Mug Cake - Mug Cake, 1 CUP COOKED	342	5	27	9	0	3
Add Food | Quick Tools	342	5	27	9	0	3
Lunch						
Morrison's - British Beef Marrowbone, 300 grans	835	0	92	1	0	0
Add Food | Quick Tools	835	0	92	1	0	0
Dinner						
Meal Prep Kingz - Keto Lemon Butter Salmon, 1 Container	468	5	42	30	0	0
Add Food | Quick Tools	468	5	42	30	0	0
Snacks						
Pikok - Duck Greaves, 100 g	495	1	47	18	0	1
Add Food | Quick Tools	495	1	47	18	0	1
Totals	2,140	11	208	58	0	4

Prepared with mayfitnesspal.com

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