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COMPARISON OF SOVIET AND U.S. SPACE FOOD AND NUTRITION PROGRAMS

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ABSTRACT

This report compares the Soviet Space Food and Nutrition programs with those of the U.S. The Soviets established the first Space Food programs in 1961, when one of the Soviet Cosmonauts experienced eating in zero gravity.

A Soviet scientist recently developed "trophology" - the study of living systems which includes assimilation of nutrients. Trophology is expected to permit nutritional advances beyond the "Balanced Diet" concept of satisfying ongoing metabolic needs. The concept expands and enriches the old concepts with the new findings in space nutrition. The Soviet scientists have conducted a number of studies regarding the concepts of nutrition assimilation and increased nutritional needs in long duration missions.

U.S. Space Food and Nutrition programs have been developed over the past twenty-five years. From the early days of Mercury and Gemini to future Space Station requirements, the U.S. Space Food and Nutrition programs have progressively improved.

This study indicates that some major differences exist between the two space food and nutrition programs regarding dietary habits. The major differences are in recommended nutrient intake and dietary patterns between the cosmonauts and astronauts. The intake of protein, carbohydrates and fats are significantly higher in cosmonaut diets compared to astronauts. Certain mineral elements such as phosphorus, sodium and iron are also significantly higher in the cosmonauts' diets. Cosmonauts also experience intake of certain unconventional food and plant extract to resist stress and to increase stamina.

COMPARISON OF SOVIET AND U.S. SPACE FOOD AND NUTRITION PROGRAMS

INTRODUCTION

The successful conquest of space was facilitated considerably by the creation of a life support system for cosmonauts and astronauts. One of the more important elements of life support is nourishment for the spacecraft crews. Collective efforts of technologists, nutritionists, engineers, physicians and microbiologists have developed a solution for these problems. Foods not only provide astronauts or cosmonauts nutrition for normal vital activities, but also provide psychological fulfillment.

For more than thirty years, Russian food industry technologists, scientists and specialists have studied and developed various forms, types and groups of food products. This resulted in a specialized food production industry to develop food for the cosmonauts. Nine food products with very limited storage lives were developed and tested for Yuriy Gagarin in 1961. One of the first tasks of the first man in space was to attempt eating in zero gravity. A food ration was then proposed for flights lasting from one to four days. The products were canned meats, the first dinner foods, and fruit juices in aluminum tubes, and bite-sized pieces of bread. All were considered to have very limited shelf lives. (20, 21)

The primary purpose of the U.S. Space Food and Nutrition Program is to provide nutritionally balanced diets to the astronauts during space flights and to gather physiological information and conduct nutritional studies designed to assess the effects of space flights on nutrient metabolism and its effects on crew performance. Over the past twenty-five years, the designs of food systems for spacecraft have been developed from the experience of past food systems. The foods used on U.S. space flights have been comprised of a wide variety of foods which have been specially processed and/or packaged to adapt them to zero gravity consumption. Mercury food was experimental and transient. Aluminum tubes were used for the semi-solid foods. The first manned flight of the Gemini program, Gemini 3, lasted less than five hours, but four experimental meals were aboard to test. The meals consisted of dehydrated foods in cubes, dry mix and freeze-dried products providing up to 2900 Kcal/crewmember. The Shuttle food system has over 150 items for astronauts to choose from when selecting a menu. The foods are classified by the method of preservation, namely, rehydratable, thermostabilized, natural form, and intermediate moisture. (19)

OBJECTIVES

1. To study the historical background and progression of Soviet Space Food and Nutrition programs.
2. To acquire knowledge about cosmonauts' daily dietary intake and nutritional supplements during longer duration missions.
3. To study their physiological information and nutritional research and assess the effects of space flight on nutrient metabolism on crew performance.
4. To compare the Soviet Food and Nutrition program to the U.S.

REVIEW OF THE LITERATURE

In the Soviet space programs, nutrition is given an important place in the life support systems for spacecraft crews. The "Soyuz-9" spacecraft, which was launched on July 1, 1970, with a crew of Andriyan Nikolayes and Vitaliy Sevastyanov, completed an 18-day flight. Their mission carried a device for heating food products in aluminum tubes. This made it possible to prepare hot foods onboard the spacecraft. In 1974, aboard the "Salyut-4" space station, a device was used to simultaneously heat products in aluminum tubes, and bread, which significantly improved the food intake of the spacecraft crews. (1, 20)

In the Salyut-6 missions, the food technologists, scientists, and other specialists expanded the variety of food products, increased their quality, and extended their shelf lives. A six-day ration was developed which provided a daily four-meal course (first and second breakfast, lunch and dinner). The Salyut-6 mission ration in 1977 had over 70 different products including twenty types of meat, fish, poultry, and cheese in 100gm cans, together with pureed first and second courses (10 types) in aluminum tubes. There were fourteen types of dehydrated (freeze dried) first and second courses and garnishes for the canned meats, which could be rapidly reconstituted by adding hot water, Bakery products, and desserts made from twelve types of semi-dehydrated fruits were also available. The drink selection included fruit juices, tea, coffee, milk, and fermented milk products.

In Soviet Space Food and Nutrition programs, the make-up of the diets are developed on the basis of the flight duration, the complexity of the program, the anticipated energy use, the storage, heating and dispensing equipment, the water reclamation systems, and other equipment. In long term-space flights, the relative monotony concerning diet does become annoying to some degree. In order to prevent the monotony of the diets and uplift the psychological aspects of life, some specially prepared fruits and vegetables were transported on an experimental basis. The shipment of fresh apples, onions, and garlic also was transported at the request of cosmonauts G. Crechko and Yu Romenenko during their Soyuz mission. The use of fresh fruits and vegetables was expanded. Oranges, lemons, melons, honey, cranberries, and even fresh cherries, were sent at the request of V. Ryumin during his Soyuz mission. The cargo spacecraft were used to send fresh fruits and vegetables to Vladmir Lyakhov and Aleksander Aleksandrov, who stayed three months in space during Soyuz T-9 mission in 1983.

The food service provisions aboard the Salyut-6 mission consisted of the following elements: Container for stowing and storing foods, tables to make meals, an electric warmer, place settings, a device to recycle, measure, and dispense hot and cold water, and containers for disposal of packages and left over foods. (15, 9)

TABLE I - MENU EXAMPLE (COSMONAUTS) (4)

MENU EXAMPLE (COSMONAUTS)

List of foods for a one-day menu on Salyut-6:

First Breakfast:	
Chicken with Prunes	100g
Bread	45g
Candy	50g
Coffee with Milk	150g
Lunch:	
Cottage Cheese with Pureed Black Currants	165g
Honeycake	45g
Black Currant Juice with Pulp	50g
Dinner:	
Sauerkraut Soup	165g
Roast Beef with Mashed Potatoes	57.5g
Bread	45g
Prunes with Nuts	60g
Candied Fruit	50g
Coffee with Sugar	24g
Supper:	
Chicken in Tomato Sauce	165g
Bread	45g
Cheese	100g
Tea with Sugar	23g

V. P. Bychkov, et. al, 1986, researched the diets of three Salyut-7 prime crews. The Salyut-7 cosmonauts experienced the best nutritional systems of the Soviet Space Nutrition programs. The rations of the Salyut-7 crews had a caloric value of 3150 Kcalories and were well balanced, containing all the nutritional requirements. The food system included cosmonauts rations, containers for serving and storing food, a dining table, an electric food heater, utensils and dishes, devices for regenerating water and measuring hot and cold water to packages of freeze-dried food, containers for disposing of waste, and a refrigerator for storing fruit and vegetables. The food had equivalent food value of diets of Salyut-6, but consisted primarily (65%) of freeze-dried products, rehydrated with hot or cold water. (5, 17, 20)

In a study by V. P. Bychkov, et. al., 1981, concerning the adequacy of the protein supplied in the diet of crews of Salyut-6, it was found that the physical status of the cosmonauts and the parameters of nitrogen metabolism after the missions were indicative of adequate protein intake. Examination of nitrogen metabolism in the crew of the first main expedition aboard Salyut-6 (96-day mission) revealed that, in spite of individual fluctuations in the excretion of the end products of nitrogen metabolism in the post-flight period, their range was within the pre-flight levels. Urinary excretion of the total nitrogen was 11.1 gm per day post-flight and 11.6 gm per day pre-flight. On the 3rd and 4th post-flight days, it dropped to 9.0 gm per day, then reverted to the base level on the 5th and 7th days. (8)

In the second expedition aboard Salyut-6 (140-day mission), the post-flight excretion of the end product of nitrogen metabolism was close to pre-flight levels. On the 3rd post-flight day, there was a 40% decrease in excretion of total nitrogen, 21% decrease for urea, and 44% decrease for ammonia, with retention of normal proportion. There was a tendency toward normalization of these changes on subsequent post-flight days. (8)

I. G. Popov, et. al, 1982, conducted a study to determine the effect of a 48-day flight on the blood amino acids content in the crew of Salyut-5. It was found that changes in essential and non-essential amino acids ratios, e.g., methionine and cysteine, are of major concern. They observed that the changes in amino acids metabolism could be due to several nutritional factors. The transition from the pre-flight diet to the inflight diet could lead to a reduction in the essential amino acids content. A decreased intake of dairy products, eggs, leguminous products, freshly prepared food, and an excess intake of foods which had gone through severe heat processing and drying. They suggested that this offsets the amount of amino acids in foods and their accessibility to digestion. They also suggested that changes in living conditions may change the synthesis of amino acids. Similar studies were conducted by I. G. Popov, et. al., 1983, to measure the amino acids levels in blood of cosmonauts during the 185-day Salyut-6 flight. It was found that appreciable decreases in the concentration of most amino acids occurred in both cosmonauts. The threonine and cysteine levels in blood plasma of both cosmonauts were below the bottom of the normal range cited in the Russian Medical Encyclopedia. Alanine and histidine for the commander, and methinine, isoleucine, and arginine for the flight engineer, were also below the normal range. The demonstrated changes in plasma amino acids were attributed to similar factors cited by Popov in 1982. Recommended countermeasures are also similar, such as organizing nutrition rehabilitation for cosmonauts by increasing all amino acid intake, particularly methionine, cysteine, valine, histidine, tyrosine, arginine, aspartic, and glutamic acids. (23, 24)

K. V. Smirnov, et. al., 1982, studied the state of the digestive system following long-term space flights. Those studies included: gastric, pancreatic and intestinal enzymes. These studies demonstrated consistent changes in the digestive system function. The depth and severity were related to duration and the condition of the space flights. It was found that weightlessness plays an effective role in these changes. There was a noticeable change of increased activity of gastric pepsinogen and pancreatic lipase after the first day of the 96-day mission. They were normalized by the 25th day of the readaptation period for the 96- and 140-day flights, and at the 43rd day after the 175-day space flights. They suggested inflight use of preventive measures and conditioning of cosmonauts to develop changes in enzyme secretion in the gastrointestinal tract during the readaptation period. The marked changes were not noted on the first day after the 185-day space flight, in comparison with the 175-day flight, due to the preventive measures of adequate nutrition used during the readaptation period. (27)

V. P. Bychkov, et. al., 1982, studied the effects of hypokinesia on man's nutritional status. They found that during and after the bed rest studies adequate nutrition and certain unidentified nutrients can serve as efficient countermeasures against metabolic changes, such as weight loss, negative nitrogen, phosphorus, potassium, and sodium balance. The nutrient rehabilitation led to a positive nitrogen balance, increase in the utilization of vitamin C, B1, B6, and faster termination of compensatory nitrogen retention, as compared to subjects in the control group. Physical exercise with adequate nutrition was found to be the most effective means of preventing changes observed under hypokinetic conditions. (3)

I.A. Radayeva, et. al., 1982, conducted research regarding the biological value and shelf life of cultured dairy products in the diet of cosmonauts. Freeze-dried cultured milk products, yogurt with sugar, and yogurt with fruits and berries were examined for shelf life. It was determined that the realistic shelf life was 12 months at 20° ± 5° C and 18 months at 1-4° C. They considered these foods to have a high biologic value with respect to their protein. The leucine/isolucine ratio is 2:1 for acidophilus paste, 2:3 for sweetened yogurt, 2:4 for fruit and berry yogurt. It was reported that freeze-dried cultured dairy products may be quite beneficial in the diet of cosmonauts and were recommended to be incorporated into space diets. (26)

N. G. Bogdanov, et. al., 1986, studied vitamin levels in cosmonauts during pre-flight training and after completion of short-term space flights. They reported a statistically significant decrease in the excretion of a number of vitamins during the post-flight period. They suggested that it was due to an increased vitamin metabolism which leads to an increased need for them during post-flight. (2)

DISCUSSION

Soviet specialists believe that both a regular meal schedule and carefully selected diet are important for the maintenance of overall conditioning in space. Nutrition is thought to have a synergestic effect with other countermeasures on the control of adaptive changes, such as musculoskeletal strength and mass losses. It has been observed that cosmonauts can actually gain weight in space if exercise is combined with vitamins, calcium supplements, appealing foods, and appetite stimulators, such as onions, garlic and spices. (4, 16)

USSR SPACE FOOD AND NUTRITION CONCEPTS

FOOD

In the 30th minute of the 1961 mission, Yuri Gagarin ate and drank. This became the first evidence of the possibility of eating, chewing, and swallowing liquid and solid food in weightlessness. Daily ration of the cosmonauts on Vostok and Vostok-2 contained about 2800 Kcal, including 100 gm of protein, 118 gm of fat and 308 gm of carbohydrates. Foods which were used in the flights were packaged in dispenser tubes and included soups, cottage cheese, as well as drinks: coffee, cocoa, juices. The rations had limited shelf lives without refrigeration (up to 5 to 6 days). Meat products in packets had to be prepared directly prior to flight. (20, 21)

In the Soyuz missions, foods with long shelf life, such as bread, were baked in the form of small "one-bite" rolls to prevent crumbs. Meat products such as ham, steak, and veal, were also included in the diet. The daily dietary intake for cosmonauts in Soyuz had a 3-day menu cycle with four meals per day. The Soyuz mission also included dehydrated boiled meat, and Soyuz-9 cosmonauts were the first to heat meals at 60° to 70° C and drink from the dispenser tubes. (20)

Cosmonauts P. Popvich and Yu Artyukhin on Salyut-3 were the first to test dehydrated products, rehydrated with recovered water. These experiments were continued in Salyut-4. Dehydrated products now comprise up to 20% of the food rations. The second crew of the Salyut-4 took additional food products of limited shelf life, as well as bread, coffee, and tea for the first time in the transport ship. The unmanned "Progress" transport ship is in widespread use to deliver fresh food rations to the orbital station. (20)

The water supply system on board the spacecraft functions in conjunction with the food systems. The supply of drinking water in the orbital station is produced at a rate of up to two liters per man per 24 hours. (17)

The most recent and satisfactory cosmonaut nutritional system on Soviet manned space flights was the one developed for Salyut-7. There is a buffet table on Salyut for eating food, as well as a set of table accessories, a food heater, facilities for sanitary cleaning of the table accessories, and bags for leftovers and packaging. The calorie content of the daily diet was increased up to 3200 Kcal to combat the negative consequences of weightlessness and physical training exercises during the missions. (5, 16)

NUTRITION

Dr. Oleg Gazenko, 1987, in an address to the U. N. committee on the peaceful uses of outer space, discussed the concepts regarding digestive physiology. He described "a recently developed branch of medicine - trophology" as the study of general principles of fundamental vital processes of living systems, such as ingestion, processing, and assimilation of nutrients. Several discoveries in this area were outlined: New information regarding the immunological defense of the small intestine, importance of dietary fiber in digestive functioning and overall health, and microbiology of the digestive tract in medical support of long-term space flight. (12)

Dr. Gazenko suggests that trophology will advance the nutritionists' knowledge beyond the accepted concept of "Balanced Diet", which means satisfying on-going metabolic needs, to the new concepts of "Adequate Nutrition." The new concept does not really replace the previous concepts but expands and enriches them with new findings in the field of space nutrition. (12)

In research findings, decreases observed in essential amino acids in cosmonauts after the 211-day mission led researchers to the conclusion that the pre-flight diet should be supplemented with methionine and aspartic acid and inflight and post-flight diets with seven essential amino acids plus cysteine, arginine, proline, and aspartic acid. (6, 11)

Soviet scientists believe that increased exercise regimens require an additional intake of calories to maintain proper energy balance. They also believe that supplements consisting of vitamins, amino acids and minerals promote the retention of fluids and electrolytes. They have shown that proper dietary combinations can also help to regulate the digestive and enzymatic changes associated with stresses of space flights. (22, 25)

The Soviet scientists also believe that the plant extract (Eleutherococcus), exercise and high calcium diet are three major ways by which reduction in calcium loss is possible in the spacecraft crews. They also use the plant extract to resist stress and to increase stamina among the cosmonauts. (10)

PACKAGING AND PRESERVATION

Snack products, bread products and appetizers, as well as sweet pastry products and fruits, were packaged for the Soviet space missions in film packets made of viscotene, a clear plastic film material similar to polyethylene. Some of them were vacuum packed. The ration of cosmonauts in the Soyuz ship included new shelf stable foods with a long shelf life, and pureed and liquid products in dispenser tubes. Meat products - ham, steak, and veal - were prepared in the form of meals preserved in metal cans. The sweet products included chocolate candy, prunes with nuts, and honey ginger bread, all in film packages. Some of the products, in the form of briquettes, were covered in edible film. The dehydrated boiled meat included in the menu was vacuum packed in a film. (9, 17, 20, 25)

U.S. SPACE FOOD AND NUTRITION CONCEPTS

The food systems planned for the U.S. Space Station are detailed in reference (28).

SUMMARY AND CONCLUSION

The research study shows that the successful conquest of space, either for astronauts or cosmonauts, depends on the collective efforts of technologists, engineers, physicians, microbiologists, nutritionists and psychologists.

According to the Congressional Research Service Report prepared by Hon. Ernest F. Hollings, May 1988, the Soviets have continued to make steady strides toward their goals of having a permanently occupied space station in Earth orbit. The Soviets hold a commanding lead in the operational use of crews. They have introduced two new launch vehicles and continue to develop a space shuttle and space plane. (13, 14)

A comparison time line of U.S. and Soviet space missions is shown in the Appendix.

Cosmonaut Romanenko, after his 326-day flight in space in 1987, stated that Mars is getting nearer and nearer to Earth. The Soviets also conducted a variety of studies dealing with new concepts regarding nutritional assimilation and increased needs in long duration missions. However, when comparing the research data, these reports are equivocal regarding countermeasures taken, the increased needs, and types of tests used in the analyses. (14)

The present research study indicates that food for U.S. space flight has improved steadily throughout the space programs. From the early days of Mercury and Gemini to future Space Station requirements, the U.S. Space Food and Nutrition program has progressively improved. The U.S. Space Food and Nutrition programs are more advanced in terms of their food packaging, preservation techniques and flexible menu patterns for long duration missions. (28) However, some major differences exist between the two space nutrition programs regarding the respective dietary habits. These differences are shown in Tables 2 and 3.

TABLE 2 - DIFFERENCES IN RECOMMENDED NUTRIENT INTAKE OF COSMONAUTS AND ASTRONAUTS

NUTRIENTS	COSMONAUTS	ASTRONAUTS
Kilocalories	3200 Kcal	2300-3100 Kcal
Protein	1.5g/kg Bwt. (140g)	8g/kg Bwt.
Fat	1.4g/kg Bwt. (100g)	1.3g/kg Bwt. (93g)
Carbohydrates	4.5g/kg Bwt. (395g)	4.8g/kg Bwt. (350g)
Phosphorus	1.7g	.8g
Sodium	4.5g	3.5g
Iron	50mg	18mg

TABLE 3 - OTHER DIFFERENCES IN FOOD INTAKE OF COSMONAUTS AND ASTRONAUTS

FOOD	COSMONAUTS	ASTRONAUTS
Plant Extract (Eleutherococcus) 500mg/day or 1.00g every other day	Used to increase stamina to resist stress	None
-Garlic	As food seasoning	None
Vodka	Small amount	None
Brandy	Small amount	None
Fresh Fruits and Vegetables	Supplied by Progress ship	Stored 16 hours before launch
Onion, Dill, Parsley	Cultivated in on-board vegetable garden (18)	None
Multivitamin	Supplement--twice/day	Optional (Shuttle)
Undevit	Vitamin--twice/day	None
Aerovit	Vitamin--twice/day	None
Essential Amino Acids (Methionine)	Supplements/increased amount	None
Glutamic Acid Decamerit	Supplement	None

The cosmonauts' nutrient intake is probably higher than the astronauts'. The mean daily inflight nutrient consumption per person during Shuttle STS-1 through STS-61C indicate higher intake of nutrients by the astornauts compared to the RDA (Appendix). The difficulty exists in estimating the nutrient intake since Shuttle crews are not required to maintain a food intake log. (29)

FUTURE RECOMMENDATIONS FOR U.S. SPACE NUTRITION PROGRAMS

1. Determine nutrient requirements for longer duration missions.
2. Understand the increased essential amino acids requirements during pre-flight, inflight, and post-flight diets.
3. Determine the effects of plant extract as a stimulant.
4. Determine the beneficial effects of alcohol for longer duration missions in space.
5. Study the regulatory effects of proper dietary combinations on digestive and enzymatic changes which are associated with stresses of long duration flights.
6. Study the accepted concept of "Balanced Diet", which means satisfying only ongoing metabolic needs, to the new concept of "Adequate Nutrition", which does not really replace the previous concepts, but expands and enriches them with new findings in the field of space nutrition.

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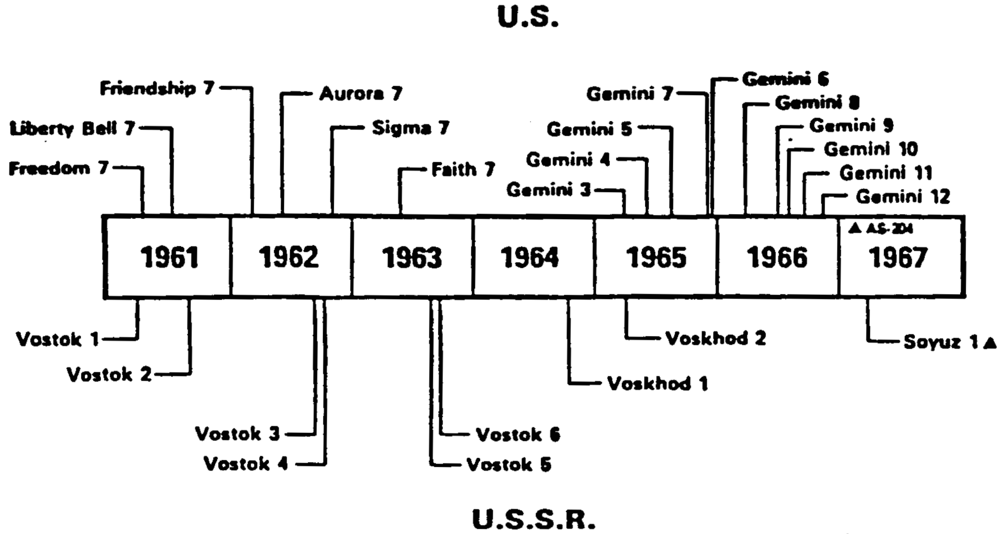
TIME LINE OF U.S. AND U.S.S.R. PILOTED SPACE MISSIONS



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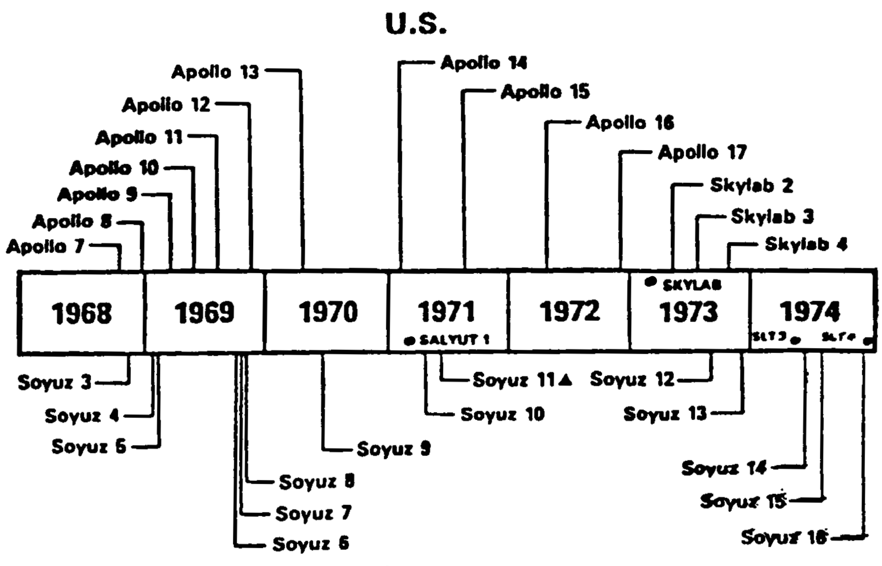
TIME LINE OF U.S. AND U.S.S.R. PILOTED SPACE MISSIONS (continued)



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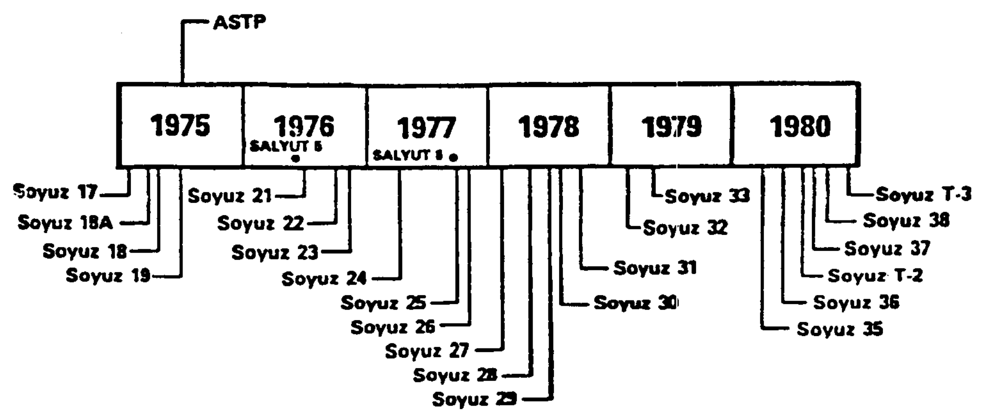
TIME LINE OF U.S. AND U.S.S.R. PILOTED SPACE MISSIONS (continued)



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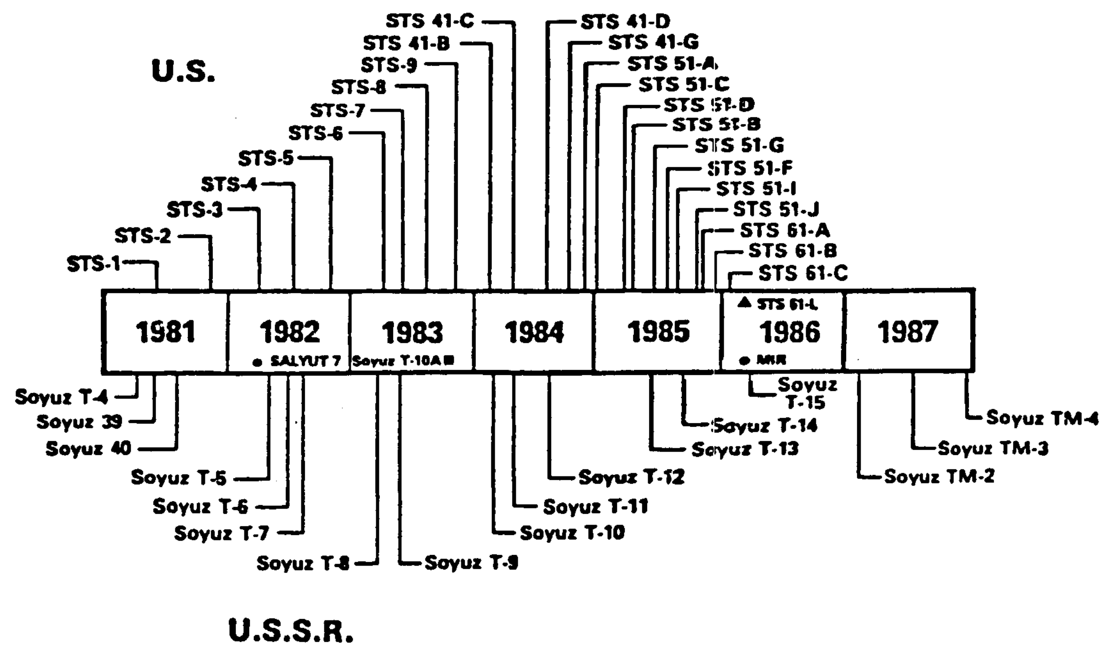
TIME LINE OF U.S. AND U.S.S.R. PILOTED SPACE MISSIONS (continued)



ESTIMATED MEAN DAILY INFLIGHT NUTRIENT CONSUMPTION PER PERSON DURING SHUTTLE STS-1 THROUGH STS 61-C

STS Flight	Days #	Crew M[3] #	Crew F[3] #	RH_2O[1] gm	NH_2O[2] gm	KCal	Prot gm	Fat gm	CHO gm	Ca mg	Phos mg	Na mg	K mg	Iron mg	Mg mg	Mn mg	Cu mg	Zn mg
1	2	2				2656	106.8	83.1	358.6	1210	1706	4506	3238	27	387			8
2	2	2		1134	88	1100	58.5	28.0	152.0	687	916	1782	1362	12	154			9
3	8	2		1393	353	1910	66.1	49.6	280.2	885	1210	3010	2244	17	229	1.6	1.9	10
4	7	2		1711	326	2446	85.6	73.5	319.2	954	1474	3506	2558	20	286	2.2	2.2	12
5	5	4		1378	378	2322	73.2	59.7	338.0	931	1464	3333	2415	22	272	2.6	2.6	9
6	5	4		1324	357	1957	75.7	52.1	281.1	787	1227	2829	2226	18	227	1.1	1.5	8
7	6	4	1	1983	281	2535	86.7	76.1	339.4	995	1841	3818	2567	20	336	4.2	3.4	12
8	6	5		1445	378	2517	90.3	67.4	359.3	1026	1729	3697	2822	20	309	2.6	2.4	11
9	9	6		1083	291	1945	68.6	55.7	267.7	833	1382	3138	2393	15	212	1.9	1.9	10
41-B[4]	8	5		1428	411	2684	94.3	81.1	353.4	857	1740	3956	3532	18	355	4.2	3.2	13
41-C	7	5		1687	364	2673	91.5	83.3	344.5	954	1766	3784	3226	16	369	4.0	3.2	13
41-D[4]	6	5	1	1666	382	2143	85.5	63.0	275.8	886	1658	3565	2549	15	303	2.9	2.8	11
41-G	8	5	2	2069	367	2994	103.9	92.1	393.1	1003	1956	4379	3512	19	382	4.7	3.4	13
51-A	8	4	1	1502	283	2383	83.5	73.4	319.8	974	1681	3367	2548	13	273	2.9	2.7	11
51-C[5]	3	5		1937	348	3838	119.7	170.9	395.1	1201	2503	5123	4127	23	543	6.1	3.9	17
51-D[4,6]	7	6	1	1414	282	2219	72.6	74.3	288.6	891	1500	3433	2653	14	315	2.8	1.7	11
51-B[4,7]	7	7		1551	438	2862	90.0	87.6	396.2	968	1761	3698	3684	20	356	3.1	2.4	14
51-G[4,7]	7	6	1	1785	487	3423	107.7	126.1	397.6	1025	2010	4728	4099	19	454	4.1	2.7	19
51-F[4,7]	7	7		1840	363	2783	91.4	91.7	361.2	905	1692	3975	3387	16	362	3.9	2.1	13
51-I[4,7]	7	5		1841	431	2958	105.5	105.2	356.9	980	1779	4547	3630	17	404	4.1	2.3	15
51-J[4,8]	4	5		1240	549	2839	95.4	92.3	378.4	942	1671	3860	3336	16	363	3.8	2.1	13
61-A[4]	7	7	1	1751	418	3287	114.5	116.8	401.5	1224	2008	5654	3517	20	422	4.2	2.3	15
61-B[4,7]	7	6	1	1137	301	2659	93.4	99.2	312.9	806	1484	4244	2785	15	327	3.6	1.9	15
61-C[4,7]	5	7		1772	482	3367	116.1	118.8	411.1	1029	1944	5589	3803	20	431	5.0	2.6	17
Mean (All Flights)[9]				1589	374	2692	92.8	87.8	346.2	957	1715	4037	3132	18	346	3.5	2.5	13
Mean (588 Man Days)[10]				1491	355	2476	85.7	78.0	327.1	911	1606	3673	2913	17	316	3.1	2.4	12
Recommended Minimum Levels							56			800	800	3450	2737	18	350			15

Percent of Calories: 14.6% Prot 31.0% Fat 54.4% CHO

[1] RH_2O = Rehydration Water [2] NH_2O = Moisture in Food [3] M = Males F = Females
[4] Estimated from returned food only. Trash given to Ames and not inventoried.
[5] DOD flight, food was packed for 7 days but they returned after only 3 days. Trash given to Air Force and not inventoried. Fresh food locker not included. [6] Mission extended 2 days. [7] Launch sandwiches not included.
[8] No launch sandwiches sent with STS 51-J. [9] Mean for all flights included 799 man days. [10] Mean omitting flights with unrealistically high caloric intakes i.e., 3000 Kilocalories or more (STS 41-G, 51-C, 51-G, 61-A, 61-C).