IV. RESULTS

A. Tests of Normalcy of Subjects

The physical normality of the group of subjects studied in this experiment may be confirmed by reference to table 10. In this table are listed the age, height, weight, average blood tests, and basal metabolism of each subject. Also given in table 10 are the average normal values for height and weight (Donelson et al., 1943), blood tests (Ohlson et al., 1944), and basal metabolism (Pittman et al., 1943) for Iowa State College women. If these latter data are used as a reference standard, it will be seen that values for each subject and average values for all subjects present a normal physiologic pattern. Eight of the nine subjects appear to have a slightly low red cell count, but the deficit is within the range of variation found in a normal group (Ohlson et al., 1944).

Table 10

Age, Height, Weight, Average Blood Constants, and Basal Metabolism of Subjects.

Subject	Age	Height	Weight	Hbg.	R.B.C.	Cell Volume	Basal Metabolism
		inches	pounds	gm./100 ml.	million	per cent	cal./sq.m./hr.
L. K.	21	66.5	129.0	14.0	4.60	41.9	35.6
M. T.	21	67.0	136.0	14.2	4.48	43.0	35.6
D. H.	20	63.0	126.0	13.0	3.92	39.3	34.7
B. H.	21	67.0	125.0	15.0	4.75	44.5	30.2
E. C.	19	62.0	141.0	15.2	4.24	42.0	31.6
M. F.	28	63.0	117.5	13.8	4.17	40.8	34.4
D. A.	21	65.0	125.0	13.5	4.27	40.7	34.3
R. P.	20	65.0	125.0	13.8	4.18	41.6	34.0
A. S.	21	66.5	156.0	12.1	4.17	37.4	32.8
Average	21	65.0	131.2	13.8	4.31	41.2	33.7
Average I.S.C. women	17 to 30	64.6	127.0	13.4	4.56	40.9	33.4 to 35.6

B. Ascorbic Acid Studies

Protocols for each of the nine subjects are presented in tables 11 to 19 inclusive. Data are given in these tables on plasma, urinary, and food ascorbic acid during each experimental period. Pertinent comments and subjective findings also are noted on the individual tables.

1. Plasma ascorbic acid

A wide range of plasma ascorbic acid values were found in the preliminary period. Average plasma concentrations of the vitamin varied from 0.38 to 0.94 mg. per cent. Such differences in plasma ascorbic acid for individuals on the same dietary regime are consistent with evidence in the literature that with adequate vitamin C stores the individual maintains a characteristic plasma concentration of the vitamin. Belser et al. (1939) found that the minimum intake of ascorbic acid sufficient to maintain complete tissue saturation in seven subjects varied from 70 to more than 100 mg. daily. Whether the differences are attributable to variation in kidney threshold or in total metabolism is not known. The data do demonstrate that a given intake will maintain a plasma concentration of the vitamin characteristic of the individual.

Eight out of nine subjects showed a decrease in plasma vitamin C during the first exercise period. The one exception to the pattern is the case of L. K. It might be

Table 11

Protocol: Subject L. K.
Studied--Fall, 1942.

Date 1942	Total Dietary Intake of Ascorbic Acid Found (mg./24 hrs.)	Calc.	Plasma Ascorbic Acid mg. %	Urinary Ascorbic Acid mg./24 hrs.	Work Output ergs	Date	Comment
			Diet self-selected.				
11- 2			0.62				This subject required more than average amount of sleep. Menstrual periods began: 10-19-42 11-12-42
11- 3							
11- 4							
11- 5							
11- 6							
11- 7							
11- 8							
11- 9							
11-10							
11-11							
11-12							
11-13			0.66				
Average			0.64				
			Research diet (started 11-16).				
11-14							
11-15							
11-16						11-16	Slept all afternoon.
11-17		53.57	0.62			11-17	Bowled 1 line; waited tables 5.5 hrs.
11-18		98.87				11-18	Ping pong 1 hr.
11-19		44.47	0.68			11-19	Bowled 2 lines.
11-20		89.91				11-20	Danced 1 hr.; ping pong .25 hr.; bowled 1 hr.
11-21		72.62	0.72			11-21	Danced 3 hrs.; bowled 1 hr. ping pong 0.5 hr.
Average		59.91	0.68				

(Continued)

Table 11 (Continued)

Date 1942	Total Dietary Intake of Ascorbic Acid Found (mg./24 hrs.)	Total Dietary Intake of Ascorbic Acid Calc. (mg./24 hrs.)	Plasma Ascorbic Acid mg. %	Urinary Ascorbic Acid mg./24 hrs.	Work Output ergs	Date	Comment
Average (entire control period)			0.66				
			Research diet; exercise.				
11-22						11-22 to 11-29 incl.	Exercise 15 min. daily.
11-23			0.72		702×10^9	11-22	Slept until 11:00 a.m. and 3:00-5:00 p.m..
11-24	75.22				761×10^9	11-24	Bowled 1 hr.; seemed tired; very sleepy; muscles sore.
11-25	86.66				724×10^9	11-25	Danced 3.5 hrs.
11-26			0.70		713×10^9	11-26	Slept 2 hrs. in morning, 3 hrs. in afternoon; sore muscles; very tired.
11-27	58.65				712×10^9	11-27	Slept morning and afternoon; muscles sore; coordination poor.
11-28	105.87		0.72		686×10^9	11-28	Slept 2.5 hrs. in a.m.; danced 2.5 hrs.
11-29					689×10^9	11-29	Slept a.m. 2 hrs.; not complaining but not peppy.
Average	81.60		0.72		712×10^9		
			Research diet plus 100 mg. ascorbic acid daily.				
12- 1	59.53		0.80			12- 1	Bowled 1 hr.; 5.5 hrs. stood in laboratory.
12- 2						12- 2	Bowled 3 hrs.; subject more buoyant.
12- 3	92.37		0.94				
12- 4	73.05						
12- 5			0.90				
Average	74.98		0.88				

Table 12

Protocol: Subject M. T.

Studied--Winter, 1943

Date 1943	Total Dietary Intake of Ascorbic Acid Found (mg./24 hrs.)	Total Dietary Intake of Ascorbic Acid Calc. (mg./24 hrs.)	Plasma Ascorbic Acid mg. %	Urinary Ascorbic Acid mg./24 hrs.	Work Output ergs	Date	Comment
			Diet self-selected.				
1-26			1.04				Menstrual periods began:
1-27							1-22-43
1-28							3-15-43
1-29							
1-30							
1-31							
2- 1							
2- 2			0.80				
2- 3							
2- 4			0.98			2- 4	to
2- 5						2- 8	incl. 200 mg. ascorbic
2- 6			1.20				acid daily.
2- 7							
2- 8							
2- 9			1.32				
Average		86.65	1.07				
			Research diet; began 2-9.				
2-11			1.20				
2-12							
2-13			1.02				
2-14							
2-15							
2-16		81.97	1.00				
2-17							
2-18			0.64				

(Continued)

Table 12 (Continued)

Date 1943	Total Dietary Intake of Ascorbic Acid Found (mg./24 hrs.)	Total Dietary Intake of Ascorbic Acid Calc. (mg./24 hrs.)	Plasma Ascorbic Acid mg. %	Urinary Ascorbic Acid mg./24 hrs.	Work Output ergs	Date	Comment
			Research diet (continued).				
2-19							
2-20			0.94				
2-21							
2-22		67.13					
2-23			0.94				
2-24							
2-25			1.00				
2-26		87.15					
2-27			0.98				
2-28							
Average		78.75	0.97				
			Research diet; exercise.				
3- 1		75.55			731×10^9	3- 1 to 3-10 incl.	Exercise 15 min. daily.
3- 2			0.90		756×10^9	3- 1	Folk dancing 1 hr.
3- 3		80.81			765×10^9	3- 3	Folk dancing 1 hr.
3- 4			0.80		759×10^9		
3- 5		102.27			781×10^9	3- 5	Folk dancing 1 hr.
3- 6			0.66		786×10^9		
3- 7		80.15			804×10^9		
3- 8					776×10^9		
3- 9			0.62		784×10^9		
3-10					783×10^9		
3-11			0.50				
Average		84.70	0.70		763×10^9		

(Continued)

Table 12 (Continued)

Date 1943	Total Dietary Intake of Ascorbic Acid Found	Calc.	Plasma Ascorbic Acid	Urinary Ascorbic Acid	Work Output	Date	Comment
	(mg./24 hrs.)		mg. %	mg./24 hrs.	ergs		
			Research diet; post-exercise.				
3-12							
3-13		74.81	0.24				
3-14							
3-15		113.57					
3-16							
3-17			0.52				
Average		94.16	0.38				
			Research diet plus 100 mg. ascorbic acid daily. Began 3-19.				
3-22		82.55	0.96				
3-23							
3-24		96.40					
3-25			0.90				
3-26		62.63					
3-27			1.00		792×10^9		
Average		80.53	0.95				
			Research diet plus 100 mg. ascorbic acid daily; exercise.				
3-28					787×10^9	3-27	to
3-29					798×10^9	4- 5	incl. Exercise 15 min.
3-30		100.42	0.70		793×10^9		daily.
3-31					793×10^9	3-31	Swimming 1 hr.
4- 1			0.56		778×10^9	4- 1	Raked leaves 1 hr.
4- 2					801×10^9	4- 2	Swimming 1 hr.
4- 3		63.40	0.60		809×10^9		
4- 4					786×10^9		
4- 5		64.95			770×10^9		
4- 6			0.60				
Average		76.26	0.62		791×10^9		

(Continued)

Table 12 (Continued)

Date 1943	Total Dietary Intake of Ascorbic Acid Found (mg./24 hrs.)	Calc.	Plasma Ascorbic Acid mg. %	Urinary Ascorbic Acid mg./24 hrs.	Work Output ergs	Date	Comment
	Research diet plus 100 mg. ascorbic acid daily; post-exercise.						
4- 7		74.81					
4- 8		63.15	0.60				
4- 9		98.52	0.72				
4-10							
Average		78.83	0.66				

Table 13

Protocol: Subject D. H.

Studied--Winter, 1943.

Date 1943	Total Dietary Intake of Ascorbic Acid Found (mg./24 hrs.)	Calc.	Plasma Ascorbic Acid mg. %	Urinary Ascorbic Acid mg./24 hrs.	Work Output ergs	Date	Comment
			Diet self-selected.				
1-26			0.82				Menstruation began 1-10-43.
1-27							
1-28							
1-29							
1-30							
1-31							
2- 1			0.82				
2- 2							
2- 3			0.98				
2- 4						2- 4 to	
2- 5			1.04			2- 8 incl.	200 mg. ascorbic acid daily.
2- 6							
2- 7							
2- 8			1.14				
2- 9							
Average			0.96				
			Research diet.				
2-10		87.67					This subject averaged only about 6 hrs. sleep per night.
2-11			1.46				
2-12							
2-13			0.82				
2-14							
2-15							
2-16		82.99	0.88				
2-17							
2-18			0.96				

(Continued)

Table 13 (Continued)

Date 1943	Total Dietary Intake of Ascorbic Acid Found (mg./24 hrs.)	Total Dietary Intake of Ascorbic Acid Calc. (mg./24 hrs.)	Plasma Ascorbic Acid mg. %	Urinary Ascorbic Acid mg./24 hrs.	Work Output ergs	Date	Comment
				Research diet (continued).			
2-19							
2-20			0.80				
2-21		68.15					
2-22			0.94				
2-23							
2-24			0.82				
2-25		88.17					
2-26			0.82				
2-27							
2-28			0.84				
3- 1		76.57			704×10^9		
Average		81.75	0.94				
				Research diet; exercise.			
3- 2					679×10^9	3- 1 to 3-10 incl.	Exercise 15 min. daily.
3- 3		81.83			708×10^9		
3- 4			0.82		698×10^9	3- 3	Ping pong, 25 min.
3- 5		103.29			707×10^9		
3- 6			0.76		729×10^9		
3- 7		81.17			734×10^9		
3- 8					722×10^9		
3- 9		60.67	0.60		732×10^9		
3-10					724×10^9		
3-11			0.54				
Average		80.71	0.71		714×10^9		
				Research diet; post-exercise.			
3-12							
3-13		75.83	0.52				
3-14							
3-15		114.59					

(Continued)

Table 13 (Continued)

Date 1943	Total Dietary Intake of Ascorbic Acid Found (mg./24 hrs.)	Total Dietary Intake of Ascorbic Acid Calc. (mg./24 hrs.)	Plasma Ascorbic Acid mg. %	Urinary Ascorbic Acid mg./24 hrs.	Work Output ergs	Date	Comment
			Research diet; post-exercise (cont'd).				
3-16							
3-17			0.50				
Average		95.21	0.51				
			Research diet plus 100 mg. ascorbic acid daily				
3-18							
3-19			0.72			3-17	to
3-20						4-10	incl. 100 mg. ascorbic acid daily.
3-21							
3-22		83.57					
3-23			0.98				
3-24		97.42					
3-25			0.78				
3-26		63.65					
3-27			0.96		750×10^9	3-27	to
Average		81.55	0.86			4- 5	incl. Exercise 15 min. daily.
			Research diet plus 100 mg. ascorbic acid daily; exercise.				
3-28					758×10^9		
3-29					738×10^9		
3-30		101.44	0.74		758×10^9	3-30	Nose bleed 3 times, lasting 10, 15, and 20 min.
3-31					752×10^9		
4- 1			0.72		750×10^9		
4- 2					749×10^9		
4- 3		64.42	0.82		750×10^9		
4- 4					735×10^9		
4- 5		65.97	0.78		730×10^9		
4- 6							
Average		77.29	0.77		747×10^9		

(Continued)

Table 13 (Continued)

Date 1943	Total Dietary Intake of Ascorbic Acid Found (mg./24 hrs.)	Total Dietary Intake of Ascorbic Acid Calc. (mg./24 hrs.)	Plasma Ascorbic Acid mg. %	Urinary Ascorbic Acid mg./24 hrs.	Work Output ergs	Date	Comment
		Research diet plus 100 mg. ascorbic acid daily; post-exercise.					
4- 7		75.83					
4- 8		65.17	0.76				
4- 9		99.54					
4-10			0.92				
Average		80.18	0.84				

Table 14

Protocol: Subject B. H.
Studied--Spring, 1943

Date 1943	Total Dietary Intake of Ascorbic Acid Found (mg./24 hrs.)	Calc.	Plasma Ascorbic Acid mg. %	Urinary Ascorbic Acid mg./24 hrs.	Work Output ergs	Date	Comment
			Research diet.				
4-26							
4-27			0.30			4-27	Last menstruation 4-18-43 Received 100 mg. ascorbic acid.
4-28							
4-29			0.36				
4-30		66.73					
4-31							
5- 1			0.56				
5- 2						5- 2	Tennis, 2 hrs.
5- 3							
5- 4		66.77	0.48			5- 4	to
5- 5						5-14	Bad cold.
5- 6			0.66				
5- 7		71.21					
5- 8			0.80				
5- 9							
5-10							
5-11			0.82				
5-12						5-12	Only 5 hrs.' sleep.
5-13		54.25	0.50				
5-14							
5-15		64.75	0.56		654×10^9	5-15	Dancing, 4 hrs.
						5-15	to
Average		64.74	0.56			5-24	incl. Exercise 15 min. daily.

(Continued)

Table 14 (Continued)

Date 1943	Total Dietary Intake of Ascorbic Acid Found (mg./24 hrs.)	Total Dietary Intake of Ascorbic Acid Calc. (mg./24 hrs.)	Plasma Ascorbic Acid mg. %	Urinary Ascorbic Acid mg./24 hrs.	Work Output ergs	Date	Comment
			Research diet; exercise.				
5-16					631×10^9		
5-17					749×10^9	5-17	Muscles very sore.
5-18		56.75	0.46		749×10^9		
5-19					748×10^9		
5-20		64.75	0.36		740×10^9		
5-21					761×10^9		
5-22		63.75	0.44		749×10^9	5-22	Dancing 2.5 hrs.
5-23					762×10^9	5-23	Only 5 hrs.' sleep.
5-24		101.27			745×10^9		
5-25			0.25				
Average		71.63	0.39		729×10^9		
			Research diet; post-exercise.				
5-27		61.21	0.54				
5-28		113.50				5-28	Only 3 hrs.' sleep.
5-29		101.87	0.56				
5-30		36.99				5-30	Only 4 hrs.' sleep.
5-31							
6- 1		73.72	0.36				
Average		77.46	0.49				
			Research diet plus 100 mg. ascorbic acid daily.				
6- 9		89.65	0.62			6- 1	to
6-10						6- 8	Diet self-selected.
6-11		65.05	0.48	128.6			
6-12		87.28				6- 2	to
6-13			0.28	137.1	654×10^9	6-28	100 mg. ascorbic acid daily.
Average		80.66	0.46	132.85			

(Continued)

Table 14 (Continued)

Date 1943	Total Dietary Intake of Ascorbic Acid Found (mg./24 hrs.)	Total Dietary Intake of Ascorbic Acid Calc. (mg./24 hrs.)	Plasma Ascorbic Acid mg. %	Urinary Ascorbic Acid mg./24 hrs.	Work Output ergs	Date	Comment
	Research diet plus 100 mg. ascorbic acid daily; exercise.						
6-14		96.48			631×10^9	6-13 to	
6-15				138.70	749×10^9	6-22 incl.	Exercise 15 min. daily.
6-16			0.38		749×10^9		
6-17		73.95		113.80	748×10^9		
6-18			0.46		740×10^9		
6-19					761×10^9	6-19	Tennis 2 hrs.; very hot weather.
6-20		100.97		106.40	749×10^9	6-20	Tennis 2 hrs.; very hot weather.
6-21			0.26		762×10^9	6-21	Tennis 2 hrs.; very hot weather.
6-22				152.50	745×10^9		
6-23		58.21	0.28			6-23	Hiking 1 hr.
Average		82.40	0.35	127.85	729×10^9		
	Research diet plus 100 mg. ascorbic acid daily; post-exercise.						
6-24		95.70		82.20			
6-25		101.85	0.52			6-25	Bad sore throat starting.
6-26							
6-27		70.52		168.40			
6-28			0.72				
Average		89.36	0.62	125.30			