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& ADULTS FED AN IDENTICAL HIGH
PROTEIN MEAL

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FINAL REPORT

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L.J. Filler, Jr., M.D., Ph.D.


George L. Baker, M.D.


Lewis D. Stegink, Ph.D.

University of Iowa College of Medicine
Department of Pediatrics
Iowa City, Iowa 52242

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PLASMA AMINOGRAMS OF INFANTS & ADULTS FED AN IDENTICAL HIGH PROTEIN MEAL

**L. J. Filler, Jr., M.D., Ph.D.
George L. Baker, M.D.
Lewis D. Stegink, Ph.D.
Department of Pediatrics
University of Iowa**

Adibi and Mercer have shown that exogenous protein is the principal source of increased free amino acids in plasma (1). These investigators reported increases in plasma concentrations of lysine, alanine, leucine and valine whenever fasted healthy young adult males were fed 50 grams of purified bovine serum albumin. In addition they observed that the digestion of protein ingested as a meal component extends over a time period in excess of 4 hours.

The movement of amino acids from the gut into the peripheral circulation is complex, being dependent upon a number of transport and metabolic processes. What effect if any age plays in these homeostatic processes has not been determined.

We have investigated the ability of the infant to metabolize amino acids relative to that of the adult by feeding an identical high protein meal to fasted subjects, measuring changes in plasma free amino acid concentrations with time. We were particularly interested in the capacity of the infant to regulate metabolism of the dicarboxylic acids, glutamic and aspartic acids and phenylalanine.

METHODS

Sixteen healthy one-year-old and 8 healthy two-year-old infants and

6 healthy young adults (3 male and 3 female) were given a chocolate-flavored custard following an overnight fast. The custard, whose composition is shown in Table I, contained 14 percent by weight protein. Each subject was fed an amount of custard to provide protein at one gram per kilogram body weight. A typical one-year-old infant was fed approximately 70 grams of custard and a typical 70 kilogram male ingested 500 grams.

The amino acid composition of the custard was calculated from the amino acid composition of milk and egg as published by Orr and Watt (2). Calculated intake of amino acids for each subject is given in Tables IIA and IIB.

Heparinized blood samples for amino acid analysis were collected serially on both infants and adults. Each adult was studied over a period of 6 hours with blood samples (7 ml) collected via an indwelling 20 gauge needle at intervals of 0, 30, 60, 90, 120, 150, 180, 240, 300 and 360 minutes following feeding. A dilute heparin solution was instilled into the needle to maintain patency between bleedings. Two venous blood samples (3 ml) were collected from each infant. All infants provided a fasting specimen. Blood samples were obtained on four one-year-old infants and four two-year-old children one hour after feeding and on four one-year-old infants and four two-year-old children two hours after feeding. Blood samples were obtained on four one-year-old infants three hours after feeding and on four one-year-old infants four hours after feeding.

The proposed study was explained to each subject or their parents in the case of the infants and children and informed written consent was obtained. The project was reviewed and approved by the Human Subjects Committee of

the University of Iowa prior to its initiation.

Blood samples for amino acid analyses were centrifuged immediately to separate plasma and erythrocytes. The plasma was deproteinized with sulfo-salicylic acid according to the method of Efron (3) and analyzed immediately or stored at -70°C to prevent loss of glutamine and cystine (4,5). Amino acid analyses were carried out on a Beckman 121M analyzer.

Response to the protein load was determined by plotting the change in plasma concentration of each amino acid as a function of time. Such plots enable one to determine peak response and area under the curve as well as provide a means for comparison of infant to adult response.

RESULTS

Plasma free amino acid concentrations following ingestion of a protein load of one gram per kilogram body weight are given in Table III for adults and in Table IV for infants. The response of infants and adults to an identical protein load at one gram per kilogram body weight is shown in Figure 1 for aspartic acid, glutamic acid, tyrosine and phenylalanine. It is evident that infants have a slightly higher fasting plasma concentration of free aspartic and glutamic acids than adults, while fasting plasma concentrations of free tyrosine and phenylalanine do not differ with age. The milk-egg protein load of one gram per kilogram body weight produced a similar rise in plasma concentration of aspartic acid, glutamic acid, phenylalanine and tyrosine in both infants and adults.

Fasting and postprandial plasma concentrations for 10 indispensable amino acids in infants and these same amino acids in adults are compared in Table V. Concentrations of free amino acids in fasting and postprandial blood samples representing peak response to the feeding of custard are comparable for both infants and adults. Changes in concentration of plasma free amino acids in adult subjects given the egg-milk protein mixture are comparable to those reported by Adibi and Mercer for adults fed bovine serum albumin.

Using the method described by Swendseld and co-workers (6), the ratio of essential to nonessential amino acids was calculated. In the fasting state these ratios were 0.48 and 0.56 for infants and adults respectively. In the postprandial state these ratios were 0.61 for infants and 0.69 for adults. Swendseld and co-workers reported ratios of essential to nonessential amino acids of 0.5 for fasting young adults after 7 days on diets providing approximately 90 grams of protein per day.

The change in plasma concentration of free glutamic and aspartic acids, phenylalanine and tyrosine following the feeding of one gram per kilogram body weight of protein is comparable in infant and adult (Table VI). Postprandial concentrations of glutamic and aspartic acids, phenylalanine and tyrosine of 9, 1, 9 and 11 μ Moles/dl, respectively, observed in these infants are comparable to postprandial concentrations of these amino acids found in infants fed either human milk (7) or various commercial infant formula products (8) (Table VII). With the latter feedings, the load of glutamic acid is 25 to 40 percent of that supplied by the custard. The loads of aspartic acid, phenylalanine and tyrosine are 20 to 70 percent of that supplied by the custard.

Marrs and co-workers have suggested a means for determining whether there is any relationship between the amino acid composition of a meal and increments of plasma concentrations of individual amino acids (9). On the basis of plasma aminograms obtained on blood samples collected serially following a test meal an absorption curve is plotted for each amino acid. The area under the curve for each amino acid is determined and this value is plotted as a function of the molar ratio of each amino acid in the test mixture relative to histidine. When Marrs and co-workers studied a casein hydrolysate and an amino acid mixture resembling casein according to this procedure, they established that amino acids from these mixtures were absorbed in a comparable manner, i.e. a plot of area versus relative composition was found to fit a common regression line.

This method of analysis has been applied to the aminogram data obtained on the infant and adult subjects fed custard. The molar ratio for 15 amino acids relative to histidine (indexed at one) was calculated from the amino acid composition of the custard. Area under the curve in arbitrary units was calculated for these amino acids (Table VIII) and plotted as a function of relative molar ratio (Figure 2). Individual amino acids in this figure are identified according to the one-letter notation employed in the Atlas of Protein Sequence and Structure (10). If the infant and adult transport and metabolize the egg-milk load in a similar manner, the data should fit a common regression line. As shown in Figure 2, adults and infants have a similar regression line. Calculated

coefficients of correlation are: adults $r = 0.73$; infants $r = 0.81$.

SUMMARY

Plasma aminograms of normal healthy infants fed a milk-egg custard meal providing a protein intake of one gram per kilogram body weight were comparable to plasma aminograms obtained on healthy young adults fed the same protein load.

When increments in levels of individual plasma amino acids (area under the curve) were plotted relative to the amino acid composition of the custard meal, the regression line was similar for both infants and adults.

Plasma concentrations of glutamic acid, aspartic acid, phenylalanine and tyrosine in infants fed a meal providing one gram per kilogram body weight of protein were not elevated beyond those postprandial concentrations observed in normal term breastfed infants.

These data support the conclusion that healthy one-year-old infants have the capacity to transport and metabolize aspartic acid, glutamic acid, phenylalanine and tyrosine to the same degree as normal healthy young adults.

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Table I

COMPOSITION OF CUSTARD

COMPONENT	WEIGHT	WATER	PROTEIN	FAT	CHO
	g	g	g	g	g
Egg	150	110	20	17	1
NFDM	150	6	54	1	78
Fructose	30	0	—	—	30
Water	200	200	—	—	—
Total	530	316	74	18	109

Calculated protein content - 13.96 gm protein per 100 gm custard.

Actual protein content of each custard batch confirmed by analysis.

Table IIA. Calculated Intake of Amino Acids From Custard Meal
(mg/kg kilogram body weight)

One-Year-Olds

SUBJECT	WT	HT	S.A.	PROT/KGTAURIN	ASPART	THREONIN	SERINE	ASPARA	GLUTAM	GLUTAM	GLUTAM	PROLIN	CITRUL	GLYCIN	ALANIN	A-AMIN
CEPRENGER	9.08	72.30	355	1.08	0.0	78.84	51.84	64.80	0.0	0.0	223.56	100.44	0.0	25.72	47.68	0.0
BEEMER	9.92	73.20	435	1.04	0.0	75.92	49.92	62.40	0.0	0.0	215.28	96.72	0.0	24.76	41.84	0.0
CSTRAADER	9.00	74.30	422	1.03	0.0	75.19	49.44	61.60	0.0	0.0	213.21	95.79	0.0	24.72	47.38	0.0
BUEITNER	9.70	78.50	455	1.16	0.0	84.68	55.68	69.60	0.0	0.0	240.12	107.88	0.0	27.84	53.36	0.0
FASTENCH	8.58	72.80	407	1.09	0.0	79.57	52.32	65.40	0.0	0.0	225.63	101.37	0.0	26.16	50.14	0.0
DOOPER	10.66	80.30	480	1.13	0.0	82.49	54.24	67.80	0.0	0.0	233.91	105.09	0.0	27.12	51.98	0.0
PITCHELL	9.78	72.30	428	1.20	0.0	87.60	57.60	72.00	0.0	0.0	248.40	111.60	0.0	28.80	55.20	0.0
STORY	9.93	74.60	441	1.09	0.0	79.57	52.32	65.40	0.0	0.0	225.63	101.37	0.0	26.16	50.14	0.0
EASKA	11.00	74.50	460	1.11	0.0	81.03	53.28	66.60	0.0	0.0	229.77	103.23	0.0	26.64	51.06	0.0
CSTRANDER	9.16	75.10	428	1.07	0.0	78.11	51.36	64.20	0.0	0.0	221.49	99.51	0.0	25.68	49.22	0.0
SOPHER	8.13	73.70	401	1.09	0.0	79.57	52.32	65.40	0.0	0.0	225.63	101.37	0.0	26.16	50.14	0.0
MILDER	8.86	74.50	420	1.12	0.0	81.76	53.76	67.20	0.0	0.0	231.84	104.16	0.0	26.88	51.52	0.0
PUNAT, LEAH	9.03	71.60	411	1.11	0.0	81.03	53.28	66.60	0.0	0.0	229.77	103.23	0.0	26.64	51.06	0.0
MCWILLIAMS, L	8.62	73.60	411	1.09	0.0	79.57	52.32	65.40	0.0	0.0	225.63	101.37	0.0	26.16	50.14	0.0
TOPPKIAS	9.91	71.60	428	1.18	0.0	86.14	56.64	70.80	0.0	0.0	244.26	109.74	0.0	28.32	54.28	0.0
BAKEFIELD	8.39	72.60	402	1.12	0.0	81.76	53.76	67.20	0.0	0.0	231.84	104.16	0.0	26.88	51.52	0.0

Two-Year-Olds

PCNINGER	13.40	91.70	582	1.07	0.0	78.11	51.36	64.20	0.0	0.0	221.49	99.51	0.0	25.68	49.22	0.0
SMITH	12.92	88.30	558	1.09	0.0	79.57	52.32	65.40	0.0	0.0	225.63	101.37	0.0	26.16	50.14	0.0
CINGERICH	12.32	85.90	536	1.18	0.0	86.14	56.64	70.80	0.0	0.0	244.26	109.74	0.0	28.32	54.28	0.0
TRUETT	12.30	86.90	540	1.17	0.0	85.41	56.16	70.20	0.0	0.0	242.19	108.81	0.0	28.08	53.02	0.0
SALES	10.55	83.00	489	1.18	0.0	86.14	56.64	70.80	0.0	0.0	244.26	109.74	0.0	28.32	54.28	0.0
SKYDER	12.49	87.60	547	1.17	0.0	85.41	56.16	70.20	0.0	0.0	242.19	108.81	0.0	28.08	53.92	0.0
PEGGERS	10.40	85.10	496	1.20	0.0	87.60	57.60	72.00	0.0	0.0	243.40	111.60	0.0	28.80	55.20	0.0
JASSEN	14.74	89.70	557	1.18	0.0	86.14	56.64	70.80	0.0	0.0	244.26	109.74	0.0	28.32	54.28	0.0

Adults

L. RUELLER	56.20	165.11	645	1.09	0.0	79.57	52.32	65.40	0.0	0.0	225.63	101.37	0.0	26.16	50.14	0.0
FLATNER	64.70	172.71	805	1.04	0.0	77.38	50.88	63.40	0.0	0.0	219.42	98.58	0.0	25.44	49.76	0.0
M. WYATT	54.20	169.51	652	1.04	0.0	75.92	49.92	62.40	0.0	0.0	215.28	96.72	0.0	24.96	47.84	0.0
F. WYATT	82.00	180.22	860	1.04	0.0	75.92	49.92	62.40	0.0	0.0	215.28	96.72	0.0	24.96	47.84	0.0
VALER	76.00	182.92	816	1.09	0.0	79.57	52.32	65.40	0.0	0.0	225.63	101.37	0.0	26.16	50.14	0.0
JANDENSCM	77.00	170.01	922	1.08	0.0	78.84	51.84	64.80	0.0	0.0	223.56	100.44	0.0	25.92	49.68	0.0

Table IIA. Calculated Intake of Amino Acids From Custard Meal
(mg/kglogram body weight)

One-Year-Olds

SUBJECT	WT	ME	S.A.	PROT/KGVALINE	CYSTIN	METHION	ISOLEU	LEUCIN	TYROSI	PHENYL	ORNITH	LYSINC	HISTID	ARGINI	TRYPTO
DEPRENGER	8.08	72.10	355	1.08	76.68	29.16	70.20	105.84	54.00	56.16	0.0	82.08	28.08	48.60	16.20
BEHMER	9.92	73.20	435	1.04	73.84	28.08	67.60	101.92	52.00	54.08	0.0	79.04	27.04	46.80	15.20
CSTRANDER	9.00	74.30	422	1.03	73.13	27.81	66.95	100.94	51.50	53.56	0.0	78.28	26.78	46.15	15.45
BUETINLA	9.70	70.70	455	1.16	82.36	31.32	75.40	113.68	58.00	60.32	0.0	88.16	30.16	52.20	17.40
FASTENON	8.58	72.80	407	1.09	77.39	29.43	70.85	106.82	54.50	56.68	0.0	82.84	28.34	49.05	16.35
CCANER	10.66	80.30	480	1.13	80.23	30.51	73.45	110.74	56.50	58.76	0.0	85.88	29.38	50.85	16.75
PITCHELL	9.78	74.30	428	1.20	85.20	32.40	70.00	117.60	60.00	62.40	0.0	91.20	31.20	54.00	18.00
STORY	9.93	74.60	441	1.09	77.39	29.43	70.85	106.82	54.50	56.68	0.0	82.84	28.34	49.05	16.35
EAKA	11.00	74.50	460	1.11	78.81	29.97	72.15	108.78	55.50	57.72	0.0	84.36	28.86	49.95	16.65
CSTRANDER	9.16	75.10	428	1.07	75.57	28.89	69.55	104.86	53.50	55.64	0.0	81.32	27.82	48.15	16.35
SOPHER	8.13	73.70	401	1.09	77.39	29.43	70.85	106.82	54.50	56.68	0.0	82.84	28.34	49.05	16.35
PILDER	8.86	74.50	420	1.12	79.52	30.24	72.80	115.76	56.00	58.24	0.0	85.12	29.12	50.40	16.80
PUNT, LEAM	9.03	71.60	411	1.11	78.81	29.97	72.15	108.78	55.50	57.72	0.0	84.36	28.86	49.95	16.65
ACMULLEN, L	8.62	73.60	411	1.09	77.39	29.43	70.85	106.82	54.50	56.68	0.0	82.84	28.34	49.05	16.35
LOMPKINS	9.91	71.60	420	1.18	83.78	31.86	76.70	115.64	59.00	61.36	0.0	89.68	30.68	53.10	17.70
BAKEFIELD	8.39	72.60	402	1.12	79.52	30.24	72.80	109.76	56.00	58.24	0.0	85.12	29.12	50.40	16.80

Two-Year-Olds

ACNINGER	13.40	81.70	582	1.07	75.97	13.91	69.55	104.86	53.50	55.64	0.0	81.32	27.82	48.15	16.05
SMITH	12.92	82.30	558	1.09	77.39	14.17	70.85	106.82	54.50	56.68	0.0	82.84	28.34	49.05	16.35
GINGERICH	12.32	85.90	536	1.18	83.78	15.34	76.70	115.64	59.00	61.36	0.0	89.68	30.68	53.10	17.70
TRUITT	12.30	86.90	540	1.17	83.07	15.21	76.05	114.66	58.50	60.84	0.0	88.92	30.42	52.65	17.55
SALES	10.55	83.00	489	1.18	83.78	15.34	76.70	115.64	59.00	61.36	0.0	89.68	30.68	53.10	17.70
SNYDER	12.49	87.60	547	1.17	83.07	15.21	76.05	114.66	58.50	60.84	0.0	88.92	30.42	52.65	17.55
ROGERS	10.46	85.10	496	1.20	85.20	15.60	78.00	117.60	60.00	62.40	0.0	91.20	31.20	54.00	18.00
JANSSEN	14.74	89.70	597	1.18	83.78	15.34	75.70	115.64	59.00	61.36	0.0	89.68	30.68	53.10	17.70

Adults

L. MUELLER	56.20	165.11	645	1.09	77.39	14.17	70.85	106.82	54.50	56.68	0.0	82.84	28.34	49.05	16.35
FLATTEN	64.70	172.71	805	1.06	75.26	13.78	68.90	103.88	53.00	55.12	0.0	80.56	27.56	47.70	15.90
A. WYATT	54.20	169.51	652	1.04	73.84	13.52	67.60	101.92	52.00	54.08	0.0	79.04	27.04	46.80	15.60
P. WYATT	82.00	180.22	960	1.04	73.84	13.52	67.60	101.92	52.00	54.08	0.0	79.04	27.04	46.80	15.60
BALKER	76.00	182.92	916	1.09	77.39	14.17	70.85	106.82	54.50	56.68	0.0	82.84	28.34	49.05	16.35
JANDERSON	77.00	170.01	922	1.08	76.68	14.04	70.20	105.84	54.00	56.16	0.0	82.08	28.08	48.60	16.20

Table III. Calculated Intake of Amino Acids From Custard Meal
(mg/square meter body surface)

One-Year-Olds.

	WT	HT	S.A.	PROT/KGTAURIN	ASPART	THREON	SERINE	ASPARA	GLUTAM	GLUTAM	PROLIN	CITRUL	GLYCIN	ALANIN	A-AMIN
PROJECT															
PRENGER	0.08	72.30	3.55	1.08	0.0	1613.55	1326.20	C.0	0.0	4575.41	2055.62	0.0	530.48	1016.76	0.0
EMER	9.92	71.20	4.35	1.04	0.0	1732.30	1139.05	C.0	0.0	4912.14	2206.91	0.0	569.52	1091.59	0.0
STRANDER	9.00	74.30	4.22	1.03	0.0	1604.91	1055.28	C.0	0.0	4550.89	2044.61	0.0	527.64	1011.31	0.0
JETTNER	9.70	70.90	4.55	1.16	0.0	1806.13	1187.59	C.0	0.0	5121.50	2300.96	0.0	593.80	1138.11	0.0
STFACH	8.58	72.80	4.07	1.09	0.0	1677.15	1103.79	C.0	0.0	4755.76	2136.65	0.0	551.39	1056.84	0.0
MEIER	10.66	80.30	4.80	1.13	0.0	1833.73	1205.74	C.0	0.0	5199.75	2336.12	0.0	602.87	1155.50	0.0
ITCHELL	9.78	72.30	4.28	1.20	0.0	2000.51	1315.40	C.0	0.0	5672.67	2548.59	0.0	657.70	1260.59	0.0
FORV	9.93	74.60	4.41	1.09	0.0	1791.75	1178.14	C.0	0.0	5080.73	2282.65	0.0	589.07	1127.05	0.0
ARKA	11.00	74.50	4.60	1.11	0.0	1936.01	1273.59	C.0	0.0	5492.34	2467.57	0.0	636.79	1220.52	0.0
STRANDER	9.16	75.10	4.28	1.07	0.0	1671.10	1098.81	C.0	0.0	4738.61	2128.94	0.0	549.40	1053.02	0.0
UPPER	8.13	73.70	4.01	1.09	0.0	1611.61	1059.69	C.0	0.0	4569.89	2053.14	0.0	529.84	1015.53	0.0
ILDER	8.86	74.50	4.20	1.12	0.0	1726.13	1134.99	C.0	0.0	4094.63	2199.04	0.0	567.49	1087.70	0.0
UNT, LEAM	9.03	71.60	4.11	1.11	0.0	1780.20	1170.54	C.0	0.0	5047.95	2267.92	0.0	585.27	1121.77	0.0
CHULLEN, L	8.62	73.60	4.11	1.09	0.0	1668.31	1096.97	C.0	0.0	4730.69	2125.38	0.0	548.49	1051.27	0.0
OPPAINS	9.91	71.60	4.28	1.18	0.0	1996.22	1312.50	C.0	0.0	5660.51	2543.13	0.0	656.29	1257.89	0.0
AKFIELD	8.39	72.60	4.02	1.12	0.0	1704.72	1120.91	C.0	0.0	4833.93	2171.76	0.0	560.66	1074.21	0.0

Two-Year-Olds

CHINGER	13.40	91.70	5.82	1.07	0.0	1797.60	1181.99	C.0	0.0	5097.32	2290.10	0.0	590.99	1132.74	0.0
WITTH	12.92	88.30	5.58	1.09	0.0	1643.27	1212.01	C.0	0.0	5226.80	2349.27	0.0	406.01	1161.51	0.0
INGENICH	12.32	85.90	5.36	1.18	0.0	1981.08	1302.63	C.0	0.0	5617.58	2523.84	0.0	651.11	1248.35	0.0
RUITT	12.30	86.90	5.40	1.17	0.0	1546.00	1279.56	C.0	0.0	5518.10	2479.15	0.0	635.78	1226.24	0.0
ALLES	10.55	83.00	4.89	1.18	0.0	1858.22	1221.84	C.0	0.0	5269.20	2367.32	0.0	616.92	1170.93	0.0
HYDER	12.49	87.60	5.47	1.17	0.0	1951.74	1283.35	C.0	0.0	5534.45	2486.49	0.0	641.67	1229.88	0.0
UGERS	10.46	85.10	4.96	1.20	0.0	1846.55	1214.17	C.0	0.0	5236.10	2352.45	0.0	607.08	1163.58	0.0
IASSEN	14.74	89.70	5.97	1.18	0.0	2127.77	1399.08	C.0	0.0	6033.53	2710.72	0.0	695.54	1340.78	0.0

Adults

PUELLER	56.20	165.11	6.45	1.09	0.0	2717.17	1787.03	C.0	0.0	7706.54	3462.36	0.0	893.51	1712.57	0.0
FLATTEN	64.70	172.71	8.05	1.06	0.0	2773.15	1823.44	C.0	0.0	7863.59	3532.92	0.0	911.72	1747.46	0.0
WYATT	54.20	169.51	6.52	1.04	0.0	2491.55	1638.28	C.0	0.0	7065.10	3174.18	0.0	819.14	1570.02	0.0
WYATT	82.00	180.22	0.60	1.04	0.0	3022.25	1987.23	C.0	0.0	8569.93	3850.26	0.0	993.62	1904.43	0.0
WALKER	76.00	182.92	0.16	1.09	0.0	2599.71	1972.41	C.0	0.0	8506.02	3821.55	0.0	986.21	1893.23	0.0
ANDERSON	77.00	170.01	9.22	1.08	0.0	3158.34	2076.72	C.0	0.0	8955.86	4023.65	0.0	1038.16	1990.19	0.0

CUSTARD

PLASMA AMINO ACIDS, TIME (MIN)	SUBJECTS										CUSTARD meal c 1 gm/kg body weight	Subjects Fed High Protein
	0	30	60	90	120	150	180	240	300	360		
AURINE	5.09 1.08	4.36 3.96	4.54 0.90	4.67 0.85	4.74 1.14	4.62 1.02	4.64 1.08	4.72 1.44	4.50 0.76	4.22 0.90	0.0 0.0	0.0 0.0
SPART	0.35 0.06	0.36 3.10	0.33 0.13	0.35 0.17	0.45 0.19	0.59 0.43	0.43 0.17	0.47 0.20	0.48 0.25	0.41 0.22	0.0 0.0	0.0 0.0
HREON	15.89 4.13	22.25 3.55	23.37 5.12	23.16 5.94	23.45 5.25	23.04 6.18	24.26 7.18	24.44 7.24	24.56 6.76	22.95 6.30	0.0 0.0	0.0 0.0
KEKINE	11.71 1.41	16.55 2.06	16.44 2.53	16.20 3.09	16.56 2.90	15.89 3.18	16.18 3.26	16.21 3.48	16.23 3.08	15.36 3.60	0.0 0.0	0.0 0.0
SPARAGH	5.91 2.65	8.45 3.07	9.67 2.56	8.62 3.29	7.56 2.77	8.50 3.03	8.97 4.13	8.93 3.77	8.17 3.35	7.84 2.59	0.0 0.0	0.0 0.0
GLUTAMIN	40.30 7.08	52.52 7.27	53.95 5.14	52.11 4.96	49.71 5.27	40.24 6.86	49.88 5.78	51.16 7.66	50.07 3.07	48.59 6.43	0.0 0.0	0.0 0.0
GLUTAMAT	3.27 1.63	5.18 3.55	4.01 4.06	6.32 4.22	6.33 4.21	6.38 3.42	5.89 3.64	6.23 3.30	6.11 3.61	5.99 3.51	0.0 0.0	0.0 0.0
PROLINE	18.56 5.67	31.00 9.12	32.42 9.90	35.88 11.46	37.07 13.18	37.97 13.81	38.99 11.99	40.12 12.45	39.41 12.68	37.91 10.67	0.0 0.0	0.0 0.0
ITRULLIN	2.50 1.19	2.37 0.61	2.03 0.84	2.34 0.62	2.63 0.58	2.08 1.09	2.98 1.11	3.92 0.90	4.15 1.27	3.40 1.13	0.0 0.0	0.0 0.0
GLYCINE	21.48 2.81	22.48 2.67	22.10 3.76	21.75 3.24	21.36 3.56	20.09 3.37	21.37 4.10	21.56 5.07	20.13 3.37	18.78 3.28	0.0 0.0	0.0 0.0
LAMINE	34.79 7.69	49.86 3.14	56.13 11.94	57.78 15.96	53.83 12.25	51.87 14.60	53.74 13.67	55.38 16.81	49.99 10.69	48.12 9.19	0.0 0.0	0.0 0.0
AMINOB	2.62 0.85	2.92 1.14	2.87 1.05	2.83 1.08	2.63 0.87	2.51 0.78	2.68 0.82	2.46 0.76	2.42 0.66	2.30 0.73	0.0 0.0	0.0 0.0

Table III: Plasma amino acids (umoles/dl) in adult subjects 1.1 a high protein meal at 1 gm/kg body weight

CUSTARD

PLASMA AMINO ACIDS, DOSE = 60		0		150		180		240		300		360			
TIME (MIN)		0		30		60		90		120		150			
VALINE	23.30	33.53	33.97	35.61	37.52	37.81	40.46	42.14	43.76	42.22	0.0	0.0	0.0	22.97	11.20
	4.95	6.68	5.00	6.95	8.31	9.12	8.23	7.07	7.08	4.57	0.0	0.0	0.0	5.03	2.65
CYSTINE	9.79	10.45	10.58	10.37	10.33	9.89	10.48	10.30	10.33	9.82	0.0	0.0	0.0	1.07	1.31
	1.87	1.97	1.42	1.78	1.52	1.93	1.45	1.30	1.77	1.34	0.0	0.0	0.0	2.01	0.62
METHION	2.86	5.50	5.68	6.21	6.41	6.93	6.77	7.14	7.12	6.27	0.0	0.0	0.0	4.95	19.92
	0.62	1.13	0.73	1.54	1.57	1.08	1.47	0.58	1.21	1.12	0.0	0.0	0.0	1.11	0.45
ISOLEUCN	7.84	12.50	12.46	12.50	12.00	12.02	13.02	13.33	13.63	12.21	0.0	0.0	0.0	6.69	8.48
	1.70	1.56	2.20	3.19	3.80	3.01	3.15	3.21	3.62	2.25	0.0	0.0	0.0	1.93	0.79
LEUCINE	13.00	23.11	22.79	23.45	24.19	24.12	24.84	25.42	26.04	23.58	0.0	0.0	0.0	14.87	12.84
	2.73	3.43	5.28	6.54	7.49	7.66	6.87	6.09	6.70	4.22	0.0	0.0	0.0	2.44	1.16
TYROSINE	5.58	8.95	9.26	9.91	10.39	10.60	10.99	11.50	11.70	10.93	0.0	0.0	0.0	6.84	9.04
	1.49	2.25	2.68	3.32	3.93	4.17	3.57	3.43	3.60	2.89	0.0	0.0	0.0	1.85	0.76
PHENYLAL	5.13	7.21	7.28	7.44	7.57	7.49	8.02	8.20	8.45	7.66	0.0	0.0	0.0	3.53	13.30
	0.86	1.03	0.83	1.15	1.50	1.59	1.57	1.55	0.98	0.72	0.0	0.0	0.0	0.67	0.27
ORNITHN	4.97	6.74	6.89	6.94	7.02	7.12	7.56	7.56	7.23	7.31	0.0	0.0	0.0	3.20	17.03
	1.05	1.34	1.23	1.53	1.95	2.04	1.60	1.36	1.01	0.94	0.0	0.0	0.0	0.44	0.18
LYSINE	18.53	29.55	30.45	30.57	30.04	29.80	31.59	30.28	30.18	27.07	0.0	0.0	0.0	15.68	25.70
	3.54	6.59	3.84	5.19	6.61	6.48	4.88	5.64	4.69	3.78	0.0	0.0	0.0	1.51	0.62
HISTIDIN	8.58	13.56	11.23	10.84	10.14	10.01	10.86	11.03	11.47	10.63	0.0	0.0	0.0	3.71	5.42
	1.24	1.11	1.43	1.86	1.39	2.17	2.28	2.59	1.91	2.65	0.0	0.0	0.0	1.53	0.69
ARGININ	10.45	14.73	14.47	14.55	15.73	14.12	14.79	15.05	14.32	13.44	0.0	0.0	0.0	6.11	6.70
	3.24	4.36	4.17	4.74	5.18	5.61	3.96	5.22	4.02	3.36	0.0	0.0	0.0	1.72	0.70

RECORD COUNT NUM IS 966

IER0361 - B = 7280
 IER0371 - G = 316
 IER0381 - MAX = 21922
 IER0451 - END SORT PH
 IER0491 - SKIP MERGE PH
 IER0541 - RCD IN 966,OUT 966
 IER0521 - EOI

REAL STUDIES. . . - INDUSTRY
LASVA AMINO ACIDS

DOSE = 0 MG/KG												
VARIABLE IS TAURINE												
SUBJECT / TIME	3 MIN	30 MIN	60 MIN	90 MIN	2 HR	2.5 HR	3 HR	4 HR	5 HR	6 HR		
FLATTEN	5.48	4.01	4.88	5.51	4.86	5.06	5.17	4.31	4.35	4.07		
FLATTEN	5.98	4.60	5.13	5.52	5.40	5.32	5.85	5.24	4.62	4.75		
FLATTEN	6.20	4.93	4.57	4.57	6.36	5.53	5.51	7.32	5.75	5.60		
FLATTEN	3.26	3.63	3.15	3.74	3.52	4.57	3.76	3.98	5.00	2.92		
FLATTEN	4.52	2.94	3.69	3.61	3.36	2.69	3.06	3.14	3.52	3.06		
FLATTEN	5.08	5.43	5.32	5.07	4.97	4.54	4.50	4.34	4.22	4.11		
FLATTEN	5.09	4.36	4.54	4.67	4.74	4.62	4.64	4.72	4.58	4.22	0.0	0.0
FLATTEN	1.08	0.96	0.90	0.85	1.14	1.02	1.03	1.44	0.76	0.90	0.0	0.0
FLATTEN											0.0	0.0

...LASTING VALUE.

CUSTARD		DOSE = 0 MG/KG		VARIABLE IS ASPART									
SUBJECT / TIME		3 MIN	10 MIN	30 MIN	60 MIN	90 MIN	2 HR	2.5 HR	3 HR	4 HR	5 HR	6 HR	
WYATT, N	0.36	0.24	0.20	0.14	0.16	0.28	0.21	0.23	0.20	0.17			
FLATTEP,	0.40	0.26	0.19	0.23	0.29	0.26	0.24	0.16					
WALKER,	0.36	0.51	0.50	0.42	0.64	1.44	0.62	0.73	0.76	0.56			
WYATT, R	0.28	0.32	0.34	0.43	0.57	0.43	0.51	0.59	0.59	0.39			
ANDERSON	0.30	0.43	0.45	0.54	0.46	0.48	0.49	0.45	0.48	0.55			
MUELLER,	0.43	0.39	0.33	0.43	0.52	0.58	0.60	0.63	0.49				
MEAN	0.35	0.36	0.33	0.35	0.43	0.59	0.47	0.48	0.41	0.0	0.0	0.0	
STD. DEV	0.06	0.10	0.13	0.17	0.19	0.43	0.17	0.20	0.22	0.0	0.0	0.0	
N	6	6	6	6	6	6	6	6	6	0	0	0	

Table III: Plasma amino acids (umoles/dl) in adult subjects fed a high protein CUSTARD meal vs. 1 gm/kg body weight

PEAL STUDIES - INDIVIDUAL PLASMA AMINO ACIDS

CUSTARD • DOSE • 0 KG/KG

NUMERICAL IS THREE

[illegible]

PLASMA AMINO ACIDS

CUSTARD ; DOSE - 0 MG/KG

VARIABLE IS SERINE

[illegible]

HEAL STUDIES - INDIVIDUO PLASMA AMINO ACIDS

CUSTARD • DOSE = 0 MG/KG

VARIABLE IS GLUTAMATE

[illegible]

PLASMA AMINO ACIDS

CUSTARD

VARIABLE IS PROLINE.

[illegible]

CUSTARD, DOSE - 0 MG/KG

CUSTARD, DOSE - 0 MG/KG

SUBJECT / TIME **3 MIN** **30**

[illegible]

CUSTARD , DOSE - 0 MG/XG

CUSTARD , DOSE = 0 MG/XG

SUBJECT / TIME 3 MIN 30 S

MEAL STUDIES - INDIVIDUAL D PLASMA AMINO ACIDS

CUSTARD • DOSE = 0 MG/KG

VARIABLE IS ALANINE

PLASMA-ALKALINE

CUSTARD , DOSE = 0 MG/KG

VARIABLE IS A_HINOB.

MEAL STUDIES PLASMA AMINO ACIDS

CUSTARD , DOSE - 0 MG/KG

VARIABLE IS VALINE.

[illegible]

PLASMA AMINO ACIDS

CUSTARD , DOSE = 0 MG/KG

VARIABLE IS CYSTINE

[illegible]

Table III: Plasma amino acids (umoles/dl) in adult subjects fed a .51gN protein CUSTARD meal at 1 gm/kg body weight

[illegible]

TABLE III: Plasma amino acids (umoles/dl) in adult subjects fed a high protein, CUSTARD meal at 1 gm/kg body weight

[illegible][illegible]

Table III: Plasma amino acids (umoles/dl) in adult subjects fed a high protein CUSTARD meal at 1 gm/kg body weight

VARIABLE IS LYSINE

CUSTARD , DOSE = 0 MG/KG

VARIABLE IS HISTIDIN

Table III: Plasma amino acids (umoles/dl) in adult subjects fed high protein
CUSTARD meal at 1 gm/kg body weight

MEAL STUDIES - INDIVIDUAL DATA
PLASMA AMINO ACIDS

CUSTARD DOSE = 0 MG/KG

VARIABLE IS ARGININ

SUBJECT / TIME	3 MIN	30 MIN	60 MIN	90 MIN	2 HR	2.5 HR	3 HR	4 HR	5 HR	6 HR
FLATTEN,	8.54	13.66	12.80	12.32	13.12	13.22	13.41	12.43	11.74	9.46
WATT, N	7.08	12.94	12.28	10.52	10.48	8.99	10.86	13.02	13.15	13.15
WALKER,	11.02	15.72	14.82	16.48	17.46	13.85	15.23	12.45	13.20	14.61
ANDERSON	10.81	15.12	15.44	15.49	15.46	15.69	17.03	15.42	15.80	15.31
WATT, R	16.35	22.13	21.86	22.60	25.09	24.12	21.25	25.38	21.65	18.22
MUELLER,	8.92	8.03	9.60	9.87	12.75	8.84	11.03	11.62	10.39	9.88
MEAN	10.45	14.73	14.47	14.55	15.73	14.12	14.79	15.05	14.32	13.44
STD. DEV	3.24	4.36	4.17	4.74	5.18	5.61	3.96	5.22	4.02	3.36
N	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.

0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

Table IV: Plasma Amino Acids (umoles/dl in infants and children) at 1 gm/kg body weight

PLASMA AMI ACID LEVELS
TIME: 4 hours

VARIABLE	N	MEAN	STANDARD DEV	VARIANCE	SUM	CORRECTED SS	LCV	HIGH	C.V. %
AGE	4	1.000000	0.0	0.0	4.000000	0.0	1.000000	1.000000	0.0
TAURINE	4	4.972500	2.14710	7.671292	15.890000	23.013875	1.720000	8.250000	55.701
ASPARTAT	4	0.962500	0.223663	0.050025	3.850000	0.150075	0.740000	1.240000	23.238
IMREDAIN	4	12.952500	1.676730	2.811425	51.810000	8.434275	11.500000	14.600000	12.945
LEUCINE	4	14.100000	0.449667	0.202200	56.400000	0.606600	13.640000	14.570000	3.189
ASPARGI	4	3.945000	0.932541	0.869633	15.780000	2.639900	2.900000	5.170000	23.639
CLUTAPIN	4	11.025000	1.1219312	125.872959	44.710000	377.610875	21.000000	48.120000	31.128
CLUTAPAT	4	11.025000	4.145844	17.139433	44.710000	51.565300	7.030000	16.050000	37.634
FRALINE	4	33.507500	5.559359	35.513958	134.030000	106.541875	26.100000	40.510000	17.785
CITAUILL	4	2.350000	0.348234	0.121267	9.400000	0.363800	1.900000	2.730000	14.818
GLYCINE	4	16.372500	4.302491	18.511425	65.490000	55.534275	10.900000	21.400000	25.279
ALANINE	4	25.965000	9.771914	95.490300	103.860000	286.470900	12.930000	33.780000	37.635
VALINE	4	33.177500	13.421667	180.329092	132.710000	540.987275	20.400000	47.600000	43.475
PETHICHI	4	4.552500	0.373575	0.139558	18.470000	0.416675	7.170000	8.050000	4.904
ISOLEUCI	4	12.870000	1.84528	3.403758	51.480000	10.211275	1.930000	5.930000	40.526
LEUCINE	4	22.337500	3.367759	11.341000	89.350000	34.025400	9.820000	17.410000	26.168
TYROSINE	4	10.515000	6.140048	37.798492	42.350000	113.395475	14.070000	28.650000	27.523
PHENYLAL	4	8.000000	2.637075	6.954167	32.660000	20.862500	6.870000	13.090000	25.077
CARITIM	4	6.837500	2.625605	6.893800	27.350000	20.681400	4.760000	10.900000	32.576
LYSINE	4	17.002500	3.545517	12.570692	68.210000	37.712075	4.200000	11.760000	51.854
PISTIDIN	4	7.032500	3.55746	12.655425	28.210000	37.966275	13.350000	21.230000	20.923
TRACIMINE	4	9.422500	1.758378	3.091892	31.330000	9.275675	5.230000	8.950000	22.450
POP	4	1.152500	2.900349	8.412025	4.610000	25.236075	6.200000	13.240000	30.781
			0.359664	0.129358		0.388075	0.630000	1.450000	31.207

* Two two-year-old infants refused to eat the custard after a fasting blood sample was obtained. These two infants were averaged into the zero time values for a N = 26.

Table V

CUSTARD STUDY

PLASMA FREE AMINO ACID CONCENTRATION
FOLLOWING ONE GRAM/KBW PROTEIN

AMINO ACID UMOLS/DL	INFANT		ADULT	
	FASTING	POSTPRANDIAL	FASTING	POSTPRANDIAL
THREONINE	9.6	18.8	15.9	24.6
VALINE	20.5	41.3	23.3	43.8
1/2 CYSTINE	7.3	8.9	9.8	10.5
METHIONINE	2.0	4.8	2.9	7.1
ISOLEUCINE	6.5	13.0	7.8	13.6
LEUCINE	10.8	23.0	13.0	26.0
PHENYLALANINE	5.0	8.9	5.1	8.4
LYSINE	13.5	29.5	18.5	31.6
HISTIDINE	7.8	10.2	8.6	11.5
ARGININE	8.8	15.2	10.4	15.7

Table VI

Custard Study
Adults and One-Year-Olds

		Intake (mg/KBW)				Plasma Concentration (uMoles/dl)							
N		Glu	Asp	Phe	Tyr	Glu Fast	PP	Asp		Phe Fast	PP	Tyr	
								Fast	PP			Fast	PP
Adults	6	221	78	56	53	3.3	6.4	0.4	0.6	5.1	8.5	5.6	11.7
Infants	16	231	82	58	56	6.5	9.2	0.6	1.0	5.0	8.7	5.4	10.8

Glu = Glutamate
Asp = Aspartate
Phe = Phenylalanine
Tyr = Tyrosine

Table VII

**Plasma Glutamate & Aspartate Concentrations
Term Infants - 2 Hours Postprandial**

Feeding	N	Intake mg/KBW/Feeding				Plasma Concentration uMoles/dl			
		Glutamate	Aspartate	Phenylalanine	Tyrosine	Glutamate	Aspartate	Phenylalanine	Tyrosine
Human Milk	13	64	32	14	17	12.3	0.7	4.7	8.9
Nutramigen*	8	80	28	42	17	10.1	2.1	10.7	9.5
Soy Isolate	12	95	57	23	17	13.0	0.7	5.9	7.3
Enfamil*	24	62	15	27	22	9.8	1.4	10.3	11.5

* Serum Samples

Table VIII

Area Under the Curve
Following A Custard Meal

<u>Amino Acid</u>	<u>Code Letter</u>	<u>Molar Ratio In Custard</u>	<u>Area Under Curve</u> umoles/hr/dl	
			<u>Infant</u>	<u>Adult</u>
Threonine	T	2.40	16.0	27.7
Serine	S	3.41	7.8	16.3
Proline	P	4.82	54.1	63.6
Glycine	G	1.91	-5.7	0.4
Alanine	A	3.08	37.1	69.6
Valine	V	3.62	51.2	51.5
1/2 Cystine	C	0.65	1.6	2.3
Methionine	M	1.08	7.8	12.4
Isoleucine	I	2.96	21.4	17.5
Leucine	L	4.46	36.8	39.0
Tyrosine	Y	1.65	17.8	16.8
Phenylalanine	F	1.88	10.8	7.0
Lysine	K	3.10	35.7	42.4
Histidine	H	1.00	5.4	7.7
Arginine	R	1.54	10.4	15.9
Glutamic Acid*	-	8.40	6.9	8.8
Aspartic Acid*	-	3.27	0.6	0.2

* Amino Acids not plotted in Figure 2.

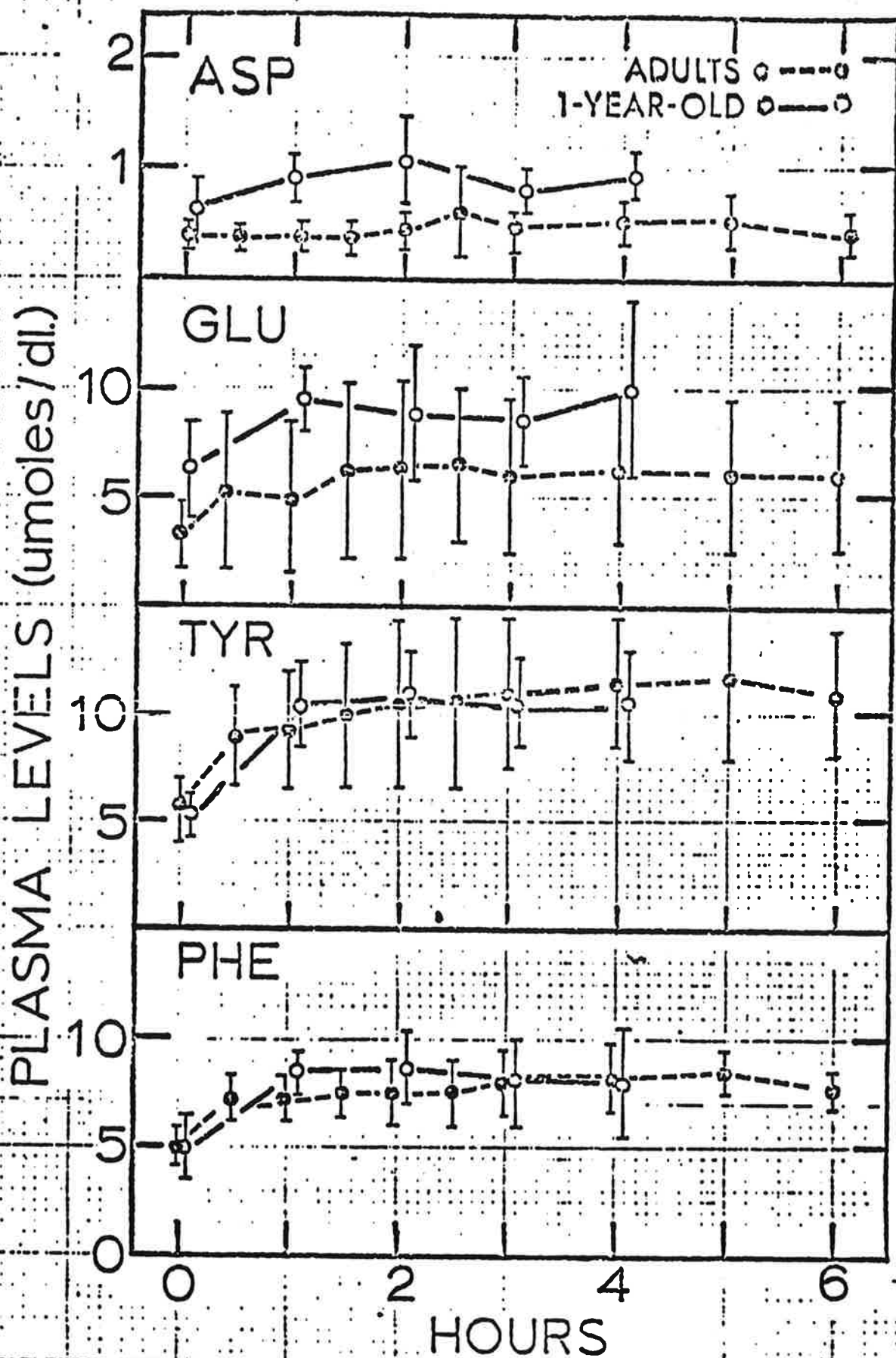


Figure 1. Plasma concentrations of aspartic acid, glutamic acid, tyrosine and phenylalanine in normal one-year-old infants and normal adults following a custard meal at 1 gram protein per kilogram body weight.

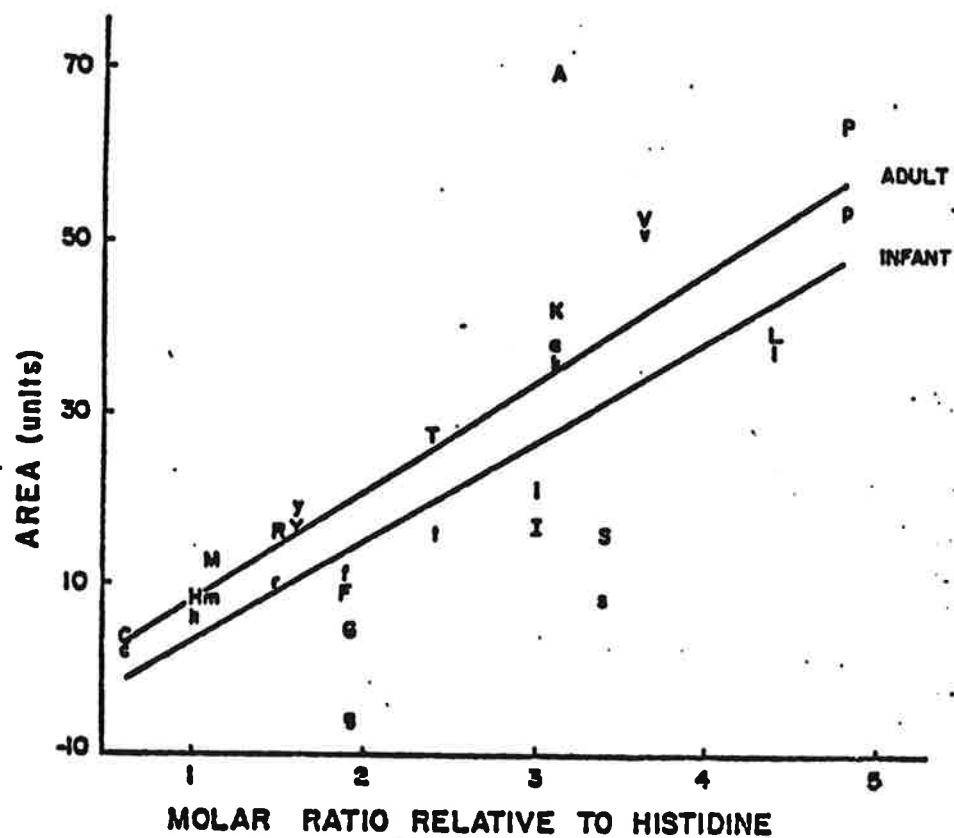


Figure 2. Area under the curve determined from aminograms following a high protein meal (milk-egg custard) as a function of molar ratios of individual amino acids relative to histidine in the meal.