CHEM-643 Intermediary Metabolism **Name/Group _____**
Wednesday, 14 November 2007
Group Quiz on Amino Acid Metabolism Case Study Problem,
"Plants vs Animals in the Dining Hall"

Average: Individual 7.22/12; Group 39.4/48

Select the ***best*** answer. Please note that true statements are not necessarily correct answers or explanations. Tables 1-3 from the case study problem are reproduced on the last page, which you can tear off for use.

____ 13. Based on the data in Table 3, which of the following amino acids would most likely have the ***longest*** biological half life?

A. Glutamate B. Leucine C. Threonine D. Serine

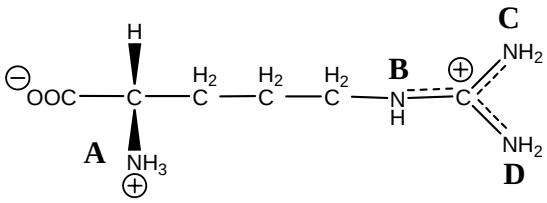
____ 14. Which of the following biomolecules would be of ***greatest concern*** to a person on a strict vegetarian diet?

A. Creatine B. Cholesterol C. Cobalamin (B_{12}) D. Thiamin

____ 15. In a mouse, ^{14}C from dietary sucrose, shows up three days later in arginine found in proteins. Which of the following metabolic precursors of arginine would contain the ***least*** amount of ^{14}C from dietary sucrose?

A. CO_2 B. Citrulline C. Pyruvate D. Ornithine

____ 16. Given the known amino acid metabolic pathways and the patterns of isotope distribution among different amino acid in rats and mice, which of the nitrogen atoms in arginine below would normally have the ***least*** ^{15}N in Table 3?



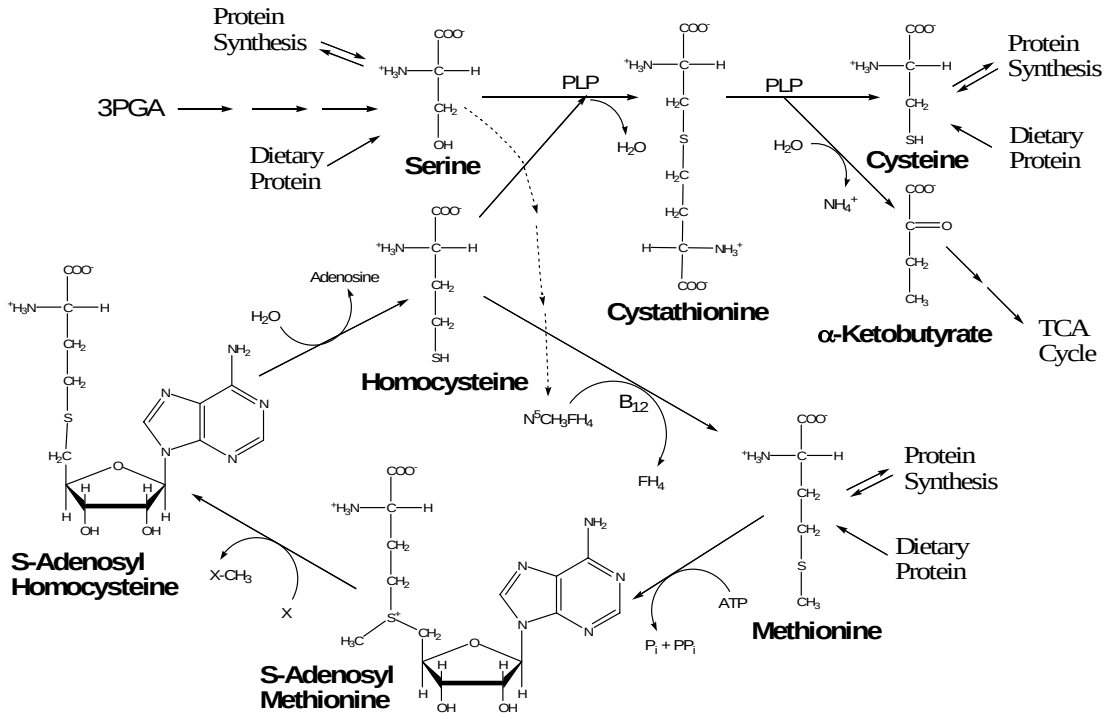
____ 17. Seeds typically provide a rich source of protein; however, compared to protein in meat, seed proteins are unbalanced with respect to one or more amino acids that are in disproportionately low amounts. Which of the following would be ***most likely*** to be in low amounts in seeds?

A. Glutamine B. Serine C. Methionine D. Alanine

____ 18. The primary selective pressure on plants to produce seeds with unbalanced amino acid content is:

A. Plants save energy by producing fewer amino acids.
B. Germinating seedlings have reduced need for the amino acids produced in low amounts.
C. The codon assignments in the genetic code dictates the amino acid composition of seed proteins.
D. The amino acid content doesn't match the amino acid needs of herbivores.

The diagram below illustrates the metabolic pathways that involve cysteine and methionine in mammals. The two questions that follow relate to how well this diagram supports the data in Tables 1-3 of the case study problem.



____ 19. Pick the ***incorrect*** statement. The above diagram is consistent with:

A. Cysteine required for L-cell growth.
B. Methionine required for L-cell growth.
C. Cysteine becoming labeled from ^{14}C-surcose.
D. Methionine becoming labeled from ^{14}C-surcose.

____ 20. Table 3 does not include cysteine or methionine. If these sulfur-containing amino acids had been used, what could you ***predict*** about the distribution of ^{15}N between them two after eight hours based on the diagram above?

A. ^{15}N from cysteine would significantly label methionine and vice versa.
B. ^{15}N from cysteine would significantly label methionine, but not the reverse.
C. ^{15}N from methionine would significantly label cysteine, but not the reverse.
D. Very little ^{15}N would be exchanged between cysteine and methionine.

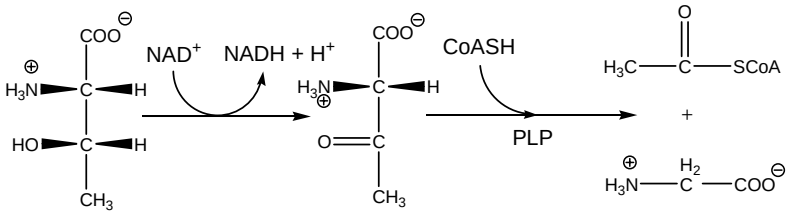
____ 21. Three days after feeding mice ^{14}C-sucrose, tyrosine in their proteins does not contain measurable ^{14}C (Table 1). Furthermore, tyrosine is required for the growth of mouse L-cells (Table 2). Yet, tyrosine is often classified nutritionally as a non-essential amino acid. The ***best*** way to make sense of this discrepancy is:

A. Experimental error.
B. Phenylalanine is converted to tyrosine.
C. Tyrosine is converted to phenylalanine.
D. Tyrosine is non-essential only in young rats and L-cells are a differentiated cell type with atypical tyrosine metabolism.

____ 22. Nitrogen in glutamate, aspartate, and alanine gets rapidly redistributed to most other amino acids, but not to threonine, lysine, and histidine (Table 3). From these data ***one can infer that***:

A. Glutamate, aspartate, and alanine are nutritionally essential amino acids.
B. Transaminases that transfer amino groups between essential and non-essential amino acids are highly regulated.
C. The carbon in glutamate, aspartate, and alanine rapidly exchanges with carbon in the TCA cycle intermediates.
D. Threonine, lysine, and histidine are catabolised by separate pathways in rats.

____ 23. Marcus et al. [*Biochem. Biophys. Res. Commun.* **190**, 1066 (1993)] reported that 90% of the threonine catabolised in human liver proceeds via the reactions shown below. Based on data in Table 3 and assuming that mammals are similar in their metabolism of threonine, select the statement below that is ***incorrect***.



A. This would explain that ^{15}N from threonine transfers to glycine, but not in the reverse direction.
B. Implies there should be higher incorporation of ^{15}N from threonine to arginine.
C. Consistent with the relatively small transfer of ^{15}N from threonine to glutamate.
D. Would help explain why serine becomes labeled with ^{15}N from threonine.

____ 24. Maura wanted to be a vegetarian primarily for the following reason:

A. She didn't like the idea of killing animals for food.
B. Her family's religious convictions.
C. Her concern about environmental pollution caused by cattle feedlots.
D. Raising animals for food is a waste of natural resources on a shrinking planet.

Table 1. Specific radioactivity of amino acids biosynthesized from ^{14}C sucrose in three days by a mouse (Steele, 1952).

Amino Acid	nCi/mgC	Amino Acid	nCi/mgC	Amino Acid	nCi/mgC	Amino Acid	nCi/mgC
Glutamate	19.0±1.9	Threonine	0.09±0.02	Valine	0.02±0.01	Lysine	0.0±0.02
Aspartate	15.8±0.9	Serine	8.4±0.1	Phenylalanine	0.02±0.07	Histidine	0.07±0.08
Alanine	26.5±3.3	Glycine	5.1±0.2	Tyrosine	0.0±0.07	Cystine	3.3±0.3
Proline	3.1±0.1	Isoleucine	0.06±0.05	Arginine	3.0±0.2	Methionine	1.03±0.06

Table 2. Growth of mouse L cells in media lacking the indicated amino acid (Eagle, 1955).

Amino Acid	Cell Growth	Amino Acid	Cell Growth	Amino Acid	Cell Growth	Amino Acid	Cell Growth
Glutamate	3.6 - 4.5	Threonine	0.2	Valine	0.06 - 0.2	Lysine	0.2 - 0.5
Aspartate	3.6 - 6.1	Serine	2.5 - 2.8	Phenylalanine	0.3 - 0.4	Histidine	0.3 - 0.4
Alanine	2.2 - 2.6	Glycine	3.6 - 3.7	Tyrosine	0.06 - 0.2	Cystine	0.1 - 0.3
Proline	2.4 - 6.8	Isoleucine	0.1 - 0.4	Arginine	0.4 - 0.9	Methionine	0.3 - 0.4
		Leucine	0.4 - 0.6	Tryptophan	0.3 - 0.4		

Table 3. Distribution of ^{15}N among the amino acids of liver proteins 8 hours after intravenous injection of various amino acid sources of ^{15}N. Values are normalized to the ^{15}N content of the source amino acid (100) incorporated into protein (Aqvist, 1951).

	Amino acids incorporated into rat liver proteins														
^{15}N-Amino Acid	Glu	Asp	Ala	Pro	Thr	Ser	Gly	Leu	Ile	Val	Phe	Tyr	Arg	Lys	His
Glutamate	100	50	74	12	3	46	19	31	nd	20	14	20	34	4	2
Aspartate	186	100	125	29	2	40	38	49	111	nd	26	38	60	15	25
Alanine	77	44	100	16	<1	23	21	38	40	29	9	10	33	4	3
Proline	23	14	18	100	1	5	3	4	5	5	1	2	11	2	<1
Threonine(1)	6	5	5	2	100	20	14	1	2	4	2	5	5	1	<1
Serine	9	9	12	2	14	100	50	3	2	2	2	6	9	1	1
Glycine	19	12	16	1	0	88	100	nd	nd	nd	3	nd	16	<1	2
Leucine	30	15	25	nd	<1	7	7	100	25	12	3	7	11	0	<1
Isoleucine	28	14	23	11	<1	9	8	34	100	15	8	12	10	4	3
Valine	34	19	29	7	0	12	10	46	41	100	5	6	14	1	2
Phenylalanine	24	12	18	2	<1	3	2	3	5	3	100	74	10	7	2
Tyrosine(2)	23	13	16	3	<1	4	4	4	5	4	44	100	9	1	1
Arginine(3)	34	23	20	18	2	6	1	nd	nd	nd	11	10	100	13	5
Lysine[3]	23	19	12	5	3	8	3	nd	nd	nd	6	nd	9	100	4
Histidine[3]	28	25	30	6	2	8	10	nd	nd	nd	9	nd	24	6	100

1. Slightly contaminated with ^{15}N serine. Data from one rat only.
2. Administered by a stomach tube. Animals killed after 12 hours.
3. ^{15}N excess significantly less than for other administered amino acids.