PETITION

To the U.S. Department of Agriculture National Organic Program

To Amend 7 CFR §205.603(d) To Include Required Amino Acids As A Synthetic Substance Allowed For Use in Organic Pet Food Production

Submitted January 30, 2012

By Pet Food Institute 2025 M St., NW Suite 800 Washington, D.C. 20036 Tel: 202 367-1120 Fax: 202-367-2120 www.petfoodinstitute.org

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January 18, 2012

Miles McEvoy Deputy Administrator USDA/AMS/TMP/NOP 1400 Independence Ave., S.W. Room 2646-S Ag Stop 0268 Washington, D.C. 20250-0201

Dear Mr. McEvoy,

The Pet Food Institute (PFI), the trade association comprised of pet food manufacturers which produce 98% of the dog and cat sold in the United States, an \$18 B business with an additional \$1.2B in exports, formally submits this petition to the U.S. Department of Agriculture's National Organic Program. We request the amendment of §205.603(d) of the National Organic Standards to include required amino acids as synthetic substance allowed for use in organic pet food production on behalf of all Organic pet food producers in the U.S. This petition is being submitted in anticipation of the development of formal regulations governing the certification of pet food under the National Organic Standards.

In accordance with the instructions on the National Organic Program website, we have provided answers to all of the questions below, and in a manner that satisfies the criteria in 7 USC 6517 and 6518, commonly known as the Organic Foods Production Act.

We, of course, are ready to provide any additional information that you, the National Organic Standards Board, or the Technical Advisory Panels may require to complete your review process.

Sincerely,

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Nancy K. Cook Vice President

www.petfoodinstitute.org

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Petition Information

Overview and Introduction

The U.S. Department of Agriculture's National Organic Standards recognized from the outset that vitamins, minerals and other required nutrients are essential in formulating certified organic products that will meet the nutritional requirements of humans and animals.

Specifically, §205.603(d)(2) and §205.603(d)(3) allow trace minerals and vitamins to be utilized in livestock for enrichment or fortification when FDA approved. Those nutrients are allowed for use in livestock feed regardless of the method of manufacturing or handling.

Under the current regulations, pet food products seeking certification under the USDA Organic Standards must be produced in accordance with §205.605 and §205.606 of the National Organic Standards. However, this petition is being submitted in anticipation of proposed regulations to allow certification of pet food as organic under §205.603 of the National Organic Standards.

This petition is also being submitted in accordance with the consent of the National Organic Standards Board Livestock Committee—and the National Organic Program—to consider a petition for required nutrients as defined by the National Research Council in the National Academy of Science's Nutrient Requirements of Dogs and Cats.

That decision is consistent with the information supplied to the National Organic Program on June 27, 2011 by the U.S. Food and Drug Administration's (FDA) Center for Veterinary Medicine (CVM). In that communication, the FDA stated, "The CVM relies on the various *ad hoc* expert nutrition committees under the Committee on Animal Nutrition of the National Research Council in the National Academy of Sciences for establishment of which nutrients, and in what amounts, are essential in the diets for specific species of domestic animals to meet that species' daily nutrient requirements. For dogs and cats, the required essential nutrients are listed and described in the 2006 edition *of Nutrient Requirements of Dogs and Cats.*¹ The CVM considers the nutrients listed in Tables 15-3,15-5, 15-8, for dogs, and Tables 15-10, 15-12,15-14 for cats, to be essential nutrients and eligible for supplementation if required to meet and provide the listed MR, or in the absence of a stated value for the MR then the listed value for AI for that nutrient, in products represented to be "complete and balanced." (underline added)

Note - The tables referenced above at included with this petition as Attachment D.

State regulators utilize the Official Publication of the Association of American Feed Control Officials (AAFCO) as a model for the regulation of pet food products, including the nutrient

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composition of products eligible to be labeled as "complete and balanced." As explained in the FDA's June 2011 memorandum, "The AAFCO Dog and Cat Food Nutrient Profiles do not contain any nutrient that has not been determined to be essential and listed in the previously referenced tables in the 2006 edition *of Nutrient Requirements of Dogs and Cats.*"

Accordingly, this petition request approval for the addition of amino acids to add a section §205.603(d)(3) stating "For dogs and cats, synthetic amino acids defined as required by the National Research Council of the National Academy of Sciences."

While this petition requests the allowance of those materials as a category—consistent with the language in 205.603(d)(2) and 205.603(d)(3), these amino acids are discussed individually to the extent possible throughout this document.

The importance for consideration of all of these required amino acids cannot be understated. Unlike humans, dogs and cats rely on their daily ration of commerciallyprepared pet food as their sole source of nutrition. The absence of any of these required amino acids will have a serious detrimental effect upon the health of that pet.

1. The substances' common names

This petition covers the category of required amino acids. Amino acids categorized as required by the National Research Council's Nutrient Requirements of Dogs and Cats include all of the following:

- Arginine
- Methionine
- Cysteine
- Lysine
- Taurine
- Tryptophan
- Threonine
- Histidine
- Isoleucine
- Leucine
- Phenylalanine
- Tyrosine
- Valine

2. The official name, address, and telephone number for Pet Food Institute:

Pet Food Institute 2025 M St., NW Suite 800 Washington, D.C. 20036 Tel: 202 367-1120 Fax: 202 367-2120 Website: <u>www.petfoodinstitute.org</u>

Contact Persons:	Nancy Cook, nancy@petfoodinstitute.org
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3. The intended or current use of the substance:

The above-listed amino acids are required in the diets of canine and felines. Without the inclusion of the proper levels of these amino acids, dog and cat food formulations cannot be classified as "complete and balanced" under the guidelines of the American Association of Feed Control Officials (and, which guidelines are based upon the NRC Nutrient Requirements of Dogs and Cats). As mentioned above, State regulators utilize the Official Publication of the Association of American Feed Control Officials (AAFCO) as a model for the regulation of pet food products. Accordingly, commercially-produced pet food products cannot be labeled as "complete and balanced unless those products contain the required amino acids in the minimum (and maximum) levels listed in the tables below:

	A	AAFCO Dog Food Nutrient Profiles			
		Based on Dry Matter			
		Growth &	Adult		
	Units DM	Reproduction	Maintenance		
	Basis	Minimum	Minimum	Maximum	
Arginine	%	0.62	0.51		
Histidine	%	0.22	0.18		
Isoleucine	%	0.45	0.37		
Leucine	%	0.72	0.59		
Lysine	%	0.77	0.63		
Methionine-cystine	%	0.53	0.43		
Phenlyalanine-tryosine	%	0.89	0.73		
Threonine	%	0.58	0.48		
Tryptophan	%	0.20	0.16		
Valine	%	0.48	0.39		

	A	AAFCO Dog Food Nutrient Profiles			
		Based on Ca	Iorie Content	1	
	Units per	Growth &	Adult		
	1000 kcal	Reproduction	Maintenance		
	ME	Minimum	Minimum	Maximum	
Arginine	g	1.77	1.46		
Histidine	g	0.63	0.51		
Isoleucine	g	1.29	1.06		
Leucine	g	2.06	1.69		
Lysine	g	2.20	1.80		
Methionine-cystine	g	1.51	1.23		
Phenlyalanine-tryosine	g	2.54	2.09		
Threonine	g	1.66	1.37		
Tryptophan	g	0.57	0.46		
Valine	g	1.37	1.11		

	AAFCO Cat Food Nutrient Profiles			
		Based on Dry Matter		
		Growth &	Adult	
	Units DM	Reproduction	Maintenance	
	Basis	Minimum	Minimum	Maximum
Arginine	%	1.25	1.04	
Histidine	%	0.31	0.31	
Isoleucine	%	0.52	0.52	
Leucine	%	1.25	1.25	
Lysine	%	1.20	0.83	
Methionine-cystine	%	1.10	1.10	
Methionine	%	0.62	0.62	1.50
Phenlyalanine-tryosine	%	0.88	0.88	
Phenylalanine	%	0.42	0.42	
Threonine	%	0.73	0.73	
Tryptophan	%	0.25	0.16	
Valine	%	0.62	0.62	
Taurine (Dry Food)	%	0.10	0.10	
Taurine (Wet Food)	%	0.20	0.20	

	A	AAFCO Cat Food Nutrient Profiles Based on Calorie Content		
	Units per 1000 kcal	Units per Growth & Adult		
	ME	Reproduction Minimum	Maintenance Minimum	Maximum
Arginine	g	3.10	2.60	
Histidine	g	0.78	0.78	
Isoleucine	g	1.30	1.30	
Leucine	g	3.10	3.10	

Required Amino Acid Organic Petition Information Prepared by Crystal Springs Consulting, Inc. Page 8 of 117

Lysine	g	3.00	2.08	
Methionine-cystine	g	2.75	2.75	
Methionine	g	1.55	1.55	3.75
Phenlyalanine-tryosine	g	2.20	2.20	
Phenylalanine	g	1.05	1.05	
Threonine	g	1.83	1.83	
Tryptophan	g	0.63	0.40	
Valine	g	1.55	1.55	
Taurine (Dry Food)	g	0.25	0.25	
Taurine (Wet Food)	g	0.50	0.50	

These materials are petitioned as a category for use as a synthetic allowed substance under §205.603(d) of the National Organic Standards.

The Organic Pet Food Recommendation unanimously adopted by the NOSB in November 2008 contained an appendix listing materials for possible petition to the National List for use in pet food. That appendix specifically listed the following amino acids for petition as allowed feed additives under §205.603(d):

- l-arginine for pet food (amino acid)
- d-l Methionine for pet food (amino acid)
- Carnitine for pet food (amino acid)
- l-cysteine for pet food (amino acid)
- l-lysine, l-lysine monochloride for pet food (amino acids)
- Taurine for pet food (amino acid)
- l-tryptophan for pet food (amino acid)

Because the absence of even one required amino acid prohibits a pet food product from being labeled as complete and balanced, the National Organic Program and the National Organic Standards Board have consented to consider required amino acids as a categorical addition to the National Organic Standards. Accordingly this petition includes all forms to the required amino acids as identified by the National Research Council and as listed in the Official Publication of AAFCO.

However, the list contained in the Appendix of the National Organic Standards Board recommendation identifies those amino acids that are not readily available from agricultural products used in commercially-manufactured pet food products. The other required amino acids not listed in the NOSB recommendation are available in agricultural products and will not need to be utilized in a synthetic format.

A list of activities for which the substance will be used – mode of action

Activities

Accordingly, these required amino acids will be used as an ingredient in the following products to be manufactured as "organic" or "made with organic:"

- Wet cat food formulations labeled as complete and balanced for adult maintenance, and for growth and reproduction;
- Semi-moist cat food formulations labeled as complete and balanced for adult maintenance, and for growth and reproduction;
- Dry cat food formulations labeled as complete and balanced for adult maintenance, and for growth and reproduction;
- Wet dog food formulations labeled as complete and balanced for adult maintenance, and for growth and reproduction; Semi-moist dog food formulations labeled as complete and balanced for adult maintenance, and for growth and reproduction;
- Dry dog food formulations labeled as complete and balanced for adult maintenance, and for growth and reproduction; and
- Pet Treats.

Mode of Action

Comprised of 23 different amino acids, proteins are often called the "building blocks" of the tissues. The bodies of dogs and cats can manufacture 13 of these amino acids. The other 10 amino acids, however, must come from dietary meat and plant sources and are called the "essential amino acids". The biological value of a protein is a measure of that protein's ability to supply amino acids, particularly the 10 essential amino acids, and to supply these amino acids in the proper proportions.

Additionally, Taurine, Cysteine and Tyrosine, are recognized by the National Research Council as required amino acids. The reasons for inclusion for these three materials are explained in the following sections of the NRC:

Cysteine:

"Cysteine is an important component of proteins for their secondary structure and a major constituent of hair and glutathione. Since methionine serves as a precursor to cysteine, cysteine is a dispensable amino acid. Because cysteine is made only from methionine and can provide about one-half of the total need for sulfur amino acids, cysteine and methionine must both be considered when establishing the total sulfur amino acid requirement. Therefore, the requirements are presented as the MR of methionine when there is excess cysteine in the diet, and the total sulfur amino acid requirement, which can be met with only methionine, but commonly involves a combination of methionine and cysteine. Cysteine cannot be converted to methionine; so the MR of methionine must be met with methionine." (NRC, 2006, Page 126)

Taurine:

"Taurine is a β -aminosulfonic acid (2-aminoethanesulfonic acid), an essential dietary nutrient for cats but dispensable for dogs fed adequate quantities of sulfur-containing

amino acids. Taurine is one of the most abundant free amino acids in mammals, being particularly high in brain, heart, and skeletal muscle. Peak concentrations of taurine occur in the total body of newborns and in neonatal brain and gradually decrease by 75 percent as cats mature, but 10 mmol taurine-kg^{"1} is maintained in several tissues in adult cats (Sturman, 1988)."

"Since taurine does not contain a carboxyl group and is a β -amino acid, it is not found in proteins and is made in most species from cysteine. The synthesis of taurine appears to be severely limiting for strict carnivores, but not for most herbivores or omnivores."

"Taurine deficiency causes a multitude of metabolic aberrations and clinical signs. Taurine is involved in fetal development, growth, reproduction, neuro-modulation, sight, hearing, heart function, osmoregulation, fat emulsification, neutrophil function, immune response, antioxidation, and bile acid and xenobiotic conjugation and acts as an anticonvulsant." (NRC, 2006, Page 134)

Tyrosine:

"Although tyrosine is a dispensable amino acid, it is made in animals only from phenylalanine, and tyrosine spares about one-half of the phenylalanine needed by all species examined including dogs and cats. Thus, it is appropriate to consider the amount of phenylalanine required as the sum of phenylalanine plus tyrosine, provided the level of tyrosine in the diet is not higher than that of phenylalanine. Phenylalanine and tyrosine have not been shown to be the most limiting amino acids for growth or nitrogen balance in diets sufficient in protein or in commercial diets formulated using natural ingredients for dogs and cats." (NRC, 2006, Page 128)

5. The source of the substance and a detailed description of its manufacturing or processing procedures from the basic component(s) to the final product.

Source:

Amino acids are present in all proteins. However, purified proteins or purified amino acids, when fed alone without other food ingredients, cannot maintain dogs and cats in good health.

Manufacturing Process:

There are four general ways to obtain amino acids for commercial use: extraction from natural sources, chemical synthesis, fermentation, and enzymatic catalysis.

Extraction from Natural Sources

In extraction from natural sources the standard procedure is hydrolysis with aqueous acid, followed by capture of the amino acids by passage of the hydrolysate over a strongly acidic ion exchange resin. After the resin is washed with water, elution with aqueous ammonia frees the amino acids, which are collected in fractions. Extraction is the most

economical process for the production of both (S)-tyrosine and (R,R)-cystine. Reduction of (R,R)-cystine gives (R)-cysteine. (Journal of Chemical Education, 2004)

Chemical Synthesis

The advantage of a chemical synthesis is that it can be carried out on a very large scale, and often in a continuous way. The great disadvantage, however, is that it typically gives a racemic mixture of the enantiomeric forms of the amino acid. Thus the product of a chemical synthesis must be resolved into the R and S forms, followed by recovery and recycling via racemization of the undesired enantiomer.

An example of a chemical synthesis is provided by the preparation of (R,S)-methionine. Since both the R and S isomers of methionine can be metabolized by poultry and swine, resolution is not necessary and, in contrast to most other amino acids, chemical synthesis is predominant for the industrial production of methionine, as well as for racemic alanine and glycine.

The first step of the chemical synthesis of methionine is the conjugate addition of methyl mercaptan to acrolein to give β -methylthiopropionaldehyde.

The addition of methyl mercaptan to acrolein takes place by a nucleophilic mechanism. Attack of the conjugate base of methyl mercaptan (pKa = 10.7) gives a resonance-stabilized anion, which then accepts a proton on carbon to give the addition product, β -methylthiopropionaldehyde.

 β -Methylthiopropionaldehyde is then converted to methionine by the Bucherer method, a modification of the Strecker method in which ammonium carbonate takes the place of ammonia. (Journal of Chemical Education, 2004)

Fermentation Methods

Although it is possible to prepare any natural amino acid by fermentation, a microbiological process, the special mutants that allow production to be done on a large scale have been developed only for the preparation of (S)-lysine and (S)-glutamic acid. The carbon sources for these syntheses are typically cane or beet molasses, raw sugar, or a starch hydrolysate. Ammonia is the source of nitrogen, and oxygen is provided by passing compressed air into the fermenting mixture.

An early fermentation process for the production of lysine made use of a pair of *E. coli* mutants. Normal *E. coli* can synthesize its own lysine from carbohydrates and ammonia, but the first mutant lacked the α, ε - diaminopimelic decarboxylase that normally converts α, ε --diaminopimelic acid (DAP) to lysine.

After the concentration of DAP had reached a maximum in the presence of the first mutant, the first mutant was removed and another *E. coli* strain was added. This second mutant produced DAP decarboxylase, but lacked lysine decarboxylase, thus allowing lysine to accumulate.

A second method for the production of lysine is a single stage fermentation process, now generally used for the microbial synthesis of lysine. This process makes use of a mutant of *Corynebacterium glucamicum* in which feedback mechanisms of product inhibition are overcome. Molasses is the most common carbon source, and this contains sufficient biotin to provide the more than 30 μ g/L needed to suppress the excretion of glutamic acid. (Journal of Chemical Education, 2004)

All amino acids may be produced by fermentation. Whether they will or not depends on the costs of competing technologies such as chemical synthesis or extraction from protein sources. (holisticmed.net, 2003)

The fermentation method has the advantage of mass production at low cost, which was the great impetus for expanding the amino acid market. The manufacturing method of glutamate shifted from the extraction method to the fermentation method in the 1960s. Subsequently, a similar shift to the fermentation method took place for the other amino acids in rapid succession. (Ajinomoto, 2011)

Enzymatic Synthesis of Amino Acids

In the fourth method for synthesis of amino acids, the enzymatic procedures, pure enzymes are used, rather than the enzyme systems of living microorganisms, as in the fermentation methods.

At one time, for example, (*S*)-aspartic acid was produced mainly by the enantioselective, enzyme-catalyzed, addition of ammonia to fumaric acid, a substance that could be sup plied in large quantities and at low cost.

Since only the naturally occurring isomer of aspartic acid was formed, resolution was not necessary. This method has since been supplanted by a continuous microbiological process in which the reacting solution passes over a fixed bed of an immobilized microorganism. (Journal of Chemical Education, 2004)

Choosing between processes depends on available technology, costs of raw material, market prices and sizes, cost of running fermentation versus synthesis reactions, and the environmental impact of the process itself. (holisticmed.net)

	SOURCES OF SIGNIFICANT PRODUCTION			
		Chemical		Enzyme
Amino Acid	Extraction	Synthesis	Fermentation	Catalyst
Arginine	Y		Υ	
Cystine		Y		Y
Histidine			Υ	
Isoleucine			Y	
Leucine	Y		Y	
Lysine	Y		Υ	
Methionine				Y
Phenylalanine		Y	Y	Y
Proline			Υ	
Threonine		Υ	Υ	
Tryptophan		Y	Υ	Y
Tyrosine	Y		Υ	
Valine		Y	Υ	
Source: Journal of	Chemical Educ	cation, 2004		

Synthesis of Amino Acids

Note: The following information was produced by Timothy Paustian, of the University of Wisconsin-Madison

The amino acids synthesis pathways can be grouped into several logical units. These units reflect either common mechanisms or the use of common enzymes that synthesize more than one amino acid. These categories are: simple reactions, branch chain amino acids, aromatic amino acids, threonine/lysine, serine/glycine, and unique pathways. The aromatic amino acids, threonine/lysine and serine/glycine pathways have a common beginning and then diverge to form the amino acid of interest.

Notice that each pathway begins with a central metabolite or something derived from "central metabolism". Using common compounds instead of synthesizing them from scratch saves energy and conserves genes since fewer enzymes are needed to code for the pathways.

Simple Reactions

glutamine, glutamate, aspartate, asparagine and alanine

In most cases these amino acids can be synthesize by one step reactions from central metabolites. They are simple in structure and their synthesis is also straight forward. Glutamate can by synthesized by the addition of ammonia to α -ketoglutarate.

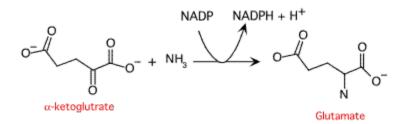


Figure 1 - The synthesis of glutamate

Glutamine is made by the addition of another ammonia molecule to glutamate.

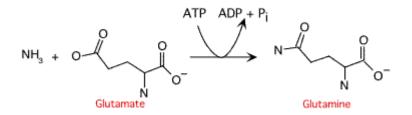


Figure 2 - Synthesis of glutamine

The rest of the simple reactions involve transfer of the amino group (transamination) from glutamate or glutamine to a central metabolite to make the required amino acid. Aspartate is synthesize by the transfer of a ammonia group from glutamate to oxaloacetate.

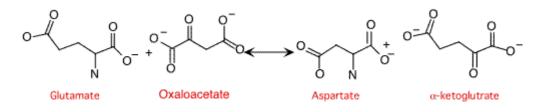
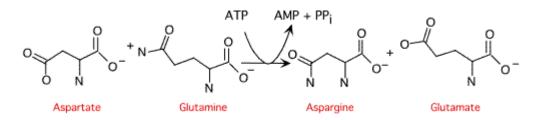


Figure 3 - The synthesis of aspartate

Asparagine is made either by transamination from glutamine or by adding ammonia directly to aspartate.



or

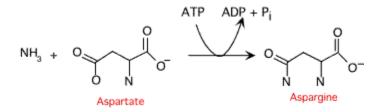


Figure 4 - Formation of asparagine. Notice the use of AMP instead of ADP in this reaction. This releases more energy which is needed to drive the synthesis.

Alanine synthesis is a bit of a mystery. Several reactions have been identified, but it has been impossible to generate an alanine auxotroph and therefore positively identify a required pathway. There are several pathways and the most likely is formation of alanine by transamination from glutamate onto pyruvate. A transamination using value instead of glutamate is also possible.

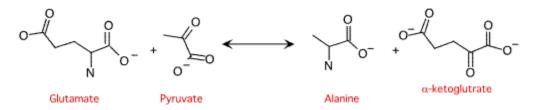


Figure 5 - Synthesis of alanine

Threonine/lysine

Synthesis of threonine and lysine begins by the conversion of oxaloacetate to aspartate semialdehyde. This shared pathway costs one ATP and two NADPH + H^+ Threonine biosynthesis is completed in three steps. First a second reduction with NADPH + H^+ , yields homoserine. This is phosphorylated to homoserine phosphate by ATP and finally converted into threonine.

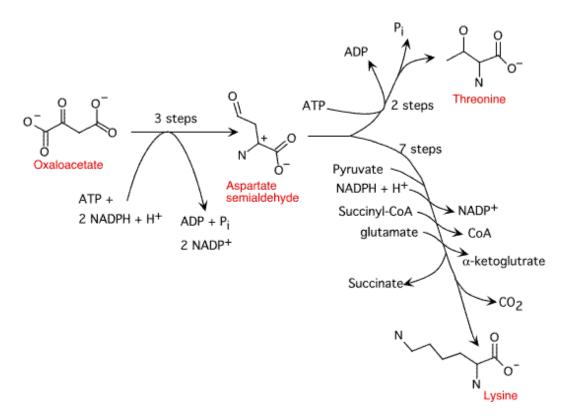


Figure 6 - Synthesis of Threonine and Lysine. Note the amount of energy that is expended in these biosytheses.

The synthesis of lysine has been found to consist of different reactions in different bacterial species. A somewhat generalize pathway is presented. Lysine synthesis involves the addition of pyruvate to aspartate semialdehyde, the use of a CoA intermediate (either acetyl CoA or succinyl-CoA) and the addition of an amino group from glutamate. The group added from CoA (either succinyl or acetyl) serves as a blocking group, protecting the amino group from attack during transamination by glutamate. NADPH + H⁺ is required for reduction in the second step of the pathway.

leucine, isoleucine and valine

Examination of the isoleucine pathway versus the valine pathway demonstrates that the only difference is the substitution of an ethyl group instead of a methyl group to the α -carbon of the intermediates. The intermediates are so similar that common enzymes catalyze four steps of each pathway. Isoleucine synthesis begins with threonine, which is deaminated to α -ketobutyrate. From here the 4 step synthesis costs one NADPH + H⁺ per amino acid synthesized.

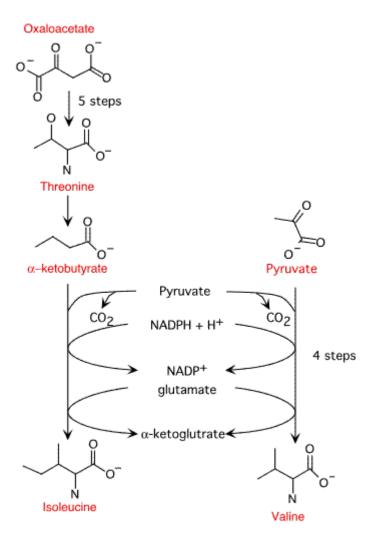


Figure 7 - Synthesis of valine and isoleucine.

Leucine biosynthesis starts off with the last intermediate in the valine synthesis, α -ketoisovalerate. In the first step Acetyl-CoA is used to add an acetyl group to the molecule. Electrons are transferred to NAD⁺ (note these can be used for other cellular processes) and one carbon is lost in the form of CO₂ at the fourth step of the pathway. In the final step, the amine from glutamate is added to α -ketoisocaproate to form leucine.

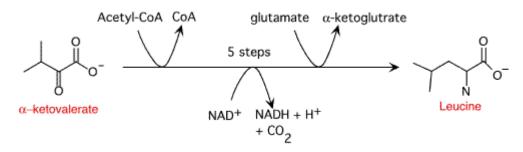


Figure 8 - Synthesis of leucine

tryptophan, phenylalanine and tyrosine

Synthesis of the aromatic amino acids begins with the synthesis of chorismate - an important intermediate for many biosynthetic pathways. Phosphoenol pyruvate and erythrose 4-phosphate serve as beginning substrates for the pathway. A price of one NADPH + H^+ and one ATP is exacted for every chorismate formed. In the sixth step of the synthesis another phosphoenol pyruvate molecule is added to the growing molecule.

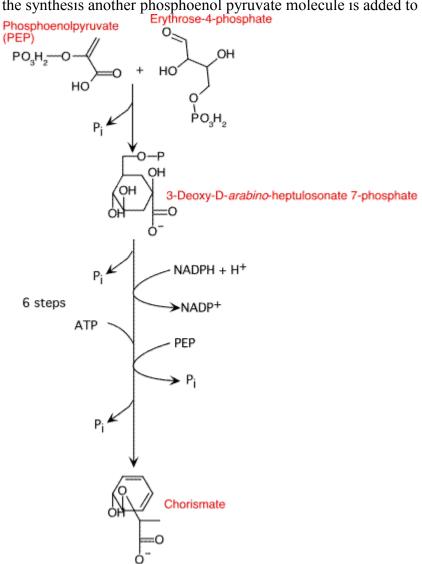


Figure 9 - Synthesis of chorismate

Phenylalanine

Chorismate is converted to phenylpyruvate in two steps and phenylalanine is synthesized by a transamination reaction with glutamate. No energy is required to run these reactions.

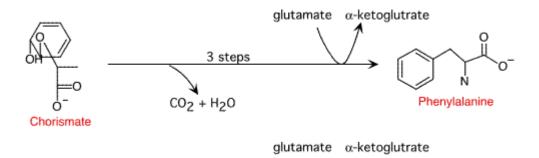


Figure 10 - Synthesis of phenylalanine

Tyrosine

The synthesis of tyrosine is very similar to the synthesis of phenylalanine, but the reactions are carried out by different enzymes under different regulatory control. NADH is created in the formation of 4-hydroxyphenylpyruvate. Tyrosine is made by a similar transamination reaction as that seen in phenylalanine synthesis.

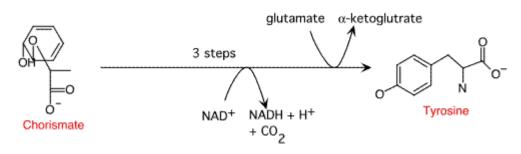


Figure 11 - Synthesis of tyrosine

Tryptophan

Trytophan synthesis is complex and involves 5 steps from chorismate. Glutamate donates an amine group in the first step of the pathway and pyruvate is lost from chorismate. In the next three steps a ribose sugar is added, this eventually contributes to the 5 membered ring of tryptophan. Energy is contributed to the process in the form of hydrolysis of pyrophosphate. This hydrolysis helps drive the addition of the ribose sugar in the second step of the reaction. In the last step of the pathway serine serves as the donor of the α carbon amino group of tryptophan.

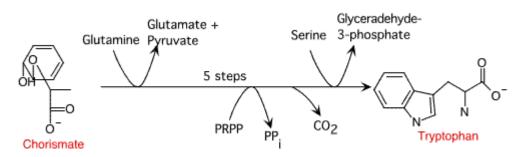


Figure 12 - Synthesis of tryptophan

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Unique pathways

cysteine, methionine, histidine and arginine

These pathways involve something unusual, either the structure of the amino acid is different enough than the other common amino acids, or sulfur is involved in their synthesis. In any case, unique enzymes are involved in every step of the way. Here we just examine what they start with and how much it costs the cell.

Cysteine

Synthesis of cysteine is a two step reaction. Serine and acetyl-CoA combine to form *O*-acetylserine. Sulfide from sulfur assimilation is then added to *O*-acetylserine to form cysteine. The pathway for cysteine synthesis was covered in sulfate assimilation.

Methionine

Methionine is synthesized from oxaloacetate. Succinyl-CoA participates and cysteine donates a sulfur group to the molecule. Oxaloacetate is first converted into homoserine as described above in the threonine biosynthetic pathway. Homoserine then has a sulfur attached to the end in two steps and finally methionine is formed by the addition of a methyl group.

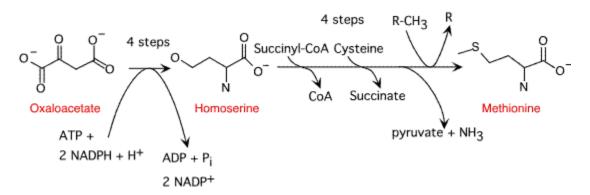


Figure 13 - Synthesis of methionine. The donor of the methyl group (R) is a methyl carrier in the cell, N^5 , N^{10} -Methylene terahydropteroyl.

Histidine

The synthesis of histidine is long and complex and its pathway is intertwined with nucleic acid biosynthesis (specifically purine). The pathway seems to be universal in all organisms able to synthesize histidine. The first five steps of the pathway take ribose from phosphoribosyl pyrophosphate (PRPP) and transform it into Imadiazoleglycerol phosphate. Once the imadiazole ring is formed, glutamate donates the α -amino group and the newly formed amine is oxidized to histidine in the last step of the pathway. Energy is required in the form of ATP (in this case elements of the ATP molecule actually becomes part of the amino acid) and pyrophosphate which is lost from phosphoribosyl pyrophosphate and ATP help drive the reaction.

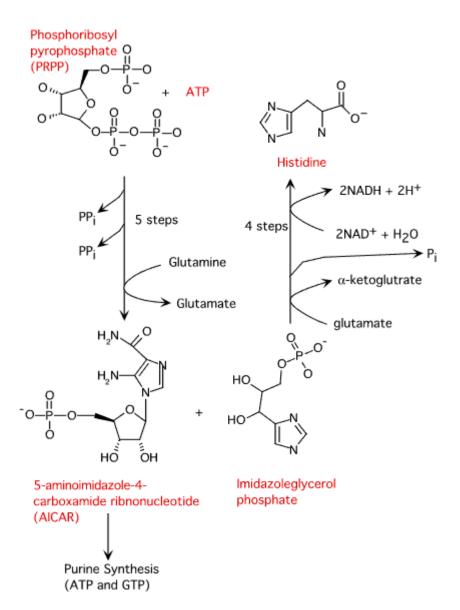


Figure 14 - Synthesis of Histidine

Investigations into histidine biosynthesis have yielded many insights into microbial metabolism that have contributed greatly to our understanding of how cells function at the genetic and biochemical level. Work in this area is still yielding important results.

Arginine

Synthesis of arginine is an eight step process starting with the amino acid glutamate. Two ATP and one NADPH $+ H^+$ are utilized to synthesize each arginine.

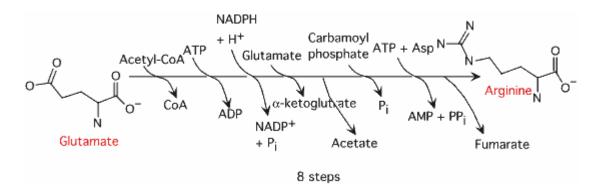


Figure 15 - Synthesis of arginine

Taurine

Taurine was first isolated from ox bile in 1827 by German scientists Fredrich Tiedemann and Leopold Gmelin. The name, taurine, is a derivative of the Latin term, taurus.

Taurine occurs naturally in food, especially in seafood and meat, and it is a normal metabolite in humans. It is a metabolic product of sulphur-containing amino acids, and it is mainly biosynthesized from cysteine in the liver (SCF, 1999).

Today, a small amount taurine is still derived from bovine and ovine sources. This natural taurine, however, is essentially a by-product from the production of cholic acid, deoxycholic acid and other bile acids, and is therefore available in extremely limited supplies. New Zealand Pharmaceuticals, Ltd., for example, produces 800 tons of bile acids each year from oxen, cattle and sheep bile. Of that amount, only 20 tons consists of taurine for all markets.

Most taurine today is synthesized from methionine, Vitamin E and cysteine.

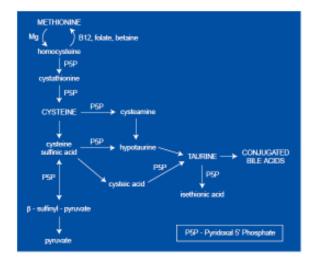


Figure 16 - Synthesis of taurine

Commercial Suppliers:

Many companies commercially supply required amino acids as ingredients for livestock feed and pet food. Major suppliers include—but are not limited to—the following companies:

Ajinomoto Heartland LLC 8430 West Bryn Mawr Avenue, Suite 650, Chicago, IL 60631-3421 Tel: +1 (773) 380-7000 Fax: +1 (773) 380-7006

Changshu Yudong Chemical Company Wangshi Haiyu Town Changshu City Jungshu Province, China PC 215519 Tel +86-512-52565808 Fax +86-512-52561808 E-mail: yonglida@public1.sz.js.cn Website: www.yudongchem.com

Qianjiang Yongan Pharmaceutical Co., LTD No. 16 Zhuze Road Qianjiang, China Tel: + 86-728-6202727/6201636 Fax: +86-728-6202797 E-mail: <u>yasales@chinataurine.com</u> Website: <u>www.chinataurine.com</u>

Changshu Yudong Chemical Company Wangshi Haiyu Town Changshu City Jungshu Province, China PC 215519 Tel +86-512-52565808 Fax +86-512-52561808 E-mail: yonglida@public1.sz.js.cn Website: www.yudongchem.com

Zone Industrielle Grasbesch L-3370 Leudelange G.D. de Lusombourg Tel: +352-49-89-770 Fax: +352-49-89-771 Email: <u>sales@taurinepffg.com</u> Website: <u>www.taurinepffg.com</u> New Zealand Pharmaceuticals Ltd. Po Box 1869, Palmerston North, 4440, New Zealand +64 6 9523840 <u>market@nzp.co.nz</u> <u>www.nzp.co.nz</u>

6. A summary of any available previous reviews by State or private certification programs or other organizations of the petitioned substance

These required amino acids not been previously petitioned, but has been allowed for use in pet food products certified as "organic", or" made with organic," since October 2002.

Following the 2004 directive by NOP that pet food products could be certified under 7 CFR § 205.605 and §205.606, certifiers have relied upon the guidance from the NOP regarding the use of taurine and other required nutrients for pet food products. In November 2006, the NOP issued a notice in response to a complaint, reading, in part:

"The complaint that resulted in the opening of this case questioned the use of the nutrients docosahexenoic acid (DHA) and arachidonic acid (ARA) in an organic (redacted). The resulting investigation led to questions concerning the use of the nutrients, nucleotides and <u>taurine</u>. FDA permits the use of all four in (redacted). Accordingly, provided the nutrients in question are in full compliance with FDA rules and regulations, they would comply with the NOP National List as currently written." (underline added)

The 2006 notice established a basis for including amino acids (sometimes referred to as "accessory nutrients" in human food) under the materials allowed to be included in certified organic food under §205.605(b) "*Nutrient vitamins and minerals, in accordance with 21 CFR 104.20, Nutritional Quality Guidelines For Foods.*"Certifiers relied upon this guidance as approval for allowing the use of required nutrients in pet food products certified as "organic" and "made with organic."

In early 2010, the USDA National Organic Program issued a memorandum to certifiers specifying that 21 CFR 104.20 covered only vitamins and minerals, and thus could not be utilized as justification for including amino acids and other nutrients in certified organic food products. The NOP has subsequently issued a directive outlining a transition period for enforcement of the new interpretation.

In addition, the NOSB in November 2008 unanimously adopted a recommendation regarding changes in the organic regulations to support labeling of organic pet food. The NOP is currently developing proposed regulations based upon the 2008 NOSB recommendation. As recommended by the NOSB, §205.603 would be amended to

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include the synthetic substances allowed for use in organic pet food. §205.603 already includes allowances for the inclusion of vitamins and trace minerals in certified organic livestock production.

7. Information regarding EPA, FDA, and State regulatory authority registrations, including registration numbers

U.S. Environmental Protection Agency (EPA)

The U.S. Environmental Protection Agency does not regulate amino acids, so these materials are not listed on the EPA List 4 list of inert pesticide ingredients.

U.S. Food and Drug Administration (FDA)

The federal regulations, enforced by the United States Food and Drug Administration (FDA), establish standards applicable for all animal feeds: proper identification of product, net quantity statement, manufacturer's name and address, and proper listing of ingredients. (FDA, 2010)

The regulatory role of the U.S. Food and Drug Administration in the area of required amino acids was addressed in a June 27, 2011 letter from FDA's Center for Veterinary Medicine to the Standards Division of the USDA National Organic Program.

In that letter, CVM states: "The Center for Veterinary Medicine (CVM) is the Center within FDA that has regulatory authority over animal feeds and the ingredients used to formulate animal feed products. For animal feeds, including foods for dogs and cats, the CVM has not established or promulgated any minimum requirements (MR), adequate intakes (AI), recommended allowances (RA) or other reference standards for daily nutrient intakes for any particular nutrient. The CVM relies on the various *ad hoc* expert nutrition committees under the Committee on Animal Nutrition of the National Research Council in the National Academy of Sciences for establishment of which nutrients, and in what amounts, are essential in the diets for specific species of domestic animals to meet that species' daily nutrient requirements. For dogs and cats, the required essential nutrients are listed and described in the 2006 edition *of Nutrient Requirements of Dogs and Cats.*¹ The CVM considers the nutrients listed in Tables 15-3,15-5, 15-8, for dogs, and Tables 15-10, 15-12, 15-14 for cats, to be essential nutrients and eligible for supplementation if required to meet and provide the listed MR, or in the absence of a stated value for the MR then the listed value for AI for that nutrient, in products represented to be "complete and balanced."

State Regulatory Authority

Most states also enforce their own labeling regulations under their state feed laws. States commonly adopt model pet food regulations established by the Association of American Feed Control Officials (AAFCO). These regulations are more specific in nature, covering aspects of labeling such as the product name, the guaranteed analysis, the nutritional adequacy statement, feeding directions, and calorie statements. (FDA, 2010). Within the pet food industry, the Dog and Cat Food Nutrient Profiles listed in the Official Publication of AAFCO is widely recognized as the definitive source of information regarding nutritional adequacy in pet food products.

As explained in the FDA CVM June 27, 2011 letter, however, the FDA relies upon the Committee on Animal Nutrition of the National Research Council as the definitive source of information regarding the nutritional requirements of dogs and cats:

"The AAFCO Dog and Cat Food Nutrient Profiles do not contain any nutrient that has not been determined to be essential and listed in the previously referenced tables in the 2006 edition of *Nutrient Requirements of Dogs and Cats*. The 2006 edition *of Nutrient Requirements of Dogs and Cats* contains some additional specific fatty acids as essential required nutrients for specific life stages of dogs and cats that are not currently listed in the AAFCO Dog and Cat Food Nutrient Profiles. The AAFCO Dog and Cat Food Nutrient Profiles are presently under consideration for revision, but what the specific revisions will be cannot be stated at this time. As previously indicated, FDA CVM relies on the Committee on Animal Nutrition of the National Research Council in the National Academy of Sciences for establishment of which nutrients are essential in the diets of animals, not the AAFCO Dog and Cat Food Nutrient Profiles."

The required amino acids are recognized as GRAS under the following sections of 21 CFR

- Arginine §582.5145
- Methionine §582.5475
- Cysteine §582.5271
- Taurine §573.980
- Tryptophan §582.5915
- Threonine §582.5881
- Histidine §582.5361

- Phenylalanine §582.5590
- Tyrosine §582.5920
- Valine §582.5925

All amino acids referenced in 21 CFR §582, except Methionine and Cysteine, are declared GRAS for both the L- and DL- form. For methionine, §582.5475 makes no reference to L- or DL form. Cysteine is declared GRAS for L- form only

U.S. Department of Agriculture (USDA)

Amino acids in animal feed are not specifically regulated by the U.S. Department of Agriculture.

Clean Air Act

These required amino acids to not contain any hazardous air pollutants. These amino acids to not contain any Class 1 Ozone depletors, nor do they contain any Class 2 Ozone depletors.

Clean Water Act

These amino acids are not listed as Hazardous Substances under the CWA, nor is it listed as Priority or Toxic Pollutants under the CWA.

OSHA

These amino acids are not considered highly hazardous by OSHA.

8. The Chemical Abstract Service (CAS) number or other product numbers of the substance and labels of products that contains the petitioned substance

Chemical Abstract Numbers

Common Name	L- CAS No.	DL- CAS No.	Other
Arginine	74-79-3		
Methionine	63-68-3	59-51-8	
Cysteine	52-90-4		
Lysine	56-87-1	70-54-2	
Taurine			107-35-7
Tryptophan	73-22-3	54-12-6	
Threonine	72-19-5	80-68-2	
Histidine	71-00-1	4998-57-6	
Isoleucine	73-32-5	328-39-2	
Leucine	61-90-5	328-39-2	
Phenylalanine	63-91-2	150-30-1	
Tyrosine	60-18-4	556-03-6	
Valine	72-18-4	516-06-3	

Labels of Products

Attachment A contains actual ingredient labels from current conventional and certified "Made with Organic" products in the marketplace.

9. The substance's physical properties and chemical mode of action

Physical Properties

Arginine

Molecular Formula:	$C_6H_{14}N_4O_2$	NH O
Molecular Weight:	174.203 g/mol	H ₂ N N OH
Cas Number:	L - 74-79-3	NH ₂

Methionine

Molecular Formula:	$C_5H_{11}NO_2S$	Q
Molecular Weight:	149.214 g/mol	нас Я ОН
Cas Numbers:	L – 63-68-3	NH ₂
	DL – 59-51-8	£

Cysteine

Molecular Formula:	$C_3H_7NO_2S$	0 0
Molecular Weight:	121.16 g/mol	H ₂ N
Cas Number:	L- 52-90-4	
		`SH

Lysine

Molecular Formula:	$C_6H_{14}N_2O_2$	ОН
Molecular Weight:	146.189 g/mol	
Cas Numbers:	L- 56-87-1	
	DL- 70-54-2	NH ₂

<u>Taurine</u>

Molecular Formula:	$C_2H_7NO_3S$	0
Molecular Weight:	125.149 g/mol	
Cas Number:	107-35-7	HO M NH ₂
		0

<u>Tryptophan</u>

Molecular Formula:	$C_{11}H_{12}N_2O_2$	
Molecular Weight:	204.229 g/mol	ОН
Cas Numbers:	L- 73-22-3	
	DL- 54-12-6	

Threonine

Molecular Formula:	$C_4H_9NO_3$	OH O
Molecular Weight:	119.12 g/mol	н _з с н
Cas Numbers:	L- 72-19-5	NH ₂
	DL- 80-68-2	

<u>Histidine</u>

Molecular Formula:	$C_6H_9N_3O_2$	Q
Molecular Weight:	155.156 g/mol	N OH
Cas Numbers:	L- 71-00-1	
	DL- 4998-57-6	HN N ¹¹ 2

Isoleucine

Molecular Formula:	$C_6H_{13}NO_2$	ÇH₃ O
Molecular Weight:	131.175 g/mol	H ₃ C
Cas Numbers:	L- 73-32-5	I ⊂… NH₂
	DL- 328-39-2	2

Leucine

Molecular Formula:	$C_6H_{13}NO_2$	\
Molecular Weight:	131.175 g/mol	H
Cas Numbers:	L- 61-90-5	H ₂ N OH
	DL- 328-39-2	0

Phenylalanine

$C_9H_{11}NO_2$	0 II
165.192 g/mol	
L- 63-91-2	NH ₂
DL- 150-30-1	· ·
	Q
181.191 g/mol	NH ₂ OH
L- 60-18-14	
DL- 556-03-6	
$C_5H_{11}NO_2$	
117.148 g/mol	H
	165.192 g/mol L- 63-91-2 DL- 150-30-1 C9H11NO3 181.191 g/mol L- 60-18-14 DL- 556-03-6 C9H11NO2

Characteristics

Cas Numbers:

With the exception of proline, all amino acids present in most proteins are α -amino acids and have α -amino and α -carboxyl groups, both of which are involved in the peptide bonds that are essential for protein structure.

L- 72-18-4

DL- 516-06-3

Chemical Mode of Action

Each amino acid has a side chain on the α -carbon that ranges in size from a hydrogen atom to an indole ring. The various side chains contribute to the secondary and tertiary structure of protein, and several are often conjugated to various other groups, such as phosphate and amino sugars. Also of nutritional importance are the acidic and basic side chains in proteins that can accept or donate protons, depending on the pH of the medium in which the protein is present. Acid-precipitated proteins (e.g., casein) have protons added to the car-boxyl group side chains. These protons, together with those on the basic side chains, are released during digestion, absorption, and utilization and contribute to metabolic acido-sis. Amino acids are important in providing building blocks for many important biologically active compounds plus countless peptides and proteins.

Chemical interactions with other substances, especially substances used in organic production

There is no evidence of negative interaction with substances used in organic production.

Toxicity and environmental persistence

In humans, symptoms of amino acid toxicity are damage to kidneys. Consuming large amounts of amino acids, increases the levels of these compounds in the bloodstream. As a result, kidneys must filter high quantities of compounds out of the blood, which can cause kidney strain over time. An amino acid overdose can also have a negative effect on the liver. Amino acid metabolism releases ammonia, a toxic compound. Very high doses of amino acids can lead to a temporary buildup in ammonia in the liver, which can prove harmful.

Here is the specific toxicity information for the required amino acids encompassed in this petition:

Arginine

Toxicity to Animals: LD50: Not available. LC50: Not available.

Chronic Effects on Humans: MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells.

Other Toxic Effects on Humans: Slightly hazardous in case of skin contact (irritant), of ingestion, of inhalation.

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: May affect genetic material. Some Laboratory experiments have resulted in mutagenic effects. Although some dietary studies in animals have demonstrated that arginine deficiency can impair reproductive organ development as well as having adverse effects on gestation and lactation, we did not locate any literature on possible adverse reproductive effects of supplemental arginine during human pregnancy.

Special Remarks on other Toxic Effects on Humans: Acute Potential Health Effects: Skin: May cause skin irritation. Eyes: May cause eye irritation. Inhalation: May cause respiratory tract irritation. Ingestion: May cause gastrointestinal tract irritation with nausea, vomiting, and diarrhea. The toxicological properties of this substance have not been fully investigated.

Methionine

Toxicity to Animals: LD50: Not available. LC50: Not available. **Chronic Effects on Humans:** Not available.

Other Toxic Effects on Humans: Hazardous in case of skin contact (irritant), of ingestion, of inhalation.

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: Passes through the placental barrier in animal.

Cysteine

Toxicity to Animals: Acute oral toxicity (LD50): 660 mg/kg [Mouse]. **Chronic Effects on Humans:** The substance is toxic to lungs, mucous membranes. **Other Toxic Effects on Humans:** Hazardous in case of skin contact (irritant), of ingestion, of inhalation. Slightly hazardous in case of skin contact (permeator). **Special Remarks on Toxicity to Animals:** Not available. **Special Remarks on Chronic Effects on Humans:** Not available.

Lysine

Toxicity to Animals: Acute oral toxicity (LD50): 10000 mg/kg [Rat].

Chronic Effects on Humans: Not available.

Other Toxic Effects on Humans: Slightly hazardous in case of skin contact (irritant), of ingestion, of inhalation.

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: Not available.

Special Remarks on other Toxic Effects on Humans: Acute Potential Health Effects: Skin: May cause skin irritation. Expected to be a low hazard. Eyes: May cause eye irritation.

Expected to be a low hazard. Inhalation: May cause respiratory tract irritation. Expected to be a low hazard Ingestion:

Expected to be a how hazard. Ingestion of large amounts may cause gastric disturbances. It may affect behavior (ataxia), respiration (dyspnea).

Taurine

Toxicity to Animals: Acute oral toxicity (LD50): >5000 mg/kg [Rat].

Chronic Effects on Humans: Not available.

Other Toxic Effects on Humans: Slightly hazardous in case of skin contact (irritant), of ingestion, of inhalation.

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans:

May cause adverse reproductive effects and birth defects (teratogenic) based on animal test data. May affect genetic material (mutagenic)

Special Remarks on other Toxic Effects on Humans:

Acute Potential Health Effects: Skin: May cause skin irritation. Eyes: May cause eye irritation. Inhalation: May cause respiratory tract irritation. Ingestion: May cause digestive tract irritation. The toxicological properties of this substance have not been fully investigated. May also affect behavior (somnolence,), metabolism.

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Tryptophan

Toxicity to Animals: LD50: Not available. LC50: Not available.
Chronic Effects on Humans: Not available.
Other Toxic Effects on Humans: Hazardous in case of ingestion. Slightly hazardous in case of inhalation.
Special Remarks on Toxicity to Animals: Not available.
Special Remarks on Chronic Effects on Humans: Not available.

Threonine

Toxicity to Animals: LD50: Not available. LC50: Not available.

Chronic Effects on Humans: Not available.

Other Toxic Effects on Humans: Hazardous in case of ingestion, of inhalation. Slightly hazardous in case of skin contact (irritant).

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: Passes through the placental barrier in human.

Histidine

Toxicity to Animals: Acute oral toxicity (LD50): 15000 mg/kg [Mouse].

Chronic Effects on Humans: The substance is toxic to lungs, mucous membranes. **Other Toxic Effects on Humans:** Hazardous in case of ingestion, of inhalation. Slightly hazardous in case of skin contact (irritant).

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: Passes through the placental barrier in human.

Isoleucine

Toxicity to Animals: LD50: Not available. LC50: Not available.

Chronic Effects on Humans: Not available.

Other Toxic Effects on Humans: Very hazardous in case of ingestion. Hazardous in case of skin contact (irritant, permeator), of inhalation.

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: Passes through the placental barrier in human.

Leucine

Toxicity to Animals: LD50: Not available. LC50: Not available. **Chronic Effects on Humans:** Not available. **Other Toxic Effects on Humans:** Extremely hazardous in case of inhalation. Very hazardous in case of ingestion. Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: Passes through the placental barrier in animal.

Phenylalanine

Toxicity to Animals: LD50: Not available. LC50: Not available.
Chronic Effects on Humans: Not available.
Other Toxic Effects on Humans: Hazardous in case of ingestion, of inhalation. Slightly hazardous in case of skin contact (irritant).
Special Remarks on Toxicity to Animals: Not available.
Special Remarks on Chronic Effects on Humans: Not available.

Tyrosine

Toxicity to Animals: LD50: Not available. LC50: Not available.

Chronic Effects on Humans: Not available.

Other Toxic Effects on Humans: Hazardous in case of ingestion, of inhalation. Slightly hazardous in case of skin contact (irritant).

Special Remarks on Toxicity to Animals: LD50 [Mouse] - Route: Intraperitoneal; Dose: >1450 mg/kg

Special Remarks on Chronic Effects on Humans: May affect genetic material (mutagenic). May cause adverse reproductive effects and birth defects (teratogenic) based on animal test data. No human data has been found.

Special Remarks on other Toxic Effects on Humans: Acute Potential Health Effects: Skin: May cause skin irritation Eyes: May cause eye irritation Inhalation: Dust may cause respiratory tract irritation. Ingestion: May cause digestive tract irritation. Ingestion of large (toxic) amounts may also affect the liver, cause corneal disease, keratitis, tachycardia and hypertension or bradycardia and hypotension. Chronic Potential Health Effects: Ingestion: Prolonged or repeated ingestion may affect the urinary system, blood, and behavior. Skin: Prolonged or repeated contact may cause dermatitis.

Valine

Toxicity to Animals: LD50: Not available. LC50: Not available.

Chronic Effects on Humans: Not available.

Other Toxic Effects on Humans: Hazardous in case of ingestion. Slightly hazardous in case of skin contact (irritant), of inhalation.

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: Passes through the placental barrier in human.

Environmental impacts from its use or manufacture;

Use:

There is no evidence of negative environmental impact from the use of essential amino acids in pet food. Excess amino acids are excreted from pets—as in other mammals, as a component of nitrogen in urine. In cows, for example, free amino acids comprise 1.3 percent of the nitrogen component in urine. (Bristow, 1992)

Because most pet foods are complete and balanced, there should be minimal impact on the environment.

Arginine

Ecotoxicity: Not available.
BOD5 and COD: Not available.
Products of Biodegradation: Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.
Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.

Methionine

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:

Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are more toxic.

Cysteine

Ecotoxicity: Not available. BOD5 and COD: Not available. Products of Biodegradation: Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise. Toxicity of the Products of Piedegradation: The products of degradation are more

Toxicity of the Products of Biodegradation: The products of degradation are more toxic.

Lysine

Ecotoxicity: Not available. **BOD5 and COD:** Not available. **Products of Biodegradation:**

Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.

Taurine

Ecotoxicity: Not available.
BOD5 and COD: Not available.
Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.
Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.

Tryptophan

Ecotoxicity: Not available.
BOD5 and COD: Not available.
Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.
Toxicity of the Products of Biodegradation: The products of degradation are more toxic.

Threonine

Ecotoxicity: Not available. BOD5 and COD: Not available. Products of Biodegradation: Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are more toxic.

Histidine

Ecotoxicity: Not available. BOD5 and COD: Not available. Products of Biodegradation: Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are more toxic.

Isoleucine

Ecotoxicity: Not available. **BOD5 and COD:** Not available.

Products of Biodegradation:

Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are more toxic.

Leucine

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:

Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are more toxic.

Phenylalanine

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:

Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are more toxic.

Tyrosine

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:

Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.

Valine

Ecotoxicity: Not available. **BOD5 and COD:** Not available.

Products of Biodegradation:

Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are more toxic.

<u>Manufacture</u>

As mentioned in Section 5, amino acids are typically synthesized through one of four processes: Extraction from natural sources; Chemical synthesis Fermentation; and Enzymatic synthesis.

Effects on human health

As in dogs and cats, amino acids are an important part of the human nutritional intake.

Amino acids are critical to life, and have many functions in metabolism. One particularly important function is to serve as the building blocks of proteins, which are linear chains of amino acids. Amino acids can be linked together in varying sequences to form a vast variety of proteins. Twenty-two amino acids are naturally incorporated into polypeptides and are called proteinogenic or standard amino acids. Of these, 20 are encoded by the universal genetic code. Nine standard amino acids are called "essential" for humans because they cannot be created from other compounds by the human body, and so must be taken in as food.

Amino acids in human food are regulated under 21 CFR §172.

Amino acid toxicity is rare, and protein restriction for patients with renal or liver failure is obsolete because this only aggravated malnutrition. A true example of protein toxicity consists of gastrointestinal hemorrhage that precipitates hepatic encephalopathy in liver insufficiency, most likely because hemoglobin is an unbalanced protein because it lacks the essential amino acid isoleucine. (Soeters, 2004)

Studies have shown that excessive intake of some amino acids may lead to some disturbances. Both the age of the subject, and the adequacy of the diet with respect to protein, caloric intake, vitamins, as well as the relative 0rooportion of amino acids in the diet influence the individual's susceptibility to the amino acid load. (Deshpande, 2002). However, this is not a relevant concern, given that these materials are not intended for human consumption in this petitioned use.

Effects on soil organisms, crops or livestock

<u>Soil Organisms</u>

Amino acids are commonly produced from microorganisms found in natural soil. One gram of natural soil contains about 100 million microorganisms. From these a useful one can be picked out.

Generally, microorganisms produce the 20 kinds of amino acids only in the amounts necessary to themselves. They have a mechanism for regulating the quantities and qualities of enzymes to yield amino acids only in the needed amounts. Therefore, it is necessary to release this regulatory mechanism in order to manufacture the target amino acid in large amounts.

Crops or Livestock

Chains of carbon, with each carbon atom linked to other carbons, form the "backbone" of organic molecules. These carbon chains, with varying amounts of attached oxygen, H, N, P and S, are the basis for both simple sugars and amino acids and more complicated molecules of long carbon chains or rings. Depending on their chemical structure, decomposition is rapid (sugars, starches and proteins), slow (cellulose, fats, waxes and resins) or very slow (lignin). (UN FAO 1998)

Many plants, including important agricultural crops, form symbioses with soil microorganisms that take N2 gas out of the atmosphere and convert it to forms that are useful for growth (called N fixation). In some cases, plants will take up simple amino acids from soil. Organic nitrogen actually exists in many forms in soil, including as free amino acids, and can be bound in large organic molecules that are associated with soil minerals. (Penn State, 2011)

The amino acids contained in this petitions are either required or recommended to adequate livestock nutrition.

10. Safety information about the substance

Material Safety Data Sheets

Attachment A includes Material Safety Data Sheets for all of the petitions amino acids in this category.

Substance Report from the National Institute of Environmental Health Studies

The Food and Drug Administration (FDA) does not require a National Institute of Environmental Health Studies report for taurine. Therefore a NIEHS report has not been developed. The information contained in this petition under Section 9 covers the safety of human health and environment. 11. Research information about the substance which includes comprehensive substance research reviews and research bibliographies, including reviews and bibliographies which present contrasting positions to those presented by the petitioner in supporting the substance's inclusion on or removal from the National List.

The National Research Council's *Nutrient Requirements of Dogs and Cats* (2006) stands as the primary source of scientific information regarding the amino acid requirements for dogs and cats. The 2006 publication was developed by an ad hoc committee convened by the NRC Committee on Animal Nutrition in 2000.

As explained in the preface of the 2006 publication "Throughout the study process, the (ad hoc) committee sought input from various sources. We held public meetings in conjunction with professional meetings and invited experts to speak with us as we completed our task. Over the course of 3 years, the committee held six meetings and four public sessions. We acquired data and information from various public and private organizations. By combining a thorough literature review with critical analysis of scientific data and professional experiences, the committee developed recommendations that are firmly founded in science. (NRC, 2006)"

12. Petition Justification Statement

Overview

The U.S. Department of Agriculture's National Organic Standards recognized from the outset that vitamins, minerals and other required nutrients are essential in formulating certified organic products that will meet the nutritional requirements of humans and animals.

Specifically, §205.603(d)(2) and §205.603(d)(3) allow trace minerals and vitamins to be utilized in livestock for enrichment or fortification when FDA approved. Similarly, §205.605(b) allows food products labeled as "organic" or "made with organic" to contain nutrient vitamins and minerals, in accordance with 21 CFR 104.20, Nutritional Guidelines for Foods. Those nutrients are allowed for use in livestock feed and human food regardless of the method of manufacturing or handling.

Under the current regulations, pet food products seeking certification under the USDA Organic Standards must be produced in accordance with §205.605 and §205.606 of the National Organic Standards. Certain nutrients required by cats and/or dogs are not included in §205.605, §205.606, and are not referenced in 21 CFR 104.20(b). Without the inclusion of those nutrients, however, commercially-produced pet foods cannot be labeled as *Complete and Balanced* under the model regulations developed by the

Association of American Food Control Officials in accordance with the National Research Council's *Nutritive Requirements of Cats and Dogs*.

The specific levels of required and recommended nutrients (including amino acids) are listed in the following tables of the National Research Council's *Nutritive Requirements of Cats and Dogs*.

Table 15-3 Nutrient Requirements for Growth of Puppies after Weaning Table 15-5 Nutrient Requirements for Adult Dogs for Maintenance Table 15-8 Nutrient Requirements for Bitches for Late Gestation and Peak Lactation Table 15-10 Nutrient Requirements for Growth of Kittens after Weaning Table 15-12 Nutrient Requirements for Adult Cats for Maintenance Table 15-14 Nutrient Requirements for Queens for Late Gestation and Peak Lactation

The tables referenced above are all included with this petition as Attachment D.

It is important to note that the NRC is recognized as the authoritative source of nutrient information within the international community. For example, The European Pet Food Industry Federation's August 2011 report entitled Nutritional Guidelines for Complete and Complementary Pet Food for Cats and Dogs, contains the following table:

TABLE A₄ – Substantiation of nutrient recommendations for dogs

	GENERAL						
1	Amino acids, trace elements, vitamins (Adult dogs)	Unless indicated with an * and substantiated hereafter, the values recommended for adult dogs are the levels recommended by NRC 2006 increased by 20% to compensate for the lower energy requirement of household dogs (see Annex I) compared to the energy intake assumed by NRC.	⁹ NRC Chapter 15. Nutrient Requirements and Dietary Nutrient Concentrations. In: Nutrient Requirements of Dogs and Cats. The National Academic Press, Washington, DC. 2006: pp. 359-360, table 15-4.				

(European Pet Food Industry Federation, 2011)

State regulators utilize the model regulations in the Official Publication of AAFCO as the basis of determining if a commercial pet food product qualifies to be labeled as complete and balanced. The specific levels of required amino acids identified in the Official Publication of AAFCO are listed on Pages 7-9 of this petition.

Other references on this topic include:

Idiosyncratic nutrient requirements of cats appear to be diet-induced evolutionary adaptations, James Morris, Department of Molecular Biosciences, School of Veterinary Medicine, University of California, Davis. <u>Nutrition Research Reviews</u>, 2002, 15 Pages 153-168.

- *The carnivore connection to nutrition in cats*, Debra L. Zoran, DVM, PhD, DACVIM Journal of the American Veterinary Association, Vol. 221, No. 11, December, 1, 2002 <u>http://catinfo.org/docs/zorans_article.pdf</u>
- *Comparative Nutrition of Cats and Dogs*, D H Baker, and G L Czarnecki-Maulden, Annual Review of Nutrition, Vol. 11: 239-263 (Volume publication date July 1991)

Additional studies used in the preparation of this petition are included in Attachment F.

Why the synthetic substance is necessary for the production of an organic product.

Because dogs and cats rely on commercially-prepared foods as their sole source of nutrition, it is vital that those commercial food products contain all of the nutrients required for healthy growth and adult maintenance. Accordingly, the American Association of Feed Control Officials (AAFCO) have developed model regulations, based upon the National Research council's *Nutrient Requirements of Dogs and Cats*, regarding the level of nutrients for a commercially-produced pet food to be labeled as *complete and balanced*. The term *complete and balanced* means that the formula supplies a nutritionally adequate diet when fed according to label instructions.

Deficiency of even one of the essential amino acids can have damaging—and even fatal—effects on the animal. Within the order Carnivora, cats are more sensitive than dogs and ferrets to hyperammonaemia resulting from consumption of an arginine-free diet. Cats are exquisitely sensitive to arginine deficiency, for there is no other example in a mammalian species where consumption of a single meal lacking an essential nutrient can lead to death. (Morris, 2002)

Nonsynthetic substances or alternative cultural methods that could be used in place of the petitioned synthetic substance

Dogs and cats have been domesticated over the past thousands of years, but their digestive tract remains largely unchanged from the time when they acted as predators in the wild. Consequently, their protein (amino acid) requirements remain largely unchanged from the time when the animals consumed diets consisting of freshly-killed animals. This historic diet included more than simply the muscle meat of the prey, and included the hide, fur, bones, --and for dogs--the contents of the stomach.

Consequently a diet consisting exclusively of fresh-killed game (for cats), and a combination of fresh killed game and plant matter (for dogs), could contain the levels of amino acids required for growth and maintenance in dogs and cats. Evidence shows that animals existing in the wild do not have as long of a lifespan as those consuming complete and balanced pet food.

Replicating the nutrient levels contained in a diet of freshly-killed game and foraged plant matter (for dogs) is extremely difficult in a commercially-manufactured food

product. For example, the heat required during processing to meet the food safety requirements for commercially manufactured food products also decreases the bioavailability of several endogenous amino acids—particularly taurine (Zoran, 2002). Accordingly, additional incremental amounts of these nutrients must be added to commercially manufactured products.

Further, even though cats do not have the ability to synthesize these amino acids, the amino acids are not conserved. In fact, utilization of taurine, arginine, methionine and cystein is higher in cats than in dogs. (Zoran, 2002)

Not all of the required amino acids will require the use of synthetic materials. As mentioned above, amino acids are derives from many animal and plant sources. The following table ists the dietary sources of the amino acids:

Amino Acid	Dietary Sources - Animal	Dietary Sources - Plant
Arginine	cottage cheese, beef, pork, poultry, wild game, seafood	wheat germ, flour, buckwheat, oatmeal, peanuts, nuts, seeds (pumpkin, sesame, sunflower), chick peas, soybeans
Methionine	eggs, fish, meats	Cereal grains, Seeds (sesame, pumpkin), nuts
Cysteine	Cottage cheese, eggs, pork, poultry (chicken, turkey, duck), yogurt	garlic, broccoli, Brussels sprout, oats, red peppers, wheat germ, sprouted lentils
Lysine	Beef, cheese, eggs, fish, milk, poultry	Amaranth, beans (kidney, Navy) Soybean, lentils,
Taurine	Meat, seafood	
Tryptophan	Beef, eggs, fish, lamb, pork, poultry (chicken, turkey), spirulina,	Bananas, nuts (almond, pistachio, cashew), potatoes, seeds (pumpkin, sesame), soybeans
Threonine	cottage cheese, poultry, fish, meat,	Lentils
Histidine	Cheese, eggs, meat, poultry, pork	Brewer's yeast, rice, rye, wheat
Isoleucine	Cheese, eggs, fish, lamb, poultry (chicken, turkey)	soy protein, seaweed
Leucine	beef, fish, , chicken, eggs,	Almonds, beans, chickpea, corn, oats, peanuts, rice, soybeans,
Phenylalanine	Beef, cheese, fish, poultry, pork, yogurt	Nuts, seeds, soy products
Tyrosine	cheese, cottage cheese, fish, poultry (chicken, turkey), yogurt,	Almonds, lima beans, peanuts, seeds (pumpkin, sesame) soy products,
Valine	cottage cheese, fish, poultry	,Peanuts, sesame seeds, and lentils

(WHO, 2007(, Virginia-Maryland Regional Veterinary College, 2010)

The following required amino acids are generally available through organically-produced dietary sources:

- Histidine
- Isoleucine
- Leucine

- Phenylalanine-tyrosine
- Valine

As noted by the NOSB in its November 2008 recommendation regarding Certified Organic Pet Food, the following amino acids are not generally available from organically produced agricultural products, and must be added in a synthetic format:

- l-arginine
- d-l Methionine
- 1-cysteine
- l-lysine
- Taurine
- l-tryptophan
- 1-threonine

Because of the specific minimum (and in some cases, maximum) level of these essential nutrients that must be present in a formulated food product to be recognized as complete and balanced, small amounts of the synthetic materials are used to balance the formulations, and to compensate for the loss that occurs through the normal manufacturing process.

Beneficial effects to the environment, human health (pet health), or farm ecosystem from use of the synthetic substance that support the use of it instead of the use of a nonsynthetic substance or alternative cultural methods.

Effect on the Environment

These required amino acids allows for the formulation of pet foods with the correct balance of these amino acids for the diet of cats and dogs. While most attention is dedicated to minimum requirements, excess levels of certain required nutrients can create an imbalance that can be detrimental to the pet, and results in higher levels of amino acids being excreted by the animal. As stated above, excess amino acids are excreted as a component of nitrogen in the urine of these animals. Formulation of pet food products with the appropriate levels of required amino acids will reduce the amount of excess amino acids excreted by the animal.

Effect on Human (and Animal) Health

The essentiality of these amino acids comprises the foundation of this petition for their addition to §205.603 of the National List.

As explained in the NRC, "Dietary protein is required for two reasons. First, protein provides amino acids that dogs and cats cannot synthesize (essential amino acids) but are required for synthesis of the many proteins in the body. Second, protein provides dispensable amino acids (amino acids that can be synthesized if appropriate nitrogen and carbon

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sources are provided) that animals need for maintenance, growth, gestation, and lactation. Dispensable amino acids provide nitrogen and carbon for the synthesis of any needed dispensable amino acid and carbon for gluconeogenesis and/or energy. Dispensable amino acids also provide nitrogen and/or structural components necessary to make other compounds that are essential for life, such as purines, pyrimidines, heme, various hormones, neurotransmitters, and/or neuromodulators (e.g., thyroxine, catecholamines, y-aminobutyric acid, taurine).

"For either dogs or cats that consume primarily animal tissue, amino acids also provide carbon chains for gluconeogenesis to supply glucose to tissues that require it (e.g., red blood cells, nervous tissue) to maintain normal tissue metabolism. As for most other animals, the following 10 amino acids have been shown to be essential for both dogs and cats: arginine (Arg), histidine (His), isoleucine (He), leucine (Leu), lysine (Lys), methionine (Met), phenylalanine (Phe), threonine (Thr), tryptophan (Trp), and valine (Val). In omnivores and certain herbivores (e.g., rats, chicks), removal of a single essential amino acid results in a decrease in food intake that is known to be a primary neuroresponse caused by the lack of the limiting essential amino acid (Gietzen, 1993). In cats, the limited work available (e.g., Hardy et al., 1977; Rogers and Morris, 1979) shows that food intake does not decrease as quickly as in rats after initial consumption of diet devoid of an essential amino acid. Although food intake does decrease with time, the depression is not as severe as in omnivores and herbivores. (NRC, 2006)"

The negative interactions among amino acids have, for the most part, not been studied in humans. (Baker, 2008)

References for Justification Statement

American Association of Feed Control Officials (2011) Official Publication, Oxford, IN

Ajnomoto (2011) Encyclopedia of Amino Acids. http://www.ajinomoto.com/amino/eng/product.html

Baker, David H (2008) Animal Models in Nutrition Research, American Society for Nutrition Journal Vol. 138, pp 391-396.

Briston, Andrew W.; Whitehead, David C.; Cockburn, John E (1992) Nitrogenous constituents in the urine of cattle, sheep and goats. Journal of the Science of Food and Agriculture, Volume 59, Issue 3, pp 387-394.

Deshpande, S.S. (2002) Handbook of Food Toxicology, Mercel Decker, Inc., New York, NY

European Pet Food Industry Federation (2011) Nutritional Guidelines for Complete and Complementary Pet Food for Cats and Dogs, B-1050 Bruxelles. <u>http://www.nutricao.vet.br/pdfs/FEDIAF_Nutritional_Guidelines_-_final_version_6-09-11.pdf</u> Holisticmed.net (2003) Amino acid Production. http://www.holisticmed.net/aspartame/aminoacid.pdf

FDA (2010) Pet Food Labels - General, Center for Veterinary Medicine, March

Journal of Chemical Education (2004) Commercial Production of MSG and Other Amino Acids, Cornell College, Mount Vernon, IA

Morris, James (2002) Idiosyncratic nutrient requirements of cats appear to be dietinduced evolutionary adaptations. Department of Molecular Biosciences, School of Veterinary Medicine, University of California, Davis. <u>Nutrition Research Reviews</u>, 15 Pages 153-168.

http://journals.cambridge.org/download.php?file=%2FNRR%2FNRR15_01%2FS095442 2402000070a.pdf&code=395e67a2405fe3e7ef0a6e06d5ccf9fa

Morris, James; and Rogers, Quinton (1978) Arginine: An Essential Amino Acid for the Cat, Journal of Nutrition, 108 Pages 1944-1953. http://jn.nutrition.org/content/108/12/1944.full.pdf

National Research Council (2006) Nutrient Requirements of Dogs and Cats, Animal Nutrition Series, NRC of the National Academes, Washington, D.C.

Paustian, Timothy (2000) Synthesis of Amino Acids. University of Wisconsin, Madison

Penn State (2011) The N Cycle, Crops and Soil Sciences, State College, PA <u>http://cropsoil.psu.edu/research/kaye-lab/lab-logo</u>

Soeter, Peter; van de Poll, Marcell; van Geemer, Wim; van Gemert, Dejong, Cornelis (2004) Amino Acid Adequacy in Pathophysiological States, <u>*The American Society for*</u> <u>*Nutritional Sciences*</u> J. Nutr. 134:1575S-1582S, June 2004

UN FAO (1998) Organic matter decomposition and the soil food web <u>http://www.fao.org/docrep/009/a0100e/a0100e05.htm</u>

UN World Health Organization (2007) Protein and Amino Acid Requirements in Human Health, Joint Report of WHO/FAO/UNU Expert Commission, http://whqlibdoc.who.int/trs/WHO TRS 935 eng.pdf

Virginia-Maryland Regional College of Veterinary Medicine (2010) Nutrition for the Adult Cat, http://www.vetmed.vt.edu/vth/sa/clin/cp_handouts/Nutrition_Adult_Cat.pdf

Virginia-Maryland Regional College of Veterinary Medicine (2010) Nutrition for the Adult Dog <u>http://www.vetmed.vt.edu/vth/sa/clin/cp_handouts/Nutrition_Adult_Dog.pdf</u>

Zoran, Debra L., DVM, PhD, DACVIM (2002) The carnivore connection to nutrition in cats. Journal of the American Veterinary Association, Vol. 221, No. 11, December, 1. http://catinfo.org/docs/zorans_article.pdf

13. Commercial Confidential Information Statement

There is no confidential Business Information being submitted with this petition.

Attachment A Current Ingredient Labels of Conventional And Made with Organic Products Containing the Petitioned Materials

Below are current labels of conventional and certified "Made with Organic" pet food products containing materials included in this petition. The petitioned materials are underlined in these examples:

Current conventional wet cat food label, with taurine, L-lysine and DL-methionine:

Water, Beef, Beef By-Product, Pork By-Products, Pork Liver, Wheat Flour, Corn Starch, Rice Flour, Powdered Cellulose, Chicken Liver Flavor, Soybean Oil, Corn Gluten Meal, Calcium Sulfate, Guar Gum, Locust Bean Gum, Carrageenan, Brewers Dried Yeast, Dicalcium Phosphate, Iron Oxide, Calcium Carbonate, Choline Chloride, <u>DL-Methionine</u>, <u>Taurine</u>, Iodized Salt, <u>L-Lysine</u>, Potassium Chloride, Vitamin E Supplement, Thiamine Mononitrate, Zinc Oxide, Ferrous Sulfate, Niacin, Manganous Oxide, Copper Sulfate, Pyridoxine Hydrochloride, Calcium Pantothenate, Vitamin B12 Supplement, Riboflavin, Biotin, Calcium Iodate, Vitamin D3 Supplement, Folic Acid, Sodium Selenite.

Current conventional dry cat food with taurine and L-arginine:

Chicken By-Product Meal, Corn Gluten Meal, Brewers Rice, Whole Grain Corn, Animal Fat (preserved mixed tocopherols and citric acid), Powdered Cellulose, Chicken Liver Flavor, Lactic Acid, Soybean Oil, Soybean Mill Run, Potassium Chloride, Choline Chloride, Calcium Sulfate, Calcium Carbonate, Iodized Salt, Natural Flavor, DL-Methionine, Vitamin E Supplement, vitamins (L-Ascorbyl-2-Polyphosphate (source of vitamin C), Vitamin E Supplement, Niacin, Thiamine Mononitrate, Vitamin A Supplement, Calcium Pantothenate, Riboflavin, Biotin, Vitamin B12 Supplement, Pyridoxine Hydrochloride, Folic Acid, Vitamin D3 Supplement), Potassium Citrate, <u>Taurine</u>, Fish Oil, minerals (Ferrous Sulfate, Zinc Oxide, Copper Sulfate, Manganous Oxide, Calcium Iodate, Sodium Selenite), preserved with mixed Tocopherols and Citric Acid, <u>L-Arginine</u>, Phosphoric Acid, Beta-Carotene, Rosemary Extract.

Current conventional dry cat food with taurine and DL-methionine:

Chicken Meal, Ground Whole Corn, Corn Gluten Meal, Chicken Fat (Preserved with Mixed Tocopherols), Ground Whole Brown Rice, Ground Whole White Rice, Tomato Pomace (Source of Lycopene), Herring Meal, Avocado, Natural Flavor, Egg Product, Chicory Root, Salt, Whey, Potassium Chloride, Vitamins (Choline Chloride, a-Tocopherol Acetate (Source of Vitamin E), Niacin, Vitamin A Acetate, Thiamine Mononitrate (Source of Vitamin B1), Calcium Pantothenate, Pyridoxine Hydrochloride (Source of Vitamin B6), Menadione Sodium Bisulfate Complex, Riboflavin Supplement, Ascorbic Acid (Source of Vitamin C), Vitamin D3 Supplement, Vitamin B12 Supplement, Folic Acid, Biotin), Minerals (Zinc Sulfate, Zinc Amino Acid Chelate, Iron Amino Acid Chelate, Ferrous Sulfate, Copper Sulfate, Manganese Amino Acid Chelate, Copper Amino Acid Chelate, Manganous Oxide, Sodium Selenite, Calcium Iodate), Avocado Oil, Lecithin, Taurine, Calcium Carbonate, Parsley Flakes, Kelp Meal, <u>DL-Methionine</u>, Yucca Schidigera Extract, Inositol.

Current dry dog food with taurine and L-carnitine:

Venison Meal, Dried Potatoes, Potato Starch, Potato Protein, Pea Protein, Sunflower Oil (preserved with mixed Tocopherols), Chicken Fat (preserved with mixed Tocopherols), Dried Plain Beet Pulp, Natural Flavors, Flaxseed, Potassium Chloride, Salt, Powdered Cellulose, Choline Chloride, Zinc Sulfate, <u>Taurine</u>, Vitamin E Supplement, Ferrous Sulfate, L-Ascorbyl-2-Polyphosphate (source of Vitamin C), Potassium Iodide, Copper Sulfate, <u>L-Carnitine</u>, Niacin Supplement, Calcium Pantothenate, Biotin, Manganous Oxide, Thiamine Mononitrate (Vitamin B1), Selenium, Vitamin A Supplement, Pyridoxine Hydrochloride (Vitamin B6), Riboflavin Supplement (Vitamin B2), Vitamin D3 Supplement, Vitamin B12 Supplement, Folic Acid, Rosemary Extract.

Current certified "Made with Organic" dry cat food with taurine:

Organic Chicken, Chicken Meal, Organic Peas, Organic Brown Rice, Organic Barley, Pea Protein, Organic Chicken Fat (Naturally Preserved with Mixed Tocopherols and Citric Acid), Salmon Meal, Organic Flaxseed, Natural Chicken Flavor, Dried Egg Product, Minerals (Zinc Proteinate, Iron Proteinate, Copper Proteinate, Manganese Proteinate, Calcium Iodate, Sodium Selenite), Calcium Sulfate, Salt, Vitamins (Vitamin E Supplement, Niacin, L-Ascorbyl-2-Polyphosphate, Vitamin A Supplement, Riboflavin, Calcium Pantothenate, Thiamine Mononitrate, Vitamin B12 Supplement, Pyridoxine Hydrochloride, Biotin, Folic Acid, Vitamin D3 Supplement), Choline Chloride, <u>Taurine</u>, Potassium Chloride, Yeast Culture (Saccharomyces cerevisiae), Dried Enterococcus faecium Fermentation Product, Dried Lactobacillus acidophilus Fermentation Product, Dried Aspergillus niger Fermentation Extract, Dried Trichoderma longibrachiatum Fermentation Extract, Dried Bacillus subtilis, Fermentation Solubles, Rosemary Extract

Current Certified "Made With Organic" dog food with L-carnitine:

Organic Chicken, Chicken Meal, Organic Brown Rice, Organic Millet, Organic Peas, Organic Oats, Tomato Pomace, Chicken Fat (Naturally Preserved with Mixed Tocopherols and Citric Acid), Salmon Meal, Natural Chicken Flavor, Organic Flaxseed, Organic Quinoa, Dried Egg Product, Minerals (Zinc Proteinate, Iron Proteinate, Copper Proteinate, Manganese Proteinate, Calcium Iodate, Sodium Selenite), Organic Apples, Organic Carrots, Organic Broccoli, Organic Pumpkin, Organic Pears, Potassium Chloride, Salt, Calcium Carbonate, Choline Chloride, Vitamins (Vitamin E Supplement, L-Ascorbyl-2-Polyphosphate, Vitamin A Supplement, Calcium Pantothenate, Niacin, Riboflavin, Vitamin B12 Supplement, Biotin, Thiamine Mononitrate, Pyridoxine Hydrochloride, Folic Acid, Vitamin D3 Supplement), Chondroitin Sulfate, L-Carnitine, Yeast Culture (Saccharomyces cerevisiae), Dried Enterococcus faecium Fermentation Product, Dried Lactobacillus acidophilus Fermentation Product, Dried Aspergillus niger Fermentation Extract, Dried Trichoderma longibrachiatum Fermentation Extract, Dried Bacillus subtilis, Fermentation Solubles, Rosemary Extract

Current Certified "Made With" gog food with taurine:

Organic Chicken, Organic Brown Rice, Chicken Meal, Organic Oats, Organic Millet, Organic Barley, Organic Grain Sorghum, Organic Peas, Organic Potatoes, Chicken Fat (Naturally stabilized with Mixed Tocopherols), Organic Canola Oil, Organic Flaxseed, Dicalcium Phosphate, Organic Carrots, Calcium Carbonate, Natural Flavor, Salt, Potassium Chloride, Organic Spinach, Organic Cranberries, Organic Tomato Pomace, Choline Chloride, Zinc Proteinate, Ferrous Sulfate, Zinc Sulfate, Vitamin E Supplement, Vitamin B-12 Supplement, <u>Taurine</u>, Manganese Sulfate, Niacin, Riboflavin (Vitamin B-2), Copper Proteinate, Copper Sulfate, Calcium Pantothenate, Vitamin A Acetate, Inositol, Folic Acid, Pyridoxine Hydrochloride (Vitamin B-6), Thiamine Mononitrate (Vitamin B-1), Vitamin D-2 Supplement, Biotin, Potassium Iodate, Cobalt Sulfate, Sodium Selenite, Yucca Schidigera Extract, Organic Parsley, Organic Rosemary, Dried Kelp, Ascorbic Acid (source of Vitamin C).

Attachment B - Material Safety Data Sheets

Arginine

		Fire 1
	(1)	
		Reactivity 0
		Personal Protection E
Material Safe	ety Data Sheet	
L-Argini	ine MSDS	
Section 1: Chemical Produc	t and Company Identifica	ation
Product Name: L-Arginine	Contact Information:	
Catalog Codes: SLA2320, SLA3823, SLA1477	Sciencelab.com, Inc.	
CAS#: 74-79-3	14025 Smith Rd. Houston, Texas 77396	
RTECS: CF1934200	US Sales: 1-800-901-724	
TSCA: TSCA 8(b) Inventory: L-Arginine	International Sales: 1-281 Order Online: ScienceLab	
CI#: Not available.		
Synonym: 2-Amino-5-guanidinovaleric acid; L-Arginine	CHEMTREC (24HR Emerger 1-800-424-9300	ncy relephone), call:
Chemical Name: Arginine	International CHEMTREC, o	all: 1-703-527-3887
Chemical Formula: C5H14N4O2	For non-emergency assista	ance, call: 1-281-441-4400
2 1 2 2		
Section 2: Composition an	d Information on Ingredie	ents
Composition:	2	20
Name	CAS #	% by Weight
{L-}Arginine	74-79-3	100
Toxicological Data on Ingredients: L-Arginine LD50: Not av	allable. LC50: Not available.	
Section 3: Haza	rds Identification	
Potential Acute Health Effects: Slightly hazardous in case of inhalation.	f skin contact (irritant), of eye cor	ntact (irritant), of ingestion, of
Potential Chronic Health Effects: CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFF TERATOGENIC EFFECTS: Not available. DEVELOPMENTAI not known to aggravate medical condition.	ECTS: Mutagenic for mammaila TOXICITY: Not available. Repe	an somatic cells. sated or prolonged exposure is
Section 4: Fin	st Aid Measures	
Eye Contact: Check for and remove any contact lenses. In case of contact,	immediately flush eves with nien	ty of water for at least 15

Skin Contact: Wash with scap and water. Cover the inflated skin with an emolient. Get medical attention if inflation develops. Cold water may be used. Serious Skin Contact: Not available.

Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention

Serious Inhalation: Not available.

Ingestion: Do NOT induce vorniting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, te, bett or wastbard.

Serious ingestion: Not available.

Section 5: Fire and Explosion Data Flammability of the Product: May be combustible at high temperature. Auto-Ignition Temperature: Not available. Flash Points: Not available. Flammable Limits: Not available Products of Combustion: These products are carbon oxides (CO, CO2), nitrogen oxides (NO, NO2...). Fire Hazards in Presence of Various Substances: Slightly flammable to flammable in presence of heat. Non-flammable in presence of shocks. Explosion Hazarda in Presence of Various Substances: Risks of explosion of the product in presence of mechanical impact. Not available. Risks of explosion of the product in presence of static discharge: Not available. Fire Flighting Media and instructions: SWALL FIRE: Use DRY chemical powder, LARGE FIRE: Use water spray, fog or foam, Do not use water jet. Special Remarks on Fire Hazards: Not available Special Remarks on Explosion Hazards: Not available. Section 6: Accidental Release Measures

Smail Split: Use appropriate tools to put the splited satid in a convenient waste disposal container. Firish cleaning by spreading water on the containinated surface and dispose of according to local and regional authority requirements.

Large Spill: Use a showei to put the material into a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system.

Section 7: Handling and Storage

Precautions:

Precautions: Keep looked up. Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire risk, evaporate the residue under a turne hood. Ground all equipment containing material. Do not breathe dust. Wear suitable protective dothing.

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If you feel unwell, seek medical attention and show the label when possible. Keep away from incompatibles such as oxidizing agents.

Storage: Light sensitive. Store in light resistant containers. Keep container tightly closed. Keep container in a cool, wel-ventilated area. Do not store above 24°C (75.2°F).

Section 8: Exposure Controls/Personal Protection

Engineering Controls: Use process enclosures, local exhaust ventilation, or other engineering controls to keep alroome levels below recommend exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to arbome contaminants below the exposure limit.

Personal Protection: Safety glasses. Lab coat. Dust respirator. Be sure to use an approvedicertified respirator or equivalent.

Personal Protection in Case of a Large Split: Splash poggles. Full sul: Dust respirate, Boots. Gloves. A self contained breathing apparatus should be used to avoid inhatation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits: Not available.

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid. (Crystalline powde)
Odor: Not available.
Taste: Not available.
Molecular Weight: 174.2 g/mole
Color: White:
pH (1% soln/water): Not available.
Bolling Point: Not available.
Melting Point: 235°C (455°F)
Critical Temperature: Not available.
Specific Gravity: Not available.
Vapor Pressure: Not applicable.
Vapor Density: Not available.
Volatility: Not available.
Odor Threshold: Not available.
Water/OII Dist. Coeff.: Not available.
Ionicity (In Water): Not available.
Dispersion Properties: See solubility in water.
Solubility: Soluble in cold water, hot water. Insoluble in diethyl ether. Sparingly soluble in alcohol
Section 10: Stability and Reactivity Data

Stability: The product is stable. Instability Temperature: Not available Conditions of Instability: Excess heat, light incompatibility with various substances: Reactive with oxidizing agents. Corrosivity: Non-corrosive in presence of glass. Special Remarks on Reactivity: Light sensitive. Special Remarks on Corrosivity: Not available. Polymerization: Will not occur. Section 11: Toxicological information Routes of Entry: Inhalation, Ingestion.

Toxiolty to Animals: LDS0: Not available. LCSD: Not available.

Chronic Effects on Humans: MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells.

Other Toxio Effects on Humans: Slightly hazardous in case of skin contact (irritant), of ingestion, of inhalation.

Special Remarks on Toxicity to Animals: Not available.

Speolal Remarks on Chronio Effects on Humans: May affect genetic material. Some Laboratory experiments have resulted in mutagenic effects. Although some dietary studies in animsia have demonstrated that arginine deficiency can impair reproductive organ development as well as having adverse effects on gestation and lactation, we did not locate any literature on possible adverse reproductive effects of supplemental arginine during human pregnancy.

Special Remarks on other Toxio Effects on Humans: Acute Potential Health Effects. Skin: May cause skin irritation. Eyes: May cause eye irritation. Inhaiation: May cause resolratory track irritation. Ingestion: May cause gaterinitestina irract irritation with nausea, vomiting, and diamhea. The toxicological properties of this substance have not been fully investigated.

Section	12: Ecological Information	

Epotoxioty: Not available.

BOD6 and COD: Not available.

Products of Biodegradation: Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise. Toxiolty of the Products of Biodegradation: The product itself and its products of degradation are not toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations Waste Dispocal: Waste must be disposed of in accordance with federal, state and local environmental control regulations

DOT Classification: Not a DOT controlled material (United States). Identification: Not applicable. Special Provisions for Transport: Not applicable.

Section 15: Other Regulatory Information

Section 14: Transport Information

Federal and State Regulations: TSCA 8(b) Inventory: L-Arginine

Other Regulations: EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances. Other Classifications:

WHMIS (Canada): Not controlled under WHMIS (Canada).

DSCL (EEC): R4D Possible risks of inteversible effects. 82- Keep out of the reach of children. 836/37- Wear suitable protective clothing and gloves.

HMIS (U.S.A.):

Health Hazard: 1 Fire Hazard: 1

Reactivity: 0

Personal Protection: E

National Fire Protection Association (U.S.A.):

Health: 1 Flammability: 1

Readtivity: 0

Specific hazard:

Proteotive Equipment: Gloves. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Safety glasses.

Section 16: Other information

References: Not available. Other Special Considerations: Not availa Created: 10/11/2005 11:20 AM Last Updated: 11/01/2010 12:00 PM The information above is believed to be accurate and represents the best information currently available to us. However, we

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Methionine



Material Safety Data Sheet DL-methionine MSDS

section 1: Chemical Proc	luct and Company Identific	auon
Product Name: DL-methionine	Contact Information:	
Catalog Codes: SLM4135	Sciencelab.com, Inc.	
CA8#: 59-51-8	14025 Smith Rd. Houston, Texas 77396	
RTEC8: PD0456000	US Sales: 1-800-801-724	
TSCA: TSCA 8(b) Inventory: DL-methionine	International Sales: 1-28	
CI#: Not available.	Order Online: ScienceLa	1223 Mar 200 AS
Synonym: DL-2-Amino-4-(methylthio)butyric acid	CHEMTREC (24HR Emerge 1-800-424-9300	ency Telephone), call:
Chemical Formula: C5H11NO2S	International CHEMTREC,	all: 1-703-577-3997
	For non-emergency assist	
	a of manual grandy second	
Section 2: Composition	and information on ingredi	ents
Composition:		
Name	CAS #	% by Weight
(DL-)methionine	59-51-8	100
Toxicological Data on ingredients: DL-methionine LDSC	Not available. LC50: Not available	5) 5)
Section 3: He	azards identification	
Potential Acute Health Effects: Hazardous in case of skir Potential Chronic Health Effects: Hazardous in case of skin contact (initiant), of eye contact (Not available: MUTAGENIC EFFECTS: Not available: TER	initant), of ingestion, of inhalation,	CARCINOGENIC EFFECTS:
TOXICITY: Not available.		
Section 4: f	First Ald Measures	
Eye Contact: Check for and remove any contact lenses. Immediately flux open. Cold water may be used. Do not use an eye ointmen Skin Contact:	sh eyes with running water for at lea it. Seek medical attention.	ast 15 minutes, keeping eyelds
Wash with a disinfectant scop and cover the contaminated sin nhalation: Allow the victim to rest in a well ventilated area. I derivous inhalation: Not available. ngedion: Do not induce vormting. Loces tight clothing such as a colla noutr-to-mouth resuscitation. Seek immediate medical atten	Seek immediate medical attention. r, te, beit or waistband. If the victin	
erious ingestion: Not available.		
Section 5: Fire	and Explosion Data	
ammability of the Product: May be combustible at high to	emperature.	
uto-Ignition Temperature: Not available.		
lach Points: Not available.		
lammable Limits: Not available.		
roduots of Combustion: These products are carbon oxide	s (CO, CO2), nitrogen aiddes (NO	NO2).
ire Hazards in Presence of Various Substances: Not ava		5765 (BES)
xplosion Hazards in Presence of Various Substances:		
isks of explosion of the product in presence of mechanical i resence of static discharge: Not available.	impact Not available. Risks of expl	osion of the product in
Ire Fighting Media and instructions:		
MALL FIRE: Use DRY chemical powder. LARGE FIRE: Us	e water spray, fog or foam. Do not	use water jet.
peolal Remarks on Fire Hazards: Not available.		
peolal Remarks on Explosion Hazards: Not available.		
Section 6: Accide	ntal Release Measures	
tmail &pili: Jse appropriate tools to put the spilled solid in a convenient he contaminated surface and dispose of according to local a spilled surface and dispose of according to local a spilled surface and dispose of according to local a spilled surface and spilled solid spilled solid spilled solid spilled spilled solid spilled solid spilled solid spilled solid spilled solid spilled spilled solid spilled solid spilled spilled solid spilled solid spilled spilled spilled spilled solid spilled solid spilled spilled solid spilled spill		
arge Spill: Ise a showei to put the material into a convenient waste disp ontaminated surface and allow to evacuate through the san		spreading water on the
Section 7: Har	ndling and Storage	
Trecautions:		
recountions: (eep away from hest. Keep away from sources of ignition. E is fure hood. Ground all equipment containing material. Do r nsufficient ventiation, wear suitable respiratory equipment if oossible. Avoid contact with shin and eyes	not breathe dust. Wear suitable pro	tective clothing in case of

Required Amino Acid Organic Petition Information Prepared by Crystal Springs Consulting, Inc.

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Section 8: Exposure Controls/Personal Protection

Engineering Controls: Use process enclosures, local exhaust ventilation, or other engineering controls to keep alfoarne levels below recommendi execoure links. Tuere operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Personal Proteotion: Splash pogges. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Split: Splash poggies. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits: Not available.

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid. (Solid powder.)	
Odor: Not available.	
Tacta: Not available.	
Holeoular Weight: 149.21 gimole	
Color: White.	
pH (1% coin/water): Not available.	
Bolling Point: Not available.	
Molting Point: Decomposes. (281*C or 537.8*F)	
Critical Temperature: Not available.	
Specific Gravity: 1.34 (Water = 1)	
Vapor Pressure: Not applicable.	
Vapor Density: Not available.	
Volatility: Not available.	
Odor Threshold: Not available.	
Water/OII Dict. Coeff.: Not available.	
konlofty (in Water): Not available.	
Dispersion Properties: See solubility in water, methanol.	
Solubility: Soluble in cold water, methanol.	
Section 10: Stability and Reactivity Data	
Stability: The product is stable.	1
	p. 3
Instability Temperature: Not available.	
Conditions of instability: Not available.	
Incompatibility with various substances: Not available.	
CorrodVity: Non-corrosive in presence of glass.	
Special Remarks on Readthity: Not available.	
Special Remarks on Corrosivity: Not available.	
Polymerization: No.	
Section 11: Toxicological Information	-
New Active Control of the Control of	-
Routes of Entry: Eye contact. Inhalation. Ingestion.	
Toxisity to Animals: LD50: Not available. LC50: Not available.	
Chronio Effects on Humans: Not available.	
Other Toxio Effects on Humans: Hazardous in case of skin contact (initiant), of ingestion, of inhalation.	
Special Remarks on Toxicity to Animals: Not available.	
Special Remarks on Chronic Effects on Humans: Passes through the placental barrier in animal.	
Special Remarks on other Toxic Effects on Humans: Not available.	
Section 12: Ecological Information	_
Eootoxioity: Not available.	
BOD5 and COD: Not available.	
Products of Biodegradation:	
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.	
Toxicity of the Products of Biodegradation: The products of degradation are more toxic.	
Special Remarks on the Products of Biodegradation: Not available.	
Section 13: Disposal Considerations	_
Waste Dispocal:	-
Section 14: Transport Information	
DOT Classification: Not a DOT controlled material (United States).	
Identification: Not applicable.	
Special Provisions for Transport: Not applicable.	
	_
Section 15: Other Regulatory Information	

Federal and State Regulations: TSCA 8(b) Inventory: DL-methionine

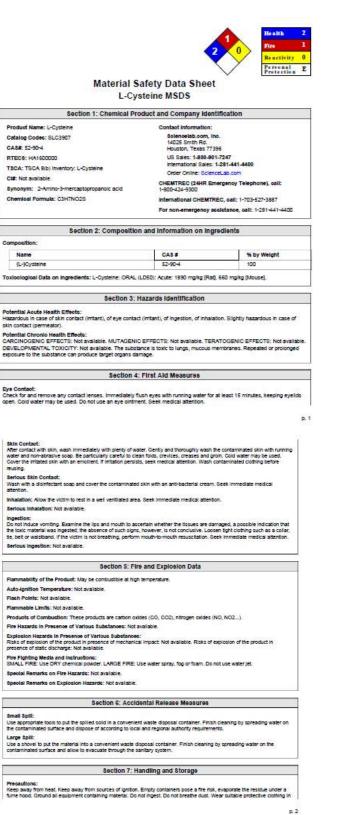
	Section 16: Other Information
Protective Equipment: Gloves. Lab coat. Dust respin	ator. Be sure to use an approved/certified respirator or equivalent. Splash goggles.
Specific hazard:	
Reactivity: 0	
Flammability: 1	
Health: 2	
National Fire Protection Ass	sociation (U.S.A.):
Personal Protection: E	
Readivity: 0	
Fire Hazard: 1	
Health Hazard: 2	
HMIS (U.S.A.):	
DSCL (EEC): R36/38- Imitatin	g to eyes and skin.
WHMIS (Canada): Not contro	vled under WHMIS (Canada).
Other Classifications:	
Other Regulations: Not avail	able.

References: Not available.

Other Special Considerations: Not available. Created: 10/09/2005 06:06 PM Last Updated: 11/01/2010 12:00 PM

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Cysteine



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case of insufficient ventilation, wear suitable respiratory equipment if ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes

storage: Keep container dry. Keep in a cool place. Ground all equipment containing material. Keep container tightly closed. Keep in a cool, well-ventilated place. Combustible materials should be stored away from extreme heat and away from strong oxidizing agents.

Section 8: Exposure Controls/Personal Protection

Engineering Controls: Use process enclosures, local exhaust ventilation, or other engineering controls to keep arborne levels below recommend exposure limits. If user operations generate dust, tune or mist, use ventilation to keep exposure to arborne contaminants below the exposure limit. Perconal Proteotion: Splash goggies. Lab coat: Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection In Case of a Large Split: Splash googles. Full suit: Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits: Not available.

Section 9: Physical and Chemical Proper	ties
Physical state and appearance: Solid.	
Odor: Not available.	
Taste: Not available.	
Molecular Weight: 121.15 gimole	
Color: Not available.	
pH (1% soin/water): Not available.	
Boiling Point: Not available.	
Metting Point: Not available.	
Critical Temperature: Not available.	
Specific Gravity: Not available.	
Vapor Pressure: Not applicable.	
Vapor Density: Not available.	
Volatility: Not available.	
Odor Threshold: Not available.	
Water/Oll Dist. Coeff.: Not available.	
ionioity (in Water): Not available.	
Dispersion Properties: See solubility in water.	
Solubility: Soluble in cold water.	

Section 10: Stability and Reactivity Data

Stability: The product is	stable.
instability Temperature	: Not available.
Conditions of Instability	y: Not available.
incompatibility with var	lous substances: Not available.
Corrocivity: Non-corrosi	ve in presence of glass.
Special Remarks on Re-	aotivity: Not available.
Special Remarks on Co	mostvity: Not available,
Polymerization: No.	Samanan Ing Chu Kawa Mala Sa
	Section 11: Toxicological information
Routes of Entry: Eye co	ntact. Inhalation. Ingestion.
Toxicity to Animals: Acu	ute oral toxicity (LD50): 660 mg/kg (Mouse).
Chronic Effects on Hum	nans: The substance is toxic to lungs, mucous membranes.
Other Toxic Effects on i	
	n contact (initiant), of ingestion, of inhalation. Slighty hazardous in case of skin contact (permeator)
	xiolity to Animals; Not available. ronio Effects on Humans; Not available.
	ronio Effects on Humans: Not available.
special remarks on our	er ruxio Ellecte dil Hamano, nut avalatic.
	Section 12: Ecological Information
Ecotoxicity: Not availabi	e.
BOD5 and COD: Not ava	alable.
Products of Blodegrada	
	term degradation products are not likely. However, long term degradation products may arise.
	s of Biodegradation: The products of degradation are more toxic. • Products of Biodegradation: Not available.
special Hemanics on the	Products of Biodegradation: Not available.
	Section 13: Disposal Considerations
Waste Disposal:	
	Section 14: Transport Information
DOT Classification: Not	a DOT controlled material (United States).
identification: Not applic	
	Transport: Not applicable
24 2022 A C C C C C C C C C C C C C C C C C C	
	Section 15: Other Regulatory Information

Federal and State Regulations: TSCA 8(b) Inventory: L-Cysteine Other Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). Other Classifications: WHMIS (Canada): Not controlled under WHMIS (Canada). DBCL (EEC): R22- Harmful If swallowed. R35/38- Imitating to eyes and skin. HMIS (U.S.A.): Health Hazard: 2 Fire Hazard: 1 Reactivity: 0 Personal Protection: E National Fire Protection Association (U.S.A.): Health: 2 Flammability: 1 Readivity: 0 Specific hazard: Proteotive Equipment: Gloves, Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Splash goggles. Section 16: Other Information

References: Not available. Other Special Considerations: Not available. Created: 10/05/2005 05:03 PM

Last Updated: 11/01/2010 12:00 PM

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Lysine



Material Safety Data Sheet L-Lysite monohydrochloride MSD5

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Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area.

Section 8: Exposure Controls/Personal Protection

Engineering Controls: Use process endosures, local exhaust ventilation, or other engineering controls to keep almorne levels below recommended exposure Inits. If user operations generate dust, tume or mist, use ventilation to keep exposure to almorne contaminants below the exposure limit.

Personal Protection: Safety glasses. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill: Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits: Not available.

Section 9: Physical and Chemical Properties Physical state and appearance: Solid. (Granular solid or Powdered solid.) Odor: Not available. Taste: Not available. Molecular Weight: 182.68 g/mole Color: White, Off-white, pH (1% soln/water): Not available. Bolling Point: Not available. Melting Point: Not available. Critical Temperature: Not available. Specific Gravity: Not available. Vapor Pressure: Not applicable. Vapor Density: Not available. Volatility: Not available. Odor Threshold: Not available. Water/OII Dist. Coeff.: Not available. Ionicity (In Water): Not available. Dispersion Properties: See solubility in water. Solubility: Soluble in cold water.

Section 10: Stability and Reactivity Data

Stability: The product is stable. Instability Temperature: Not available. Conditions of Instability: Excess heat, incompatible materials, dust generation.

incompetently with various autodament. Preach with sustaining agents.

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	Section 14: Transport Information
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Other Special Considerations: Not available, consider, tools cool of the case lapsages, 11/01/2019 (2:00 Mill)

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Taurine

	anial Cafaty Data Chart
Mat	erial Safety Data Sheet Taurine MSDS
fastion 1: Chr	emical Product and Company Identification
Product Name: Taurine	Contact Information:
Catalog Codes: SLT2014	Solenoelab.com, Inc.
CA8#: 107-35-7	14025 Smith Rd. Houston, Texas 77396
RTEC8: WX0175000	US Sales: 1-800-801-7247
TSCA: TSCA 8(b) Inventory: Taurine	International Sales: 1-281-441-4400 Order Online: ScienceLab.com
Di#: Not available.	CHEMTREC (24HR Emergency Telephone), call:
8ynonym: 2-Aminoethanesulfonic acid; 2 Aminoethylsulfonic acid; 2-Sulfoethylamine	 1-800-424-9300 International CHEMTREC, call: 1-703-527-3887
Chemioal Name: Taurine	For non-emergency accidance, call: 1-291-441-440
Chemical Formula: C2-H7-N-O3-8	
Section 2: Co	mposition and information on ingredients
mposition:	
Name	CAS # 56 by Weight
Taurine	107-35-7 100
xicological Data on Ingredients: Not app	plicable.
Se	ection 3: Hazards identification
tential Acute Health Effects: Slightly haz	tartious in case of skin contact (initiant), of eye contact (initiant), of ingestion
alaton.	
itential Chronic Health Effects: RCINOGENIC EFFECTS: Not available. N EVELOPMENTAL TOXICITY: Not available	MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not ava . Repeated or prolonged exposure is not known to aggravate medical cond
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Storage: Keep container tighty closed. Keep container in a cool, well-ventilated area,

Section 8: Exposure Controls/Personal Protection Engineering Controls: Use process enclosures, local exhaust ventilation, or other engineering controls to keep alroome levels below recomme exposure links. If user operations generate dust, fume or mist, use vertilation to keep exposure to alroome contaminant below the exposure limb. ended Personal Profestion: Safety glasses. Lab cost. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Personal Proteotion In Case of a Large Spill: Splach gogges. Full suit, Dust respirator, Boots, Gioves. A self contained breathing apparatus should be used to avoid Inhalaton of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product. Exposure Limits: Not available. Section 9: Physical and Chemical Properties Physical state and appearance: Solid. (Crystalline solid. Crystalline powder.) Odor: Odoriess. Taste: Not available. Moleoular Weight: 125.14 g/mole Color: White. pH (1% coin/water): Not available Bolling Point: Not available Melting Point: 300°C (572°F) Critical Temperature: Not available Specific Gravity: Not available. Vapor Pressure: Not applicable. Vapor Density: Not available. Volatility: Not available. Odor Threshold: Not available. Water/OII Dist. Coeff.: Not available. Ioniolity (in Water): Not available. Dispersion Properties: See solubility in water Solubility: Soluble in cold water. Solubility in water: 65 g/l Section 10: Stability and Reactivity Data Stability: The product is stable. Instability Temperature: Not available. Conditions of Instability: Excess heat, dust generation, incompatible materials p. 3 atibility with various substances: Reactive with oxidizing agents. Corrosivity: Non-corrosive in presence of plass. Special Remarks on Reactivity: Not available. Special Remarks on Corrosivity: Not available Polymerization: Will not occur. Section 11: Toxicological Information Routes of Entry: inhalation. Ingestion. Toxiolity to Animals: Acute oral toxicity (LD50): >5000 mg/kg (Rat). Chronio Effects on Humans: Not available. Other Toxio Effects on Humans: Slightly hazardous in case of skin contact (initiant), of ingestion, of inhalation Special Remarks on Toxicity to Animals: Not available. Speolal Remarks on Chronio Effects on Humans: May cause adverse reproductive effects and birth defects (teratogenic) based on animal test data. May affect genetic material (mutagenic) Beolal Remarks on other Toxio Effects on Humans: Acute Potential Health Effects: Skin: May cause skin initiation. Eyes: May cause eye imitation. Initiation: May cause respiratory track imitation. Ingestion: May cause digestive track limitation. The toxicological properties of this substance have not been fully investigated. May also affect behariorgicomolence), metabolism. Section 12: Ecological Information Eootoxiolty: Not available. BODE and COD: Not available Products of Biodegradation: Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise. Toxiolity of the Products of Biodegradation: The product itself and its products of degradation are not toxic. Special Remarks on the Products of Biodegradation: Not available. Section 13: Disposal Considerations Waste Disposal: Waste must be disposed of in accordance with federal, state and local environmental control regulations. Section 14: Transport Information DOT Classification: Not a DOT controlled material (United States). identification: Not applicable. Special Provisions for Transport: Not applicable Section 15: Other Regulatory Information

	Section 16: Other Information
Protective Equipment: Gloves. Lab coat. Dust respirator. I	Be sure to use an approved/certified respirator or equivalent. Safety glasses.
Specific hazard:	
Readivity: 0	
Flammability: 1	
Health: 1	
National Fire Protection Associa	fion (U.S.A.):
Personal Protection: E	
Reactivity: 0	
Fire Hazard: 1	
Health Hazard: 1	
HMIS (U.S.A.):	
of contact with eyes, rinse immedia	cling to the EU regulations. 824/25- Avoid contact with skin and eyes. 826- In case stely with pienty of water and seek medical advice. 828- After contact with skin, wash 36- Wear suitable protective clothing.
WHMIS (Canada): Not controlled a	inder WHMIS (Canada).
Other Classifications:	
Other Regulations: EINECS: This	product is on the European Inventory of Existing Commercial Chemical Substances.
Federal and State Regulations: T	

Other Special Considerations: Not available. Created: 10/10/2005 12:00 AM

Last Updated: 11/01/2010 12:00 PM

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of mechantability or any other warranty, express or implied, with respect to such information, and use assume no lability resumptions that use its lowers should make their own investigations to determine the subality of the information by their particular purposes. In ne event shall ScienceLab.com be lable for any claims, losses, or damages of any third party or for their particular purposes. In nevent shall ScienceLab.com be lable for any claims, losses, or damages of any third party or for has been advised of the possibility of such damages.

Tryptophan

	Health	1
	Fire	1
\checkmark	Reactivity	0
7	Personal Protection	F

Material Safety Data Sheet

Section 1: Chemical Produc	t and Company Identifi	ication
Product Name: L-Tryptophan	Contact Information:	
Catalog Codes: SLT3700. SLT1684	Sciencelab.com, Inc.	
CAS#: 73-22-3	14025 Smith Rd.	
	Houston, Texas 77396 US Sales: 1-800-901-7	
RTECS: YN6130000	International Sales: 1-2	247 281-441-4400
TSCA: TSCA 8(b) Inventory: L-Tryptophan	Order Online: Sciencel	Lab.com
CI#: Not available.	CHEMTREC (24HR Emer	gency Telephone), call:
Synonym: Tryptophan; L-alpha-aminoindole-3-propionic add; (-)-Tryptophan; (S)-alpha-Amino-1H-Indole-3-	1-800-424-9300	
propanoic acid: (S)-alpha-AminoIndole-3-propionic acid:	International CHEMTREC	
(S)-Tryptophan; 1-beta-3-indolylalanine; 1H-indole-3- alanine; (S)-; 1H-indole-3-propanoic acid; alpha-amino-, (S)-; 2-Amino-3-indolypropanoic acid; 3-indol-3-ylalanine;	For non-emergency assi	stance, call: 1-281-441-4400
(S)-; 2-Amino-3-Indolypropanoic acid; 3-Indol-3-ylalanine;		
Alanine, 3-Indoi-3-yl; L-Tryptophane; L-alpha-Amino-3- Indolepropionic Acid; Indole-3-alanine; Propionic acid, 2-		
amino-3-indol-3-yt; Tryptophane; L-Tryptofan		
Chemical Name: L-Tryptophan		
Chemical Formula: C11-H12-N2-O2		
Section 2: Composition an	d Information on Ingree	dients
Composition:		
Name	CAS #	% by Weight
{L-}Tryptophan	73-22-3	100
Toxicological Data on Ingredients: Not applicable.		
Section 2- User	rds Identification	
Potential Acute Health Effects: Slightly hazardous in case of		contact (initiant) of investion of
Potential Acute Health Effects: Signby hazardous in case of inhalation.	own contact (ittrant), or eye	version (innancy, or ingestion, of
Potential Chronic Health Effects:		
CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFF EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not	ECTS: Mutagenic for bacteria available. Repeated or proton	a and/or yeast. TERATOGENIC and exposure is not known to
aggravate medical condition.		3
CALL PARTY		
Sector 4: Fin	st Aid Measures	
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Section & Englosure Controls/Personal Protection

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Section 9: Physical and Chemical Properties

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prt (15. with water): 55 - 7.0
Defing Polit, Not avaluate.
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Citiza Temperatura not Acazane
Apartitie Genetity: Vert Available
Vapor Pressure: Not applicable.
Vapor Detroity: Hot analistia.
youtery: rod automa-
DAXY TRANSMER NOT ALLERED
Instantial part cash, fur autures
ionicity (in Violar); Not evaluate
Dispersion Properties: Say anishing investor
Solutions to a state of the second s

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	Section 10: Stability and Reactivity Data
Stability: The pro	duct is stable.
Instability Temp	erature: Not available.
Conditions of In	stability: Excess heat, incompatible materials
Incompatibility v	vith various substances: Reactive with oxidizing agents, acids.
Corrosivity: Non	corrosive in presence of glass.
Special Remarks	on Reactivity: Protect from light
Special Remarks	on Corrosivity: Not available.
Polymentzation:	Will not occur.
	Section 11: Toxicological Information
Routes of Entry:	Inhalation. Ingestion.
Toxicity to Anim	als: Acute oral toxicity (LD50): >16000 mg/kg (Rat).
Chronic Effects	on Humans: MUTAGENIC EFFECTS: Mutagenic for bacteria and/or yeast.
Other Toxic Effe	cts on Humans: Slightly hazardous in case of skin contact (initant), of ingestion, of inhalation.
Special Remarks	on Toxicity to Animals: Not available.
	 on Chronic Effects on Humans: e reproductive effects based on animal test data. May cause cancer based on animal test data. May affect mutagenci)
Acute Potential H respiratory tract in headache, exciter (dermatits). May by musculoskelet tendemess, neuri Prolonged or repe	cen other Toxic Effects on Humane: acth Effects: Size: May cause exist initiation, Eyes: May cause eye initiation, initiation: May cause intation, ingestion: Causes severe initia nausea. May affect behavioritentral nervous system (drowsheas, ent, somorelone, insomnia, murche weatness, artifaratively), respiration (acute publication), adult affect blood and cause L-Toytophan Induced exoinophila myadja syndrome. This liness is characterized a symptoms including myadjas, a atmicajas, and naresthesias. The physical findings consist of muscle pathies, ranh, peopheral and periorital edema, exoinophila. Chronic Potential Health Effects, ingestion: respiration (dyspena, chronic pulmonary edema), urinary system.
	Section 12: Ecological Information
Ecotoxicity: Not	avallable.
BOD5 and COD:	Not available.
Products of Blox Possibly hazardo	legradation: is short term degradation products are not likely. However, long term degradation products may arise.
Toxicity of the P	roducts of Biodegradation: The product itself and its products of degradation are not toxic.
Special Remarks	on the Products of Biodegradation: Not available.
	Section 13: Disposal Considerations

Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information			
DT Classification: Not a DOT controlled material (United States).			
entification: Not applicable.			
Special Provisions for Transport: Not applicable.			
Section 15: Other Regulatory Information			
ideral and State Regulations: TSCA 8(b) inventory: L-Tryptophan			
ther Regulations: EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.			
ther Classifications:			
HMIS (Canada): Not controlled under WHMIS (Canada).			
SCL (EEC): ils product is not classified according to the EU regulations. S24/25- Avoid contact with skin and eyes.			
MIS (U.S.A.):			
Health Hazard: 1			
Fire Hazard: 1			
Readbivity: 0			
Personal Protection: E			
ational Fire Protection Association (U.S.A.):			
Health: 1			
Flammability: 1			
Reactivity: 0			
Specific hazard:			
otective Equipment: oves. Lab coal. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Safety glasses.			
Section 16: Other Information			
eferences: Not available.			
ther Special Considerations: Not available.			
reated: 10/11/2005 12:50 PM			
ist Updated: 11/01/2010 12:00 PM			
e Information above is believed to be accurate and represents the best information currently available to us. However, ake no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assus liability resulting from its use. Users should make their own investigations to determine the suitability of the information and is possible for any salams, losses, or damages of any third party or its postion or any special, indired, incliential, consequential or exemplary damages, howsoever artsing, even if ScienceLab or seen advised of the possibility of such damages.	ne for for		

Threonine



Material Safety Data Sheet L-Threonine MSDS

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14025 6mBr Rol. Houston Texas 7739 US Sales: 1-800-801 htemational Sales: 1 Order Online: Scienci CHEMTREC (24HR Emi- 1-800-42-9300 international CHEMTRE For non-emergency ask and information on ingre CA8 # 72-19-5	16 .7247 .281.441.4400 eL3b.com ergensy Telephone), call: EC, call: 1-703-527-3887 eletance, call: 1-281-441-4400 edlients % by Weight
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nalation. Signey hazaroous in	case of skin contact (imtant).
STATES AND	
haladon. Slightly hazardous in	case of skin contact (imitant).
TERM available. (ERM	In a sective principal of the available
irst Ald Measures	
h eyes with running water for a	it least 15 minutes, keeping eyelids
. Seek medical attention.	
	P
: Gently and thoroughly wash	the contaminated skin with running
folds, crevices, creases and g	roin. Cold water may be used.
seek medical attention. Wash	contaminated clothing before
seek immediate medical attent	ton.
to bell or relationed without	define to part brought in a standard
tion.	acum is not preasing, periorin
and Explosion Data	
mperature.	
s (CO, CO2), nitrogen axides ((NO, NO2).
lable.	
mpact: Not available. Risks of	explosion of the product in
e water spray, fog or foam. Do	not use water jet.
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e water spray, fog or foam. Do ntal Release Measures	not use water jet.
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tal Release Measures wate disposal container. Finis nd regional authority requirem osal container. Finish cleaning	In cleaning by spreading water on ents.
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tal Release Measures wate disposal container. Finis nd regional authority requirem osal container. Finish cleaning	In cleaning by spreading water on ents.
	halation. Slightly hazardous in halation. Slightly hazardous in FFECTS: Not available. TER/ Inst Ald Measures treyes with running water for a Seek medical attention. Gently and thoroughly wash folds, crevices, creases and g seek medical attention. Wash eek immediate medical attent on. the, beit or waistband. If the tion.

fume hood. Ground all equipment containing material. Do not breathe dust, whold contact with eyes Wear suitable protective clothing in case of insufficient ventilation, wear suitable respiratory equipment if you feel unwell, seek medical attention and show the black when possible.

er dry. Keep in a cool place. Ground all equipment containing material. Keep container tightly closed. Keep in a tilated place. Combustible materials should be stored away from extreme heat and away from strong oxidizing Section 8: Exposure Controls/Personal Protection Engineering Controls: Use process enclosures, local exhaust ventilation, or other engineering controls to keep alroome levels below recommended exposure links. If user operations generate dust, fume or mist, use vertilation to keep exposure to airborne contaminants below the exposure limb. Personal Proteotion: Splash goggles. Lab coat. Dust respirator. Be sure to use an approved certified respirator or equivalent. Gloves. Personal Proteotion in Case of a Large Spill: Splash poggers. Full stud. Dust respirator, Boots, Gloves. A self contained breathing apparatus should be used to svoid initiaation of the product. Suggested protective conting might not be sufficient, consult a specialist BEFORE handling this Exposure Limits: Not available. Section 9: Physical and Chemical Properties Physical state and appearance: Solid Odor: Not available. Taste: Not available. oular Weight: 119.12 gimole Mo Color: Not available pH (1% coin/water): Not available Bolling Point: Not available. Melting Point: Decomposes. (256°C or 492.8°F) Critical Temperature: Not availab Specific Gravity: Not available Vapor Pressure: Not applicable Vapor Density: Not available. Volatility: Not available. Odor Threshold: Not available. Water/OII Dict. Coeff.: Not available. ionioity (in Water): Not available. Dispersion Properties: See solubility in water Solubility: Easily soluble in cold water. Section 10: Stability and Reactivity Data Stability: The product is stable. p. 3 Instability Temperature: Not available. Conditions of instability: Not available. incompatibility with various substances: Not available Corrosivity: Non-corrosive in presence of glass. Special Remarks on Reactivity: Not available. Speolal Remarks on Corrosivity: Not available. Polymerization: No. Section 11: Toxicological Information Routes of Entry: Eye contact. Inhalation. Ingestion. Toxioity to Animais: LDSD: Not available. LCSD: Not available. Chronic Effects on Humans: Not available. Other Toxio Effects on Humans: Hazardous in case of ingestion, of inhalation. Slightly hazardous in case of skin contact (intant). olal Remarks on Toxiolity to Animals: Not available. Special Remarks on Chronic Effects on Humans: Passes through the placental barrier in human. Special Remarks on other Toxic Effects on Humans: Not available. Section 12: Ecological Information Eootoxiolty: Not available. BOD5 and COD: Not available. Products of Biodegradation: Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise. Toxioity of the Products of Biodegradation: The products of degradation are more toxic. Special Remarks on the Products of Biodegradation: Not available. Section 13: Disposal Considerations Waste Disposal: Section 14: Transport Information DOT Classification: Not a DOT controlled material (United States). Identification: Not applicable. Special Provisions for Transport: Not applicable. Section 15: Other Regulatory Information

Federal and State Regulations: TSCA S(b) Inventory: L-Threonine Other Regulations: Not available. Other Classifications: WHMIS (Canada): Not controlled under WHMIS (Canada). DSCL (EEC): R36- Initiating to eyes. HMIS (U.S.A.): Health Hazard: 2 Fire Hazard: 1 Readivity: 0 Personal Protection: E National Fire Protection Association (U.S.A.): Health: 2 Flammability: 1 Readbulty: 0 Specific hazard: Protective Equipment: Gloves. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Splash goggies.

References: Not available.

Other Special Considerations: Not available. Created: 10/10/2005 08:30 PM

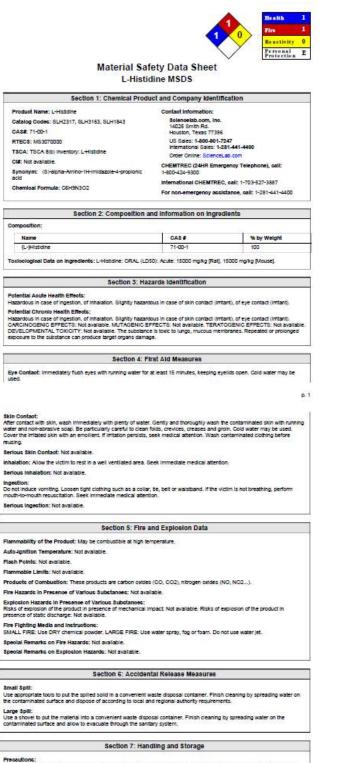
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Section 16: Other Information

Histidine

reusing.



Precautions: Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire risk, evaporate the residue under a turne hood. Ground all equipment containing material. Do not ingest. Do not breathe dust. Wear suitable protective clothing in case of insufficient ventilation, wear suitable respiratory equipment if ingested, seek medical advice immediately and show the container or the label.

Storage: Keep container dry. Keep in a cool place. Ground all equipment containing material. Keep container tightly closed. Keep in a cool, well-vertilated place. Combustible materials should be stored away from extreme heat and away from strong oxidizing agents.

Section 8: Exposure Controls/Personal Protection

Engineering Controls: Use process enclosures, local exhaust ventilation, or other engineering controls to keep alroome levels below recommended exposure links. If user operations generate dust, tume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limb.

Personal Proteotion: Safety glasses. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

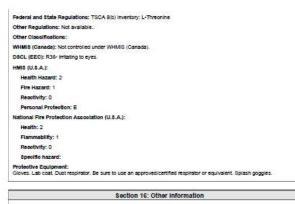
Personal Proteotion In Case of a Large Split: Splash progress Full actu. Dust respirator, Boots. Gloves: A self contained breathing apparatus should be used to avoid minatation of the product. Suggested protective conting might not be sufficient; consult a specialist SEFCRE handling this

Exposure Limits: Not available

Section 9: Physical and Chemical Properties	
Physical state and appearance: Sold. (Crystalline sold.)	
Odor: Odoriess,	
Tacte: Not available.	
Moleoular Weight: 155.16 gimole	
Color: White.	
pH (1% coln/water): Not available.	
Bolling Point: Not available.	
Molting Point: Decomposes. (287°C or 548.6°F)	
Critical Temperature: Not available.	
Specific Gravity: 1.44 (Water = 1)	
Vapor Pressure: Not applicable.	
Vapor Density: Not available.	
Volatility: Not available.	
Odor Threshold: Not available.	
Water/Oli Dict. Coeff.: Not available.	
ionioity (in Water): Not available.	
Dispension Properties: See solubility in water.	
Solubility: Partially soluble in cold water. Very slightly soluble in methanol. Insoluble in diethyl ether.	

Section 10: Stability and Reactivity Data

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References: Not available.

Other Special Considerations: Not available.

Created: 10/10/2005 08:30 PM

Last Updated: 11/01/2010 12:00 PM

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warrandy of mechanizability or any other warrandy, express or implied, with respect to such information, and we assume to liability resumptions that such associates their own investigations to determine the subatility of the information har their particular purposes. In no event shall believed the any claims, losses, or damages of any third party or the loss profits or any special, indirect, inclinental, consequential or exemplary damages, howsoever artising, even if ScienceLab.com has seen advised of the possibility of such damages.

tability: The product is stable.	
nstability Temperature: Not availabi	•
Conditions of instability: Not availab	ile.
noompatibility with various substar	noes: Not available.
Corrosivity: Non-corrosive in presenc	e of glass.
Special Remarks on Reactivity: Not	avalable.
Special Remarks on Corrosivity: No	t avalable.
Polymerization: No.	
	Section 11: Toxicological Information
Routes of Entry: Inhalation, Ingestion	
Toxiolity to Animals: Acute oral toxici	ty (LD50): 15000 mp/kg (Mouse).
	bstance is toxic to lungs, mucous membranes.
Other Toxio Effects on Humans:	NEW CONTRACTOR OF AN ADVANCED
	alation. Slightly hazardous in case of skin contact (initiant).
Special Remarks on Toxicity to Anin	
	s on Humans: Passes through the placental barrier in human.
Special Remarks on other Toxic Eff	eots on Humans: Nulsance dust.
	Section 12: Ecological Information
Epotoxiolty: Not available.	
BOD6 and COD: Not available.	
Products of Blodegradation:	
	ation products are not likely. However, long term degradation products may arise.
	adation: The products of degradation are more toxic.
Special Remarks on the Products o	f Blodegradation: Not available.
	Section 13: Disposal Considerations
Waste Disposal:	
Waste Disposal:	
Waste Disposal:	Section 14: Transport Information
DOT Classification: Not a DOT contr	
DOT Classification: Not a DOT contri dentification: Not applicable.	alled material (United States).
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DOT Classification: Not a DOT com dentification: Not applicable. Ispecial Provisions for Transport: N S Federal and State Regulations: TSC/ Other Regulations: OSHA: Hazardou Other Classifications: WHMIS (Canada): CLASS D-2A: Mate DOL (EEC):	olied material (United States). of applicable. section 15: Other Regulatory Information A 8(b) inventory: L+Hatidme by definition of Hazard Communication Standard (29 CFR 1910.1200). rial causing other toxic effects (VERY TOXIC).
DOT Classification: Not a DOT comp dentification: Not applicable. Special Provisions for Transport: N S Federal and State Regulations: TSC/ Other Regulations: OSHA: Hazardou Other Classifications: WHMIS (Canada): CLASS D-2A: Mate DSCI. (EEC): The product and classified according The product and classified according	olied material (United States). of applicable. section 15: Other Regulatory Information A 8(b) inventory: L+Hatidme by definition of Hazard Communication Standard (29 CFR 1910.1200). rial causing other toxic effects (VERY TOXIC).
DOT Classification: Not a DOT comp dentification: Not applicable. Special Provisions for Transport: N S Federal and State Regulations: TSC/ Other Regulations: OSAA Hazardou Other Classifications: WHMIS (Canado): CLASS D-2A: Mate DSCI. (EC): The product in not classified according HMIS (U.S.A.):	olied material (United States). of applicable. section 15: Other Regulatory Information A 8(b) inventory: L+Hatidme by definition of Hazard Communication Standard (29 CFR 1910.1200). rial causing other toxic effects (VERY TOXIC).
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DOT Classification: Not a DOT comp dentification: Not applicable. Special Provisions for Transport: N Several and State Regulations: TSIC Other Regulations: OSHA: Hazardou Other Classifications: MMMS (Canado): CLASS D-2A: Mate DOL (EEC): This product is not classified according HMS (U.S.A.): Health Hazard: 1 Fire Hazard: 1 Fire Hazard: 1 Resolvity: 0 Personal Protection: E National Fire Protection: E National Fire Protection: E Health: 1 Flammability: 1	olied material (United States). of applicable. Section 15: Other Regulatory Information A 8b) Inventory: L-Hatidme s by definition of Hazard Communication Standard (25 CFR 1910.1200). rial causing other toxic effects (VERY TOXIC). to the EU regulations.
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Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

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Low operation, in the local is load in the time information currently available to us. However, we make no warranty of mechantability or any other warranty, express or implicit, with respect to such information, and we assume no iability resumptions that such issues should name their own investigations to determine the subalability of the information bit their particular purposes in no event shall ScienceLab com be labele for any claims, issues, or damages of any third party or for loss provide or any subcidil, individe, incloident of consequential or exemptiony damages, howsoever arising, even if ScienceLab com has been advised of the possibility of such damages.

Isoleucine



Material Safety Data Sheet L-Isoleucine MSDS Section 1: Chemical Product and Company Identification Product Name: L-Isoleucine Contact Information: Solencelab.com, Inc. 14025 Smith Rd. Houston, Texas 77396 Catalog Codes: SLI1882, SLI1222, SLI1645 CA8#: 73-32-5 US Sales: 1-800-901-7247 International Sales: 1-281-441-4400 Order Online: ScienceLab.com RTEC8: NR4705000 TSCA: TSCA 8(b) inventory: L-Isoleucine Ci#: Not available. CHEMTREC (24HR Emergency Telephone), call: 1-800-424-9300 Synonym: 2-Amino-3-methylvaleric acid International CHEMTREC, gall: 1-703-527-3887 Chemical Formula: C6H13NO2 For non-emergency assistance, call: 1-281-441-4400 Section 2: Composition and Information on Ingredients Composition: Name CAS# % by Weight (L-)Isoleucine 73-32-5 100 Toxicological Data on Ingredients: L-Isoleucine LDSD: Not available. LOSD: Not available. Section 3: Hazards identification Potential Acute Health Effects: Very hazardous in case of Ingestion. Hazardous in case of skin contact (intlant, permeator), of eye contact (intlant), of inhalaton. Potential Chronic Health Effects: Very hazardous in case of Ingestion. Hazardous in case of skin contact (intlant, permeator), of eye contact (intlant), of Inhalaton. CARCINGOBIOL EFFECTS: Not available. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. Section 4: First Ald Measures Eye Contaot: Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Do not use an eye ointment. Seek medical attention. 0.5 Skin Contact: After contact with skin, wash immediately with pienty of water. Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cold water may be used. Cover the initiated skin with an emolient. If initiation persists, seek medical attention. Wash contaminated clothing before reusing. Serious Skin Contact: Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention. inhalation: Allow the victim to rest in a well ventilated area. Seek immediate medical attention. Serious inhalation: Not available. Ingection: Do not induce vomting. Loosen sight clothing such as a colar, ite, beit or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention. Serious Ingestion: Not available. Section 5: Fire and Explosion Data Flammability of the Product: May be combustible at high temperature. Auto-Ignition Temperature: Not available. Flash Points: Not available. Flammable Limits: Not available Products of Combustion: These products are carbon oxides (CO, CO2), nitrogen oxides (NO, NO2...). Fire Hazards in Presence of Various Substances: Not available. Explosion Hazards in Presence of Various Substances: Rinks of explosion of the product in presence of mechanical impact Not available. Risks of explosion of the product in presence of ratic discharge: Not available. Fire Fighting Media and Instructions: SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use water spray, fog or foam. Do not use water jet. Special Remarks on Fire Hazards: Not available Special Remarks on Explosion Hazards: Not available. Section 6: Accidental Release Measures Small Split: Use appropriate tools to put the splited solid in a convenient waste disposal container. Finish cleaning by spreading water on the containitated surface and dispose of according to local and regional authority requirements. Large Split: Use a shove to put the material into a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system. Section 7: Handling and Storage Presoutions: Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire risk, evaporate the residue under a fume hood "ground all equipment containing material. Do not preathe dust. Wear suitable protective clothing in case of insufficient ventilation, wear suitable respiratory equipment if you feel unwell, seek medical attention and show the label when possible. Avoid contact with skin and eyes p. 2

storage:	
	In a cool place. Ground all equipment containing material. Keep container tightly closed. Keep in a Combustible materials should be stored away from extreme heat and away from strong oxidizing.
	Compusible materials should be spreadway nom experiences and away nom shong oxidizing
agents.	

Section 8: Exposure Controls/Personal Protection

Engineering Controls: Use process enclosures, local exhaust ventilation, or other engineering controls to keep alrborne levels below recommend exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Profection: Splash goggles. Lab coat: Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Proteotion in Case of a Large Spill: Spish pogges. Full suit. Dust respirator: Boots. Gioves. A self contained breathing apparatus should be used to avoid initiaation of the product. Suggested protective conting might not be sufficient; consult a specialist BEFORE handling this product

Exposure Limits: Not available.

Section 9: Physical and Chemical Properties	
Physical state and appearance: Solid. (Powdered solid.)	
Odor: Not available.	
Taste: Not available.	
Moleoular Weight: 131.17 gimole	
Color: White.	
pH (1% coin/water): Not available.	
Boiling Point: Not available.	
Weiting Point: Decomposes. (284°C or 543.2°F)	
Critical Temperature: Not available.	
Specific Gravity: Not available.	
Vapor Pressure: Not applicable.	
Vapor Density: Not available.	
Volatility: Not available.	
Odor Threshold: Not available.	
Water/OII Dist. Coeff.: Not available.	
ioniolty (in Water): Not available.	
Dispersion Properties: See solubility in water.	
Solubility: Partially soluble in cold water.	
Section 10: Stability and Reactivity Data	

Stability: The product is stable.

instability Temperature: Not available. Conditions of instability: Not available Incompatibility with various substances: Not available. Corrosivity: Non-corrosive in presence of glass. Special Remarks on Reactivity: Not available. Special Remarks on Corrosivity: Not available. Polymerization: No.

Section 11: Toxicological Information

Routes of Entry: Dermai contact. Eye contact. Inhalation. Ingestion, Toxiolity to Animale: LD50: Not available. LC50: Not available. Chronic Effects on Humans: Not available. Other Toxio Effects on Humans: Very hazardous in case of ingestion. Hazardous in case of skin contact (initiant, permeator), of inhalation. Special Remarks on Toxicity to Animals: Not available. Special Remarks on Chronic Effects on Humans: Passes through the placental barrier in human. Special Remarks on other Toxic Effects on Humans: Not available.

	Section 12: Ecological Information
Eootoxicity: Not availab	ie.
BOD5 and COD: Not av	alabie.
Products of Blodegrad Possibly hazardous shor	ation: t term degradation products are not likely. However, long term degradation products may arise
Toxicity of the Product	is of Blodegradation: The products of degradation are more toxic.
Special Remarks on th	e Products of Biodegradation: Not available.
	Andrea 1A. Diseased Annul Jacobier
	Section 13: Disposal Considerations
Waste Disposal:	

DOT Classification: Not a DOT controlled material (United States). identification: Not applicable. Special Provisions for Transport: Not applicable.

Section 15: Other Regulatory Information

p.4

Section 16: Other information		
Proteotive Equipment: Sloves, Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Splash g	oggies.	
Specific hazard:		
Reactivity: 0		
Flammability: 1		
Health: 2		
National Fire Protection Association (U.S.A.):		
Personal Protection: E		
Readtivity: 0		
Fire Hazard: 1		
Health Hazard: 2		
HMIS (U.S.A.):		
DSCL (EEC): R35/38- Imitating to eyes and skin.		
WHMIS (Canada): Not controlled under WHMIS (Canada).		
Other Classifications:		
Other Regulations: Not available		
Federal and State Regulations: TSCA 8(b) Inventory: L-Isoleucine		

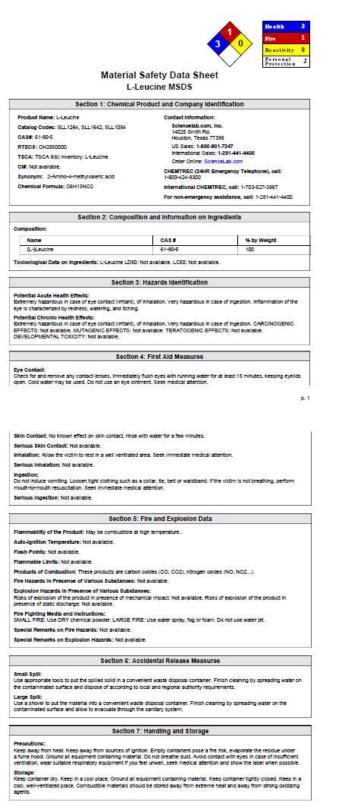
References: Not available.

Other Special Considerations: Not available. Created: 10/10/2005 08:20 PM

Last Updated: 11/01/2010 12:00 PM

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Leucine



Section 8: Exposure Controls/Personal Protection

Engineering Controls: Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommend exposure limit. If user operations generate dust, tume or mist, use vertilation to keep exposure to airborne contaminants below the exposure limit. Personal Protection: Splash goggles. Lab coat.

Personal Protection In Case of a Large Split: Splash pogges. Full suit Boots. Gloves. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handing this product. Exposure Limits: Not available.

	al and Chemical Properties
Physical state and appearance: Solid.	
Odor: Not available.	
Taste: Not available.	
Molecular Weight: 131.17 g/mole	
Color: Not available.	
pH (1% soln/water): Not available.	
Boiling Point: Not available.	
Melting Point: Subimes. (144°C or 291.2°F)	
Critical Temperature: Not available.	
Specific Gravity: 1.293 (Water = 1)	
Vapor Pressure: Not applicable.	
Vapor Density: Not available.	
Volatility: Not available.	
Odor Threshold: Not available.	
Water/OII Dist. Coeff.: Not available.	
Ioniolfy (in Water): Not available.	
Dispersion Properties: See solubility in water. Solubility: Soluble in cold water.	
ondering, condition in Cold Water.	
Section 10: Sta	bility and Reactivity Data
Stability: The product is stable.	
instability Temperature: Not available.	
Conditions of instability: Not available.	
incompatibility with various substances: Not available	
Corrosivity: Non-corrosive in presence of glass.	
Special Remarks on Reactivity: Not available.	
Polymerization: No	
Polymerization: No.	
Section 11: To	oxicological information
Section 11: To Routes of Entry: Eye contact. Inhelation. Ingestion.	xicological information
Section 11: To Routes of Entry: Eye contact. Inhalation. Ingestion. Toxiality to Animals:	oxicological information
Section 11: To Roufes of Entry: Eye contact. Inhalation. Ingestion. Toxicity to Animate: LDS: Not available. LDS: Not available.	oxicological information
Section 11: To Routes of Entry: Eye contact. Inhailation. Ingestion. Taxilatify to Animals: LISG: Not available. Chronic Effects on Humans: Not available. Chronic Effects on Humans:	
Section 11: To Roufes of Entry: Eye contact, inhalation, Ingestion, Toxidatry to Animals: DES Not available. Chronic Effects on Humans: Not available. Other Toxic Effects on Humans: Stermen (nazarobus in case of Inhalation, Very Nazardou	us in case of ingestion.
Section 11: To Routes of Entry: Eye contact. Inhalation. Ingestion. Toxidity to Animals: DES: Not available. Chronio Effects on Humans: Not available. Other Toxio Effects on Humans: Exernetly hazardous in case of Inhalation. Very hazardos Special Remarks on Toxiothy to Animals: Not available	us in case of ingestion.
Section 11: To Routes of Entry: Eye contact. Inhalation. Ingestion. Toxidify to Animale: LDSD: Not available. LDSD: Not available. LDSD: Not available. LDSD: Not available. Other Toxio Effects on Humans: Externey hazardous in case of inhalation. Very hazardou Special Remarks on Toxiolity to Animale: Not available Special Remarks on Chronio Effects on Humans: Pas	us in case of ingestion. Sees through the placental barrier in animal.
Section 11: To Routes of Entry: Eye contact. Inhalation. Ingestion. Toxidify to Animale: LDSD: Not available. LDSD: Not available. LDSD: Not available. LDSD: Not available. Other Toxio Effects on Humans: Externey hazardous in case of inhalation. Very hazardou Special Remarks on Toxiolity to Animale: Not available Special Remarks on Chronio Effects on Humans: Pas	us in case of ingestion. Sees through the placental barrier in animal.
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Section 11: To Routes of Entry: Eye contact. Inhaiation. Ingestion. Toxidity to Animals: LDS: Not available. Chronio Effects on Humans: Not available. Other Toxio Effects on Humans: Not available Special Remarks on Toxioity to Animals: Not available Special Remarks on Chronio Effects on Humans: Pas Special Remarks on other Toxio Effects on Humans: Special Remarks on other Toxio Effects on Humans: Section 12: I Ecotoxioity: Not available.	us in case of ingestion. - -
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Section 11: To Routes of Entry: Eye contact, inhalation, Ingestion, Toxidity to Animals: LDS: Not available, LDSE: Not available. Other Toxio Effects on Humans: Not available. Other Toxio Effects on Humans: Not available Special Remarks on Toxioity to Animals: Not available Special Remarks on Othernio Effects on Humans: Pas Special Remarks on other Toxio Effects on Humans: Section 12: I Ecoloxioity: Not available. BODE and COD: Not available. Products of Biodegradation: Possibly hazarious short term degradation products are	us in case of ingestion. Less through the placental barrier in animal. Nuisance dust. Ecological Information not likely. However, long term degradation products may arise.
Section 11: To Routes of Entry: Eye contact. Inhaiation. Ingestion. Toxidity to Animals: DES: Not available. LCSC: Not available. Chronio Effects on Humans: Not available. Differ Toxio Effects on Humans: Not available special Remarks on Toxioity to Animals: Not available special Remarks on Chronio Effects on Humans: Pas appealal Remarks on other Toxio Effects on Humans: Pas appeala Remarks on other Toxio Effects on Humans: Pas Special Remarks on other Toxio Effects on Humans: Section 12: I Ecotoxioity: Not available. Products of Biodegradation: Toxioity of the Products of Biodegradation: The prod	us in case of ingestion.
Section 11: To Routes of Entry: Eye contact. Inhaiation. Ingestion. Toxidity to Animals: DES: Not available. LCSC: Not available. Chronio Effects on Humans: Not available. Differ Toxio Effects on Humans: Not available special Remarks on Toxioity to Animals: Not available special Remarks on Chronio Effects on Humans: Pas appealal Remarks on other Toxio Effects on Humans: Pas appeala Remarks on other Toxio Effects on Humans: Pas Special Remarks on other Toxio Effects on Humans: Section 12: I Ecotoxioity: Not available. Products of Biodegradation: Toxioity of the Products of Biodegradation: The prod	us in case of ingestion.
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Section 11: To Routes of Entry: Eye contact. Inhalation. Ingestion. Totalefy to Animale: DBO: Not available. DBO: Not available. Dthornie Effects on Humans: Not available. Dthor Toxic Effects on Humans: Not available. Dthor Toxic Effects on Humans: Not available special Remarks on Orkolofy to Animals. Not available special Remarks on Other Toxic Effects on Humans: Pas Special Remarks on other Toxic Effects on Humans: Section 12: I Section(by: Not available. Products of Blodegradation: The products are Foxisity of the Products of Blodegradation: Section 13: D	us in case of ingestion.
Section 11: To Routes of Entry: Eye contact, inhaistion, Ingestion, Toxidity to Animals: LDS: Not available, LDSE: Not available. Other Toxio Effects on Humans: Not available. Other Toxio Effects on Humans: Not available Special Remarks on Toxioity to Animals: Not available Special Remarks on Toxioity to Animals: Not available Special Remarks on Other Toxio Effects on Humans: Pas Special Remarks on other Toxio Effects on Humans: Pas Special Remarks on other Toxio Effects on Humans: Section 12: I Ecotoxioity: Not available. Products of Biodegradation: Products of Biodegradation: Toxioity of the Products of Biodegradation: Section 13: D Waste Disposal:	us in case of ingestion. See through the placental barrier in animal. Nutraince dust. Ecological Information not likely. However, long term degradation products may arise. Acts of degradation are more toxic. Not available. Isposal Considerations
Section 11: To Routes of Entry: Eye contact, inhalation, Ingestion, Toxidity to Animals: LDS: Not available, LDSD: Not available. Other Toxio Effects on Humans: Not available. Other Toxio Effects on Humans: Not available Special Remarks on Toxioity to Animals: Not available Special Remarks on Other Toxio Effects on Humans: Pas Special Remarks on other Toxio Effects on Humans: Pas Special Remarks on other Toxio Effects on Humans: Pas Special Remarks on other Toxio Effects on Humans: Section 12: 1 Ecoloxiolity: Not available. BODE and COD: Not available. Products of Biodegradation: Toxioity of the Products of Biodegradation Special Remarks on the Products of Biodegradation Section 13: D Waste Disposal:	us in case of ingestion. Sees through the placental barrier in animal. Nutraince dust. Ecological Information not likely. However, long term degradation products may arise. Acts of degradation are more toxic. Not available. Isposal Considerations Transport Information
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Section 11: To Roufes of Entry: Eye contact. Inhalation. Ingestion. Toxidity to Animale: LDS: Not available. Chronic Effects on Humans: Not available. Other Toxis Effects on Humans: Not available Extremely hazardous in case of inhalation. Very hazardou Special Remarks on Toxiolty to Animals: Not available Special Remarks on Other Toxis Effects on Humans: Pass Special Remarks on ther Toxis of Biodegradation Special Remarks on the Products of Biodegradation Special TS: D Waste Dispocal:	us in case of ingestion. Sees through the placental barrier in animal. Nutraince dust. Ecological Information not likely. However, long term degradation products may arise. Acts of degradation are more toxic. Not available. Isposal Considerations Transport Information
Section 11: To Routes of Entry: Eye contact, inhalation, Ingestion, Toxidity to Animals: LDS: Not available, LDSD: Not available. Other Toxio Effects on Humans: Not available. Other Toxio Effects on Humans: Not available Special Remarks on Toxiofty to Animals: Not available Special Remarks on Chronio Effects on Humans: Pas Special Remarks on Other Toxio Effects on Humans: Section 12: 1 Ecoloxiofty: Not available. BODE and COD: Not available. BODE and COD: Not available. BODE and COD: Not available. BODE and COD: Not available. Special Remarks on the Products of Biodegradation Special Remarks on the Products of Biodegradation Special Remarks on the Products of Biodegradation Special Remarks on DOT controlled material (Unt Isentification: Not applicable. Special Provisions for Transport: Not applicable.	us in case of ingestion. See through the placental barrier in animal. Nutrained dust. Ecological Information not likely. However, long term degradation products may arise. And available. Isposal Considerations Transport Information ed States).
Section 11: To Routes of Entry: Eye contact, inhalation, Ingestion, Tooldify to Animale; DSG: Not available, LOSC: Not available, Dthornio Effects on Humans: Not available, Dthornio Effects on Humans: Not available, Special Remarks on Toxiofly to Animale:. Not available special Remarks on Orbonio Effects on Humans: Section 12: 1 Bootoxiofly: Not available, BODS and COD: Not available, Bootoxiofly: Not available, BODS and COD: Not available, Bootoxinty, Not availabl	us in case of ingestion. See through the placental barrier in animal. Nutrained dust. Ecological Information not likely. However, long term degradation products may arise. And analable. Isposal Considerations Transport Information ed States). er Regulatory Information

Federal and State Regulations: TSCA 8(b) Inventory: L-Leucine Other Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). Other Classifications: WHMIS (Canada): CLASS D-2B: Material causing other toxic effects (TOXIC). DSCL (EEC): R41- Risk of serious damage to eyes.

HMIS (U.S.A.): Health Hazard: 3 Fire Hazard: 1 Readivity: 0 Personal Protection:] National Fire Protection Association (U.S.A.): Health: 3 Flammability: 1 Readivity: 0 Specific hazard: Protective Equipment: Not applicable. Lab coat. Wear appropriate respirator when ventilation is inadequate. Splash goggles.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/10/2005 08:21 PM Last Updated: 11/01/2010 12:00 PM

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of mechantability or any other warranty, express or impled, with respect to such hitomation, and we assume no lability resumptions that such current shall be here own investigations to determine the subalability of the information by their particular purposes. In no event shall belence labor there are used any claims, losses, or damages of any third party or br loss profits or any seecial, indiversi, incidental, consequential or exemplary damages, howsoever arising, even if ScienceLab com has been advised of the possibility of such damages.

Phenylalanine

	2	0 Fire Reactivity Personal
	afety Data Sheet	Protection
Section 1: Chemical Pro	duct and Company Identifica	tion
Product Name: L-Phenylalarine Catalog Codes: SLP4771, SLP1942, SLP3751 CA54: 63-91-2 RTEC3: AY7535000 TSCA: TSCA 8(b) Inventory: L-Phenylalarine Cl#: Not available. Synonym: L-Japha-Aminohydrochnamic add Chemical Formula: C9H11NO2	Contact Information: Sciencelab.com, inc. 14025 Smth Rd. Houston, Texas 77396 US Sales: 1400-901-7247 International Sales: 1-281 Order Online: ScienceLab. CHEMTREC (24HE Emergen 1-600-424-9300 International CHEMTREC, ci For non-emergency assistant	441-4400 com icy Telephone), call: all: 1-703-527-3887
Section 2: Composition	and Information on Ingredie	nts
Composition:		
Name {L-}Phenylaianine	CAS # 63-91-2	% by Weight
Toxicological Data on Ingredients: L-Phenylalanine LD	1999-0648	1024943
	azards Identification	
Potential Chronic Health Effects: lazardous in case of eye contact (inflant), of ingestion, of ARCINOGENIC EFFECTS: Not available. MUTAGENIC DEVELOPMENTAL TOXICITY: Not available.	Inhalation. Slightly hazardous in case EFFECTS: Not available. TERATOG	e of skin contact (irritant). ENIC EFFECTS: Not available
Section 4:	First Aid Measures	
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Section C Acceleral	al Robury Minister	10
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	Section 8: Exposure Controls/Parsonal Pretection
ngineeting Caribosi be process endoures, be polare time, if any oper- eres the exposure limit.	e anhazal vertilative, or other amplements controls to asser attorne towas before recommended apple generate built, turine a nact, use vertilation to save regulation to attorne calibamicants
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	Section 11 Topicological Information
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Special Nation in 25	er Tuelo (Effects of Hamans, 163 Julii Do-
-	Section 17: Ecological Information
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\$005 and COD: Not any	ruha.
Products of Ekstegrads Reality factorities and	ern degratatur protucts an not bely nonever, ong tern-degratation produtts may alter
	of Boolegalacidius. The principle of legislation ale more trace, Products of Baolegalacidius. Hist subscript
	Anches 12 Disposal Considerations
visels Disponsi	
	Bection 14. Transport Information
	a DCP carlitoled nativita (pridea 32844)
BUT CAMEBOARDE NO	
identification: NR appro-	208
ide/chutos: sit spin	

Section 16: Other Info	ormation
Protective Equipment: Gloves. Lab coat. Dust respirator. Be sure to use an approved/certified r	espirator or equivalent. Splash goggler
Specific hazard:	
Reactivity: 0	
Fiammability: 1	
Health: 2	
National Fire Protection Association (U.S.A.):	
Personal Protection: E	
Reactivity: 0	
Fire Hazard: 1	
Health Hazard: 2	
HMIS (U.S.A.):	
DSCL (EEC): R36- Initating to eyes.	
WHMIS (Canada): Not controlled under WHMIS (Canada).	
Other Classifications:	
Other Regulations: Not available	
Federal and State Regulations: TSCA 8(b) Inventory: L-Phenylalanine	

References: Not available.

Other Special Considerations: Not available. Created: 10/10/2005 08:45 PM

Last Updated: 11/01/2010 12:00 PM

Les opposes in mance is believen in The information currently available to us However, we make no warrantly of mechanizability or any other warrantly, express or implied, with respect to such information, and we assume no lability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall ScienceLab com be lable for any claims, losses, or damages of any third party or for loss pression systemic indicates in content shall scienceLab com the label for any claims, losses, or damages of any third party or for loss pression advised of the possibility of such damages.

Tyrosine



Material Safety Data Sheet L-tyrosine MSDS

Section 1: Chemical Produc	t and Company Identification
Product Name: L-tyrosine	Contact Information:
Catalog Codec: SLT3931, SLT1912, SLT3205	Solencetab.com, inc. 14025 Smith Rd.
CA3#: 60-18-4	Houston, Texas 77396
RTEC8: YP2275600	US Sales: 1-800-901-7247
TSCA: TSCA 8(b) Inventory: L-tyrosine	International Sales: 1-281-441-4400 Order Online: ScienceLab.com
Cl#: Not available.	CHEMTREC (24HR Emergency Telephone), call:
Synonym: p-Tyrosine; L-Beta-(p-Hydroxypheny()alanine;	1-800-424-9300
(-)-aipha-Amino-p-hydroxyhydrocinnamic acid; (S)- aipha-Amino-4-hydroxybenzenepropanoic acid;	Infernational CHEMTREC, call: 1-703-527-3887
Benzenepropanoic acid, alpha-amino-4-hydroxy-, (8)-; L- Phenylalanine, 4-hydroxy-; Propanoic acid, 2-amino-3-(4- hydroxyphenyl)-, (8)	For non-emergency assistance, call: 1-281-441-440
Chemioal Name: L-Tyrosine	
Chemical Formula: C9H11NO3	

Section 2:	Composition and Information on	Ingredients
Composition:		
Name	CAS #	% by Weight
(L-)tyrosine	60-18-4	100
	Section 3: Hazards Identification	8
Potential Acute Health Effects: Hazardous in case of ingestion, of inhaiat	ion. Slightly hazardous in case of skin cont	sct (irritant), of eye contact (irritant).
Potential Chronic Health Effects:		Not available. MUTAGENIC EFFECTS:

Section 4: First Ald Measures

p. 1

Section 7: Handling and Storage	
Large Splii: Use a showin to put the material into a convenient waste disposal container. Finish cleaning by spreading wa contaminated surface and allow to evacuate through the sanitary system.	ter on the
Small Split: Use appropriate tools to put the splited solid in a convenient waste disposal container. Finish cleaning by spr the containinated surface and dispose of according to local and regional authority requirements.	eading water on
Section 6: Accidental Release Measures	
Special Remarks on Explosion Hazards: Ene dust dispersed in air in sufficient concentrations, and in the presences of an ignition source is a potentia azard.	i dust explosion
Special Remarks on Fire Hazards: As with most powdered organic solids, fire is possible at elevated temperatures or by contact with an ignition	source.
Fire Fighting Media and Instructions: SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use water spray, fog or foam. Do not use water jet	
Explosion Hazards in Presence of Various Subdanoes: Ricks of explosion of the product in presence of mechanical impact. Not available. Slightly explosive in prese fames and sparks.	nce of open
Fire Hazards in Presence of Various Substances: Slightly flammable to flammable in presence of open flames and sparks, of heat. Non-flammable in presence	of shocks.
Products of Combustion: These products are carbon oxides (CO, CO2), nitrogen oxides (NO, NO2).	
Flammable Limits: Not available.	
Flach Points: CLOSED CUP: 175*C (348.8*F).	
Auto-Ignition Temperature: Not available.	
Rammability of the Product: May be combustible at high temperature.	
Section 5: Fire and Explosion Data	
Serious Ingestion: Not available.	
Ingestion: Do NOT induce womiting unless directed to do so by medical personnel. Never give anything by mouth to an person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight cithting se, bet or walstband.	
Serious Inhalation: Not available.	
inhalation: I inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. I attention.	Get medical
Serious Skin Contact: Not available.	
Skin Contact: Wash with scap and water. Cover the irritated skin with an emolitent. Get medical attention if	initation develops
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for ninutes. Cold water may be used. WARM water MUST be used. Get medical attention if imitation occurs.	at least 15

Prevaultions: Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire fisk, evaporate the residue under a fume hood. Ground all equipment containing material. Do not breathe dust. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If you feel unwell, seek medical attention and show the label when possible. Keep away from incompatibles such as outdaring agents. Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area.

Section 8: Exposure Controls/Personal Protection

Engineering Controls: Use process enclosures, local eshault ventilation, or other engineering controls to keep alroome levels below recommendi exposure limits. Your operations generate duct, tume or mist, use ventilation to keep exposure to aircome contaminants below the exposure limit.

Personal Protection: Safety glasses. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent.

Personal Protection in Case of a Large Spill: Spissh goggies. Full suit. Dust respirator. Boots. Gioves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits: Not available.

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid. (Powdered solid. Crystaline powder. Crystals solid.) Odor: Odoriess. Taste: Not available. Moleoular Weight: 181.19 g/mole Color: White. pH (1% coin/water): Not available. Boiling Point: Not available. Melting Point: Decomposition temperature: 344*C (651,2*F) Critical Temperature: Not available. Specific Gravity: Density: 1.456 (Water = 1) Vapor Pressure: Not applicable Vapor Density: Not available. Volatility: Not available. Odor Threshold: Not available Water/OII Dist. Coeff.: The product is more soluble in oil; log(oil/water) = 2.3 Ionioty (in Water): Not available Dispersion Properties: Not available. Solubility: Very signify soluble in cold water. Insoluble in diethyl ether, acetone. Solubility in water: 0.453 gl @ 25 C. Insoluble in absolute alcohol. Soluble alkaline solutions. Signify soluble in acetic acid.

p. 3

Section 10: Stability and Reactivity Data Stability: The product is stable. Instability Temperature: Not available Conditions of instability: Excess heat, ignition sources, dust generation, incompatible materials incompatibility with various substances: Reactive with oxidizing agents. Corrostvity: Non-corrostve in presence of glass. Special Remarks on Reactivity: Not available. Special Remarks on Corrosivity: Not available. Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Inhalation. Ingestion. Toxisity to Animals: LDSD: Not available, LCSD: Not available. Chronio Effects on Humans: Not available. Other Toxio Effects on Humans: Hazardous in case of ingestion, of inhalation. Slightly hazardous in case of skin contact (initiant). Special Remarks on Toxiolity to Animals: LD50 [Mouse] - Route: Intrapertoneal; Dose: >1450 mg/kg Special Remarks on Chronio Effects on Humans: May affect genetic materia (imdagenic). May cause adverse reproductive effects and birth defects (lenatogenic) based on animal test data. No human data base been found. aliman exclusion, no human can be been human: Special Remarks on other Toxico Effects on Humans: Acute Fotential Health Effects: Skin, May cause skin kintation Eyes: May cause eye initiation inhalation: Dust may cause resolvatory including thatason, ingestion May cause digetable track inflamion, lingestion of large (bock) amounts may also affect the liver, cause comesi disease, keralits, tackycardia and hypertension or bradycardia and hypotension. Chronic Potential Healt Effects: ingestion: Provided or repeated ingestion may affect the uninary system, blood, and behavior. Skin: Prolonged or repeated contact may cause dematities. Section 12: Ecological Information Eootoxiolty: Not available. BOD5 and COD: Not available.

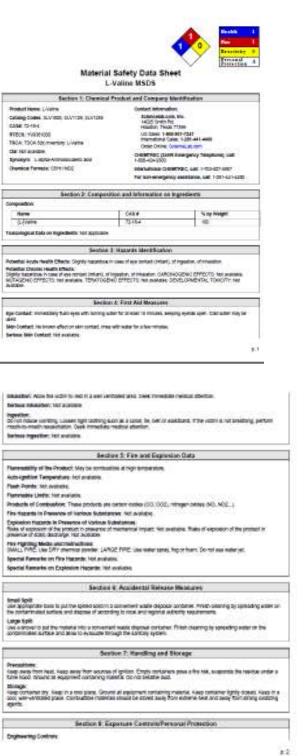
Products of Biodegradation: Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise. Toxiolity of the Products of Biodegradation: The product itself and its products of degradation are not toxic. Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal: Waste must be disposed of in accordance with federal, state and local environmental control regulations.

	Section 14: Transport Information
DOT Classification: No	a DOT controlled material (United States).
identification: Not appli	table.
Special Provisions for	Transport: Not applicable.
	Section 15: Other Regulatory Information
Federal and State Regu	dations: TSCA S(b) inventory: L-tyrosine
Other Regulations: EIN	ECS: This product is on the European inventory of Existing Commercial Chemical Substances.
Other Classifications:	
WHMIS (Canada): Not c	ontrolled under WHMIS (Canada).
with skin, wash immedia	fied according to the EU requisitions. 824/25- Avoid contact with skin and eyes. 829- After contact lety with plenty of water. 837- Wear suitable gloves. 846- in case of accident or if you feel unwell, edately (show the label where possible).
HMIS (U.S.A.):	
Health Hazard: 1	
Fire Hazard: 1	
Readivity: 0	
Personal Protection	E
National Fire Protection	Association (U.S.A.):
Health: 1	
Flammability: 1	
Readivity: 0	
Specific hazard:	
Protective Equipment: Gloves. Lab coat. Dust n	espirator. Be sure to use an approved/certified respirator or equivalent. Safety glasses,
	Section 16: Other Information
References: Not availab	e.
Other Special Concider	ations: Not available.
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Last Updated: 11/01/20	10 12:00 FM
make no warranty of mer no ilability resulting from their particular purposes. lost profits or any special	s believed to be accurate and represents the best information currently available to us. However, w chantability or any other warrantly express or incided, with respect to such information, and we assum its use. Users should make their own investigations to determine the suitability of the information to in one event shall ScienceLak.come liable for any claims, losses, or damages of any finite party oriti, indirect, incidental, consequential or exemplary damages, howsoever arising, even if ScienceLak.com possibility of user damages.

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Personal Protection in Case of a Cargo Split: Split oppose, for last, Room, Interest, Suggester protective conting imprint on a submert, contast a su- training the protect.	NUMBER OF CASE
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Section 3: Physical and Chemical Properties	
Physical state and appearance: Solid (Solid system) powder (
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Reasonar Verget: 177.18 (210)	
CORF WWW	
per pro. Aconventery: Not available	
Bolling Part Decorposes.	
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Critical Temperature: Not account	
tgeatto araetty: 1.23 (Mater - 1)	
Trapid Pressants: 162 applicates.	
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Department Pringer/Seat. Dev schuckty of autor.	
Nocelity Tematy volume in non-water. Very styrity volume in methanic, and me	
Section 10: Stability and Reactivity Data	
Manally The product is state.	
Instability Temperature: 101 a cardine	
Conditions of Webbardly risk bullcole	
incompatibility with vertices extentances: thit available,	
Contrakinity: Non-contains in presence of gives.	
Ipecial Famerics on Reactivity: rist available.	
Ipecial Remarks on Companyity: net available	
Polytewitedox. to.	

	Section 11: Toxicological Information
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UDSD: Not provideline, LCSIE: Net provideline	
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	Section 12: Enclogical Information
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Products of Biologradation:	
	an boards are up any reason, out pay where a branch branch way are
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lipidal liamante on the Products of t	Steckegnodelfion. Hist available.
	Section 13: Disposal Considerations
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	Section 14: Transport Information
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seronation for legitude	
Special Provintians for Transport: Not	grinds.
le le	otion 12: Other Regulatory Information
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Other Requiring Mit purples.	
Che Classification	
WHAT I CARAGE NEL CONTINUE ADDR	WHAT COUNTS
DAGE (PECE	
This product is not presented according to	othe burequisitions
estimation and the second seco	

Protective Equipment: Not applicable. Lab coat. Not applicable. Safety glasses.	
Specific hazard:	
Reactivity: 0	
Flammability: 1	
Health: 1	
National Fire Protection Association (U.S.A.):	
Personal Protection: a	
Reactivity: 0	

Section 16: Other Informatio

References: Not available. Other Special Considerations: Not available.

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Last Updated: 11/01/2010 12:00 PM

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Attachment C -- June 27, 2011 Memorandum from FDA CVM to USDA NOP



DEPARTMENT OF HEALTH & HUMAN SERVICES

Food and Drug Administration Rockville MD 20857

June 27, 2011

Ms. Shannon Nally Standards Division United States Department of Agriculture National Organic Program 1400 Independence Avenue SW Room 2646-S, STOP 0268 Washington, District of Columbia 20250

Dear Ms. Nally:

We are responding to your e-mail request of May 31, 2011 for clarification on how the United States Food and Drug Administration (FDA) determines which nutrients are required in the diets of animals other than man and the acceptability of ingredients used to supplement animal diets in order to meet specific nutrient requirements.

The regulations in Title 21 of the Code of Federal Regulations (21 CFR) Parts 500 to 599 [21 CFR 500-599] that pertain to the labeling and formulation of animal feeds, including foods for dogs and cats, do not contain a corresponding or homologous Part to 21 CFR 104, Nutritional Quality Guideline for Foods which applies ONLY to foods for people. Part 104 of 21 CFR sets Daily Reference Values (DRV) or Recommended Daily Intakes (RDI) for 21 nutrients that may be added to certain foods for people under the conditions specified within the regulation.

The Center for Veterinary Medicine (CVM) is the Center within FDA that has regulatory authority over animal feeds and the ingredients used to formulate animal feed products. For animal feeds, including foods for dogs and cats, the CVM has not established or promulgated any minimum requirements (MR), adequate intakes (AI), recommended allowances (RA) or other reference standards for daily nutrient intakes for any particular nutrient. The CVM relies on the various *ad hoc* expert nutrition committees under the Committee on Animal Nutrition of the National Research Council in the National Academy of Sciences for establishment of which nutrients, and in what amounts, are essential in the diets for specific species of domestic animals to meet that species' daily nutrient requirements. For dogs and cats, the required essential nutrients are listed and described in the 2006 edition of *Nutrient Requirements of Dogs and Cats.*¹ The CVM considers the nutrients listed in Tables 15-3, 15-5, 15-8, for dogs, and Tables 15-10, 15-12, 15-14 for cats, to be essential nutrients and eligible for supplementation if required to meet and provide the listed MR, or in the absence of a stated value for the MR then the listed value for AI for that nutrient, in products represented to be "complete and balanced."

¹ National Research Council (NRC). 2006. Nutrient Requirements of Dogs and Cats. Washington, D.C.: National Academy Press.

Page 2 of 4 - Ms. Shannon Nally

FDA regulates the ingredients added to animal foods, one purpose of which can be to supply nutrients to the finished product. Ingredients that FDA finds acceptable for inclusion in animal feeds may be found in several lists, publications and locations. Title 21 CFR Part 573, Food Additives Permitted in Feed and Drinking Water of Animals lists the additives that FDA has formally approved for the indicated intended use contained in the specific regulations. Substances that are generally recognized as safe (GRAS) for an intended use in animal feeds are listed in 21 CFR 582 and 21 CFR 584. The CVM has recently initiated a GRAS Notification Pilot Program similar to the GRAS Notification Pilot Program for ingredients in foods for people administered by the FDA Center for Food Safety and Applied Nutrition. Although at the time of this letter no substances have completed the CVM GRAS Notification process, eventually substances for which CVM has no questions regarding a GRAS determination made by a stakeholder will be indicated at

http://www.fda.gov/AnimalVeterinary/Products/AnimalFoodFeeds/GenerallyRecognizedasSaf eGRASNotifications/ucm19224.htm. Finally, although not formally approved through the food additive approval process or reviewed under the GRAS Notification Pilot Program, CVM generally allows the use of ingredients defined in Official Names and Definitions of Feed Ingredients in the *Official Publication* (OP) of the Association of American Feed Control Officials (AAFCO) in animal feeds within the specifications or restrictions contained in a particular ingredient's definition. At this time the Official Names and Definitions of Feed Ingredients in the OP of the AAFCO is likely the most comprehensive listing of ingredients acceptable for use in animal feeds.

Many dog and cat foods, possibly even the majority, are formulated to be complete nutrition products, similar in concept and objective to total mixed rations for cattle and complete feeds for swine and poultry. It is generally not possible to attain all required nutrients from a combination of typical food ingredients used to make dog and cat foods without including one or more specific nutrient supplements in the products. This is especially true for one or more required vitamins, minerals, and a few amino acids, and such nutrient supplements are not likely to meet the definition or standard for being organically produced. The National Organic Program (NOP) undoubtedly will have encountered such occurrences in the diets (or rations) required for cattle to produce organic milk and for the production of pork or poultry that can be labeled as organic. A notable required nutrient for cats that will likely not have merited consideration in the diets of other organic feeds is a requirement for the beta-sulfonic amino acid taurine. Because of losses in taurine content during processing and because taurine deficiency manifests as serious, irreversible blindness, heart failure, reproductive, and developmental failure, all complete cat foods are supplemented with synthetic taurine. The food additive regulation for taurine at 21 CFR 573.980 is for use in the feed of growing chickens. However, given the scientific determinations of the need for taurine in the diets of cats and the National Research Council's declaration of taurine as being essential for cats, CVM has not objected to inclusion of taurine in the diets for cats. The feed ingredient definition 6.12 for taurine in the OP of the AAFCO indicates it may be used in the diets for cats and dogs. There may be other nutrient-supplement ingredients specific to dog and cat foods that the NOP Standards Board has not considered before in regards to the formulation of diets for other animal species. Taurine is simply the most obvious example.

Page 3 of 4 – Ms. Shannon Nally

Your e-mail mentions the AAFCO Dog and Cat Food Nutrient Profiles. These profiles contain a list of required nutrients and recommended concentrations for those nutrients in dog or cat food products if a manufacturer wants to claim the product is complete and balanced based on the product containing the nutrient concentrations listed in the particular profile. Such claims are enforced by various states through the state's feed laws and regulations if that state has adopted the AAFCO Model Regulations for Pet Food and Specialty Pet Food that are also contained in the OP of the AAFCO. The AAFCO Dog and Cat Food Nutrient Profiles do not contain any nutrient that has not been determined to be essential and listed in the previously referenced tables in the 2006 edition of Nutrient Requirements of Dogs and Cats. The 2006 edition of Nutrient Requirements of Dogs and Cats contains some additional specific fatty acids as essential required nutrients for specific life stages of dogs and cats that are not currently listed in the AAFCO Dog and Cat Food Nutrient Profiles. The AAFCO Dog and Cat Food Nutrient Profiles are presently under consideration for revision, but what the specific revisions will be cannot be stated at this time. As previously indicated, FDA CVM relies on the Committee on Animal Nutrition of the National Research Council in the National Academy of Sciences for establishment of which nutrients are essential in the diets of animals, not the AAFCO Dog and Cat Food Nutrient Profiles.

In terms of concentrations of nutrients to meet some reference standard for daily nutrient intakes, the values in the AAFCO Dog and Cat Food Nutrient Profiles generally are equivalent to the AI or the RA amounts listed in the 2006 edition of *Nutrient Requirements of Dogs and Cats*. This is to provide a safety factor to ensure that minimum requirements are met should any interference in nutrient availability occur due to interactions between ingredients or from nutrient losses over the product's shelf life. Such formulations above absolute minimum requirements will generally not dictate whether a specific nutrient supplement is needed to be used, as in the case of taurine discussed above. The need for supplementation will exist regardless, only the amount used to meet a given reference standard will vary.

I hope the information in this letter is helpful in clarifying the following points:

- 1. The nutrients FDA consider essential in dog and cat foods and the source of the designation for essentiality.
- 2. The various listings for ingredients the FDA considers to be acceptable for use in animal feeds, including ingredients for supplementation of specific nutrients in diets for animals. Please note, such ingredients may not meet the National Organic Program's criteria for being considered acceptable in organic products, but are acceptable for use in animal feeds under FDA's policies and authority.
- 3. The relationship between the 2006 edition of *Nutrient Requirements of Dogs and Cats* and the AAFCO Dog and Cat Food Nutrient Profiles.

Page 4 of 4 - Ms. Shannon Nally

You may contact me by telephone (240-453-6865), telefacsimile (240-453-6882) or email (<u>william.burkholder@fda.hhs.gov</u>) and refer to DAF 11177 if you have any questions concerning the content of this letter.

Sincerely,

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Attachment D - NRC Discussion on Protein and Amino Acids

Protein and Amino Acids

BASIC CONCEPTS

Introduction

Dogs have been used as a model for the study of human nutrition for nearly two centuries. Magendie (1816) was the first to demonstrate that protein was essential for life by showing that olive oil or sugar alone would not support life. but if protein was added, the dogs were in better condition for a much longer period of time. These early experiments and many others were confounded by the lack of knowledge and appreciation of the need for essential micronutrients. Nevertheless, it was clearly understood that protein was essential in the diet. The Magendie Commission was appointed in 1815 to evaluate the nutritive value of gelatin. In 1841, it reported (cited by McCollum, 1957) that dogs could not be maintained when fed gelatin alone. This led to the testing of other purified proteins with the result that no purified protein, when fed alone without other food ingredients, could maintain a dog in good health. Despite the lack of knowledge of the essentiality of micronutrients, over a period of a few decades there came a realization that the quality (amino acid composition) of protein in dog diets was important (Chittenden, 1904). In 1905, Kaufmann reported that dogs maintained nitrogen equilibrium when fed a gelatin-based diet supplemented with tyrosine, cystine, and tryptophan. Later work with rats showed that a similar diet was not nutritionally adequate (Jackson et al., 1928). The concentrations of other essential amino acids were too low to meet the requirement of animals for maintenance. Nevertheless, nutritional research with dogs helped establish that certain amino acids present in protein were essential in the diet. Although Abderhalden and coworkers were able to formulate satisfactory diets for dogs using protein hydrolysates during the early part of the twentieth century, they were never successful in formulating a satisfactory diet using amino acids as the sole nitrogen source (Abderhalden et al., 1912). This feat had to wait until Rose isolated and characterized threonine, the last essential amino acid to be discovered that is required by all animals (McCoy et al., 1935). In 1939, Rose and Rice reported a slight positive nitrogen balance in dogs fed amino acid diets containing the same 10 essential amino acids that are required for the growing rat. They also reported that the removal of arginine had no effect on nitrogen equilibrium, whereas later work (Burns et al., 1981) showed that arginine was an essential amino acid for the adult dog. Since Rose and Rice did not publish the composition of the diet they used, the difference between the two studies remains unexplained.

Cats were not used as early or as routinely in nutrition experiments on the essentiality of protein and amino acids as were dogs. One early experiment using cats that had general application was published by Bidder and Schmidt in 1852 in which they showed, using controlled experimental conditions, that after cats ingested all the meat they could eat during a 7-day period, all of the dietary nitrogen (except 0.7 percent, which was within experimental error) was found in feces and urine and none was released as nitrogen gas. Nevertheless, it was not until the middle of the twentieth century that Da Silva and coworkers (1950a,b) and Allison and coworkers (1956) designed satisfactory purified diets that cats would eat readily, and cats could then be used effectively in nutrition research. Not until 1979 were the same 10 amino acids shown to be essential for cats as for dogs and other animal species (Rogers and Morris, 1979).

Structure and Function

With the exceptioff of proline, all amino acids present in most proteins are α -amino acids and have α -amino and α -carboxyl groups, both of which are involved in the peptide bonds that are essential for protein structure. Each amino acid has a side chain on the α -carbon that ranges in size from a hydrogen atom to an indole ring. The various side chains contribute to the secondary and tertiary structure of protein, and several are often conjugated to various other groups such as phosphate and amino sugars. Also of nutritional importance are the acidic and basic side chains in proteins that can accept or donate protons, depending on the pH of the medium in which the protein is present. Acid-precipitated proteins (e.g., casein) have protons added to the carboxyl group side chains. These protons, together with those on the basic side chains, are released during digestion, absorption; and utilization and contribute to metabolic acidosis. Amino acids are important in providing building blocks for many important biologically active compounds plus countless peptides and proteins. The sensory perception of purified proteins per se is that they are quite bland, whereas peptides, and free amino acids have various tastes for humans that range from bitter (e.g., phenylalanine, tryptophan, arginine, leucine), to sour (e.g., glutamic and aspartic acids).

sweet (e.g., <u>glycine</u>, threonine), umami (monosodium glutamate), or combinations thereof. The D-amino acids often have a different taste; for example, D-tryptophan is many times sweeter than sucrose. Whether dogs and cats perceive (taste) amino acids in the same way as humans is not known; however selection of amino acids such as leucine by the cat and different neuroresponses by cats and dogs indicate some differences in taste perceptions of different amino acids.

Essentiality of Amino Acids

Dietary protein is required for two reasons. First, protein provides amino acids that dogs and cats cannot synthesize (essential amino acids) but are required for synthesis of the many proteins in the body. Second, protein provides dispensable amino acids (amino acids that can be synthesized if appropriate nitrogen and carbon sources are provided) that animals need for maintenance, growth, gestation, and lactation. Dispensable amino acids provide nitrogen and carbon for the synthesis of any needed dispensable amino acid and carbon for gluconcogenesis and/or energy, Dispensable amino acids also provide nitrogen and/or structural components necessary to make other compounds that are essential for life, such as purines, pyrimidines, heme, various hormones, neurotransmitters, and/or neuromodulators (e.g., thyroxine, catecholamines, y-aminobutyric acid, taurine). For either dogs or cats that consume primarily animal tissue, amino acids also provide carbon chains for gluconeogenesis to supply glucose to tissues that require it (e.g., red blood cells, nervous tissue) to maintain normal tissue metabolism. As for most other animals, the following 10 amino acids have been shown to be essential for both dogs and cats: arginine (Arg), histidine (His), isoleucine (Ile), leucine (Leu), lysine (Lys), methionine (Met), phenylalanine (Phe), threonine (Thr), tryptophan (Trp), and valine (Val). In omnivores. and certain herbivores (e.g., rats, chicks), removal of a single essential amino acid results in a decrease in food intake that is known to be a primary neuroresponse caused by the lack of the limiting essential amino acid (Gietzen, 1993). In cats, the limited work available (e.g., Hardy et al., 1977;

Rogers and Morris, 1979) shows that food intake does not decrease as quickly as in rats after initial consumption of a diet devoid of an essential amino acid. Although food intake does decrease with time, the depression is not as severe as in omnivores and herbivores. The depression of food intake appears to be a secondary effect, and the result of a lack of need of energy for growth, since the kittens stop growing and slowly lose weight. Cats may be a good model for strict carnivores since it could be argued teleologically that strict carnivores that eat only animal tissue would never experience an essential amino acid deficiency. Therefore, carnivores do not need to respond in such a sensitive way to a protein or an essential amino acid deficiency as omnivores and herbivores. There is less evidence for dogs. It appears, however, that dogs may respond more like other omnivores (Milner, 1979a.b).

Omnivores and herbivores avoid diets deficient in a single essential amino acid. Rats are able to select between diets that contains less than 0.1g/kg⁻¹ difference in an essential amino acid (Hrupka et al., 1997). Hrupka et al. (1999) also showed that the learned taste aversion that mediates this choice against a low dietary concentration of a particular essential amino acid occurs before food intake is decreased. That is, the establishment of a learned taste aversion is more sensitive to a deficiency than simply a reduction of food intake. Little work has been done on whether learned aversions occur after feeding various essential amino acid-deficient diets to dogs and cats. Dogs are known to select for an adequate quantity of protein (three to four times their requirement; Romsos and Ferguson, 1983; Torres et al., 2003), whereas cats do not (Cook et al., 1985).

Digestibility and Bloavallability of Protein and Amino Acids

Digestion of dietary protein by animals involves enzymatic cleavage of the protein to amino acids and small peptide residues that are capable of being absorbed by the mucosal cells of the small intestine. Protein digestibility-or more specifically, total digestive tract digestibility-is generally defined in nutritional science as the percentage of ingested protein that is not excreted in the feces as measured by input and output of nitrogen. Bioavailability is generally defined as the degree to which an ingested nutrient in a particular source is absorbed in a form that can be utilized in the animal's metabolism (Lewis and Bayley, 1995). Much detailed work has been done on the bioavailability of amino acids from common proteins in food-animal nutrition (Lewis and Bayley, 1995; Sibbald, 1987) using ileal digestibilities as a measure of bioavailability. Similar studies have been done with dogs (see Johnson et al., 1998; Bednar et al., 2000; Clapper et al., 2001); however, almost nothing is available for cats (Hendriks and Emmens, 1998; Larsen et al., 2001, 2002), perhaps because of the perceived difficulty in keeping ileally cannulated cats (Mawby et al., 1999).

The first approach in determining bioavailability is to measure "apparent digestibility" of protein in a diet. This provides an overall evaluation of nitrogen absorbed but does not provide a measure of the "quality" or efficiency of utilization of nitrogen or of the individual essential amino acids. Historically, in human and animal nutrition, protein quality tests such as protein efficiency ratio (PER), biological value (BV), and net protein utilization (NPU), as determined in rat assays, have been used as one measure of overall amino acid bioavailability. Net protein utilization provides a measure of the efficiency of utilization of a protein. Differences in efficiencies of utilization of the same protein in various species may result from different digestibilities and/or nitrogen and amino acid requirements. Carnivores in general, including cats, have lower apparent digestibilities of poorly digestible proteins (Kendall et al., 1982; Ahlstrom and Skrede, 1998) and higher requirements for some amino acids such as arginine (Anderson et al., 1979a; Costello et al., 1980). Further refinement of the bioavailability values for individual amino acids results from determination of the ileal digestibility of individual essential amino acids. Although these values provide a better indication of bioavailability than total gastrointestinal (GI) tract digestibility, dietary protein could be 100 percent digested and absorbed, but protein and amino acids would still enter the colon because of gastrointestinal secretions (sloughed mucosa and digestive enzymes). Thus, "true" ileal digestibilities have been measured using a number of techniques to estimate endogenous protein excreted from the ileum (Moughan et al., 1998). Since only some of this endogenous protein is essential for protein utilization, even true digestibilities of nitrogen and essential amino acids may not reflect true bioavailabilities. It should be noted that some dietary proteins contain inhibitors of trypsin or other enzymes that can greatly increase the loss of secreted enzymes. Generally, some in vivo measure, such as weight gain and/or nitrogen retention, is considered the ultimate or "gold standard" for determining nitrogen and amino acid bioavailabilities (Lewis and Bayley, 1995).

The apparent total tract digestibility of protein is similar in rats, cats, and dogs for highly digestible proteins. Proteins with lower digestibilities have higher apparent digestibilities in dogs than in cats (Kendall et al., 1982). For proteins with digestibilities greater than 90 percent (e.g., fresh mince and purified diets), there is no difference in digestibility between dogs and cats. For dry or canned dog or cat foods, dogs have a protein digestibility about 5-8 percent higher than do cats (Kendall et al., 1982). This difference in digestibility of protein in processed foods appears to be the result of the shorter length of the small intestine, relative to body size, in cats compared to dogs. Animal proteins generally have a higher digestibility than do plant proteins (Meyer et al., 1981, 1989; Kendall and Holme, 1982; Neirinck et al., 1991), and prolonged heat processing decreases animal protein digestibility by dogs and cats (Meyer et al., 1981; Backus et. al., 1998; Johnson et al., 1998). Heat processing increases the digestibility of some proteins because antitryptic activity is destroyed by heat (Morgan et al., 1951). The digestibility of protein varies with size, breed, and age of dogs. Pointers had a higher apparent total tract digestibility of protein than huskies (85 vs. 81 percent), and young miniature poodles or schnauzers had a higher digestibility (about 4 percent higher) than did older ones (Hannah et al., 1995). Insoluble fiber is not reported to affect protein digestibility, whereas soluble fiber often decreases the total tract protein digestibility in both dogs (Muir et al., 1996; Silvio et al., 2000) and cats (Sunvold et al., 1995; Harper, 1996).

Digestibilities of the protein in various ingredients of typical dog food by ileally cannulated dogs have shown that the apparent ileal digestibility of crude protein (CP) is about 1-20 percentage units lower than apparent total tract digestibility. Presumably, bacteria degrade and utilize protein in the colon, with the release and absorption of ammonia and other low-molecular-weight nitrogen-containing compounds (Mühlum et al., 1989; Muir et al, 1996; Murray et al., 1997, 1998; Hendriks and Sritharan, 2002). Ileal crude protein digestibilities ranged from 63 to 96 percent whereas total tract protein digestibilities ranged from 71 to 98 percent. When diets contained a high content of low-digestible carbohydrate, ileal apparent protein digestibility was even more impaired than total tract digestibility (Muhlum et al., 1989). Ileal digestibilities of individual amino acids from normal ingredients in dog foods have been shown to vary tremendously (Johnson et al., 1998). True ileal digestibilities for some amino acids such as arginine varied from 77 to 87 percent, whereas others such as cystine, threonine, and lysine varied from 29 to 66 percent, 52 to 78 percent, and 62 to 84 percent, respectively. The lowest amino acid digestibilities were reported for rendered lamb meal, presumably because of extended heating during the rendering and drying process. For all of the essential amino acids, digestibilities of low-ash meat and bone meal were lower (5-18 percentage units) than those of high-ash meat and bone meal. The same was not true for poultry by-product meals for which no difference was found between high- and lowash meals. Of particular interest is the very low cystine digestibility (29 percent) found in low-ash lamb meal and the finding that, in general, meat and bone meals had higher digestibilities of all of the essential amino acids than did poultry by-product meals. These results indicate the importance of quality control in processing ingredients (i.e., the need to control the rendering and drying processes to preserve a high digestibility of athino acids, especially cystine, threonine, and lysine). Surprisingly, the digestibility of methionine was not as low in this study, varying only from 83 to 93 percent (Johnson et al., 1998). Fiber content of the diet had little effect on ileal digestibility of crude protein except for soluble dietary fibers such as pectin (Meyer et al., 1989; Muir et al., 1996; Silvio et al, 2000). Addition of 50 g pectin-kg-1 diet caused a decrease of about 7 percent in ileal,

but only 2 percent in total tract crude protein digestibility (Muir et al., 1996). Good-quality soybean meal (properly heat treated) as an ingredient in dog food has equal or higher ileal and total tract digestibilities than good-quality meat meals (Bednar et al., 2000; Clapper et al., 2001), and the content of various carbohydrates including oligosaccharides in soybean meal had no significant effect on ileal digestibility of soybean protein (Meyer et al., 1989; Zuo et al., 1996). Johnson et al. (1998) compared digestibilities of dog food determined with cecectomized roosters to that with ileally cannulated dogs and found correlation coefficients of 0.89. 0.94, 0.87, and 0.90 for lysine, cystine, threonine, and methionine, respectively, Thus, apparent digestibilities determined by cecectomized roosters may be reasonable approximations for the bioavailabilities of amino acids for dogs.

Larsen et al. (2001, 2002) reported validation of a growth assay to determine bioavailabilities of lysine and methionine in proteins for growing kittens. They showed that weight gain was 25 percent lower when kittens were given a casein diet (moistened, 50 g glucose-kg-1 casein, heated at 121°C for 2 hours) than when they were given a diet of non-heatprocessed casein. Lysine in the casein before heat treatment had a bioavailability of 96 percent, whereas heat processing with glucose decreased its bioavailability to 56 percent. Since total tract protein digestibilities for the same food are lower in cats than in dogs (Kendall et al., 1982), it is doubtful that the rat or other omnivorous species will be satisfactory as a model for cats (Hendriks and Emmens, 1998).

Assessing Protein and Amino Acid Status

Long-term protein status can be assessed by the maintenance of serum albumin and lean body mass. Examination of concentrations of amino acids in plasma provides a basis for determining which amino acids may be limiting (Zicker and Rogers, 1990) in a particular diet. Acute protein deficiency with adequate intake of energy (e.g., very low protein or protein-free diet) causes a decrease in all amino acids in plasma. In long-term protein deficiency (protein-energy malnutrition), the concentrations of both serum albumin and the essential amino acids (except histidine and phenylalanine) plus tyrosine and cyst(e)ine are much lower than normal, and the dispensable amino acids (especially proline, alanine, serine, and glycine) are higher than normal (Holt et al., 1963). Since changes in concentrations of glycine and valine are most extreme after feeding a very Tow protein diet, the extent of distortion of the normal glycine:valine ratio has been used as an index of the severity of protein malnutrition. The only known cause of this unique pattern is protein-energy malnutrition. Food deprivation will not produce this pattern but will sustain a more normal amino acid pattern in plasma. If only the glycine:valine ratio is used for a nutritional diagnosis of dogs or cats with kidney disease, a false diagnosis of protein malnutrition may occur. In kidney disease, glycine increases in plasma because the kidney nor-

mally converts glycine to serine. However, dogs and cats are often anorexic during renal disease; so, some protein deficiency is not unusual.

Longenecker and Hause (1959) showed that even if dogs were not deficient in protein, the limiting dietary amino acid (and sometimes the second and third limiting) could be determined from the pattern of plasma amino acids. The essential amino acid that decreases the most (or increases the least), as a percentage, after feeding a complete meal containing the protein in question is the one that is most limit ing; the one that decreases the next most is second limiting and so forth. This technique requires overnight food depri vation and the ingestion of a large meal. It is important to note that amino acids tend to return to normal if the anima is food deprived. Alternatively, plasma samples from dogs o cats fed a diet ad libitum for several days and taken in the absorptive phase provide the same information. For exam ple, Hardy et al. (1977) reported that plasma valine de creased markedly when valine was limiting in the diet, from more than 300 nmol·mL-1 to 66 nmol·mL-1 at the require ment and to 33 nmol-mL-1 when valine was left completely out of the dict. Reference data generated in this way are use ful to determine whether the need for each essential amin acid has been met. Rogers, Morris, and coworkers have de termined the dose-response curve of each essential amin acid during amino acid requirement studies. These datathe concentration of each essential amino acid in plasm after feeding normal diets (adequate intake [AI], i.e, at leas 1.5 times the minimum requirement [MR]); the concentra tion after feeding diets devoid of each essential amino aci (AA); the concentration after feeding diets containing eac amino acid just at the MR; and for some amino acids, whe present at a great excess (upper limit of tolerance or sal upper limit [SUL]) (Table 6-1)-can be used to determin the essential amino acid adequacy of diets for cats at variou life stages. Unfortunately, similar complete plasma amin acid data are not available for dogs. Normal plasma amin acid concentrations are available (Strombeck and Roger 1978; Delaney et al., 2003), and some information is avail able for arginine, leucine, lysine, phenylalanine, and tyn sine for dogs (Tables 6-2A and B).

REQUIREMENTS, ALLOWANCES, AND TOLERANCES OF PROTEIN AND AMINO ACIDS

Role of Metabolic Adaptation in Protein and Amino Acid Nutrition

Relevant to both crude protein and essential amino ac requirements in various species is the nature and extent metabolic adaptation in nitrogen and amino acid metab lism. For example, rats can down-regulate nitrogen catabol enzymes to such an extent that they maintain nitrogen by ance when fed a diet containing 4-5 percent of metaboli able energy (ME) as protein (National Research Counc PROTEIN AND AMINO ACIDS

TABLE 6-1 Plasma Amino Acid Concentrations

Amino Acid	-AA#	MR ^A	AF	SUL/
Argining	28	75	100	400
Histidine	9	55	100	>200
Isoleucine		30	75	>3,000
Leucing	25	75	125	>1.600
Lysinc	45	60	110	>600
Methionine	11	30 (70)	45	400
Phenylalianine	11	25 (75)	65	>900
Tyrosine	10	35	50	310
Threonine	60	80	150	>1,400
Tryptophan	9	25	50	130
Valine	33	66	130	>6,000
Giutamate	50-100	1000	50-100	200

"Amino acid concentration from kittens fed, in turn, diets lacking each amino acid.

*Amino acid concentration from kittens fed, in turn, diets containing each amino acid at the minimum requirement.

^{(Antino acid concentration from kittens fed, in turu, diets containing each amino acid at 150% or more of the requirement (i.e., adequate intake), ^{(Antino acid concentration from kittens fed, in turu, diets containing each}}

amino acid at great excess, at or below the SUL

(70), without any cystine in the diet. (75, without any tyrosine in the diet.

SOURCE: Summarized from Zicker and Rogers (1990) and Taylor et al. (1996, 1998).

1995). Rats can also down-regulate the lysine catabolic pathway such that the lysine requirement for maintenance is only 12 percent that for growth, whereas the lack of specific down-regulation of isoleucine degradative enzymes results in an isoleucine requirement for maintenance 50 percent that for growth. The same detailed information is not available

TABLE 6-2A Plasma Anino Acid Concentrations

Amino Acid	$-AA^0$	MR ⁰	Ale	SUL
Arginine	25	72	135	-
Lencine	18	100	150	-
Lysine	30	85	190	-
Phenylalanine	30*	8.5*	60*	
Tyrusine	40	1.20	50/	-

"Amino acid concentration from pupples fed, in turn, diets lacking each amino acid,

^bAnsino acid concentration from puppies fed, in turn, diets containing each amino acid at the minimum requirement. 'Animo acid concentration from puppies fed, in turn, diets containing each

*Amino acid concentration from pupples (ed. in turn, diets containing each aminos acid at 150% or more of the requirement (i.e., adequate intake). *Amino acid at great excess, at or below the SUL.

among actual or great excess a solution of the solution of the solution of phenylalanine, when tyrnstine is not present in the diet. "Concentration of phenylalanine and tyrnstine when both are present in the

diet, 6Concentration of tyroside when it is not present in the diet. SOURCE: Summarized from the work of Strumbeck and Rogers (1978); Czarnecki and Baker (1984); Milner et al. (1984); Czarecki et al. (1985); Hirakawa et al. (1986); Delaney et al. (2001). TABLE 6-2B Plasma Amino Acids Concentrations (nmol·mL⁻¹) from Normal, Small-, and Large-Breed Adult Dogs (n = 131) Fed a Variety of Commercial Diets Known to Be Adequate for Maintenance

Amino Acid	Mean	SEM
Alamine	388	9.6
Arginine	102	2.6
Asparagine	40	1.1
Aspartate	7	0.2
Cinnillise	-41	1.9
Cysteing	46	1.3
Glutamate	23	1.2
Glutamine	495	9.4
Glycine	265	8.4
Histichne	71	1.0
Hydroxyproline	67	4.1
Isoleucine	51	1.3
Leacine	120	3.2
Lysine of	132	5.0
Methionine	57	1.6
Omithine	35	1.5
Phenytalamine	45	0.9
Proline	246	8.2
Serine	107	2.6
Taurine	77	2.1
Whole blood	266	5.1
Threomine	178	5.0
Tryptophan	60	1.7
Typiopian	39	1.1
Valine	157	4.1

NOTE: SEM = standard error of the mean.

SOURCE: Delanry et al. (2003).

for dogs or cats; however, it is known that neither is as efficient in down-regulating nitrogen catabolic enzymes as rats (Rogers et al., 1977; Morris et al., 2002). Herbivores and omnivores in general show up- and down-regulation of nitrogen catabolic enzymes and of enzymes involved in the first irreversible step in the catabolism of essential amino acids. For the disposal and conservation of nitrogen, these adaptations particularly involve the up- and down-regulation of all of the urea cycle enzymes (Schimke, 1962), as well as alanine aminotransferase and aspartic aminotransferase (Kaplan and Pitot, 1970). Changes in the flux through the urea cycle occur without a change in the amount of enzymes as a result of the following:

I. Increasing or decreasing the concentration of substrate. Increasing or decreasing the concentration of alanine, aspartic acid, armonia, and glutamic acid will affect the flow of nitrogen from these and other amino acids into urea since most of the catabolic enzymes are working with substrate concentrations considerably below their Michaelis constant (K_m) values.

 Changes In the concentration of ornithine in the liver. As the postabsorptive state approaches and ammonia coming from the amino acids decreases or after feeding a low-protein diet, ornithine concentration in the liver decreases (as a result of the activity of ornithine δ-aminotransferase) and with very little acceptor available for carbamoyl phosphate, urea synthesis markedly decreases. After ingestion and absorption of arginine (usually in dietary protein) and the action of liver arginase, the liver is provided with suflicient ornithine to maximize urea synthesis for any particular activity of the urea cycle enzymes. If ornithine is limiting in the liver and a nitrogen source free of or low in arginine is given to an animal (Wergedal and Harper, 1964), hyperammore sensitive to arginine deficiency than dogs (Burns et al., 1981; Czarnecki and Baker, 1984), which, in turn, are more sensitive than rats (Milner et al., 1975; Rogers, 1994).

3. Allosteric regulation of carbamoyl phosphate synthase. The first step in the synthesis of urea occurs via activation by N-acetylglutamate (NAG). Synthesis of NAG is allosterically regulated by arginine. Thus, although the K_a of NAG synthesis for arginine is five times higher in cats than in rats, the concentration of arginine in liver, as well as the precursors of NAG (glutamate and acetyl coenzyme A), influence hepatic NAG concentrations (Stewart et al., 1981). Both arginine and glutamate increase rapidly in liver after the intake of a high-protein meal, enhancing the ability of the liver to dispose of excess nitrogen. As substrates for urea synthesis decrease, NAG diffuses out of the mitochondria and is cleaved by an acetylase.

4. Up- and down-regulation of the nitrogen catabolic enzymes. The final level of control to enable the animal to maintain amino acid homeostasis is the up- and down-regulation of the nitrogen catabolic enzymes. This regulation can occur by changing the rate of degradation of the enzymes or, more generally, by changing the rate of synthesis of the enzymes through increasing the rate of synthesis of mRNA. Up- and down-regulation of the nitrogen catabolic enzymes does not appear to occur to any great extent in the cat (Rogers et al., 1977; Tews et al., 1984) and occurs to a lesser extent in the dog (Morris et al., 2002) than in the rat. The three levels of control mentioned above are all rapid, occurring in seconds, whereas the changes in the amounts of the enzymes take 1-5 days. It appears that the extent to which animals can up- and down-regulate the amounts of the nitrogen catabolic enzymes is what really dictates the ability. on the one hand, to efficiently utilize high-protein diets, and, on the other, to be able to maintain nitrogen balance when fed a low-protein diet. Thus, it has been suggested that the high-protein requirement of adult cats at maintenance is the result of the inability to effectively down-regulate the hepatic nitrogen catabolic enzymes (Rogers et al., 1977). This interpretation has been challenged by Russell et al. (2002) using respiration calorimetry to measure protein oxidation in adult cats; they showed that cats fully oxidized all of the protein after adaptation to a normal (350 g-kg-1) and a high (520 g·kg-1) crude protein diet. These authors suggest that it is still unknown how the cats adapted to these two levels of

protein, whereas Rogers and Morris (2002) contend that the first three levels of control described above, together with an increase in liver size (thereby increasing the total hepatic nitrogen catabolic enzymes), are sufficient to provide for complete oxidation of the relatively high quantities of dietary protein tested. Russell et al. (2002) did not address the inability of the cat to adapt to low-protein diets. Regardless of the interpretation of the results of these two groups, studies of the requirement for maintenance of adult cats show the lack of ability of cats to maintain nitrogen balance at the same minimal dietary concentration as dogs and the inability of dogs (at least long term) to maintain nitrogen balance at the same low concentration as that of rats.

The limited information available on the effect of dietary protein on amino acid metabolism (Primal et al., 1986; Humbert et al., 2002) and the adaptation of enzymes involved in the first step of the degradation of the essential amino acids (as well as important dispensable amino acids such as tyrosine and cystine) indicate some up- and downregulation of these enzymes in the cat, but not to the same extent as in rats. For enzymes involved in the metabolism of tryptophan (Leklem et al., 1969), histidine (Rogers et al., 1977), methionine (Fau et al., 1987a; Strieker, 1991), threonine (Hammer et al., 1996b), tyrosine (Bai et al., 1998), cysteine (Park et al., 1999), and taurine transport (Park et al., 1989), only about a 20-120 percent increase in activity occurs in cats switched from a low- to a high-protein diet. compared to a severalfoid increase of these enzymes in rats. For example, threonine catabolic enzymes increase only about twofold when cats are switched from a low- to a highprotein diet (Hammer et al., 1996b), whereas under similar conditions, better than a tenfold increase occurs in rats (Freedland and Avery, 1964; Harper, 1968). Likewise, dietinduced daily rhythms as a result of eating a normal diet cause only a slight change (about 35 percent) in hepatic tyrosine aminotransferase activity of cats (Bai et al., 1998), whereas in rats a four- to five-fold change occurs (Wurtman and Axelrod, 1967). The consequence of less metabolic adaptation in dogs and cats is that even after adapting to a high-protein diet, plasma amino acid concentrations are higher after a meal (Tews et al., 1984; Torres and Rogers, 2002), whereas in rats after adaptation, plasma amino acids are similar whether they are adapted to a low- or a highprotein diet (Anderson et al., 1968).

Nitrogen (Crude Protein) Minimum Requirements, Recommended Allowances, and Adequate Intakes

Variables Used in Assessing Protein and Amino Acid Requirements

Nitrogen Balance

Nitrogen balance has, for many decades, been the preferred dependent variable for determining nitrogen and

PROTEIN AND AMINO ACIDS

amino acid requirements for all life stages. Often, there is no difference in the breakpoints for weight gain or nitrogen retention to determine individual amino acid requirements for growth of many species. Nevertheless, there are situations (and certain requirements) in which for dogs and cats, the breakpoint for nitrogen balance results in a higher requirement than that for weight gain. However, in determination of the nitrogen requirement of cats, a clear plateau does not always occur (Hammer et al., 1996a), but, after the breakpoint, there is still a significant positive slope. Although maximal nitrogen retention has been the standard variable used, when determining the nitrogen requirement, it has been shown that apparent nitrogen balance for maintenance. may be sustained while lean body mass is decreasing, apparently because of the low sensitivity and consistent errors in a positive direction for nitrogen retention that do not exist for the usual determinations of lean body mass (Hannah and Laflamme, 1996). In some experiments, only weight gain has been used; in others, both weight gain and nitrogen balance or just nitrogen balance (e.g., for maintenance). In still others, some other metabolic or physiological variable was used. In reviewing the literature on nitrogen and amino acid requirements, the variable that resulted in the highest MR was used.

Growth

The crude protein requirements for growing puppies and kittens have been determined primarily by using weight gain and nitrogen balance as the dependent variable. Mixed-food proteins have been used in practical diets, and purified proteins or free amino acids have been used in purified diets. Many experiments were done before the individual essential amino acid requirements were known for either of these species. There do not appear to be any detrimental effects (except a slightly lower growth rate) of feeding diets at or slightly below the nitrogen requirement, provided all of the essential amino acid requirements are met for all functions known besides growth of muscle tissue and other structural body proteins (e.g., sufficient arginine for optimal urea cycle function, sufficient histidine to prevent cataracts). Under these conditions, if energy intake is restricted along with protein, there may be an increase in longevity in some breeds of dogs due to a delay in onset of chronic diseases (e.g., arthritis and insulin resistance) (Kealy et al., 2002).

Maintenance, Gestation, and Lactation

Satisfactory maintenance can be achieved using a wide variety of dietary crude protein concentrations for adult cats on purified diets and diets using common feed ingredients. Cats, as compared to dogs, rats, and many herbivores or omnivores, do not show effective adaptation to low-protein diets and, thus, excrete considerably more nitrogen when fed a protein-free diet (Hendricks et al., 1997) or when food deprived (Biourge et al., 1994). A comparison of obligatory nitrogen excretion in various species is shown in Table 6-3. It is apparent that the obligatory nitrogen loss in cats is similar whether adult cats were fed a protein-free diet or were food deprived, the loss being nearly twice that of dogs, while the loss in dogs is more than three times that of humans. These data support the fact that cats have a higher nitrogen requirement than these other species. The efficiency of ntilization (e.g., NPU; Jansen et al., 1975) of protein for maintenance and growth is also lower in cats than in these other species. This appears to be the result of lack of ability to conserve both nitrogen and essential amino ucids even though, on a relative basis, the nitrogen requirement is higher than that for the essential amino acids.

The protein requirements for reproduction of dogs or cats have not been studied extensively and, therefore, have not been well defined. General observations in both species indicate that the crude protein requirement and amino acid requirements for gestation do not exceed those found for maximal nitrogen retention of weanling puppies or kittens, whereas the requirement for maximal lactation is known to exceed that for maximal weight gain of weanling puppies and kittens.

Application of Variables to Assess Requirements

The most common variables found in reviewing the literature for crude protein and amino acid requirements of dogs and cats at various life stages were weight gain for growing animals and nitrogen balance for adult animals. In this section, the variables that result in the maximum requirement are used. Most often, a metabolic variable, such as minimizing urinary orotic acid for the arginine requirement or maximizing blood hemoglobin for the histidine requirement, gave the highest value. Often data on response to variable dietary concentrations were not available, especially for maintenance, gestation, and lactation. Therefore, for each amino acid, an adequate intake (AT) was estimated for the life stage from the quantity of each amino acid in the digestible protein of commercial, dry diets that were known to support normal maintenance, growth, and reproduction. Successful growth and reproduction of dogs and cats fed

TABLE 6-3 Endogenous Urinary Nitrogen Excretion of Animals Fed a

Protein-Free Diet	
iii Animal	mg N-kg ^{-0.75} d ⁶⁴
Human	62
Marmoset	110
Rat	128
Pig	163
Dog	210
Cat	360

SOURCE: Taken from Hendriks et al. (1997).

such diets over a period of several years are common. When requirement data were not available, these estimated AIs were also used as the recommended allowances.

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Growth

Dogs

Estimates of the nitrogen requirement of growing puppies go back many decades. Summaries in the National Research Council (NRC) Nutrient Requirements series for dogs for crude protein, as a percentage of energy, in 1953, 1962, 1972-1974, and 1985 were, respectively, 200, 220, 220, and ~95-115 g-kg-1 diet. There is general consistency in the recommended crude protein requirement across the decades except the 1985, which is the sum of the amino acids suggested (including the dispensable amino acids). It becomes apparent from the review by the 1985 NRC committee and from reviewing the literature over the past 20 years that there is a marked decrease in the requirements for both nitrogen and essential amino acids between about 10 and 14 weeks of age for growing puppies; thus, different requirements for weanling puppies before and after 14 weeks of age are suggested. Also, in some instances, weight gain. rather than nitrogen balance, has been used as the variable to determine the requirement. For dogs, generally more dietary crude protein is required for maximal nitrogen retention than for maximal weight gain. For newly weaned smallbreed or large-breed puppies, when near maximal weight gains were obtained, the MR appears to be a 180-g CP-kg-1 diet containing 4.0 kcal ME·g⁻¹ (Milner, 1981; Burns et al., 1982; Nap et al., 1993; Schaeffer et al., 1989; Delaney et al., 2001). These studies used either highly digestible protein or free amino acid diets, and all of the known essential amino acid requirements were met for maximal nitrogen retention. When practical diets from cereals and various animal byproducts are used, the crude protein needed for maximal nitrogen retention (AI) appears to be about 250 g-kg-1 diet (Ontko et al., 1957; Case and Czarnecki-Maulden, 1990). For puppies over 14 weeks of age, the respective crude protein requirements (MR) for purified highly digestible diets and practical diets (AI) are, respectively, 140 and 200 g-kg -1 diet containing 4.0 kcal ME-g-1 (Gessert and Phillips, 1956; Burns et al., 1982; Delancy et al., 2001).

Cats

Several estimates have been made of the nitrogen requirement of growing kittens. The earliest estimates, determined without considering the essential amino acid requirements, were about 250-350 g of dietary crude protein per kilogram of diet (Dickinson and Scott, 1956; Miller and Allison, 1958; Greaves, 1965; Jansen et al., 1975). More recent estimates, based on dose-response curves in which protein or amino acid diets were used that contained all of the essential amino acids at least 50 percent above the requirements as listed by the NRC (1986), reported crude protein requirements in the range of 160-240 g-kg-1 diet containing 4 kcal ME/g⁻¹ (Anderson et al., 1980a; Smalley et al., 1985; Rogers et al., 1987). In a series of papers, Taylor and coworkers (1996, 1997, 1998; Rogers et al., 1998) examined the pattern of amino acids required for maximal weight gain and nitrogen retention by growing kittens, varying both the concentration of crude protein in the diet and the ratio of essential amino acid nitrogen to total amino acid nitrogen (E:T). At or below the essential dietary amino acid requirements, the addition of crude protein (as dispensable amino acids) caused a decrease in weight gain and nitrogen retention that was corrected by additional arginine supplementation. If methionine and arginine were restricted to not more than about twice their requirements, optimal weight gains and nitrogen retention were observed, with all of the nitrogen coming from essential amino acids plus cystine and tyrosine. Kittens, therefore, can grow maximally (see Figure 6-1) with a much broader E:T ratio (Rogers et al., 1998; Taylor et al., 1998) than rats (Stucki and Harper, 1962) or chicks (Stucki and Harper, 1961). This work, using free amino acid diets and diets containing purified proteins (Smalley et al., 1985; Schaffer et al., 1989), indicates the minimum crude protein requirement (MR) for growth (with essential amino acids at about 150 percent of the 1986 NRC requirements) is about 180 g CP-kg-1 diet containing 4.0 kcal ME-g-1. The E:T ratio may vary widely at intermediate crude protein concentrations; however, the ratio has to be higher for similar weight gains at both low and high dietary crude protein concentrations (Figure 6-1). The E:T ratio must be high for low dietary crude protein concentrations in

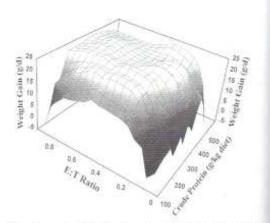


FIGURE 6-1 Effect of dietary crude protein and ratio of essential amino acid nitrogen to total amino acid nitrogen (E:T) on weight gain of kittens. SOURCE: Taken with permission from Rogers et al., 1998.

PROTEIN AND AMINO ACIDS

order to provide all of the necessary essential amino acids (Taylor et al., 1997) and high at very high dietary crude protein concentrations to prevent toxicity of some dispensable amino acids such as glutamate. Glutamate is considerably more toxic when other dispensable amino acids are also high in the diet, presumably because metabolic equilibrium results in higher plasma and tissue glutamate concentrations (Taylor et al., 1998). Thus, for both low and high dietary protein concentrations, body weight gains are higher with high-quality than with low-quality proteins. Protein quality is less important at intermediate protein concentrations in the diet. In evaluating commercial, dry expanded diets that have sustained normal growth for growing kittens, none contained less than 280 g CP-kg⁻¹ diet containing 4.0 kcal ME⁻g⁻¹.

Maintenance

Dogs

Early estimates of the MR for crude protein for adult dogs at maintenance, using nitrogen balance as the criterion, varied from about 35 to 90 g/kg-1 diet containing 4.0 kcal ME-g-1 for good-quality proteins. These values came from experiments using food proteins without knowledge of the amino acid requirements for either growth or maintenance (Melnick and Cowgill, 1937; Kade et al., 1948; Arnold and Schad, 1954; Wannemacher and McCoy, 1966). Recently, Sanderson et al. (2001) published a study in which beagles maintained body weight (BW) and sustained normal blood chemistries and health (except for one dog that developed dilated cardiomyopathy, which was corrected by taurine supplementation) for 42-48 months with a dict calculated to be 82 g·kg-1 diet containing 4.0 kcal ME·g 1 as a highly digestible, high-quality protein. Except for the question about meeting the taurine need of the dogs, these results together with earlier work suggest 80 g of crude protein per kilogram of diet containing 4.0 kcal ME-g-1 as the MR. Other studies (Wannemacher and McCoy, 1966; Ward, 1976), published and unpublished, support an AI of about 100 g·kg 1 diet containing 4 kcal ME·g⁻¹ as being adequate, thus suggesting 100 g CP-kg 1 diet as the RA. Older dogs appear to require somewhat more crude protein to maintain labile protein (socalled protein reserves), perhaps as much as 50 percent more (Wannemacher and McCoy, 1966). The optimal concentrations for other variables and outcomes (e.g., optimal immune response, wound healing, health in old age) have to be evaluated before more specific recommendations can be made.

Cats

Early estimates of the minimum crude protein requirement (or allowance) (MR) of adult cats for maintenance, using nitrogen balance as the criterion, varied from about 10 to 30 percent of ME. These values came from experiments 119

using food proteins without knowledge of the amino acid requirements for either growth or maintenance (Allison et al., 1956; Miller and Allison, 1958; Greaves and Scott, 1960) or sometimes without considering the digestibility of the dietary proteins. The difficulty in making a purified diet readily acceptable to adult cats, (often very choosy about the texture and taste of their food), has made determining the crude protein and amino acid requirements problematical. Indeed, in one of the most thorough, long-term studies reported, using nitrogen balance as the criterion in which the dict contained the essential amino acids at a dietary concentration at least equivalent to the essential amino acid requirements of the growing kitten, the crude protein requirement was suggested to be 125 g-kg-1 diet (100 g-kg-1 diet containing 4.0 kcal ME·g⁻¹) (Burger et al., 1984; Burger and Smith, 1987). However, the authors removed some cats from the study because they would not accept the diet, and the cats as a whole lost a small amount of weight. Nitrogen balance is known to underestimate the nitrogen requirement because of incomplete collection of feces and spilled food. In most experiments with most species, there is a plateau at a small positive nitrogen balance. In the work of Burger et al. (1984), when the regression line crossed at 0 nitrogen balance, 7 of 18 cats fed 164 g CP-kg-1 diet were in negative nitrogen balance. With all but one cat in positive nitrogen balance, the protein intake was calculated to be about 160 g kg-1 diet containing 4 kcal ME-g-1. This value is taken as the crude protein MR of adult cats for maintenance. It should be pointed out that other outcome variables such as optimizing immune response, labile tissue protein, or environmental stress were not considered in this MR. If a safety allowance is made for such needs, a recommended allowance (RA) of 200 g CP-kg-1 diet containing 4 kcal ME-g-1 is suggested. In evaluating commercial, dry, expanded diets that have sustained maintenance for months to years, none were found with less than 265 g CP-kg-1 diet containing 4.0 kcal ME-g-1.

Gestation and Lactation

Dogs

The protein and amino acid requirements of dogs during reproduction have not been well defined. In general, it has been assumed that, if the dietary crude protein requirement is met for growing puppies, the diet would meet the crude protein requirement of bitches during gestation and lactation. No reports could be found in which the crude protein requirement for gestation or factation had been determined using dose-response relationships in bitches' fed purified diets. From experimental work using natural ingredients (Visek et al., 1976) and evaluating commercial, dry dog foods that have routinely supported normal gestation and lactation, the AI for crude protein for gestation and lactation for the bitch has been shown to be 180-210 g·kg⁻¹ diet containing 4 kcal ME·g⁻¹. Meyer et al. (1985) did a factorial calculation based on experimental work on milk yield and milk composition of bitches and recommended 210 g CP-kg-1 diet containing 4 kcal ME·g-1, provided the protein quality was good and the diet contained carbohydrates. Based on their experimental work, they also calculated values of 10 g protein-kg BW-0.75 for small bitches suckling two puppies. 20 g-kg BW-075 for medium-sized bitches suckling six puppies, and 25 g-kg BW-0.75 for large bltches suckling eight puppies. Romsos et al. (1981) evaluated reproduction with and without dietary carbohydrate using diets containing about 260g-kg-1 crude protein (180-210 g digestible crude protein kg-1 at 4 kcal ME-g-1) and showed that this concentration was ample protein for both gestation and lactation if the diet contained carbohydrate, whereas, if the diet contained no carbohydrate, 260 g CP-kg-1 diet was insufficient for the latter part of gestation but was sufficient for lactation. Kienzle et al. (1985) showed that, when carbohydrate-free diets were fed to pregnant and lactating bitches, a protein content of 400 g-kg-1 diet was sufficient for successful reproduction, but a protein content of only 200 g-kg-1 diet led to severe impairment of reproduction including hypoglycemia in the bitches, high losses of puppies, low liver glycogen in the puppies, increased milk fat, decreased milk lactose and water content, and decreased milk yield. From the above results, the AI/RA for highly digestible crude protein for gestation and lactation is set at 200 g-kg-1 diet containing 4.0 kcal ME-g-1, provided there is carbohydrate in the diet.

Cats

The protein and amino acid requirements of queens during reproduction have not been well defined. It has been assumed that the dietary crude protein requirement for the growing kitten would meet the crude protein requirement of the queen during gestation and lactation. Factorial calculations by Kienzle (1998) of the protein requirements of queens during peak lactation indicated that 210-290 g-kg-1 diet containing 4 kcal ME/g⁻¹ was required. Piechota et al. (1995), using purified diets based on soybean protein-casein (supplemented with essential amino acids to bring each one to at least 150 percent of the 1986 NRC requirements for growth), reported the MR to be not greater than 170 g-kg-1 diet containing 4 kcal ME-g-1 for gestation and about 240 g-kg-1 for lactation using kitten weight gain and queen weight loss during lactation as key variables. Thus, the MRs for crude protein for cats during gestation and lactation, respectively, are taken as 170 and 240 g-kg-1 diet containing 4.0 kcal ME g⁻¹. This requirement for lactation is consistent with the lowest level of digestible crude protein found in a number of dry, expanded, commercial diets that have regularly sustained gestation and lactation. From an evaluation of plasma amino acid results, the highest nutritional requirement appeared to be during peak lactation (third to fourth week), before the kitten's intake of the queen's diet was significant. When plasma amino acids were used as the criterion, several essential amino acids appeared to be near limiting, even with commercial diets containing 260 g·kg⁻¹ crude protein (4 kcal ME·g⁻¹). Methionine appeared to be the limiting amino acid most often, with the crude protein and amino acid requirements being higher for maximal lactation than for maximal growth of kittens.

Amino Acid Minimum Requirements, Recommended Allowances, Adequate Intakes, and Safe Upper Limits

Satisfactory maintenance and maximal growth and reproduction of dogs and cats can be achieved on a wide variety of concentrations of amino acids in purified diets using either free amino acids, amino acids in purified proteins, or proteins from common feed ingredient incorporated into dry expanded or canned diets; that is, no upper limit is known. The 10 amino acids shown to be essential for growing rats have been shown to be essential for growing dogs and cats. No studies have been reported in which the essential amino acids for other life stages have been deleted from the diet of either dogs or cats, except for the abstract of Rose and Rice (1939), which showed that all of the same amino acids that are essential for adult rats are essential for adult dogs. Later, Burns et al. (1981) reported that arginine was essential in the diet to prevent hyperammonemia and orotic aciduria in the adult dog. Similar to other adult species, it is assumed all of the other amino acids essential for adult rats and humans are essential for adult dogs and cats.

Arginine

Some synthesis of arginine occurs in many mammals and at a sufficient rate to provide all of the arginine needs for a variety of species including humans, ruminants, and adult rats and swine (Rogers, 1994). Metabolically, arginine is glucogenic and has functions other than its role in the synthesis of innumerable proteins. Arginine is an intermediate in the urea cycle, and when absorbed with a meal, it acts both anaplerotically to stimulate urea synthesis and as an allosteric activator of acetylglutamate, which in turn, is an essential allosteric activator of carbamoyl-phosphate synthase, the first enzyme in the detoxification of ammonia and the synthesis of urea. In addition, arginine has been shown to elicit the release of several hormones and metabolic mediators including insulin, glucagon, and gastrin, and it is a precursor of biogenic amines, which are important in cell replication. Arginine is also the precursor of nitric oxide, the neurotransmitter involved in many systems, from its effect on blood pressure via relaxation of blood vessels to its role in macrophages in killing foreign cells (e.g., bacteria and viruses). There have been many studies using arginine as a therapeutic agent, apart from its role in normal nutrition and health. The committee's recommendations are based on the need of dogs and cats to minimize arinary orotic acid.

Attachment E -- NRC Tables for Nutrient Requirements of Dogs and Cats

Table 15-3 Nutrient Requirements for Growth in Puppies afterWeaning

Name Reprises. Average	Manual B	Name Reprint		Adopted Testin	Think.		Married	Horsenwood Albrewood		Skill Upper Links	- Inter-	
	No. 1	2813	3,1	2011	1011	Ami ta Burro	No. 1	100	Land Land	Anti- Mata Mata Hotori Mata	1991) 1991) 1993	tant Marine
WITH A				(irekty l	Tuppic 4.1	(newley Pappics 4-14 Wests (W)	-	- 74	1.14	į.		
Dauly Press (g)		9	11				14		6			
Annual Autors	19.84	1.26	1141				-	10	-001			
Interface (c)	1395	10.00	0.22				10	100				
Testhorczer 1g1	190	100	10.0				5.5	100				
Mathemate (g)	1.2.8	1.0	100				2 F	No.	101			
Medianetice A.C. printer all-	100		110				1023	C A	0.00			
Low second		1.5	inter a				NN.	1200	100	101	1919	57
Contemporture	110	- 10	10.0				10.8	(97)	144			
Placed Autor & Treester Inf.	10.1	201	10.00				194	五次	8.0			
Warman Lat	100	1.40	0.05				Q.	THE	5.			
Trottesture (a)	1.1	929	0.0				1		10.00			
Value 100	34	1.19	10.0	Sector-Sector	Contraction of the	Contraction of the second			The second			
	-	1	-	Gravity Pi	Were the	Gravity Papers AI Bucks and Links	10	400	112			
COMPLEXIVE CONTRACTOR												
Antonio Antoni	3.1	100	N.M.				6.0	1.05	-			
When the second s	107	050	0.04				1	000				
had we when 1g1	4.0	1003	100					11				
Wethanser (2)	2	0.00	3					101				
Multiplement de Cycarae (2)	124	111	110				U	210			3	1000
Location with	14	111	10.0				101	100		ņ.	-	10.11
Pherodolization 121	10	100	609				95	63	ST-10			
Presidente A. Dreife OF	-	-	950				1	100				
Thronomical 3	-	1	0.05				1	and a				
Withershim	14	200	100				44	110	101			
	E			Creeks	Pagerer /	Green Pages Alter Manue	-		1.800	ANT	111	11
East Part (j)				ŝ	ŝ	1	0					
Party Austr				116	3.0	1.6	10	242	108.	10	9	575
LINGOR ANI 121				0.1	8118	610	100	ALC: NO.	(00)			
Arachillener Acid (g)					1000	1000	1	008				
Electropretaries &					11.0	000	111	100	1110	111	82	0.77
Water and the second second					ł							
Calcinet (a)*	0.6	Ŧ	1020				致		100	×	2)	1
Phonodelectrics (a)				8	1	1440	and a	2.8	THE			
Magnetation of all			2	2.380	1911		1200	100	1001			
a distant a second					1	100	11	01.1.1.1	0010			

	Minimal F	Minimal Requirement		Adequate Intake	Intake		Recomment	Recommended Allowance		Safe Upper Limit	r Limit	
Nutrient	Amt/ kg DM (=4,000 kcal) ^r	Amt/ 1.000 keal ME ⁶	Amir' kg BW875	Amt/ kg DM (=4,000 kcaly*	Amt/ 1,000 kcal ME*	Amil kg BW ⁰⁷⁰	Amt/ kg DM (=4,000 kcatr	And Loos	Ameri ke BWW	Amt./ kg DM (=4,000- kcaft*	AmL/ 1.000 Real MP ⁸	Amil/ kg BW ^{0.56}
Chloride (mg)	ŧ			2,900	120	200	2.900	82	200	0.000		
Copper (mg) ¹	*	8	RC	=	2.0	01.10	8 =	a ²	1.4			
Zinc (mg)	97	10	2.7		CO.	W1 11	1001	52	6.84			
Manganese (mg)				5.6.	17	0.38	5.6	1.4	0.38			
Selenium (µg)	210	525	13.7				350	87.5	25.4			
fodine(jg)				088	220	61.0	880	220	61.0			
Vironning												
Vitamin A (REy				1.212	300	84	1,515	926	105	15,000	105.L.E	1.0440
Cholocalciferol (µg) ⁶				0.11	2,75	0,76	BEI	3.4	0.96		8	3.6
Vitamin E (actocopherol) (mg/				27	6.0	1.7	96	7.5	2.1			
Vitamin K												
(Menadione) (mg)"				13.	0.33	0600	1.64	1970	0.11			
Thinnin (mg)				1.08	0.27	0.075	1.38	0.34				
Riboflavin (mg)				¢1 7	1.05	0.27	5.25	121				
Pyridoxine (rog)				¢4	0.3	0.084	3.15	0.375	0.10			
Nascin (mg)				13.6	3.4	0.94	17.0	424				
Pantothenic Acid (mg).				<u>11</u>	3.0	0.84	15.0	3.75	1.04			
Cobalamin (Jrg)				28	L	1.95	12	\$.75				
Folic Acid (µg)				216	5	15.0	270	68	18.8			
Boutur												
(Dolline (mg)				1,360	055	56	1,700	425	118			

to calculate the ArmN& DM for each muritm, multiply the value for the numbers in the column labeled AnmNg DM by the energy density of the per food (in Keil MENg) and dredle 94,000. 1,000.1

The values for Am/BW^{4/5} apply only to 5.5-kg puppies of expected minute body weight of 35 kg. To calculate the amount of a matteriat for puppies of lifflorent current or expected manue body weights, calculate the energy requirement from Table 15-2 and multiply this by the nutrient Amt/1,000 kcal and divide by 1,000.

Thir 4 to 14 week oid pupples. 0.01 g arginize should be added for every g of crude protein above 180 g and 225 g, for the MR and RA, respectively, of arginize. For pupples over 14 weeks of age, 0.01 g

arginine should be added for every g of crude protein above 140 g and 175 g for the MR and RA of arginine, respectively.

The quantity of tyresine required to maximize black hair color may be about 1.5-2.0 times this quantity.

The requirement for ar-Inolenic usid varies depending upon limiteic acid content of the dist. The ratio of limiteic acid to a -linolenic acid should be between 2.6 and 10. Note that 0.8 gkg DM value shown is the minimum RA of re-linolenic acid at 13 g finolesic acid per kg DM, resulting in a ratio of finoletic acid to re-linolenic acid of approximately 16. PEccosapentacnoic acid should not exceed 60% of the total amount.

The RA for the calcium requirements of weared pupples (of expected mattery body weight >25 kg) far up to 14 weeks of life should not be less than 0.54 g calcium/kg body weight

Some exide forms of iron and copper should not be used because of low binaronitability.

For vitamin A, requirements are expressed as RE (retinol equivalents). One RE is equal to 1 µg of all-strans retinol, and one IU of vitamin A is equal to 0.3 RE. Safe upper limit values are expressed as µg ⁴L µg choisenleiferol = 40 IU vitamin D_v. retinol.

"Dogs have a metabolic requirement, but a dictary requirement has not been demonstrated when natural diets are feel. Adequate viramin K is prohably synthesized by intestinal microbes. The simula K al-Higher concentrations of vitamin E are recommended for high PUFA diets. One international unit of vitamin E = 1 mg all-nor-or-to-opticeyl acture (see Chapter 8).

or is expressed in turns of the commercially used precursor menolone that requires alkylation to the active vitamin K 100

stime. Diets containing mothéorics may need supplementation 3 interiments are still white, when are builded is probably provided by microbial synthesis in the

TABLE 15-3 (continued)

	Werning	- Star owner Commonwer with WEPHIAL	The state of the second									
	Abuve average risquirements.	coporement	3	Call of	and the second				140			
	Ynung	adult laborat	ory dogs or y	Young adult laboratory dogs or young adult active pet ungo	vic ber milts				100			
	PV	ult laboratory	- Gross Dames	Adult laboratory Great Danes or active pet Great Danes	mean Dance				190			
	Ad	ult taboration	/ lettiers or au	Adult laboraticy territers or active pet territers					191			
	Below average raquirements:	instantanta -	81						95			
	80	mactive per usign Older laboratory (y diago ar edde	macrose per users. Otdare hithornationy dogs are oldere activee per dogs or haboratory. Newfoundhards	gs or luborat	ory Newfourn	dlands		501	1		
	 Dogs kept in a domestic environment with strong st back, to the connect or in a basic with a free vard. 	a domestici e	incirconnent w	th strong stim	the and and	ole opportunit	Togs kept in a domestic traincontent with strong stimulos and angle opportunity to exercise, such as dogs in multiple dog house- terts, is the sources of in a bonde with a free word.	uch as dogs it	multiple dog	house-		
	to the second se	a domestic i verestimated	W MUSHING A	with Dittle stimm	dus and opp	octumity to ex-	notes in the comments on it is notes over a new with little stimulus and opportunity to evervise. Requirements of older or overweight dogs may still be overselimised.	ments of olde	t or period	a degs		
TABLE 15-5 Nutrient Requirements of Adult Dogs for Maintenance	irements of Ac	Jult Dogs	for Mainter	ance								
	Maimul 1	Minimal Requirement		Adequate Intake	Intake		Reconnien	Reconniended Allowance	0	Safe Upper Limit	climit	
	Amt/ kg DM (e4.000	2813	Amt/ kg awerr	Amil kg DM (=4,000 kealt	Amt/ L.009 Koal	Amt./ kg BW ^{0.75}	Amel Ng DM (++,000 koal?	Amt/ 1,000 keal ME*	Amt) hg BW ⁶²	Amu/ kg DM (=4.000 kcal9 ^c	Am6/ t.000 kcal ME*	Amt/ kg BW0.75
Pouttorit. Pouto Postela (e)	80	30	2.62				100	52	N.C.K.			
Contraction of the second seco												
Arreword Actuals	10		0.00				3.5	0.88	0.11			
Arginitie (g)	9 -	11.0	0.048				61	0.48	0.062			
Printeneties (c)	20	0.75	88010				3.8	96'0	0.12			
Mechiconian (c)	2.6	665	0.085				££	0.83	110			
Methionine & Cystine (g)	5.1	1.30	0.17				20	31	17:0			
Lencine (g)	5.4	136	0.18				40	0.88	0.11			
Lysine (g)	Ke y	0.20	76010				45	EPT	0.15			
Phenylalantae	0.9	1.46	1010				4.5	1.85	0.24			
Theorem and the set of the second se	49	0.855	0.01				43	1.08	0.14			
Tryconhun (e)	11	0.28	0.036				1	550	0000			
Valine (g)	3.9	16:0	0.13		1000	100	4 5	9.8	1.8	3309	82.5	30.8
Total Fut (g) Futro Achde				14			(-	100	-	14
P. Landardin, Month J. M.				9.5	44	6.0	- Contraction	8'P	92	9	101	117
collimation Acid at				0.36	0.09	0.012	44	0.13	0.014			
Arachidonic Acid (g)				1000	1000	Control of the second	110	11.1	0.03	111	8 5	0.37
Eleosopentacione + Docosanevaencie Acid (gV				14 1	171	1110	ł		1			
Mineraly	1	1	and a second				9		0.13			
	92	050	6000	3.0	0.75	0.10	3.0	0.75				
Phrephortex (g) Maserestum (mo)	180	45	5.91				009					(Joundary)
COLUMN ADDRESS OF THE OWNER OF	Contraction of the local division of the loc											Thomas and

Table 15-5 Nutritional Requirements of Adult Dogs for Maintenance

Kcal × kg BW^{0.15}

TABLE 15-4 Daily Metabolizable Energy Requirements for Adult Logs in Municipative

Average for laboratory kennel dogs ac active pet dogs* Above average requirements.

Type

130 130

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	Minimak 8	Minimal Requirement		Adequate Intake	Intake		Recommende	Recommended Allowance		Safe Upper Limit	Limit	
bi de la companya de	MC SA	Ne con	Amt/ kg BW ⁰⁷¹	Amt/ kg DM (=4,000 kcal?	Amt./ L000 ME ^b	Amt./ kg BW073	And/ kg DM re4000 kcatr	And toos Meri	And ke BWeS	AmL/ Ag DM (=4.000) kcaly	Annel Icol MB ⁰	Antr/ kg BW ^{n/5}
Stellum (mg) Potassium (g) Cthoride (mg)	8	3	9.85	1200	1.0	0.14 40	808 4.0 1.200	200 100 100	28.2 61.0 61.0	215 g 21.5 g		
from (mg)* Copper (mg)* Zine (mg) Mungarese (mg) Selevium (ng)		1	;	30 4 60 350 350	5 5 5 1 2 5 1 2 5 5 5 5 5 5 5 5 5 5 5 5	1.0 0.2 0.16 0.16 11.8	8 * 8 7 8 9	52 II 22 II 25 05	9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	and to	an:	
Indine (Jug)	ę	2	017					1				
tátramotos Vituamita A (REJ) Choleculuiferol (µg9)				2121	343	40 0.36	1,515 13,8	er M	8 870 870	64.000 ^h 80	16,000 ⁴ 20	2,899 ^k 2.6
Vitamin E (co-tocopheral) (mg)/ Vitamin & Monuficaet (ma)/				2	0.33	0.8	1.63	0.41	0.054			
Thursday (mg)				1.8	0.45	0.050	225	0.56	0.074			
Rihoflavin (mg)	42	1.05	0.138	0.1	0.0	0.04	22	1	0.049			
Pyridoxine (mg)				13.6	3.4	0.45	17.0	423	0.57			
Protection (1982) Recorded and Article Devel				5	3.0	0.39	15	3.75	0.49			
Cobalonnin (no)				ň	~	26.0	SE .	8.75	(115			
Folic Acid (pg)				216	54	7.1	67	60.5	8.9			
Bioture Choline (mr)				0.360	740	57	1200	425	56			

T pg concentration = 40 to variant D = Higher concentration of stamin E are recommended for high PUFA data. One international unit of variant E = 1 mg all-rea-et-to-cophesyl actuate (see Chapter 8). Dogs have a metadone requirement, but a dreaty sequirement has not been denominated when natural driets are fed. Adequare vitamin K si probably synthesized by intestinal microbes. The vitamin K al-Dogs have a metadone requirement, but a dreaty sequirement has not been denominated when natural driets are fed. Adequare vitamin K is probably synthesized by intestinal microbes. The vitamin K al-lowance is expressed in terms of the commercially used prevaled that requires alkylation to the active vitamin K.

Table 15-8 Nutrients Requirements of Bitches for Late Gestation and Peak Lactation

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	Minimal R	Minimal Requirement		Adequate Intake	pratic		Recomment	Recommended Allowatere	8	Safe Upper Limit	er Limit	
Nutrient	And A No Children Marity	View Party	Amil) kg BW ^{6/14}	Amt./ kg DM (m4.000 kcaf/	Amt./ 1.000 Mcst MRP	Amt./ kg BW ^{0,754}	Amt/ kg DM (=4,000 keal?	A le lo	Amt/ Marty BWess	Amt./ kg DM (==4,000 kcall*	Amel keal	Amt/ kg BW ^{0,550}
Crude Printein				200	20	24.6	200	8	24.6			
Amatric Acady Aminima amin				10.0	2.616	141	10.0	3.50	1.14			
Histoffine (e)				4 4	110	150	44	1.10	130			
Isolencine (g)				7.1	1.78	0.87	172	1.78	0.87			
Methionine (g)				3.1	0.78	0.38	3.1	0,28	0.38			
Methionine & Cystine (g)				6.2	1.55	0.76	6.2	1.55	0.76			
Lencine (g)				20.0	0055	2.46	20.0	5.00	2.46			
Lysine (g)				0.9	2.25	101	0.0	222	113			
Phonylalanine (g)				2	2.008	1.02	8.3	2005	1.02			
Phenylalanine & Tyrosine(z)				12.3	3.036	1.51	12.3	3008	1.51			
Threatine (g)				10.4	2.60	1.28	10.4	2.60	128			
Tryptophan (g)				1	0.30	0.15	4	050	0.15			
Value (g)				1330	3.25	1.60	13.0	3.25	1.60			
Testal For (g)				88	117	10.5	85	21.3	10.5	330%	82.5	40.6
Farry Actids												
Limbole Acid (g)				11	20 13 13	1.4	E,	2	116	684	£'91	8.0
to Linolenic Acid (g/				0.7	0.18	0.09	0.8	0.2	0.10			
Amehidonic Acid (g)												
Eleosapentaenoie + December - Acid (_ 0)				6:0	0.13	0.00	0.5	0.13	0.06	110	28	1.4
Minerally												
Calcium (g)				8.0	6.1	0.82	8.0	1.9	0.82			
Physiophysius (g)				5.0	1.2	0.58	5.0	12	0.58			
Magnesium (mg)				(909)	130	69	600	150	60			
Sodium (mg)				2,000	500	338	2,000	500	238			
Potassium (g)				3.6	6:0	0.430	3.6	0.9	0.43			
Chloride (sug)				5,000	150	358	3,000	150	358			
Iron (mg)				70	11	8.67	20	11	8.67			
Copper (mg)				12.4	110	1.52	12.4	115	12			
First (High				.96	54	2715	96	12	167			
Menganove Imal				1.Ja	1.8	111	73	1.1	111			

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			Annual and a second									
		ME (keal) = ME (keal) = Whene	$\begin{split} \text{ME} \; & (keal) = \text{multitumer annual} \times 6.7 \times [e^{i(0.100)} - 0.66] \\ \text{ME} \; & (keal) = 100 \times \text{BW}_{e}^{-0.07} \times 6.7 \times [e^{i-0.1000} - 0.66] \\ \text{Whence} \end{split}$	$\begin{array}{l} \text{mount} \times 6.7 \\ \text{s} \times 6.7 \times 1e^{1.0} \end{array}$	(1000-1100) 1000-1000	0.66				4	1.1	
			$\begin{split} \rho &= BW_{\mu}/BW_{\mu}\\ BW_{\mu} &= weight at time of evaluation (kg)\\ BW_{\mu} &= expected manne boly weight (kg)\\ \sigma &= bose of matural log = 2.718 \end{split}$	dy weight at d mature body ral log = 2.71	time of eval weight (kg	uation (kg)						
		Cyample: K	$ \begin{array}{l} \label{eq:constraint} \text{Karmpler} \ \text{Kitten, 1 kg BW}_{a} + 1 \text{kg BW}_{a} \\ \text{MF} \ \text{(krad)} = 100 \times t^{0.07} \times 6.732 \times t^{0.01} \mathrm{GeV}_{a} \\ \text{10} \ \text{(krad)} = 100 \times t^{0.07} \times 6.732 \times t^{0.01} \mathrm{GeV}_{a} \\ \end{array}$	$1.4 \text{ kg BW}_{0.732 \times [e^{1.6}]}$	9×141-019	6] = 198 kcal			54			
TABLE 15-10 Nutrient Requirements for Growth of Kittens After Weaning	irenents for	Growth o	f Kittens Af	ter Weanin	-						u:	
	Minimal J	Minimal Requirement		Adequate Intake	Intake		Recommen	Recommended Alfonsance		Safe Upper Limit	r Limit	
	Amil kg DM (=4,000	Amt/ 1.000 keal	Amt <i>i</i> kg	Amt/ kg DM (=4,000		Aunt./ kg	Amit/ kg DM	And/ 1,000 Ital	Amel	Amt/ kg DM c=4.000	Ant./ 1.000 Load	Amt/
Nument	kcal)*	ME	BW000	local)*	MB ^b	BW005	health	ME	BWerm	Acal)*	ME	BWOW
Crowle Protein Anotica Actuals	180	5	9.40				a	56.3	11.8			
Arginine (g) ⁴	112	1.93	0.40				9.6	2.4	0.50	35	8.75	1.83
Histodine (g)	02	0.65	0.14				313	0.83	0.17	522	53.5	>1.15
Methicanic (g)	11	1000	120				75	1.4	670	LN×	>21.7	オズ
Methionine & Cystine (g)	12	1.75	0,37				* *	= 2	800	13	3.25	8970
Leucine (g)	10.2	2.55	0.53				12.8	19	1910	CSK<	117	14
Lysine (g)	6.8	1.70	0.35				£.3	7	0.44	8	>14.5	POTES
enenyiaianine qgi Phenylalunine & Twosing Cole	4.0	182	12.0				20	1	0.27	>20	>7.25	>1.51
Threonine (g)	52	91	0.27				1.61	44	100	ž ;	11	155
Tryptopham (g)	13	0.33	0.069				2 4	0.40	0.064	ē 1	21.21	>2,06 N SO
Valiac (g)	5.1	1.28	(23)				6.4	1.6	0.73	-87	>21.7	177
Containing Acad (g)			and a							25	18.8	3.92
Automotion (g) A	570	0,000	21010				050	0110	0.021	⇒8.9	>2.22	>0.46
court cut (g) Furty Acridy				96	22.5	4.7	8	22.5	4.7	>330*	>82.5	>17.2
Linolese Acid (g)				5.5	41	0.29	3.5	14	0.29	155	13.8	0.0
er-Lintelenic Acid (g)				20	0.05	0100	0.2	0.05	010/0		1000	1.416
Procession Acta (2)					0.05	01010	0.2	0.05	0.001			
Douverhearensie (24				0.1	0.025	0.005	10	0.025	0000			
Mimerals												
Calcium (g)	52	1,3	0,274				8.0	2.0	0.410			

Table 15-10Nutrient Requirements for Growth of Kittens afterWeaning

Required Amino Acid Organic Petition Information Prepared by Crystal Springs Consulting, Inc. Page 110 of 117

Magnesium (mg) Sodium (mg)	190	310	52 S				1,400	895	R 2	>10 g		
Potassium (g)	2.68	0.67	0.14				4.0	1.0	0.200			
Chloride (mg)	760	051	17				006	225	46.5			
Iron (mg) ^h	11	17	32				.80	R	4.1			
Copper (mg/h	45	1.1	1220				8.4	23	0.44			
Zinc (mg)	30	12.5	2.6				19	18.5	3.9			
Manganese (mg)				4.8	2	0.25	4.8	11	0.25			
Selenium (pg)	120	30	623				300	75.	15.8			
fodine (µg)				1.800	450	93	1,800	450	60			
Vitamins												
Vitamin A tag rotinoly				1008	200	Ģ	1,000	250	25	XH00'08	20,000	4,1M0
Cholecalciferol (pg)	2.0%	0.70	0.14				5.6.	1.4	().29	750	188	66
Vitamin E co-tocopherol) (mg) ^b				(FC	1.15	1.6	38	9.4	2.0			
Vitamin K (Menudione) (mg) ¹				1.0	0.25	0.05	1.0	0.25	0.05			
Thannin (mg)	44	151	0.23				5.5	2	0.29			
Ribaflavin (mg).				1.2	0.80	0.87	4,0	1.0.	0.21			
Pyridovine (mg)	2.01	0.5	0.10				2.50	0.625	0.13			
Niacitt (mg)				1E	8.01	2.1.2	40	10.0	11			
Passiothenic Acid (mp)	4.6	1.15	0.24				5,70	143	0.30			
Cobalantin (ptg)				181	1.4	0.0	22.5	5.6	1.18			
Folic Acid (ug)	600	350	31				052	188				
Biotin (µg) th				09	15	3.3	75	18.75	3.9			
Choline (mg)	2,040	510	107				2,550	637	133			

⁴To calculate the amount to feed of each matrient, multiply the value for Amof (2000 kcal) ME for each mutical by the energy requireense in kcal for kinems (calculated from Table 15-9) and divide by 1,000. The values for AmofBW⁰⁰⁷ apply only to 800 µ kitens with an expected matrice body weight of 4 kg. To calculate the amounts for kinems of thifteent actual or expected matrice body weights, calculate the energy requireense from Table 15-9 and multiply the yate unnexe. Amof 1,000 kcal and fixide by 1,000. Energy requireent from Table 15-9 and multiply this by the unnexe hand (200 kcal and fixide by 1,000). Energy requireents from calce for every µ of crude protein above 180 µ and 225 g for the MR and Kx, respectively. To maximise these hands for every µ of crude protein above 180 µ and 225 g for the MR and Kx. To maximise these hands for every µ of crude protein above 180 µ and 225 g for the MR and Kx. "To calculate the annual to feed of each natrient,

This advised that excessperamenoic acid not exceed 60% of the outal eccessperatements - docroatheratemoic annount "Some forms of iron and copper abound not be used become of low histowalability." "Some forms of iron and copper abound not be used become of low histowalability." "Some forms of iron and copper abound not be used become of low histowalability." "Some forms of a summa A is equadro 0.3 ag of all-trans retinod or 1 ag retinod = 3.333 UU of vitamin A. Sufe upper limit values expressed as gg retinod. To pit cholecorficted = 4.0 UL vitamin Dy. "Higher concentrations of vitamin B are recommended for high PUFA diets. One international init of vitamin E = 1 mg all-nov-ar-netopheryLanetate (see Chipper 8). "Higher concentrations of vitamin B are accommended for high PUFA diets. One international diet (except fish-based tiets) are faire (see Chipper 8). "East how a methodic requerement, has not been demonstrated when natural diets (except fish-based tiets) are fair vitamin K. it prohably synthe-sized by intertial microbes. The vitamin K allowance its expressed in terms of the connectually used precursor menatione that requires alkylation to the active vitamin K. "The normal diets not containing teak egg while, idequare fortin is probably provided by microbial synthetis in the interdine. Diet containing mellibilities may need supplementation.

eq:product on the large barries of the large barries and the large barries of the large barries and large barries and large barries and large bar			Type			Me	cabolizable En	Metabolizable Energy Requirement	ent.)				
Constrained by more than 90%. Safe Upped tank 5.71) = 5 on a 9-point scale. 5.71 b) = 5 on a 9-point scale. 5.71) = 5 on a 9-point scale. Recommended Althonance 6.71) = 5 on a 9-point scale. Recommended Althonance 0.00 Amt/ Amt/ 0.01 Amt/ Amt/ 0.00 kanil Mut/ 0.00 kanil kg.DM 1.00 0.00 Amt/ 1.13 0.00 Amt/ 1.13 0.01 1.1 1.13 0.03 0.09 1.13 0.03 0.09 1.13 0.01 0.03 1.13 0.01 0.03 1.13 0.01 0.03 1.14 0.03 0.03 1.15 0.01 0.03 1.14 0.03 0.03 1.15 0.03 0.03 1.16 0.03 0.03 1.17 0.04 0.04 1.18 0.03 1.18 </th <th></th> <th></th> <th>Domesti Domesti Exotic ci</th> <th>e cats, lean^b e cats, overwe as</th> <th>age.</th> <th>100 138-</th> <th>keal × kg BV) keal × kg BV 260 keal × kg</th> <th>W⁰⁰⁰⁷ W⁰¹⁴ BW⁰¹²⁵</th> <th></th> <th></th> <th></th> <th></th> <th></th>			Domesti Domesti Exotic ci	e cats, lean ^b e cats, overwe as	age.	100 138-	keal × kg BV) keal × kg BV 260 keal × kg	W ⁰⁰⁰⁷ W ⁰¹⁴ BW ⁰¹²⁵					
Induction Recommended Althounce Safe Upperfaint 0/1 Ann/i Ann/i <t< th=""><th></th><th></th><th>"Require "Body o</th><th>ments of indi- addition score multition score</th><th>vidual cats may s (Table 3-7) % s (Table 3-7) ></th><th>be over a 5 on a 9-p 5 on a 9-p</th><th>e underestima soint scale. aint scale.</th><th>ited by more thi</th><th>m 50%.</th><th></th><th></th><th></th><th></th></t<>			"Require "Body o	ments of indi- addition score multition score	vidual cats may s (Table 3-7) % s (Table 3-7) >	be over a 5 on a 9-p 5 on a 9-p	e underestima soint scale. aint scale.	ited by more thi	m 50%.				
	ABLE 15-12 Nutrient Requ	irements of A Minimul R	dult Cats equirement	for Mainter	annce Adequate h	naker.		Recommend	fed Allewanc		Sale Uppe	et.imit	
	Atient	Amt/ kg DM (=4,000 kca0*	Amt/ 1,000 keat ME ⁶	Amt/ kg BW(tr)	Ann/ kg DM (=4,000 kcal)*	Amt/ L000 kcal ME*	Amt/ kg BW ^{0,655}	Amt/ kg DM (=4,000 kcabr	Area (1.000 kcal ME ³	Annul kg BW042-	Annu/ kg DM r=4,000 kcul7	Amt/ 1,000 kcal ME*	Antil kg BW ^{g tric}
1 1	rude Protein	160	40	3.97				200	20	4.96			
	anno Actido Argunine (gy'				7.7	1.93	0.19	12	103	0.19			
ergy ac Cyclemetry 1.35 2.7 0.04 0.00 0.01 2.7 1.17 0.06 0.01 0.01 1.17 2.9 0.05 0.00 0.01 0.1 0.05 2.05 0.01 0.1 0.05 0.05 0.06 0.05 0.05 0.05 0.06 0.05 0.05 0.05 0.06 0.05 0.05 0.05 0.06 0.05 0.05 0.05 0.06 0.05 0.05 0.05	Mistidine (g) Isoletacine (g)				91	60'D	0.11	59	1.08	11.0			
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Methionine (g/	135	0.34	60.03				12	0.45	0.042			
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	tructure (2)	1	00111	Jonor	10.2	2.55	0.25	10.1	2.55	0.25			
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Lysine (g)	23	0.68	0.067				3.4	0.85	0.054			
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Pisetylahunine (g)				4.0	8	6600	40	100	0.09			
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Pherophalantine & Tyrutaine (g)/ Threemine (u)				5.2	DE I	£1.0	2 21	130	60			
0 011 023 013 014 013	Tryptophan (g)				61	0.33	0.032	1	0.33	0.032			
0 0.41 0.000 0.001 <th0.001< th=""> 0.001 0.001</th0.001<>	Valine (g)	-	in man	A north	2.1	1.28	6.1.9	1 8	13	0.13			
Achil(1) 55 1.4 0.14 5.5 1.4 0.14 55 in: Achil(2) in: Achil(2) 0.005 0.005 0.005 0.01 0.03 0.005 27 in: Achil(2) 0.01 0.025 0.0055 0.0055 0.01 0.005 0.015 0.005 0.015 0.	thurme (g) ^r tul Fat (g)	0.12	00000	2000	6	22.5	2.2	06		17	3,002	82.5	8.2
Conserve	ary Acado-				4.6	2.47	0.11	55	14	0.14	551	13.8	1.00
Ions. Actif (y) 0.02 0.005 0.006 0.013 0.005 0.001 0.005 0.001 0.005 0.001	tustation working) collimateria Acid (e)										-	0017	A THE MAN
entrationic & 0.1 0.025 0.0025 0.1 0.025 0.0025 0.0025 0.0025 0.0025 0.0025 0.0025 0.0025 0.0025 0.0025 0.0025 0.0025 0.0025 0.002 0.002 0.002 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	Acachidonic Acid (g)				0.02	0.005	0.00005	000	0.015	0.0015	P4	0.5	6H0/0
U(g) 1/6 6.40 0.300 0.30 0.37 0.071 cond(z) 1.4 6.35 0.003 2.6 0.64 0.003 cond(z) 2.0 30 4.9 0.03 2.6 0.64 0.063 cond(z) 2.0 1.4 0.35 0.03 2.6 0.64 0.063 cond(z) 2.0 1.9 6.0 1.60 1.0 2.5 cond(z) 2.0 1.9 1.0 1.0 2.5 0.64 0.063 cond(z) 2.0 1.0 1.0 1.0 1.0 2.5 0.64 0.063 cond(z) 2.0 1.0 1.0 1.0 1.0 2.5 0.64 0.063 cond(z) 2.0 1.0 1.0 1.0 1.0 1.6 1.6 1.6 1.6 1.6 1.6 1.6 1.6 1.6 1.6 1.6 1.6 1.6 1.6 1.7 1.7 1.7 1	Elecostpentactoric & Dosonahexaenoic Acid (g) ^b				0.1	0.025	0.0025	0.1	0.025	0,0025			
1.4 0.15 0.035 2.6 0.64 0.063 20 30 40 100 10 25 20 50 4.9 400 160 25 20 100 160 70 25 26 20 100 160 40 167 167	raeroan Calcium (g)	1.6	0.40	0.040				2.9	0.72	12010			
(c) 200 50 4.9 4.0 100 5.5 4.0 100 5.5 5.6 5.6 5.6 5.6 5.6 5.6 5.6 5.6 5.6	Phospherus(g)	1.4	0.35	0.035				92	0.64	6000			
10 11 11 11 11 11 11 11 11 11 11 11 11 1	Magnesium (mg)	002	98	16.0				87 B	8 2	16.7	>15 e		
	Potassium (g)	1000			5.2	1.3	0.13	23	1	0.13	0		

Table 15-12 Nutrient Requirements of Adult Cats for Maintenance

			2											atta i	
			2,469/	61										ucic + di	
			25,000	188										respectively. escosapentare e vitamin K is tion.	
>600			100,000	181										 1.7 g/kg diet. 01. of the total 01. of the total 01. of the total 03. 83. 84. 84. 85. 64. 64.	
6100	0.119	35	24.7	0.17	0.94	27020	0.000	0.06	0.99	0.56	10	1.9	19	s are 1.0 and it exceed 20 exe Chapter eve Chapter not event	
18.5	22 17	350	250	1.75	10	971	10	0.625	10.01	28	1881	18.75	(637	clauted face cluded four in g retitioil. sy't acetate (i e fed. Under ins alkylatios uneg antibiot	
25 0 27	4.8	00f*1	1,000	4	ř,	35	04	2.50	0F	225	150	15	2,550	y expanded an ensic acid is in expressed as y t-rate actoroph t-based dist() at first that requir first ordinate	
0.119	0.119 6.95		8/61	0.14	0.74	10.0	0.079		678	0.44		15		invances for dr nat cionsipenta per limit values in $E = 1$ mg al ets (except fish returner metha	
183	2 2		200	14	512	0.20	0.80		8.0	15		15		ine- thinad, is required, bereas the all is advised of it.A. Safe upp it.A. Safe upp it.A. Safe upp it.A. Safe upp it.a. synthesis disal synthesis	
50	4.8		(NX)	5.6	90	01	110		R.	18		8		 1,000. 1,000. e.RA. of argin phenylationin 4, g/ke gliet, wa annote neidd. JU of vitaam 3, U of vitaam monstrand wi monstrand wi the commer vided by miss 	
		31.6						0.05	1.10	N.M.	5		30	Land divide 5 for the complexity of the transfluentian size to that of field discs to 0 on elecosapear w bicavalidati retinol =3.33 FA dires. On FA dires. On the transf probably pro-	
		330						5.0	110	-	150		510	url.1000 ken muttan aboo quintennent quintennent seartible puri seartible puri seartible puri seartible puri non or 1 ag to the puri to the puri- tant search are be cupte at bentim is	
		1,300						2.0		7	(09)		2,040	a nutient An y g of crude ann of the n ann of the n ann of the n information information information information a distary rede a distary rede in K allowa white, adeque	
copper (mg) ¹ Zine (mg)	Manganese (rug) Selenium (jug)	Iteline (ag)	Vitamin A (µg retinoly	Choleculotferol (µg) ⁶	Vitamin E (or-tocopherol) (ong)	Vitamin K. (Memolook) (mg/"	Rebullavin (rac)	Pyradoxine (mg)	Niacin (mg)	ramoanemic Acad. (10g.) Cobadamin (110)	Folic Acid (µg)	Biotin (µg)*	Choline (mg)	9.02 graphine should be used by the numeur Anuch 200 keal and fixink by 1,000. 9.03 graphine should be used by the numeur Anuch 200 g for the RA of againee. 9.05 graphine black hair color, an equal quantity or greater of youster to that of phenylationic + systame continuine that hair back and the equiprement for methionize + systame continuine. 9.05 graphine black hair color, an equal quantity or greater of youster to that of phenylationic is required. The necesimaended allowance of numie for highly digestible purified firsts to 14 g/sg dist, whereas the allowances for dry expanded and canned duets are 10 and 1,7 g/tg dist, respectively. The necesimaended allowance of numie for highly digestible purified firsts to 14 g/sg dist, whereas the allowances for dry expanded and canned duets are 10 and 1,7 g/tg dist, respectively. The necesimaended allowance of numie for highly digestible purified firsts to 14 g/sg dist, whereas the allowances for dry expanded and canned duets are 10 and 1,7 g/tg dist, respectively. Some reviews of inormation is available on eiccooperatemole usid. It is advised that econspentations and i and canned duets are 100 and 1,7 g/tg dist, respectively. Some reviews of inormation is available on eiccooperatemole usid. It is advised that econspentations and is an econd to the rest of an econometal or 1 ag returol = 3.333.10 of vitamin A. Safe upper limit values expressed as ag returol. Some reviews of vitamin B. Higher concentrations of vitamin B. To a subscience and an the aread because of law house vitamin A. Safe upper limit values expressed as ag returol. Some reviews of vitamin B. Use the necilement Ha. or been demonstrated when the conspentations and is a reaction of the rest forces the another that requires alloyande vitamin K is probably synchroster in the interface. The vitamin B, alwanne with an equivable provided by meridoal synchroster in the unsertine and the investive. Dues containing anth	

15 38 081 15 3.8 0.81

Table 15-14 Nutrient Requirements of Queens in Late Gestationand Peak Lactation

121 and 1 1110				5.5	1.4 0.050 0.050	0,3 0,011 0,0007 0,0007	222	14 0000 17	0.3	550	13.8	2.05
sate Acids				0.2	0.050	0.011 0.011 0.0067	0.2	0.050	0.011			
Linoleic Acid (g) of Linolesic Acid (c)					0.050	0.011	0.2	Servin .	0.0044			
Arachidenic Acid (g)				23	10070101		0.1	CTIVIN				
Electratpentarmose & Decersalterarmose Acid (g#												
dimenuls				10.8	2.7	0.565	10.8	23	0.565			
Calcium (g)	14	1.22	1361				2.6	13	0.411			
Protoporten (L)	416	164	22			1220	500	20	12			
				2,6801	679	142	2,000	D CU	LEE V			
Available (e)				5.2		117	1000	1 1000	Els			
(Thinkide (me))				4/000		111	UNN'S		1.1			
tion they				8	62	54	00		100			
Concertmed				¥.¥	g	21-10	8.8	1 and	1.1			
	42.	10.5	22			1222	8		11.75			
				12	1.8	0.38	111	61	N.M.			
Manganewe (mg)				300	-15	9	900	4	4			
Selemum (µg)				1,800	450	8	1,800	450	96			
Instanto spaga						1	in court	200	100	100.000	25,000	10005
Alternative A. Const mediated P.				1.66M)	400	52	2000		44.00	USE	188	9
Viamiti A (p.g. renework				3.6	1.4	0.30	101	Crit		ALC: N		
PORTINUED AND AND A DESCRIPTION AND A DESCRIPTIO				98	54	1.6	IE:	1.0	101			
un E. sur-surveynstruut tuder				1.0	0.25	0.18	1.0	670	0.15			
MUNITURI A. (ONCOMPOSE) UMBU				5.0	1.25	0.27	53	81	26.0			
Thumm (mg)				3.2	0.80	0.47	4.0	10				
Rebotlavin (1982)	2.01	519	0.10				2.50					
Pyratoxeno (1982)	-	1	and the second	P	8.0	17.1	40		2.10			
Nazin (mg)	1.6.5	. 59.4	92.0				5/33		131			
Puntoffication Actid (ITR2)	ę.	-		18	の時間	0.80	22.5		130			
	0.00	140	27				122	181				
683				8	2	12	15		2			
		11 mm					2,550		113			
Cholme (mg) 2.000 310 91	2.040	310	16				10000			L'ELENCE ARTICLE MALE	C. Kon Building	V rotation

Table 15.1, multiply this value by matter Am1.100 text and others by 1.00m. In concurst a matter of the state 1.0 and 1.7 g/g distary DM, respectively of the system of the optimization of the optimate th

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Attachment F -- References and Research Information

American Association of Feed Control Officials (2011) Official Publication, Oxford, IN

Ajnomoto (2011) Encyclopedia of Amino Acids. http://www.ajinomoto.com/amino/eng/product.html

Baker, David H (2008) Animal Models in Nutrition Research, American Society for Nutrition Journal Vol. 138, pp 391-396.

Briston, Andrew W.; Whitehead, David C.; Cockburn, John E (1992) Nitrogenous constituents in the urine of cattle, sheep and goats. Journal of the Science of Food and Agriculture, Volume 59, Issue 3, pp 387-394.

Deshpande, S.S. (2002) Handbook of Food Toxicology, Mercel Decker, Inc., New York, NY

European Pet Food Industry Federation (2011) Nutritional Guidelines for Complete and Complementary Pet Food for Cats and Dogs, B-1050 Bruxelles. <u>http://www.nutricao.vet.br/pdfs/FEDIAF_Nutritional_Guidelines_final_version_6-09-11.pdf</u>

Holisticmed.net (2003) Amino acid Production. http://www.holisticmed.net/aspartame/aminoacid.pdf

FDA (2010) Pet Food Labels - General, Center for Veterinary Medicine, March

Journal of Chemical Education (2004) Commercial Production of MSG and Other Amino Acids, Cornell College, Mount Vernon, IA

Morris, James (2002) Idiosyncratic nutrient requirements of cats appear to be dietinduced evolutionary adaptations. Department of Molecular Biosciences, School of Veterinary Medicine, University of California, Davis. <u>Nutrition Research Reviews</u>, 15 Pages 153-168.

http://journals.cambridge.org/download.php?file=%2FNRR%2FNRR15_01%2FS095442 2402000070a.pdf&code=395e67a2405fe3e7ef0a6e06d5ccf9fa

Morris, James; and Rogers, Quinton (1978) Arginine: An Essential Amino Acid for the Cat, Journal of Nutrition, 108 Pages 1944-1953. http://jn.nutrition.org/content/108/12/1944.full.pdf

National Research Council (2006) Nutrient Requirements of Dogs and Cats, Animal Nutrition Series, NRC of the National Academes, Washington, D.C.

Paustian, Timothy (2000) Synthesis of Amino Acids. University of Wisconsin, Madison

Penn State (2011) The N Cycle, Crops and Soil Sciences, State College, PA <u>http://cropsoil.psu.edu/research/kaye-lab/lab-logo</u>

Soeter, Peter; van de Poll, Marcell; van Geemer, Wim; van Gemert, Dejong, Cornelis (2004) Amino Acid Adequacy in Pathophysiological States, <u>*The American Society for*</u> <u>*Nutritional Sciences*</u> J. Nutr. 134:1575S-1582S, June 2004

UN FAO (1998) Organic matter decomposition and the soil food web <u>http://www.fao.org/docrep/009/a0100e/a0100e05.htm</u>

UN World Health Organization (2007) Protein and Amino Acid Requirements in Human Health, Joint Report of WHO/FAO/UNU Expert Commission, <u>http://whqlibdoc.who.int/trs/WHO_TRS_935_eng.pdf</u>

Virginia-Maryland Regional College of Veterinary Medicine (2010) Nutrition for the Adult Cat, <u>http://www.vetmed.vt.edu/vth/sa/clin/cp_handouts/Nutrition_Adult_Cat.pdf</u>

Virginia-Maryland Regional College of Veterinary Medicine (2010) Nutrition for the Adult Dog <u>http://www.vetmed.vt.edu/vth/sa/clin/cp_handouts/Nutrition_Adult_Dog.pdf</u>

Zoran, Debra L., DVM, PhD, DACVIM (2002) The carnivore connection to nutrition in cats. <u>Journal of the American Veterinary Association</u>, Vol. 221, No. 11, December, 1. <u>http://catinfo.org/docs/zorans_article.pdf</u>