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Global Leader in Pet Nutrition
Essential fatty acids are generally considered to be functional fats. Both facilitative and functional fats are components of dog and cat diets. Facilitative fats are those that add palatability and texture to foods, provide a dense source of calories for energy, can be stored for energy in tissues, and can facilitate the absorption of other nutrients such as the fat-soluble vitamins from the digestive tract. Many of the facilitative fats for dogs and cats include saturated and monounsaturated fatty acids. These may either be present in the diet or synthesized by the body. Trans fatty acids are likely to be facilitative as well, although there are limited studies published on the effects of these fats in companion animals. Studies to date indicate that they are metabolized in a fashion similar to metabolism of saturated fats.

Facilitative fats:
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- Provide a dense source of calories for energy
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Functional fats:
- Are involved in a particular aspect of cellular regulation or metabolism

One reason certain fatty acids are essential is because they are not synthesized by the animal body and must be supplied in the diet. Functional fats are those involved in some particular aspect of cellular regulation or metabolism. Not all functional fats are essential fatty acids. However, all essential fatty acids are functional fats. Two examples of nonessential functional fats are conjugated linoleic acid and medium-chain triglycerides. By contrast, examples of functional fats that are dietary essentials include the omega-6 fatty acid, linoleic acid (LA), and the omega-3 fatty acid, α-linolenic acid (ALA). Longer chain fatty acids that are derived from LA and ALA are also functional fats. These include arachidonic acid (AA) from LA and eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) from ALA.

WHAT CONSTITUTES AN ESSENTIAL FATTY ACID?
One reason certain fatty acids are essential is because they are not synthesized by the animal body and must be supplied in the diet. However, there are two equally important aspects that characterize their essential nature. First, they need to contain at least two double bonds. Second, these double bonds must be placed in a methylene interrupted cis, cis-configuration, which is the precise structure that imparts essentiality to the fatty acid molecule. It is this particular sequence of double bond placement that is required because it governs how the molecule will fold upon itself, allowing it to participate in cellular and membrane events. It is of interest that the presence of a trans-double bond in a fatty acid is not incompatible with essential fatty acids.
acid activity as long as the basic pattern of a methylene interrupted double bond sequence of the cis, cis type is also present. Figure 1 shows a comparison of selected saturated, monounsaturated, and polyunsaturated fatty acids and the methylene interrupted sequence. Conjugated LA, while functional in many ways, does not qualify as an essential fatty acid because its double bonds are “conjugated” instead of methylene interrupted. A comparison of the methylene interrupted sequence and the conjugated sequence of double bonds is shown in Figure 2.

Both LA and ALA have methylene interrupted double bonds and are essential fatty acids. In addition, each serves as a precursor of unique long-chain fatty acids and eicosanoids, which are powerful physiological mediators of cell function in numerous tissues. These findings have added new complexities to their essential nature because diets generally contain both 18-carbon precursors and their 20- and 22-carbon long-chain derivatives (LCPUFAs). These derived LCPUFAs are important because, under some conditions or life stages, there may not be adequate conversion of the precursor 18-carbon acids, making them “conditionally essential.”

ESSENTIAL AND CONDITIONALLY ESSENTIAL FATTY ACIDS FOR DOGS AND CATS

The most widely recognized and historic essential fatty acid for mammals, including dogs and cats, is LA (an 18-carbon omega-6 fatty acid). It was the first essential fatty acid to be discovered, probably because deficiencies of this fatty acid led to such dramatic and noticeable effects on animal well-being. One important deficiency sign was impaired growth and scaly skin lesions of dogs and other species. LA is also important for proper cellular development and reproductive, gastrointestinal, and renal functions, to mention a few of the other well-known effects of this fatty acid in addition to the maintenance of healthy skin. Recommended amounts of total fat and LA for dogs and cats are generally similar to those for humans although differences exist. For example, a safe upper limit of both total fat and LA is typically greater than those amounts defined for human diets. Reasons for these differences include the fact that dogs and cats are 1) HDL mammals with little risk...
of atherogenesis and 2) fur-bearing animals with considerable lipid associated with their normal hair coats.

LA is well recognized for its role in maintaining the transepidermal water barrier and hydration status of skin. In healthy skin, ceramides containing LA are extruded as intercellular lamellar granules from epidermal keratinocytes, which enhances cell cohesion and imparts an effective water barrier to the epidermis.4,5 Because LA is directly involved, many instances of dry, dull hair coat and scaling, nonpruritic skin disorders of dogs generally respond to dietary vegetable oil supplements rich in this fatty acid such as corn or sunflower oils. There is evidence that ALA may also contribute to an effective transepidermal water barrier. However, it has also been observed that ALA provides a sparing effect on LA, resulting in the accumulation of additional LA — which, in turn, may be incorporated into skin ceramide fractions. Thus, the benefit of ALA may be indirect in this instance.

Historically, ALA has not been regarded as the nutritional equivalent of LA because signs of ALA deficiency are more subtle than those of LA deficiency.6 In dogs and cats, definitive studies of the essentiality of ALA have not been performed. However, based on studies in other mammals, ALA should now be considered to be an essential nutrient.7 Although ALA is less potent as an essential skin fatty acid than LA, several of its long-chain derivatives (i.e., EPA and DHA) have important metabolic consequences, particularly in immune and inflammatory responses, nervous tissues, and especially neurological development.8-12 Studies in numerous species, including dogs, have found that modest or inadequate intakes of ALA are associated with decreased visual function and polyneuropathy.6,8,13,14 Thus, appropriate amounts of ALA are recommended for most life stages of both dogs and cats especially because it is a precursor of DHA. It should be noted, however, that the metabolic conversion of ALA to DHA is inefficient. Thus, under conditions of high demand such as growth or reproduction, a dietary source of DHA is considered “conditionally essential,” which means that under certain conditions a dietary supply of the nutrient appears necessary.

Although further study is needed, it is likely that effects of ALA, or perhaps its derivatives, may also be necessary for other life stages. Until more is known about the actual minimal requirements of the omega-3 polyunsaturates, small (and presumed adequate) amounts of both the 18-carbon and 20/22-carbon types are recommended for most life stages.

It is now generally accepted that both LA and ALA are essential fatty acids for adult dogs. In addition, DHA is conditionally essential13,14 for puppy growth and successful reproduction. LA is also essential for adult cats. However, there is no infor-
information to date on the essentiality of ALA in feline species, even though small amounts are “recommended” for growth and reproduction. Arachidonic acid (AA) is conditionally essential for growth of kittens and reproduction of queens and a recent study has suggested that for adult cats and for conception to occur,15 lower amounts of AA are supportive. It may be that very little dietary AA is necessary for adult cats; nonetheless, small dietary amounts of AA are recommended to balance the omega-3 fatty acids that are also often present in practical feline diets.

Table 1 presents a summary of the essential and conditionally essential fatty acids in dogs and cats. Specific recommended allowances for dogs and cats for each life stage have also been made as part of the 2006 Nutrient Requirements for Dogs and Cats document currently in press by the National Research Council.

### KEY RESEARCH QUESTIONS AND ISSUES

Although considerable progress has been made in recent years with respect to the nature of the essential fatty acids in dogs and cats, numerous aspects require further study.

#### Fundamental Questions

The extent to which ALA can substitute as substrate for DHA synthesis during gestation and suckling and after weaning in puppies and kittens needs investigation. When large amounts of ALA are fed during gestation and lactation, canine milk becomes enriched in ALA but no DHA accumulates.15 When puppies suckle this markedly ALA-enriched milk, accumulation of DHA has been found in their plasma phospholipid fraction.16 Whether smaller amounts of ALA will have a similar result is unknown. However, feeding preformed DHA is a more efficient source of this fatty acid during this life stage. Thus, providing dams with preformed DHA during lactation assures the omega-3 status of developing puppies.

Very little information on omega-3 fatty acid metabolism in cats has been published and efforts to understand fundamental aspects of ALA conversion and omega-3 fatty acid requirements and effects in this species are needed. One example is whether gamma-linolenic acid may substitute for AA in feline growth and reproduction. The use of polyunsaturated fatty acids in inflammatory and atopic skin disorders continues to be recommended. One fundamental study is whether dog and cat keratinocytes possess delta-6 desaturase activity. If not, other cell types involved in the inflammatory response need to be enriched in the types of fatty acids necessary to help control certain skin disorders. Studies on the resultant cell to cell signaling pathways involved may help to better understand mechanisms of epidermal inflammation.

#### Clinical Questions

Several areas of clinical investigation are warranted where the essential fatty acids are concerned. Preliminary studies have shown promise in several clinical conditions. Areas include:

- Controlled studies of ALA metabolism on skin and hair coat condition of dogs
- Effects of conjugated LA in maintaining lean body mass
- Use of omega-3 long-chain polyunsaturated fatty acids (LCPUFAs) in inflammatory bowel diseases and other progressive inflammatory disorders
- Studies on omega-3 PUFAs and neurological development

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**Table 1: Summary of the Essential and Conditionally Essential Fatty Acids for Dog and Cat Life Stages**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Dogs</th>
<th>Cats</th>
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<tbody>
<tr>
<td></td>
<td>Growth</td>
<td>Adult</td>
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<tr>
<td>Omega-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LA</td>
<td>X(^a)</td>
<td>X</td>
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<tr>
<td>AA</td>
<td>Rec(^b)</td>
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<tr>
<td>Omega-3</td>
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</tr>
<tr>
<td>ALA</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>EPA(^c)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>DHA(^d)</td>
<td>C</td>
<td>Rec(^b)</td>
</tr>
</tbody>
</table>

\(\text{a. X, Essential fatty acid; C, Conditionally essential for the respective life stage}
\(\text{b. Recommended but no requirement established}
\(\text{c. Many omega-3 LCPUFA sources contain both EPA and DHA; EPA should not exceed 60% of EPA + DHA total.}}

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It is now generally accepted that both linoleic acid and \(\alpha\)-linolenic acid are essential fatty acids for adult dogs.
Utility of omega-3 LCPUFAs in aging, memory, and cognitive function

Benefit of omega-3 LCPUFAs in aggression in dogs and cats

Role of omega-3 LCPUFAs in mitigating insulin sensitivity, obesity, and metabolic syndromes

Relationship between omega-3 LCPUFAs and cancer prevention and therapy

Involvement of omega-3 LCPUFAs in immune-mediated disorders

**FUTURE STUDIES**

Future studies designed to investigate both fundamental and clinical effects of the essential fatty acids will help answer the above questions. They will require specific approaches in both planning and implementation. Where studies on dietary fatty acids are concerned, it is imperative that the source, dose, test duration, and sustainment of effect after discontinued use be included. The quantity and specific fatty acids present in the test materials or food used must also be known. ALA is not the biological equivalent of EPA or DHA due to its inefficient conversion. Thus, attempts to relate findings to total omega-6 to total omega-3 ratios should be done cautiously. Existing literature should be verified for the presence of mixed sources of the omega-3 fatty acids where ratios are calculated. It would be helpful if future studies included both a fish oil group (or even specific omega-3 LCPUFA types) and a vegetable omega-3 group with all fatty acid types defined, along with a separate control group to better delineate effects of ALA from those of the longer chain fatty acid species. Baseline assessments of omega-6 and omega-3 intakes should also be performed at the outset of any clinical studies to better define the populations being evaluated. Finally, it is important not to neglect the fact that arachidonic acid and its eicosanoid derivatives continue to be important cell regulators. Studies in which this omega-6 fatty acid is substituted with omega-3 analogue must keep this fact in mind.

Careful attention to these aspects and rigorous efforts to control both clinical and fundamental studies will result in new and interpretable data on the myriad potential of these lipid nutrients in veterinary animal health and practice.

**REFERENCES**


