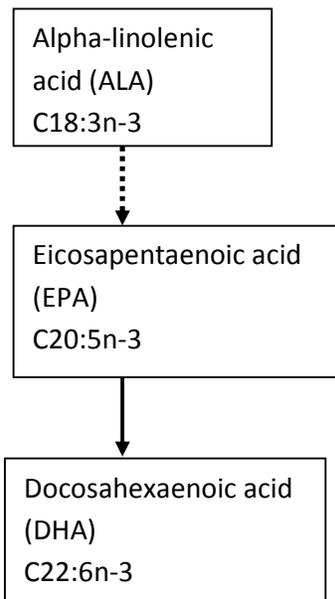


## Essential fatty acids ('healthy oils')

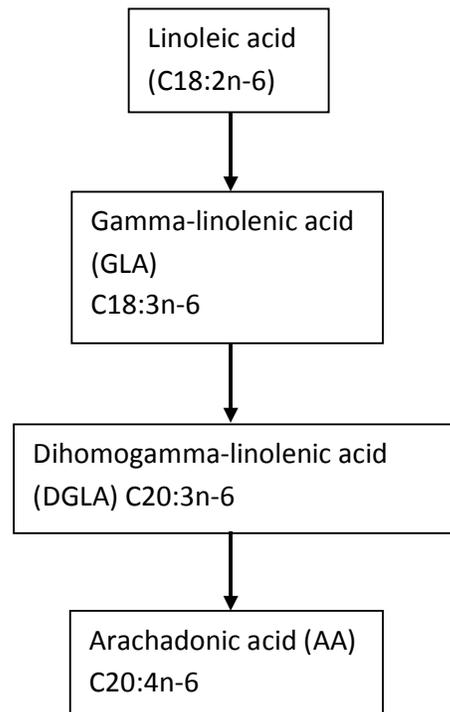
### 1. What are essential fatty acids?

Essential fatty acids (EFA) are fatty acids that we need for our health, but cannot be synthesised in the human body from any other fatty acids provided in our diet. They belong to the class of fatty acids called polyunsaturated fatty acids (PUFAs). There are two types of EFA, omega-3 and omega-6. These names refer to the chemical structure of the fatty acid; both types are unsaturated, that is, they contain carbon-carbon double bonds, the type is determined by the final double bond being either at the n-3 or n-6 position. The main essential omega-3 fatty acid is alpha-linolenic acid (ALA), and the main essential omega-6 fatty acid is linoleic acid. Although the human body cannot synthesise either of these fatty acids from scratch, it can use them to synthesise other essential fatty acids. ALA is a precursor of the longer chain omega-3 fatty acids eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA), and linoleic acid is a precursor of the longer chain omega-6 fatty acids gamma-linolenic acid (GLA), dihomogamma-linolenic acid (DGLA) and arachadonic acid (AA). These longer chain fatty acids can also be provided directly from dietary sources. The biochemical pathways are summarised below. The C18:2, C20:4, C22:6, etc, refers to the number of carbon atoms in the fatty acid chain, the number of double bonds, and whether the final bond is at the n-3 or n-6 position (omega-3 or -6).

#### Omega-3 pathway:



#### Omega-6 pathway:



## 2. Biological roles of EFA

Both omega-3 and omega-6 EFA have a role in maintaining normal growth and development, including that of the brain, and are important components of all cell membranes in the body. However the two classes of EFA are metabolically and functionally separate, and often have important opposing physiological functions. AA (omega-6), DGLA (omega-6), and EPA (omega-3) are used to synthesise eicosanoids in the body, these are signalling molecules that exert complex control over many bodily systems, mainly in inflammation or immunity. There are four families of eicosanoids—the prostaglandins, prostacyclins, the thromboxanes and the leukotrienes. The eicosanoids derived from AA tend to increase inflammation (an important component of the immune response), blood clotting, and cell proliferation, while those derived from EPA and DGLA decrease those functions. The amounts and balance of omega-3 and omega-6 fats in a person's diet will therefore affect the body's eicosanoid-controlled functions, and are therefore important in maintaining optimum health. It is widely believed that Western diets tend to have too much omega-6, particularly in relation to omega-3 fatty acids, and that this imbalance can increase risk of cardiovascular disease, cancer, osteoporosis and other inflammatory disorders.

## 3. Food sources of EFA

The main food sources of the different EFA are shown in the table below.

<b>EFA</b>	<b>Food source</b>
<b><u>Omega-3</u></b>	
ALA	Dark, green leafy vegetables, certain nuts and seeds and their oils (flaxseed/linseed oil, hempseed oil, walnut oil)
EPA	Oily fish, fish oil supplements
DHA	Oily fish, fish oil supplements
<b><u>Omega-6</u></b>	
Linoleic acid	Commonly used polyunsaturated vegetable cooking oils, including sunflower, safflower, corn, cottonseed, and soybean. Processed foods containing these oils. Nuts, sesame and sunflower seeds
GLA	Plant based oils including evening primrose oil, borage seed oil and blackcurrant seed oil. Some hempseed oils.
AA	Egg yolk, meats

The oil highest in omega-3 fats is flaxseed (linseed), with over 50% of fatty acids as omega-3, and a ratio of 0.3:1 omega-6:omega-3. Hempseed oil also has a good balance, with about 20% omega-3, and a ratio of approximately 3:1 omega-6:omega-3. Walnut oil is often recommended as a good source of EFA: this is lower in omega-3, about 3-11% of fatty acids, with a ratio of approximately 5:1 omega-6:omega-3.

Eye Q liquid is widely used as a dietary supplement in children. This contains fish oil (EPA and DHA, omega-3), and evening primrose oil (GLA, omega-6), and also vitamin E.

Some children on the ketogenic diet may also use the prescribable dietary products calogen and/or ketocal (SHS International). These are both supplemented with omega-3 and omega-6 EFA, the amount provided will depend on the amount of the product used.

#### 4. Recommended intakes of EFA

It is recommended that a healthy diet should consist of approximately 2 - 4 times more omega-6 than omega-3 fatty acids; however a typical Western diet tends to contain 15 - 20 times more omega-6 than omega-3 fatty acids, due to the amount of vegetable oils and processed foods eaten. Healthy eating guidelines recommend lowering omega-6 intake and increasing omega-3, by reducing processed foods, including oily fish, and replacing some of the commonly used vegetable oils with oils higher in omega-3 fats, or olive oil (monounsaturated oil, so contains relatively low amounts of both omega-3 and omega-6 fatty acids, but known to be very beneficial for cardiovascular health). Although there are no recommendations for exact amounts of EFA in the diet of children, current UK department of Health (1991) dietary reference values suggest that ALA (omega-3) should provide approximately 0.2% of total dietary energy, and linoleic acid (omega-6) approximately 1% of total dietary energy. Although in most cases, the longer chain omega-6 fatty acids GLA and DGLA and omega-3 fatty acids EPA and DHA can be formed in the body from linoleic acid and ALA, there is increasing evidence that there may also be additional requirement for these longer chain fatty acids to be provided directly from the diet in some cases.

#### 5. Do EFA have benefits in ADHD?

Omega-3 fatty acids are essential for normal brain development, and it has been suggested for many years that deficiencies or imbalances of these nutrients may contribute to certain childhood neuro-developmental disorders, including attention-deficit hyperactivity disorder (ADHD) and other autistic spectrum disorders. There have been three recent randomized placebo-controlled trials examining the benefit of omega-3 and omega-6 fatty acid  
Liz Neal 2009

supplementation in ADHD. The first two, including one from the UK (Oxford-Durham study) found significant reduction in ADHD symptoms in the fatty acid supplemented group, however the children included did not have a formal ADHD diagnosis, A third, more recent trial from Sweden, included 75 children and adolescents who had been formally diagnosed with ADHD in a clinical setting. Although they found that the majority did not respond to the fatty acids, a subgroup of 26% did respond well with a clinically meaningful improvement of more than 25% reduction in ADHD symptoms. These responders tended to have associated neuro-developmental problems or ADHD inattentive subtype.

#### 6. Is it safe to use evening primrose oil supplements in epilepsy?

There was concern for a number of years that evening primrose oil might cause seizures, and advice has been given not to use this supplement if you have epilepsy. This has been an issue for parents of children with epilepsy, as this type of oil is included in the widely used children's Eye Q liquid product. The evidence was based on two studies published in the early 1980s on use of evening primrose oil in schizophrenia treatment. These were re-examined by Puri in a recent paper, which showed the original reports to be spurious, concluded that the oil might actually have benefits in epilepsy, and suggested that any contra-indications for use of evening primrose oil in epilepsy be removed from all medical formularies.

#### 7. Recommendations for use of EFA supplements while on the ketogenic diet

So, what would we recommend for children on the ketogenic diet in terms of 'healthy oil' supplementation?

To ensure a good balance between omega-3 and-6 fatty acids, it would be advised to vary the oil source wherever possible, and if using large amounts of a polyunsaturated vegetable cooking oil such as those listed in the above table (omega-6 sources), add in a small amount of an omega-3 source to the diet as well, such as flaxseed/linseed oil, hempseed oil or walnut oil. The amounts of these omega-3 oils used can be very small, eg. 2-3ml a day, but this should ensure a child is receiving the correct balance of EFA. This is also important for children following the MCT diet, especially if receiving a large percentage of their energy from the MCT oil or Liquegen, to ensure that adequate EFA are provided. General healthy eating recommendations should also be included wherever possible on any type of ketogenic diet, within the constraints of the prescription, and these include regular oily fish and dark green vegetables, both good omega-3 sources. Olive oil, although not containing any EFA, can also be included, as has known benefits on cardiovascular health.

There have been questions about whether any one particular type of EFA rich oil is better to use as a supplement on the ketogenic diet. Although flaxseed oil contains the highest proportion of omega-3 fatty acids, adequate supply can easily be provided from small amounts of walnut oil, which is more widely available. There is no evidence of advantages of any one oil type. A study from Finland examined the effects of hempseed and flaxseed oil on healthy adult volunteers. Despite the two oils having marked differences in their effects on serum fatty acid composition, there were no differences in fasting serum total or lipoprotein lipids, plasma glucose or insulin level or haemostatic factors between the two oils. An alternative supplement is the widely available Eye Q liquid.

There are a few points of caution to note when using these oils. Firstly, even small amounts contain calories, and should be included where possible into the dietary prescription, particularly if added in at a later date to starting the diet. Secondly, they do not need to be used in quantities greater than the small amounts already mentioned. We do not know what the health consequences of long-term use of large amounts of a high omega-3 oil source in the diet could be, but suggestions have been made of increased bleeding time risk. Thirdly, there have been concerns about the high level of fat soluble vitamins included in some oils. Particular concern is vitamins A and E; both of which will also be included in the vitamin supplement a child is prescribed while on the ketogenic diet, and so have an increased risk of toxicity. It is important that wherever possible, levels of these vitamins are monitored on the diet; this will reduce risk of problems occurring. As with any type of dietary supplement, use should always be discussed with a dietitian and medical team before commencing.

## References

1. Hibbeln JR, Nieminen LR, Blasbalg TL, Riggs JA, Lands WE (2006). Healthy intakes of  $n-3$  and  $n-6$  fatty acids: estimations considering worldwide diversity. *American Journal of Clinical Nutrition* **83**(6 Suppl):1483S–1493S.
2. Johnson M, Ostlund S, Fransson G, Kadesjö B, Gillberg C (2009). Omega-3/Omega-6 Fatty Acids for Attention Deficit Hyperactivity Disorder: A Randomized Placebo-Controlled Trial in Children and Adolescents. *J Atten Disord* **12** (5), 394-401.
3. Puri BK (2007). The safety of evening primrose oil in epilepsy. *Prostaglandins Leukot Essent Fatty Acids* **77**(2):101-3.
4. Richardson, AJ. Montgomery, P (2005). The Oxford-Durham study: a randomized, controlled trial of dietary supplementation with fatty acids in children with developmental coordination disorder. *Pediatrics* **115** (5): 1360–1366.
5. Schwab U, Callaway J, Erkkilä A, Gynther J, Uusitupa M, Järvinen T (2006). Effects of hempseed and flaxseed oils on the profile of serum lipids, serum total and lipoprotein lipid concentrations and haemostatic. *European Journal of Nutrition* **45** (8):470-7.
6. Simopoulos AP, Leaf A, Salem Jr N (2000). Statement on the essentiality of and recommended dietary intakes for  $n-6$  and  $n-3$  fatty acids. *Prostaglandins, Leukotrienes and Essential Fatty Acids* **63**:119–121
7. Sinn N, Bryan J (2007). Effect of supplementation with polyunsaturated fatty acids and micronutrients on learning and behavior problems associated with child ADHD. *Journal of Developmental and Behavioral Pediatrics* **28** (2): 82–91.

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