Attention deficit/hyperactivity disorder (ADHD) is a distressing diagnosis for any parent to hear. It's well known that children with ADHD are at a disadvantage in school and that ADHD can have long-term effects. In addition, a number of powerful pharmaceuticals have been used to treat the condition.

Fortunately, newer findings in nutrition and wellness, and newer generations of pharmaceuticals, have been developed that can help children with ADHD gain control over their lives. The Life Extension Foundation has conducted an extensive survey of the scientific literature to uncover the safest and best approaches for families affected by this increasingly common condition.

ADHD is defined as a persistent lack of attention to tasks (attention deficit) and/or a lack of ability to control impulses and an increase in physical activity (hyperactivity) that is not typical of others at a similar stage of development (National Institutes of Health 2006). ADHD is most prevalent in children and teens, although it can occur in adults. ADHD occurs in 3 to 6 percent of all children in the United States, with rates as high as 15 percent in some areas (Kasper DL et al 2005).

According to the fourth edition of the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders (DSM-IV), ADHD is now the most commonly diagnosed behavioral disorder of childhood. Boys with ADHD outnumber girls 3 to 1. Some children outgrow ADHD, but 60 percent continue to have symptoms (Biederman J et al 2000).

ADHD: A TYPICAL PROFILE

The behavior of children who have ADHD typically is affected in many settings such as at home and school or when they are with friends. The most prominent feature of ADHD is a consistent pattern of developmentally inappropriate levels of attention, concentration, distractibility, hyperactivity, and impulsivity. It is important to note that these problems must be inappropriate to a child’s developmental level to be considered ADHD. One concern among physicians is rampant overdiagnosis of ADHD, in part because the condition has been so hard to define.

Children who have attention deficits are unable to remain on-task for extended periods of time. They may appear forgetful, in part because their inability to attend to information prevents them from understanding it in the first place. Such children may also have cognitive and language delays. Children with hyperactivity may fidget, have difficulty engaging in quiet activities, be excessively talkative, and always seem to be on the go. Children who have impulse control problems may be impatient (for example, they may blurt out an answer before the question has been finished). They may have difficulty waiting their turn and are often perceived to be intruding on others. All of these manifestations can cause difficulties in academic and social settings (Warner-Rogers J et al 2000).

It is common for children with ADHD to be misdiagnosed as having learning disorders because they often perform poorly on tests that require information processing and concentration (Hartman CA et al 2004; Weiler MD et al 2000). There is also evidence that adults with ADHD are more likely to have a variety of addictive behaviors, among them alcoholism (Ponce AG et al 2000), smoking (Levin ED et al 2001), and cocaine use (Bandstra ES et al 2001).

WHAT CAUSES ADHD?

Although the exact causes of ADHD are unknown, it is most likely caused by an interaction of genetic, environmental, and nutritional factors, with a strong focus on the interaction of multiple genes (genetic loading) that together cause ADHD.

There is some evidence that people with ADHD do not produce adequate quantities of certain neurotransmitters, among them dopamine, norepinephrine, and serotonin. Some experts theorize that such deficiencies lead to self-stimulatory behaviors that can increase brain levels of these chemicals (Comings DE et al 2000; Mitsis EM et al 2000; Sunohara GA et al 2000).

There may also be some structural and functional abnormalities in the brain itself in children who have ADHD (Pliszka SR 2002; Mercugliano M 1999). Evidence suggests that there may be fewer connections between nerve cells. This would further impair neural communication already impeded by decreased neurotransmitter levels (Barkley R 1997). Evidence from functional studies in patients with ADHD demonstrates decreased blood flow to those areas of the brain in which “executive function,” including impulse control, is based (Paule MG et al 2000). There may also be a deficit in the amount of myelin (insulating material) produced by brain cells in children with ADHD (Overmeyer S et al 2001).

DIAGNOSING ADHD

Establishing a diagnosis of ADHD is a considerable challenge, largely because of the lack of reliable and specific testing and firm

criteria. ADHD has become a high-profile condition (which may result in it being both overdiagnosed and under diagnosed), depending on pressures from parents, teachers, and others. Although DSM-IV contains diagnostic criteria, they are often not followed by health professionals. Because of the lifelong implications of a diagnosis of ADHD, most experts recommend a multidisciplinary team approach to both diagnosis and treatment. Such an approach should involve physicians, child behavior experts, and parents. Nutritional experts may also be valuable members of the treatment team.

The core symptoms of ADHD in children are listed below. This list was adapted from the Centers for Disease Control. It is important to note that the diagnosis of ADHD cannot be made unless the patient has experienced these symptoms in ways that are disabling for a 6-month period. The DSM-IV diagnosis includes:

I. Either A or B:

A. Six or more of the following symptoms of inattention have been present for at least 6 months to a point that is disruptive and inappropriate for developmental level:

1. Often does not give close attention to details or makes careless mistakes in schoolwork, work, or other activities.
2. Often has trouble keeping attention on tasks or play activities.
3. Often does not seem to listen when spoken to directly.
4. Often does not follow instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behavior or failure to understand instructions).
5. Often has trouble organizing activities.
6. Often avoids, dislikes, or does not want to do things that take a lot of mental effort for a long period of time (such as schoolwork or homework).
7. Often loses things needed for tasks and activities (such as toys, school assignments, pencils, books, or tools).
8. Is often easily distracted.
9. Is often forgetful in daily activities.

B. Six or more of the following symptoms of hyperactivity/impulsivity have been present for at least 6 months to an extent that is disruptive and inappropriate for developmental level:

Hyperactivity:

1. Often fidgets with hands or feet or squirms in seat.
2. Often gets up from seat when remaining in seat is expected.
3. Often runs about or climbs when and where it is not appropriate (adolescents or adults may feel very restless).
4. Often has trouble playing or enjoying leisure activities quietly.
5. Is often “on the go” or often acts as if “driven by a motor.”
6. Often talks excessively.

Impulsivity

1. Often blurts out answers before questions have been finished.
2. Often has trouble waiting his/her turn.
3. Often interrupts or intrudes on others (such as butts into conversations or games).

II. Some symptoms that cause impairment were present before age 7 years.

III. Some impairment from the symptoms is present in two or more settings (such as at school or work and at home).

IV. There must be clear evidence of significant impairment in social, school, or work functioning.

V. The symptoms do not happen only during the course of a pervasive developmental disorder, schizophrenia, or other psychotic disorder. The symptoms are not better explained by another mental disorder (such as a mood disorder, anxiety disorder, dissociative disorder, or personality disorder).

TRADITIONAL MEDICAL TREATMENT

In addition to behavioral management, medical treatment of ADHD includes stimulant and nonstimulant medications.

Stimulant drugs. Effective prescription drugs are primarily the so-called stimulant drugs. These agents are known to increase brain concentrations of a variety of brain neurotransmitters, most importantly dopamine, and exert a calming effect on people who have ADHD. Since dopamine enhances signaling between nerve cells that are involved in task-specific activities and also decreases "noise," or "nonsense signaling," increased concentrations of dopamine are thought to help individuals stay focused and on-task.

Despite their limitations, stimulants are still considered first-line treatment for ADHD. They are effective in 70 to 80 percent of patients. Stimulants are highly effective at alleviating core ADHD symptoms (such as inattention, hyperactivity, or impulsivity). Original stimulant preparations had very short periods of action that could result in dramatic rises and falls in drug levels. Newer long-acting preparations have been developed to even out these swings.

Even with the newer formulations, some adverse effects are inevitable. Long-term effects, although unusual, can occur. There is some evidence, for example, that long-term use of stimulants, especially methylphenidate (Ritalin®), can cause a delay in growth (Holtkamp K et al 2002). It is understandable that many parents are hesitant to give their young children this medication.

While they are effective, stimulant drugs are members of the amphetamine class, which means they can have significant adverse effects and hold some potential for abuse. Unfortunately, methylphenidate has gained popularity as a recreational drug, especially among adolescents and college students. While methylphenidate paradoxically acts as a calming drug among people diagnosed with ADHD, it acts as a stimulant among people who do not have ADHD. Surveys have indicated that more than 90 percent of college students and adolescents who abuse prescription drugs identified methylphenidate as their drug of choice (White BP et al 2006).

Nonstimulant drugs. The negative effects of stimulant drugs have led to an intensive search for better alternatives. Atomoxetine is the first nonstimulant drug approved by the US Food and Drug Administration (FDA) for treatment of ADHD and the only agent approved by the FDA for treatment of ADHD in adults.

Atomoxetine therapy for ADHD controls symptoms and maintains remission, and has comparable efficacy with methylphenidate, a favorable safety profile, and noncontrolled substance status (Christman AK et al 2004). Atomoxetine is safe and well tolerated (Kelsey DK et al 2004). It effectively reduces ADHD symptoms and improves social functioning in school-aged children, adolescents, and adults. As with stimulant medications, atomoxetine should be used with caution in patients who have hypertension or a cardiovascular disorder (Christman AK et al 2004).

In addition to atomoxetine, other drugs that increase brain concentrations of dopamine and/or serotonin have been used with varying degrees of success. Among these are the anticonvulsant gabapentin (Hamrin V et al 2001), the dopamine-enhancing antidepressant bupropion (Daviss WB et al 2001), the wakefulness-promoting drug modafinil (Taylor FB et al 2000), and donepezil, an acetylcholinesterase inhibitor that increases brain levels of acetylcholine. Studies, however, have cast doubt on donepezil's effectiveness (Wilens TE et al 2005).

NUTRITIONAL THERAPY

As previously mentioned, ADHD is most likely caused by multiple factors, including nutritional issues. Children with ADHD may have specific nutrient deficiencies that aggravate their condition. As researchers learn more about the intersection between diet and behavioral disorders, the case for nutritional intervention among children with ADHD becomes more compelling. In the future, it is almost certain that this multifactorial disease will be treated on multiple fronts, including with nutritional intervention (Harding KL et al 2003). Already, many progressive parents and physicians are turning to comprehensive health care options to battle this frustrating condition.

Essential fatty acids. A growing body of scientific literature is helping parents and doctors better understand the link between fatty acids and behavioral disorders such as ADHD. The ratio between omega-3 and omega-6 fatty acids (such as arachidonic acid) seems especially important. Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are omega-3 fatty acids found in flaxseed oil and cold water fish. In the typical Western diet, we tend to consume more omega-6 fatty acids relative to omega-3 fatty acids. The ratio of omega-3 to omega-6 fatty acids has been shown to influence the development of neurotransmitters and other chemicals that are essential for normal brain function. Increased intake of omega-3 fatty acids has been shown to reduce the tendency toward hyperactivity among children with ADHD (Haag M 2003).

Several studies have examined the role of essential fatty acids in ADHD, with very encouraging results:

- In one pilot study, children with ADHD were given flaxseed oil, which is rich in alpha-linolenic acid. In the body, alpha-linolenic acid is metabolized into EPA and DHA. At the end of the study, researchers found that the symptoms of children with ADHD who were given the flaxseed oil improved on all measures (Joshi K et al 2006).
- Another study examined the effects of flaxseed oil and fish oil, which provide varying degrees of omega-3 fatty acids, on adults with ADHD. The patients were given supplements for 12 weeks. Their blood levels of omega-3 fatty acids were tracked throughout the 12 weeks. Researchers found that high-dose fish oil increased omega-3 acids in the blood relative to omega-6

acids. An imbalance between arachidonic acid and omega-3 fatty acids is considered a risk factor for ADHD (Young GS et al 2005).

- Finally, one study compared 20 children with ADHD who were given a dietary supplement (that included omega-3 fatty acids) to children with ADHD who were given methylphenidate. The dietary supplement was a mix of vitamins, minerals, essential fatty acids, probiotics, amino acids, and phytonutrients. Amazingly, the groups showed almost identical improvement on commonly accepted measures of ADHD (Harding KL et al 2003).

One study has also indicated that children with ADHD benefit from intake of a combination of essential fatty acids and vitamin E (Stevens L et al 2003).

Magnesium and vitamin B6. Combining magnesium and vitamin B6 has shown promise for reducing symptoms of ADHD. Vitamin B6 has many functions in the body, including assisting in the synthesis of neurotransmitters and forming myelin, which protect nerves. Magnesium is also very important; it is involved in more than 300 metabolic reactions. At least three studies have demonstrated that the combination of magnesium and vitamin B6 improved behavior, decreased anxiety and aggression, and improved mobility among children with ADHD (Nogovitsina OR et al 2006a,b; Nogovitsina OR et al 2005; Mousain-Bosc M et al 2004).

Iron. Iron deficiency may be implicated in ADHD (Konofal E et al 2004), although supplementation studies have shown minimal or no effects (Millichap JG et al 2006). Because of the potential toxicity of iron supplements, parents should consult their children's pediatrician before beginning supplementation.

Zinc. Zinc is a cofactor for production of neurotransmitters, fatty acids, prostaglandins, and melatonin, and it indirectly affects metabolism of dopamine and fatty acids. However, the role of zinc in ADHD is still emerging. Numerous studies have shown that children with ADHD are often deficient in zinc. However, researchers have not determined that a zinc deficiency causes ADHD or that treatment with zinc can improve symptoms of ADHD (Arnold LE et al 2005a,b). Two Turkish studies, however, have tested zinc therapy among children with ADHD with positive results. In these studies, children were randomized to groups that received either zinc or placebo. In one study, the conditions of children who took zinc for 6 weeks improved (Akhondzadeh S et al 2004). In the second study, zinc as the sole therapy resulted in significant improvements compared to placebo (Bilici M et al 2004).

Acetyl-L-carnitine. This superior form of L-carnitine, which is responsible for transporting fatty acids into the mitochondria, has been associated with a host of positive health benefits, including reducing impulsivity. In an animal model of ADHD, acetyl-L-carnitine was shown to reduce the impulsivity index (Adriani W et al 2004).

ADDITIONAL NUTRIENTS AND HORMONES

Melatonin. Melatonin is a hormone secreted at night by the pineal gland. It participates in multiple body processes, including regulation of the sleep/wake cycle. Because many children and adults who have ADHD also have sleep problems, melatonin can be an important part of an integrative therapy. By some estimates, up to 25 percent of children with ADHD also have sleep disorders. Unfortunately, however, conventional therapy treats the hyperactivity portion of the disease but neglects the sleep disorder (Betancourt-Fursow de Jimenez YM et al 2006). In one study of 27 children with ADHD and insomnia, 5 milligrams (mg) of melatonin, combined with sleep therapy, helped reduce insomnia (Weiss MD et al 2006).

Dehydroepiandrosterone (DHEA). DHEA is an important neuroactive steroid hormone that may be involved in ADHD, although researchers are still trying to understand the relationship. ADHD is associated with low blood levels of DHEA, its principal precursor pregnenolone, and its principal metabolite dehydroepiandrosterone-sulfate (DHEA-S). Higher blood levels of these neurosteroids are associated with fewer symptoms (Strous RD et al 2001). Furthermore, a study of adolescent boys with ADHD showed that DHEA levels rise after a 3-month course of methylphenidate treatment, which implies that DHEA somehow plays a role in the drug's effectiveness (Maayan R et al 2003).

Ginkgo biloba and ginseng. A combination of these two herbs has been studied for its ability to improve symptoms among patients with ADHD. In a study of 36 children ranging in age from 3 to 17 years old, a combination of Ginkgo biloba and American ginseng was administered twice a day on an empty stomach for 4 weeks. At the end of the study, more than 70 percent of patients had experienced improvement on a widely used measure of ADHD symptoms (Lyon MR et al 2001).

MIND-BODY APPROACHES

A number of behavioral and self-awareness strategies have been found to have some effect at improving symptoms of ADHD, and potentially reducing the amount of stimulant medications required. These include basics such as establishing household and school routines, avoiding information and stimulus overloads (Davenport TH et al 2000; Goddard J 2000), and maintaining good eye contact, as well as techniques that require more practice and specific training, such as meditation and some forms of biofeedback.

In addition, there is preliminary evidence that vigorous exercise may have a role in managing some features of ADHD, especially in boys. This may be related to exercise-induced increases in dopamine activity (Tantillo M et al 2002).

ENVIRONMENTAL AND DIETARY CONSIDERATIONS

Considerable controversy continues to surround the questions of how much environmental toxins and dietary factors contribute to ADHD (Kidd PM 2000). Overt toxicity from contaminants and pollutants such as mercury and polychlorinated biphenyls (PCBs) are known to cause a wide spectrum of behavioral disorders (Rice DC 2000), although the effects of more subtle exposures are less clear.

Similarly, several theories have been advanced regarding the association between dietary components (such as simple sugars) and ADHD, but again convincing evidence is lacking (Chaves-Carballo E 2003). Dietary manipulations, such as the Feingold elimination diet, in which one category (or several categories) of food is carefully excluded, have been tried but with no success in treating ADHD (Krummel DA et al 1996).

Likewise, although allergies to foods or food additives have been proposed as a cause of ADHD (Boris M et al 1994; Rowe KS et al 1994), there is little scientific basis for this idea. So-called oligoantigenic diets aim to reduce the number and variety of food-based allergens that children might be exposed to. A few small trials have shown some benefit in carefully selected groups of children (Egger J et al 1985). Because such diets aim to eliminate large categories of food (on which growing children may depend), they should be undertaken only in careful collaboration with a physician. Allergy testing has rarely proved helpful in treating ADHD.

The role of dietary sugar. Despite a great deal of attention in the popular press, there has been no convincing evidence that dietary sugar is causal in ADHD (Krummel DA et al 1996). In a 1985 study, children with ADHD were shown to have lower adrenaline levels after a sugar intake than control children (Girardi NL et al 1995). The implications of this study are not clear. However, other studies have suggested that some children with ADHD may have food sensitivities that include sugar. The authors of these studies conclude that diet modification is an important part of ADHD management (Schnoll R et al 2003). Whatever the outcome of this debate, there is little doubt that dietary sugar is not a benefit in children's diets. It is linked to tooth decay, obesity, and other health conditions. Therefore, it is probably wise for all children to limit or completely avoid dietary sugar.

LIFE EXTENSION FOUNDATION RECOMMENDATIONS

Ideally, ADHD treatment will touch on many aspects of a patient's life, from daily routines to exercise to behavior therapies to nutrition. ADHD is likely a multifactorial disease, therefore it deserves to be treated on many fronts. The following lifestyle changes can help in reducing the anxiety associated with ADHD:

- **Diet**. Aim for a well-balanced diet. Avoid unnecessary simple sugars. Use specific elimination diets only in partnership with a physician. People observing elimination diets are likely to need supplementation with vitamins, minerals, and possibly other nutrients.
- **Exercise**. Moderate to vigorous physical activity is beneficial for all children but especially for children who have behavior disorders. Try moderate-intensity activity for 30 minutes almost every day and a minimum of 30 minutes of vigorous activity 3 to 4 days a week.
- **Mind-body techniques**. Try massage, biofeedback, and meditation. Avoid information overload. Some children with ADHD benefit from predictable, rigid schedules.

In addition, the following nutrients may help relieve symptoms:

- **Zinc**—15 to 30 milligrams (mg)/day
- **EPA/DHA**—1400 mg/day of EPA and 1000 mg/day of DHA
- **Vitamin E**—400 International Units (IU)/day of alpha-tocopherols and at least 200 mg/day of gamma-tocopherols
- **Magnesium**—160 to 500 mg/day
- **Vitamin B6**—up to 250 mg/day
- **Acetyl-L-carnitine**—1000 to 2000 mg/day

- **Melatonin**—300 micrograms (mcg)/day to 3 mg/day
- **DHEA**—15 to 75 mg/day; have blood tested after 3 to 6 weeks to determine optimal levels
- **Ginkgo biloba**—120 mg/day
- **American ginseng**—500 mg/day

PRODUCT AVAILABILITY

All the nutrients and supplements discussed in this section are available through the Life Extension Foundation Buyers Club, Inc. For ordering information, call anytime toll-free 1-800-544-4440, or visit us online at www.LifeExtension.com.

The blood tests discussed in this section are available through Life Extension National Diagnostics, Inc. For ordering information, call anytime toll-free 1-800-208-3444, or visit us online at www.LifeExtension.com.

ADHD SAFETY CAVEATS

An aggressive program of dietary supplementation should not be launched without the supervision of a qualified physician. Several of the nutrients suggested in this protocol may have adverse effects. These include:

Acetyl-L-Carnitine

- Acetyl-L-carnitine can cause gastrointestinal symptoms such as nausea and diarrhea.

DHEA

- Do not take DHEA if you could be pregnant, are breastfeeding, or could have prostate, breast, uterine, or ovarian cancer.
- DHEA can cause androgenic effects in woman such as acne, deepening of the voice, facial hair growth and hair loss.

EPA/DHA

- Consult your doctor before taking EPA/DHA if you take warfarin (Coumadin). Taking EPA/DHA with warfarin may increase the risk of bleeding.
- Discontinue using EPA/DHA 2 weeks before any surgical procedure.

Ginger

- Do not take ginger if you have a bile duct obstruction or gallstones. Ginger may stimulate bile production.
- High doses of ginger (6 grams or more) can cause damage to the stomach lining and ulcers.
- Ginger can cause anllergic skin reactions.
- Consult your doctor before taking ginger if you take blood thinners such as warfarin (Coumadin). Ginger can increase the risk of bleeding.

Ginkgo Biloba

- Individuals with a known risk factor for intracranial hemorrhage, systematic arterial hypertension, diabetes, or seizures should avoid ginkgo.
- Do not use prior to or after surgery.
- Avoid concomitant use of ginkgo with NSAIDS, blood thinners, diuretics, or SSRI’s.
- Gastrointestinal symptoms (nausea and diarrhea) may occur.
- Allergic skin reactions may occur.
- Elevations in blood pressure may occur.

Magnesium

- Do not take magnesium if you have kidney failure or myasthenia gravis.

Melatonin

- Do not take melatonin if you are depressed.
- Do not take high doses of melatonin if you are trying to conceive. High doses of melatonin have been shown to inhibit ovulation.
- Melatonin can cause morning grogginess, a feeling of having a hangover or a “heavy head,” or gastrointestinal symptoms such as nausea and diarrhea.

Vitamin B6

- Individuals who are being treated with levodopa without taking carbidopa at the same time should avoid doses of 5 milligrams or greater daily of vitamin B6.

Vitamin E

- Consult your doctor before taking vitamin E if you take warfarin (Coumadin).
- Consult your doctor before taking high doses of vitamin E if you have a vitamin K deficiency or a history of liver failure.
- Consult your doctor before taking vitamin E if you have a history of any bleeding disorder such as peptic ulcers, hemorrhagic stroke, or hemophilia.
- Discontinue using vitamin E 1 month before any surgical procedure.

Zinc

- High doses of zinc (above 30 milligrams daily) can cause adverse reactions.
- Zinc can cause a metallic taste, headache, drowsiness, and gastrointestinal symptoms such as nausea and diarrhea.
- High doses of zinc can lead to copper deficiency and hypochromic microcytic anemia secondary to zinc-induced copper deficiency.
- High doses of zinc may suppress the immune system.

For more information see the Safety Appendix