the FELIX Letter

No. 72

A COMMENTARY ON NUTRITION

1993

LIPIDS THAT LOVE YOU

If you're having a rotten day because your kids are behaving like noodniks, try not to yell "Fatheads!" at them. It's a satisfying invective but it misses the point and could even be construed as an endearment because, after all, brains are *supposed* to be loaded with fat. Of course, it's the *kind* of lipids in our fat heads that matters. Scientists didn't have a clue until finely honed analysis became possible in the '50s. Inert, boring old fats turned out to be complex, lively substances whether in foodstuffs or body tissues. The 'simple' ones in mothers' milk, for instance, are composed of at least 40 distinct fatty acids, their proportions often shifting to accommodate the baby's development.

A critical finding is that two groups of the most abundant polyunsaturated fats in the brain 's gray matter exist there in a broadly 1 to 1 ratio. These proportions seem to be a requirement for at least 42 species--cow, mouse, zebra, monkey, dolphin, lion, elephant, etc., as well as ourselves.

I'm credited in some circles with being a guru, of sorts, on fats, but my information comes from the folks who do the actual spade work in hospitals and labs. I read mountains of stuff, go to conferences, and report to you, hoping some of it makes sense and helps you stay healthy. As a mother and grandmother, I want kids to get a good start both in the womb and afterwards. I'm worried because superb scientists reported almost 25 years ago on the special fats that babies (and all of us) need for the eyes and brain, and today those fats still are not included in any infant formula in the United States. Norwegian and British medical researchers also plead for the inclusion of these fats in the diets of pregnant and nursing women, bemoaning their lack in any infant formulas (*FL's #69 &#71*).

In the July 1993 *American J. of Clinical Nutrition*, Susan E. Carlson and a team of medical researchers at the Univ. of Tennessee tested "visual acuity" in healthy infants born a little early. The preemies who got formula with *fish oil* in it did lots better than the others. Dr. Carlson is one of a dogged group of scientists who've been writing for years about the special fats needed for the eyes and brain. Is anyone in the formula business listening out there?

Our clever body can biosynthesize some fats in brain from scratch, but this doesn't apply to the "neural" fats in gray matter described above. They're members of the only two *essential* fatty acid families, **Omega-6 (w6)** and **Omega-3 (w3)**, that people, animals, birds, and probably most insects (except maybe cockroaches!) need but can't make. The "parent" **w6, linoleic acid (LA),** and the "parent" **w3, alpha-linolenic acid (Alena)**, are required in the diet.

Fortunately *plants* make **LA** and **Alena** for all of us!

All natural fats and oils are made up of fatty acids -- molecules of generally 4 to 24 atoms of carbon linked in infinitely tiny chains. Around each carbon hover hydrogen atoms. At one end of the chain, carbon, hydrogen, and oxygen atoms cluster in an acidic group.

"Hard fats" contain mostly straight-chain fatty acids, each carbon "saturated" with hydrogens. Straight chains bunch together to form a dense, *rigid* fat, like the solid fat in beef.

Our brain has trillions of cells, each with thousands of synaptic connections. The vast numbers of lightning-swift signals processed by brains and eyes of all creatures demand tissues of supreme flexibility. Hard fats would be a disaster!

My niece & son, long ago, in Muir Woods

Enter the ***neural fatty acids.*** These fats for neural tissues are "polyunsaturated," i.e., pairs of hydrogen atoms have been removed from four or more carbons in each long chain. The chain will kink at these desaturation points, known as "double bonds." The more double bonds there are, the crookeder the chains and the less apt to bunch together like straight ones, so fat made up of these chains is *fluid and flexible.*

Arachidonic acid (AA) is the most prominent w-6 neural fatty acid in gray matter. Each chain is 20 carbons long, with four double bonds.

Docosahexaenoic acid (DHA), the most abundant w-3 in gray matter, is 22 carbons long, with six (count 'em!) double bonds. **DHA** also is the major fatty acid in another neural tissue, the ***retina of the eye.***

All of the above is by way of saying that brain power and eyesight are built on special fats that must come from the foods we eat. The significance of this relatively new information still escapes much of the medical world, including those who carry responsibility for the mental and visual development of infants before and after birth.

In the womb we depend on our moms to supply the neural fats. Afterwards, there are just two ways to get **AA** and **DHA** into our tissues. First, we can consume substances containing their respective precursors, w6 linoleic (**LA**) and w3 alpha-linolenic (**Alena**). After **LA** and **Alena** are assimilated into tissues, our enzymes can convert them, step by step, into a series of longer fatty acids with more double bonds. Eventually **LA** can be converted to **AA**, and **Alena** to **DHA**. (More on this later.)

The second way is more direct. We can consume substances with pre-formed **AA** and **DHA** which will be taken up readily by our tissues.

A long time ago, people exercised both options routinely. Nowadays, we're confronted with so many *spurious* options in food that common sense alone may not be enough to guide us.

A little pre-history, please! As hunters and gatherers, we lived on wild foods for 99.8% of our existence as a species. More correctly, we were *gatherer-hunters,* because plant foods and shellfish were mainstays in the diet and required only gathering! Ten thousand years ago, as various populations outgrew their surrounding resources, the practice began of planting crops and domesticating animals for food. Our chromosomes have hardly changed since then, but, oh Lord, how our diets have!

Based on archeological evidence and on observing the few pre-agricultural tribes existing in warm, fertile environments, the foods of our ancestors included starchy roots and tubers (wild varieties similar to cassava, yams and potatoes), leafy and pulpy vegetables, fruits, nuts, seeds, insects, game animals and birds, eggs stolen from nests, and, as a rare dessert, honey robbed from hives!

But the most dependable foodstuffs year round for gatherer-hunters were ***aquatic*** ones--fish, mollusks, crustaceans, plus aquatic vegetation. We know they still are staples today for many river, lakeshore, island, and seacoast communities, even highly industrialized ones. **DHA and another important w3, EPA, are the major polyunsaturated fatty acids in all fish and shellfish.** Aquatic plants such as kelp provide aquatic creatures with w3's **Alena, EPA, and DHA**, plus small amounts of w6's **LA and AA.**

In 1960, Prof. Sir Alister Hardy conjectured that our species may have evolved from a group of apes which left the trees for the sea and shore. The "Aquatic Ape" theory has been generating stormy yeas or nays from scientists ever since! British zoologist Michael Crawford believes there is strong evidence for at least **semi-aquatic** existence during our evolution *[FL's #35 &#58].* He doesn't think we ever were tree dwellers. And he offers a logical reason why our brain-to-body proportions are far greater than any other large primate's. Water and shore, he theorizes, provided lavish supplies of **DHA**, which was not plentiful for tree-dwelling apes! [*The Driving Force: Food, Evolution, and the Future* by Michael Crawford and David Marsh, Harper & Row, New York, 1989.]

Remember the roughly 1 to 1 ratio of w6 /w3 neural fats in brains of all animals? Crawford suggests ***a scarcity of w3 DHA limits potential brain growth and development.*** While the forests provided nutrients to enhance primate growth, *the fatty acids that let brain development keep up with body size, chiefly **DHA**, were never abundant.* As primates evolved over millions of years from tiny creatures to large ones, he speculates that their brain-to-body ratio *shrank.*

But the ones who settled at the sea and shore--the Aquatic Apes--could maintain the ratio, even as they evolved in size, because *all* nutrients for building both brain and body were easy to come by!

Nor was DHA plentiful in the grassy savannahs that nurtured many species. As horses, cattle, deer, and other herbivores evolved from tiny to large animals on nutrients that provided for growth but had little DHA, their brains had a hard time keeping up and so did their intelligence, Crawford says!

On the other hand, their *predators*---e.g., the cat family---*got ready-made DHA when they killed and ate herbivores!* DHA and other polyunsaturated fatty acids are concentrated in brains and organs. Prof. Crawford suggests there was some dwindling of brain-to-body ratio in cats and other flesh-eating predators as their body size increased over the ages. The DHA they got, however, allowed them to remain smart enough to continue to capture and eat their prey!

We know that fish and shellfish would have provided **EPA and DHA** lavishly for our hypothesized aquatic dweller. But what about ample **w6 LA and AA**, as well as **w3 Alena?** Where would our pre-human ancestors have gotten enough? They're present only in relatively small amounts in aquatic creatures.

Here's Dr. Crawford's explanation: "...one branch of the hominids found that the sea offered a wealth of food and a way of life that was congenial, much in the way that we enjoy the seaside today. This species would have taken to the shores of the freshwater lakes and rivers as well, and the adoption of an aquatic habitat would not have cut them off from other supplies of food, for the coastal regions, with their high humidities and ample rainfalls, offer equable climates and a rich growth of fruits and other vegetation. The estuaries would have been sites of particular value because it is here that the marine food chain begins in earnest, fertilised by the trace elements and minerals washed off the land, and it is here that early man could have had an abundance of food and fresh water.

"If man never went up trees, and there is no good reason why he should, there is also no reason to believe that he was wholly aquatic. He most probably evolved at the land-water interface."

It was a setting that favored development of our big brain because **Alena, LA,** and **AA** were easily gotten from plants and animals on land to balance the aquatic fats.*

I'm worried now about strict vegetarians and non-fish eating folks who depend on Alena as their only w3. Studies continue to show less EPA in their tissues compared with fish-eaters. **EPA, 20 carbons long with 5 double bonds,** is an w3 with important benefits in inflammatory and cardiovascular disorders.

Worse yet, we seem to have a big problem making enough DHA from Alena.

Most lab studies are done with rats and mice. These tiny animals happen to be whizzes at multi-step w3 conversions! Some of us, however, may be duffers at it. We're not alone, because big herbivores such as horses, deer, and cattle which munch on **Alena**-rich plants all day long still don't have much **DHA** in their tissues ***or*** their milk. Even gorilla milk is low in **DHA**! **Alena** is vital to health and life in its own right, as well as being the kickoff molecule for making **EPA** and **DHA.** But maybe we humans weren't meant to depend on it solely.

An important clue is that breast milk from nonfish-eating vegetarian mothers is 16

*Among today's best **Alena** sources are flax oil and flaxmeal. Good-to-fair **Alena** sources are oils such as Canola, walnut, and soybean, plus foods like walnuts, butternuts, chia seeds, soybeans, chestnuts, oatmeal, and purslane greens. (I've harvested my first pintsized crop this summer. I love it in salads.) Lamb, pork, and poultry contain some **Alena.**

We get ready-made **AA** from animal foods, probably much as our ancestors did, mainly muscle and organs of meat, fowl, and game; also egg yolk and shellfish such as shrimp and scallops. **Note:** Human beings seem to be more efficient at making **AA** from **LA** than they are at deriving **DHA** from **Alena.** With adequate **LA** in the diet, even strict vegetarians don't seem to be deficient in **AA.**

LA is abundant in seeds, nuts, whole grains, wheat germ, and in most commonly sold oils such as safflower, corn, and Canola, as well as in foods prepared with the oils. Modest sources are egg yolks, organ meats, poultry, pork, and game.

*times lower in **DHA** than milk from fish-eating vegetarian moms.* I hate to tell you this, but if you're a nursing mom in the no-fish category, your milk has less **DHA** than a moose's! (We're talking comparative, not actual, volumes.)

Prof. Crawford's speculations about the brain-enriching diet of the semi-Aquatic Ape make still more sense when we learn "the only other large species to remotely approach man in relation to brain capacity is not a land mammal but a marine mammal." Intelligent, playful *dolphins* have a ratio of brain weight to body weight of between 1.0 and 1.5%, compared with our own 2%. (The chimpanzee and gorilla aren't even close, with brain/body ratios of only 0.55% and 0.29% respectively.)

Dolphin milk has about 7 times more DHA than the breastmilk of women who eat a lot of seafood, *and over100 times more DHA than milk of nonfish-eating vegetarian moms!*

I suspect that our species' dietary dependance through the ages on ***ready-made*** long-chain w3 polyunsaturates is the reason many of us may have trouble making enough of them from Alena today. For the sake of our brain (also eyes, cardiovascular system, testes in males, all-over complexion, and cell membranes in general!), let's re-establish fish and shellfish consumption to the honored place it held for our gatherer-hunter ancestors.

The same nutrients that adults need for renewing tissues become mandatory for the fetus and nursing baby who are growing brand new body parts. A woman's milk quickly reflects her w6 and w3 fatty acid intake. What an opportunity to Build a Better Brain and other quality structures in the small new person!

Evidence is strong that we evolved ***successfully*** as a species because (1) an abundance of aquatic foods provided major nutrients, including pre-formed **w3 EPA and DHA** (and some **w6 Arachidonic [AA]** particularly in shellfish); and (2) because foods from the land filled in any nutritional gaps as well as balancing our fatty acid needs with **w3 Alena** and **w6 LA and AA.**

I'm seeing more and more articles by scientists urging frequent fish meals for women during pregnancy and lactation. Those who don't like or can't eat seafood should consider supplementing with capsules of fish oil or easy to digest liquid emulsions in nonfishy flavors. Both are available from healthfood and drug stores.**

**If some devoutly vegetarian chemists put their minds to it, I suspect they could come up with vegetarian EPA and DHA supplements. Sea plants such as the innumerable kelps probably would be the logical starting point. If readers have any ideas, let me know and I'll pass the word along. The important thing is to get plenty of EPA and DHA into the babies, by hook or crook!

Cousins.

Dr. Joyce Nettleton suggests we can increase EPA and DHA availability in foods "by giving livestock feeds that contain fish meal and by incorporating fish oils into widely consumed foods..." Artemis Simopoulos, M.D. says fish meal and flaxmeal added to the feed of hens cause a huge leap in EPA and DHA content of egg yolks. Typical market eggs are good sources of AA, but with judicious balancing of fish meal and flaxmeal in feed, she says they could have enough EPA and DHA too to make them a substantial source of all three fatty acids. (Nice for all of us, but a potential blessing for formula-fed infants. Breast milk, of course, contains AA, EPA, and DHA, but formula doesn't. Not yet.)

If you think I'm exaggerating the impact of aquatic riches on human existence, read *The Ohlone Way: Indian life in the San Francisco-Monterey Bay Area* by Malcolm Margolin, 1978. For thousands of years before the Spanish came the people of that region gathered and hunted. Two hundred years ago, they still were taking trips "to the seashore for shellfish, to the rivers for salmon, to the marshes for ducks and geese, to the oak groves for acorns,*** to the hills and meadows for seeds, roots, and greens."

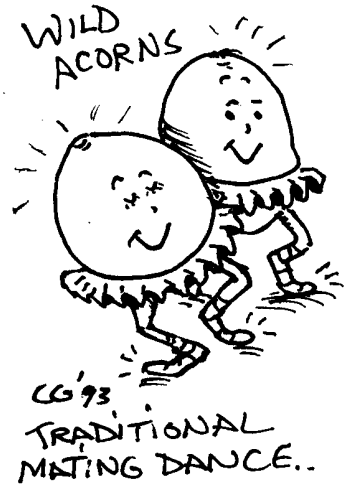
***Acorns were harvested every fall from great California oak groves, stored in granaries on stilts, pounded into flour, cooked, and eaten every day as cereal or bread (after the bitter tannins were leached out). Acorn bread was described by explorers as "deliciously rich." Acorns are fine sources of both LA and **Alena**. Maybe that's why the Indians had to compete with squirrels, deer, acorn woodpeckers, grizzlies, etc. for them!

They traveled in boats made of bundles of tule rushes, paddling, one European reported, with great facility and lightness of touch, "while another reported that the tule boats of the Indians could outrun the Spanish longboats." They traveled to offshore islands where seabirds had their rookeries, "and filled their boats with eggs." They used the boats, too, "to bring in enormous catches of salmon."

Everybody, including children, gathered shellfish to eat all year round. "..by the end of the year they had collected literally tons of mussels, clams, oysters, olivellas, crabs, gooseneck barnacles, abalones...." As centuries went by the discarded shells, piled up at village sites, formed mounds as high as 30 feet, some a quarter mile across.

A 19th century ethnologist "described the California Indians as 'almost amphibious.' 'They are always splashing in the water,' he noted....Water was everywhere, and everywhere it was teeming with life." ❑

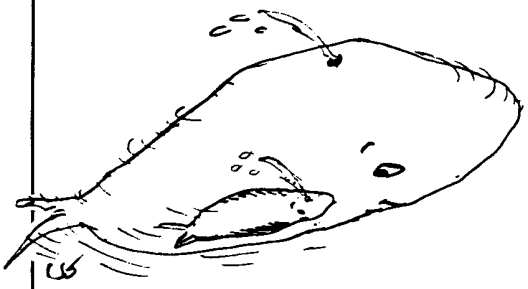
(Send $3 and SSAE if you want the list of references I used.)



SICKLE CELL A BLESSING?

I feel like waving banners and yelling with joy, because two books I've just read make clear why good science and good nutrition can be an unbeatable team. Oji Agbai, Ph.D., a biochemist from West Africa, is now director of the Biomedical Research Institute in Tulsa, Oklahoma. Dawud Ujamaa is "The Cooking Man," a gold medal award chef in Decatur, Georgia. Dr. Agbai explains why sickle cell "disease" actually may be a true *dietary deficiency disease* and why certain foods "cure" it. Chef Ujamaa tells us how to buy and prepare these foods to make them a joyful habit three times a day!

In *FL #71* I said sickle cell was found "almost exclusively in blacks," a verbatim quote from the medical 'bible,' *The Merck Manual*. We were wrong. The next edition of the *Manual* I hope will reflect a fresh awareness by the U.S. medical community that sickle cell genes cut across ethnic lines, affecting Caucasians, Jews, Arabs, Asian Indians, etc. Its presence is strong not just in Africa and countries where African descendants live, but in southern Italy, Sicily, Greece, Turkey, Saudi Arabia, and India.



We're talking about warm places where **malaria** was endemic for who knows how many centuries. We thought we could get rid of it with DDT and other slick weapons. ***Hah!*** Malaria is *still* a major killer and disabler, while the undefeated mosquito that carries the parasite merrily thumbs its long proboscis at us!

However, it's well-known in medicine that sickle cell gene carriers *have a large measure of immunity to malaria.* Apparently the genetically altered hemoglobin in their red blood cells (RBCs) creates inhospitable conditions that make it tough for the *Plasmodium falciparum* parasite to thrive in the blood. Dr. Agbai says sickle cell was not intended to be a disease. "Rather, sickle cell hemoglobin gene is the best protection against deadly malaria ....it was a biological adaptation for effective control" of the disease.

He says traditional foods allow persons who inherit sickle cell genes from both parents to withstand malaria and, at the same time, *to resist the crippling effects of anemia.* Sickle cell anemia is rare among his people, the Igbo of West Africa, even though gene carriers are plentiful. Here, he found it to be a major health problem with no palpable solution in sight.

At low oxygen pressure the hemoglobin in RBCs of sickle cell patients becomes highly insoluble, forming unnatural, rigid crystals which deform RBCs from spherical to elongated sickle-shaped cells. Anemia, crippling pain, and serious illnesses happen because (a) the sickled RBCs break down quickly; and (b) their rigid, elongated structure causes them to clog blood vessels, preventing normal blood flow and oxygen to organs and tissues.

Thiocyanate is a substance found in normal human plasma. In test tubes filled with RBCs from sickle cell patients, Dr. Ogbai shows via scanning electron micrographs that potassium thiocyanate in the right amounts is a remarkably effective preventer of sickling. It makes "the deoxygenated sickle cell hemoglobin as soluble as normal hemoglobin," he writes, thus preventing deformity and fragility of RBCs.

He says certain foods, eaten three times a day, will maintain high enough plasma levels of thiocyanate to minimize sickling of RBCs. He cites case after case where, despite repeated transfusions and standard drug treatment, sickle cell sufferers remained very ill and anemic. When he had them take three meals a day of these foods, their RBC count rose and their pain and weakness disappeared, to the amazement of their doctors. As long as they continued the dietary program, they stayed well.

Scurvy and pellagra were treated like ordinary illnesses for centuries, to no avail. They happen to be dietary deficiency diseases, i.e., until certain nutrients are restored, patients can never be cured. Dr. Ogbai proposes that sickle cell anemia should be classified as "thiocyanate deficiency anemia," just as other types of anemia are accepted as "iron-deficiency anemias."

He writes: "...sickle cell anemia is mild and rare in many parts of Africa where the staple foods are yams... and cassava... ; in Jamaica, where yams, cassava and lima beans are common foods; in Arabia, where millet, chickpeas, horsebeans and lentils are eaten regularly, and among the Veddoid ethnic groups of South India, whose staple food is millet." Some of the long list of anti-sickling foods in the book are familiar, others may seem strange. Dr. Ogbai recommends amounts to keep thiocyanate levels high, including a 7-day diet plan of "anti-sickling meals." I urge all health professionals working in this field to order *Sickle Cell Anemia: Anti-Sickling Nutrition Handbook* from Dr. Oji Agbai Chima, Biomedical Research Institute, Inc., 2007 S. Phoenix Ave., Tulsa, Oklahoma 74107. $30 includes postage.

The other wondrous book is *Back To Our Roots: Cooking For Control of Sickle Cell Anemia.* Dawud Ujamaa, award-winning chef and star of "The Cooking Man Show" on cable tv in Atlanta, knew a little about the disease because one of his children inherited a "half-dose" of the genes and presumably will be safe from serious anemia. But when his next door neighbor came to him to ask if he knew where to buy and how to cook *millet* or *African yams,* he was stumped! The neighbor had just gotten Dr. Agbai's book and wanted to start immediately on the program for one of his sons who had sickle cell anemia.

Dawud Ujamaa read Dr. Agbai's work. It inspired a voyage of discovery that led to his own scholarly and immensely practical book. In it he tells us everything we need to know about the great foods that allowed people to thrive for generations despite sickling genes. He tells us where to get the foodstuffs that're a little strange to us, and how to prepare them. The recipes look wonderful and *easy.* Write to him at 103 Eastwyck Circle, Decatur, GA 30032. His book is $18.95 plus $3 shipping.

I just chased down cassava in the Bay area at Latin American markets, where they call it Yuca ("yew-kah", not related to Yucca). Besides being a thiocyanate yielder, I understand it's a satisfying gluten-free alternative to bread, noodles, and other starchy stuff. (Big in gatherer-hunter cultures, too!) Hang in there for future culinary bulletins! I'll also be interviewing a doctor in Atlanta and the sickle cell coordinator of a local hospital. I think we're on to something special, folks. ❑

Illustrations by Clay Geerdes and other artists as noted.

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References used in "Lipids That Love You," *Felix Letter No. 72,* 1993.

- Omega-3 fatty acids in health and disease and in growth and development. Artemis P Simopoulos, MD. *American Journal of Clinical Nutrition,* September 1991, pp 438-463. (Major review article.)
- Egg yolk as a source of long-chain polyunsaturated fatty acids in infant feeding. Artemis P. Simopoulos & Norman Salem Jr. *Am J Clin Nutr,* Feb 1992.
- Visual-acuity development in healthy preterm infants: effect of marine-oil supplementation. Susan E Carlson et al, *Am J Clin Nutr,* July 1993.
- Are n-3 fatty acids essential nutrients for fetal and infant development? Joyce A Nettleton, DSc, RD. *J of the American Dietetic Assoc,* Jan 1993.
- Dietary requirements and functions of a-linolenic acid in animals. J. Tinoco, *Progress in Lipid Research, Vol 21,* pp 1-45, 1982.
- Will dietary w-3 fatty acids change the composition of human milk? W S Harris et al, *Am J Clin Nutr,* October 1984.
- Docosahexaenoic acid status of preterm infants at birth and following feeding with human milk or formula. Susan E Carlson et al, *Am J Clin Nutr,* Dec 1986.
- Clinical Studies with a-linolenic acid and long-chain n-3 fatty acids. Kristian Bjerve et al. Symposium Proceedings in *Nutrition,* Vol 8, No 2, March/April 1992.
- w-3 Fatty acids: Comparison of plant and seafood sources in human nutrition. Joyce A Nettleton, J of the American Dietetic Assoc, Mar 1991.
- Weaning foods cannot replace breast milk as sources of long-chain polyunsaturated fatty acids. Kathryn A Jackson & Robert A Gibson, *Am J Clin Nutr,* Nov 1989.
- a-Linolenic acid in humans: Direct functional role or dietary precursor? Stephen C Cunnane et al, Symposium Proceedings in *Nutrition,* Vol 7, No 6, Nov/Dec 1991.
- Brain metabolism of a-linolenic acid during development [in rodents]. Harold W Cook, Symposium Proceedings in *Nutrition,* Vol 7, No 6, Nov/Dec 1991.
- a-Linolenic acid, long-chain n-3 fatty acids, and neonatal brain development. Patricia E Wainwright, Symposium Proceedings in *Nutrition,* Vol 7, No 6, Nov/Dec 1991.
- Supply of polyenoic fatty acids to the mammalian brain. Joan M Naughton, *International J of Biochemistry,* Vol 13, 1981, pp 21-32. (Major review).
- Eggs enriched in w-3 fatty acids and alterations in lipid concentrations in plasma and lipoproteins and in blood pressure. Suk Y Oh et al, *Am J Clin Nutr,* Oct 1991.
- Plasma and red blood cell fatty acids of low birth-weight infants fed their mother's expressed breast milk or preterm infant formula. S M Innis, et al, *Am J Clin Nutr,* June 1990.
- Fatty acid composition of breast milk from three racial groups from Penang, Malaysia. Garry M Kneebone et al, *Am J Clin Nutr,* April 1985.
- Breast milk composition: fat content and fatty acid composition in vegetarians and non-vegetarians. Dorothy Ann Finley et al, *Am J Clin Nutr,* April 1985.
- Vitamin E, lipid fractions, and fatty acid composition of colostrum, transitional milk, and mature milk: an international comparative study. E Rudy Boersma et al, *Am J Clin Nutr,* May 1991.
- a-Linolenic acid and eicosapentaenoic acid. J Dyerberg et al., Letter in *Lancet,* Jan 26, 1980, p 199.
- The influence of different types of w3 polyunsaturated fatty acids on blood lipids and platelet function in healthy volunteers. T A Sanders and F Roshanai, *Clinical Sciences,* 64, pp 91-99, 1983.
- Supply of n-3 polyunsaturated fatty acids and their significance in the central nervous system. Nicolas G Bazan, in *Nutrition and the Brain, Vol. 8,* pp 1-24. R J Wurtman & J J Wurtman, editors, Raven Press, NY, 1990.
- Dietary effects on brain fatty acid composition: the reversibility of n-3 fatty acid deficiency and turnover of docosahexaenoic acid in the brain, erythrocytes, and plasma of rhesus monkeys. William E Connor et al, *Journal of Lipid Research,* Vol 31, 1990, pp 237-247.

- Dietary essential fatty acids, polyunsaturated fatty acids, and prostaglandins in the central nervous system. C Galli et al, *Advances in Prostaglandin and Thromboxane Research, Vol 4*, F. Coceani & P M Olley, editors, 1978.
- Distribution and fatty acid composition of phosphoglycerides in normal human brain. Lars Svennerholm, *J of Lipid Research*, Vol 9, 1968.
- Quantification and fatty acid and fatty aldehyde composition of ethanolamine, choline, and serine glycerophosphatides in human cerebral grey and white matter. John S O'Brien et al, *J of Lipid Research*, Vol 5, 1964.
- *THE DRIVING FORCE: FOOD, EVOLUTION AND THE FUTURE* by Michael Crawford and David Marsh. Harper & Row, New York, 1989.
- *THE PALEOLITHIC PRESCRIPTION* by S Boyd Eaton MD, Marjorie Shostak, & Melvin Konner, MD, PhD. Harper & Row, New York, 1988.
- *THE AQUATIC APE: A THEORY OF HUMAN EVOLUTION* by Elaine Morgan. Stein & Day, New York 1982.
- *THE DESCENT OF WOMAN* by Elaine Morgan. Stein & Day, New York, 1972.
- *THE 0HLONE WAY: INDIAN LIFE IN THE SAN FRANCISCO-MONTEREY BAY AREA* by Malcolm Margolin, 1978. Heydey Books, POB 9145, Berkeley CA, 94709.