The potential benefits of PUFAs are very many in human nutrition and health (Nordoy, 1994 and Nettleton, 1995). Fish food of salmon or mackerel could cut the chance of cardiac arrest by 50% in folks with weakened hearts, patients taking omega-3 supplements report less joint pains and less morning stiffness. PUFAs are useful for healthy brain function in that recent research at Purdue University showed that boys with low levels of omega-3 fats in their brains have more behaviour problems. Fish oil supplements may be helpful in lowering blood triglyceride levels in patients with high blood levels, omega-3 suppresses tumor growth in that, Japanese women using food have only a third as much breast cancer as American women. Thus PUFAs also inhibit the production of thromboxane a precursor in the formation of blood clot.

The higher the consumption of fish, the lower the risk of dying from coronary heart diseases. In people with coronary heart disease, fish oils may reduce the risk of thrombosis, reduce the pain of angina and improve cardiac function (Kendall, 1998). Since diabetes and heart disease affected millions of people including India in the 1980’s and 1990’s, the lack of heart disease in Eskimos and other societies has attracted the serious attention of many scientists around the world. Marine fish is rich source of PUFAs, which is the main food of Greenland Eskimos. But there are no reports on the occurrence and distribution of PUFAs in freshwater and brackish water fishes, which are extremely used for table purposes for millions of people, further freshwater fish food is relatively cheaper and readily available than the marine fish food. Hence to fill up the lacuna of PUFAs in freshwater fishes and their role in reducing coronary heart diseases, this work has an importance in human nutrition and health.

Further, masses of India require more proteinaceous diet with PUFAs but cheaper which can only be derived from easily approachable freshwater habitat. Hence, this work done caters to the need of people especially poor segments of the society.
Knowledge on fish oils especially PUFAs is limited and so in the role of PUFAs in human nutrition and health, hence this also substantially contributes knowledge on fish physiology, biochemistry and aquaculture and its applied studies and ultimately to the field of medicine and health education.

The basic work on PUFAs in marine fish was carried out by CORNELL UNIVERSITY, USA and at MELBOURNE UNIVERSITY by Dr. Peter McLennan. Later the role of PUFAs on human health was carried by Dr. Kendall at COLORADO STATE UNIVERSITY, USA. Preliminary studies are being made in marine resources by Dr. Kesavnath at fisheries college, Mangalore. All these studies are restricted to marine fish and no attempt is made in the fish of more approachable of freshwater habitat. Further, freshwater fish is staple for many of us, with this clue, this research has began looking at the survey of PUFA and at the physiological effects of fish oil to determine if and how they play a protective role in coronary heart diseases.

Reducing intake of saturated fat and dietary cholesterol and avoiding excess calories, which can lead to obesity, remain the corner store of the dietary approach to decreasing risk of atherosclerotic vascular disease. During the past 20 years, however, there has been renewed interest in other dietary components that might favourably improve lipid profiles and reduce risk of coronary heart diseases (CHD). Fish and fish oil, rich sources of omega-3 fatty acids, have sparked intense interest in both epidemiological studies, which suggest a favourable effect on CHD and metabolic ward studies, which show a striking improvement in lipid profiles in hyperlipidemic patients. Confusion has resulted from clinical trials of fish oil in-patients with CHD, which did not corroborate early observational findings and newer results, which suggest clinical benefit due to a mechanism independent of lipid effects.
Lipids are water soluble, oily or greasy organic compounds soluble in non-polar organic solvents. Chemically the lipids are defined as the esters of 'alcohol and fatty acids' or 'as triglycerides of fatty acids'. Lipids are composed of three fatty acids joined to a glycerol molecule. Fatty acids and alcohol are the building block components of lipids. The German Biochemist Bloor first introduced the term lipid in 1943. The lipids are the important constituents of diet due to their higher energy value. One gram of lipid yields 9.3 kilocalories of heat, while the same amount of carbohydrate or protein yields only 6.4 and 4.5 kilocalories respectively. The lipids include a heterogeneous group of compounds related to fatty acids. The common lipids are fats, oils, waxes, phospholipids, glycolipids, cerebrosides, sulpholipids, aminolipids, steroids, terpenes, carotenoids, some hormones and some vitamins. They are found in all organisms including virus.

Lipids are widely distributed in plant and animal kingdom. In plants they occur in seed, nuts and fruits. In animals they are stored in adipose tissues, bone marrows and nervous tissues. Dietary fats are derived from two main sources, namely animal sources and vegetable sources. Animal sources are ghee, butter, lard and fish oils. They have more saturated fatty acids than vegetable fats. Vegetable sources include vegetable oils such as groundnut oil, gingerly oil, mustard oil, cotton seed oil, safflower oil, coconut oil, etc. Vegetable sources have more unsaturated fatty acids.

Usually a lipid is made up of a glycerol and three fatty acids. Such a lipid is called a 'triglyceride' or a 'neutral fat'. 
Lipids are esters of glycerol and fatty acids.

\[
\begin{align*}
  \text{CH}_2\text{OH} \quad & \quad \text{Fatty acid} \\
  \quad & \quad \text{CH}_2\text{OH} \quad \text{Fatty acid} \\
  \quad & \quad \text{CH}_2\text{OH} \quad \text{Fatty acid}
\end{align*}
\]

(Glycerol)

(A simple structure of a lipid)

Fatty acids are aliphatic straight chain hydrocarbon compounds with a terminal carboxyl group. They are the building blocks of lipids. A typical fatty acid has a carboxyl group and a hydrocarbon tail.

\[
\text{Carboxyl} \quad ..., \quad \text{Hydrocarbon chain} \quad ..., \quad \text{Methyl group}
\]

\[
\begin{align*}
  \text{O} = \text{C-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{... CH}_3 \\
  \quad \text{OH}
\end{align*}
\]

Fatty acids are classified into two types based on the presence or absence of double bonds. They are saturated fatty acids, which are without double bonds and unsaturated fatty acids, which are with one or more double bonds. The saturated fatty acids have single bonds. This general formula is \( \text{C}_n\text{H}_{2n+1}\text{COOH} \). They have maximum possible number of hydrogen atoms. At one end there will be an acid group ‘— C=O’, and at the other end there will be an alkyl ‘CH\text{-methyl}’ group. In between these two groups there will be CH\text{2} groups. The saturated fatty acids end with suffix ‘anoic’. \text{Eg. Octanoic acid, Decanoic acid, Butanoic acid, etc.}

The unsaturated fatty acids have one or more double bonds, i.e., 1 to 6 double bonds. These double bonds may occur after 9, 12, 15, 18 etc., carbon atoms. The unsaturated fatty acids are named with suffix ‘enoic’. Based on the number of double
bonds, unsaturated fatty acids may be called as monoenoic (=), dienoic (two =), trienoic (three =), etc.

Based on the requirement in the diet, fatty acids are classified into two types; those which are not synthesized in the body but included in the diet are called ‘essential fatty acids’. Eg. linoleic acid, linolenic acid, arachidonic acid. Those which are synthesized in the tissues from other fatty acids and need not be included in the diet are called ‘non-essential fatty acids’. Eg. Palmitoleic acid, Oleic acid, etc.

Fats and oils are mixtures of fatty acids. Each fat or oil is designated “saturated”, “monounsaturated” or “polyunsaturated”, depending on what type of fatty acid predominates.

Saturated fatty acids have all the hydrogen the carbon atoms can hold. Saturated fats are usually solid at room temperature and they are more stable that is, they don’t combine readily with oxygen and turn rancid. Saturated fatty acids raise blood cholesterol. And the risk of coronary heart disease rises as blood cholesterol levels increase.

Unsaturated fatty acids have at least one unsaturated bond that is, at least one place that hydrogen can be added to the molecule. There are two common types: Monounsaturated fatty acids have only one unsaturated bond. Monounsaturated oils are liquid at room temperature but start to solidify at refrigerator temperatures. For example, salad dressing containing olive oil turns cloudy when refrigerated but is clear at room temperature. Monounsaturated fatty acids seem to lower blood cholesterol.

Polyunsaturated acids have more than one-unsaturated bonds. Polyunsaturated oils, which contain mostly polyunsaturated fatty acids, are liquid at room temperature and in the refrigerator. They easily combine with oxygen in the air to become rancid. Polyunsaturated fatty acids help lower total blood cholesterol.
Fatty acids can exist as straight chain or branch chain components; many of the fish fats contain numerous unsaturated double bonds in the fatty acid structures. A short bond designation for fatty acids will be used throughout where the ‘ω number’ identifies the position of the first double bond counting from the methyl end. Linolenic acid would be written “18:3ω 3”, the first number identifies the number of carbons; the second number, the number of double bonds; and the last number, the position of the double bonds.

Fish and other marine life are rich sources of a special class of polyunsaturated fatty acids known as the omega-3 or n-3 fatty acids (Nettleton, 1995 and Harris, 1989). They are so named because the first of the several double bonds occur three carbon atoms away from the terminal end of the carbon chain. The three n-3 polyunsaturated fatty acids (n-3 PUFAs) are alphanolinolenic acid (ALA), eicosapentaenoic Acid (EPA) and docosahexaenoic acid (DHA). ALA is an 18-carbon chain fatty acid (18:3ω 3) with three double bonds in the form of tofu, soy bean and canola oil and nuts, it is an important plant based source of n-3 PUFA for vegetarians and non-sea food eaters. EPA is 20-carbon chain fatty acid (20:5ω 3) and DHA is 22-carbon chain fatty acid (22:6ω 3) are very long chain fatty acids obtained from marine sources. These along with n-6 polyunsaturated fatty acids (n-3 PUFAs) that can’t be synthesized from the non-lipid precursors such as linolenic acid are considered essential fatty acids that must be consumed in the diet. The n-6 PUFAs are obtained primarily from plant sources especially seeds. Arachidonic acid is a long chain n-6 PUFA that is found in meat, fish and plants or is synthesized from linoleic acid. Arachidonic acid and marine lipids both serve as key intermediates for eicosanoids like thromboxanes and prostacyclins which are important for platelet and vessel wall physiology.
Linoleic acid (LA) and alphanolenoic acid (ALA) are desaturated and elongated in the human body cells to LC n-6 PUFA and LC n-3 PUFAs respectively. In this conversion LA and ALA compete for the same enzymes and ALA has higher affinity than LA. The most important LC n-6 PUFA are dihomogammalinolenic acid (DHGLA) and arachidonic acid (AA), these are the precursors of eicosanoids of 1' and 2' series, respectively (British Nutrition Foundation’s Task Force, 1992). The important LC n-3 PUFA are eicosapentaenoic acid and docosahexaenoic acid, the latter can be retroconverted to EPA. EPA is the precursor of eicosanoids of 3' series. The primary EFAs, LC n-6 and LC n-3 PUFA are important structural and functional membrane components and therefore essential for the formation of new tissues.

The levels of n-6 PUFA and n-3 PUFA in membranes and their ratio affect a range of biochemical processes such as membrane fluidity, nutrient transport, activity of membranes bound enzymes, receptor function either directly or via production of
eicosanoids and leukotrienes. In response to various stimuli, AA and EPA of membrane phospholipids compete for the cyclo-oxygenases and lipoxygenases and are converted to eicosanoids (for example, prostaglandins, thromboxanes and leukotrienes) of 2' and 3' series respectively. These compounds have important bio-regulatory functions. Eicosanoids derived from AA have opposing metabolic properties to those derived from EPA and therefore a balanced intake of n-6 and n-3 PUFA is essential for health.

The difference between fatty acid compositions of marine and freshwater fish has been noted. Although these fish lipids are higher in \( \omega-3 \) fatty acids, it is clear that freshwater fish have higher levels of \( \omega-6 \) fatty acids than marine species. The average \( \omega-6/\omega-3 \) ratios are 0.37 and 0.16 for freshwater and marine fish respectively. Fish in general contain more \( \omega-3 \) than \( \omega-6 \) polyunsaturated fatty acids and should have a higher dietary requirement for \( \omega-3 \) PUFA; thus the dietary EFA requirement of marine fish for \( \omega-3 \) PUFA may be higher than that of freshwater fish.

The same type of difference in the \( \omega-6/\omega-3 \) ratio between freshwater and seawater is seen when some species of fish migrate from oceans to streams or vice-versa. The PUFA ratio of sweet smelt (Plecoglosus altivelis) changes drastically in only one month as they migrate from the sea to a freshwater river. A similar but reverse change occurs in the masu salmon (Oncorhynchus masu) as they migrate from freshwater to seawater. Even in the same species of fish, the salinity of the water seems to cause a dramatic change in the fatty acid pattern.

The difference between marine and freshwater fish may be due simply to differences in the fatty acid content in the diet or it may be related to a specific requirement in fish related to physiological adaptations to the environment. The phospholipids are generally considered to be structural or functional lipid, being incorporated to a large extent in the membrane structure of the cell and subcellular
particles. The triglycerides are more often storage lipids and reflect the fatty acid composition of the diet to a greater extent than do the phospholipids. The effect of changing environment on the fatty acid composition of the phospholipid is as great in the case of salmon and considerably greater in the case of the sweet smelt than it is on the triglyceride composition. Rainbow trout on diet containing either corn oil, which is high in ω-3 but low in ω-6 PUFA shows a higher mortality and growth reduction in seawater than in freshwater over the twelve week feeding period.

There are several other factors besides the salinity of the water, which effect the fatty acid composition and especially the PUFA of fish. The salmonids, even in freshwater, tend to have a higher total PUFA of the 20 and 22-carbon chain length and a lower ω-6/ω-3 ratio than the other fish. The salmonids are mostly coldwater fish. The fatty acids from a number of marine animals from temperate and arctic waters show some significant differences in the general pattern. The general trend towards higher content of long chain PUFA at lower temperatures is quite clear. The ω-6/ω-3 ratio decreases with a decrease in temperature. If the trends in fatty acid composition can be taken as clues to the EFA requirements of fish, the ω-3 requirement would be greater for fish raised at lower temperatures. Fish raised in warmer waters such as common carp, channel cat fish and Tilapia may do better with a mixture of ω-6 and ω-3 fatty acids.

The EFA requirements of a number of species of fish have been investigated in nutritional studies. The fish themselves have given ample evidence that for EFA preference by the types of fatty acids they incorporate into their lipids. Fish, in general, tend to utilize ω-3 over ω-6. This is especially observed when the dietary lipids are high in ω-6, as the fish tend to alter the ω-6/ω-3 ratio towards the ω-3 fatty acids in the tissue lipids. The lipids of the egg must satisfy the EFA requirement of the embryo until it is able to feed. The fatty acid composition data suggest that the ω-3 requirement is greater
in seawater than in freshwater and higher in cold water than in warm water. It appears that high level of 18-carbon ω-6 or ω-3 fatty acids inhibit the synthesis and metabolism of 18:1ω 9. It is interestingly to note that the channel cat fish, which also exhibits negative growth response to dietary 18:2ω 6 or 18:3ω 3, incorporates very high levels of 18:1 into its body lipids. The inclusion of either 18:2ω 6 or 18:3ω 3 in the diet reduces the levels of 18:1 fatty acids in body lipids. A similar reduction has also been observed in Red Sea bream liver phospholipid when either of the PUFAs is added to the diet (National Research Council, 1973).

The competitive inhibition of chain elongation and desaturation of members from one series of fatty acids for members of another series is well established with ω-3 > ω-6 > ω-9 being the usual order of potency for inhibition. Mead and Kayama (1967) have reviewed the pathways of fatty acid metabolism. Fish are able to synthesize de novo from acetate, the even chain, saturated fatty acids. Radiotracer studies have shown that fish can convert 16:0 to the ω-7 monoene and 18:0 to the ω-9 monoene. The ω-5, ω-11 and ω-3 monoenes are proposed based on the identification of these isomers in the monoenes of herring oil.

Increased swelling rates of liver mitochondria occur in rainbow trout fed diets deficient in ω-3 fatty acids. It is possible that EFA plays an important role in the permeability as well as the plasticity of membranes. The role of ω-3 fatty acids in membrane permeability may be one of the factors accounting for differences in content of this family of fatty acids between freshwater and marine fish. Fish mitochondria with high levels of the ω-3 PUFA and very low levels of ω-6 fatty acids are very similar to mammalian mitochondria with respect to cytochrome content, β-oxidation of fatty acids, operation of the tricarboxylic acid cycle, electron transport and oxidative phosphorylation. The ω-3 PUFA may play the same role in fish that the ω-6 fatty acids
play in rats. The EFA play another role in the mitochondria. In addition to their importance in membrane structure, the EFA are important in some enzyme systems (Cowey and Sargent, 1977).

Unsaturated fatty acids play an important role in the transportation of other lipids. It has been repeated that feeding PUFA will lower the cholesterol levels in animals with above normal blood lipid and cholesterol levels. Fish oils are more effective in lowering cholesterol levels than are most dietary lipids. The major portion of the fatty acids absorbed across the intestinal mucosa is transported as protein lipid complex stabilized by phospholipids. The low body temperature in fish probably results in a greater importance for unsaturation in transport of lipids than in homeothermic animals.

The steps in the development of important medical discoveries rest first on intuition and then on associations of a certain factor with a disease, followed by scientifically designed experiments. The history of the importance of the n-3 polyunsaturated fatty acids EPA and DHA illustrates this point beautifully. Early Arctic explorers commented on the rarity of coronary artery disease in Eskimos despite their consumption of a very high fat, high cholesterol diet. This finding was indeed a paradox until it was resolved by two Danish scientists (Bang and Dyerberg, 1973). Gas-liquid chromatography analyses have been carried out to investigate the composition of esterified fatty acids in the plasma lipids in 130 Greenland Eskimos, compared with those of 32 Greenland Eskimos living in Denmark and of 31 Caucasian Danes in Denmark. While the Eskimos living in Denmark did not differ substantially from other persons living in Denmark and from what is found in other studies in Western communities, the Greenland Eskimos showed a completely different pattern. They demonstrated a much higher proportion of palmitic, palmitoleic and timnodonic acids,
while they had a markedly lower concentration of linoleic acid. When these investigators looked at the coronary mortality statistics in Greenland Eskimos and in Danish persons living in Greenland but having a vastly different life style, they found few deaths from coronary artery disease in Greenland Eskimos but many deaths in Danes. The answer to this riddle came from an analysis of the diet of the Eskimos compared with that of Danes. The latter group ate a diet high in saturated fat and cholesterol from meat and dairy products similar to the diet eaten in the homeland of Denmark. The Eskimos, on the other hand ate seal, whale and fish all of which are extremely rich in EPA and DHA. This was in contrast with the lower n-3 fatty acid content of the typical Danish diet. In the Greenland Eskimos also, the content of these same n-3 fatty acids in the blood was high (Dyerberg et al., 1975) and the tendency of the blood to form thrombi was lessened because the n-3 fatty acids were taken up by the blood platelets (Dyerberg and Bang, 1979).

The same situation prevails in present day Eskimos, as illustrated by the studies (Dewailly et al., 2001). The Nunavik Inuit of Quebec, despite some Westernization, still partly consume the diet of their ancestors, which is rich in fish and marine mammals. Mortality from coronary artery disease in the Inuit is 50% less than in the Quebec province as a whole. The Inuits high blood content of EPA and DHA reflects their consumption of these foods from the sea.

Diets rich in fish and marine mammals have been linked to a lower incidence of thrombotic disease in Greenland and Japan (Dyerberg et al., 1978; Yamori et al., 1985). Dietary fish and marine oils are rich in EPA (20:5α 3) and DHA (22:6α 3) which are long chain polyunsaturated fatty acids of the n-3 series. Fatty acids (n-3) favourably affect risk factors implicated in the pathogenesis of atherosclerotic and thrombotic
In 1992, daily intakes of n-3 fatty acids from traditional food, especially fish, marine mammals and piscivorous wild fowl, were high among Inuit persons compared with intakes by other populations (Yamori et al., 1985; Kris-Etherton et al., 2000). However, strong evidence exists of a decrease in traditional food consumption by the Inuit, primarily from 1950 to 1970, when Inuit populations settled into permanent communities and market foods became increasingly available (Sante Quebec, 1995; Blanchet et al., 2000). In several native populations, a shift away from traditional lifestyles and diets is associated with an increased prevalence of risk factors for CVD, such as high blood pressure, elevated blood lipids, diabetes and obesity (Robinson, 1988; Brassard et al., 1993; Welty et al., 1995; Ebbesson et al., 1996). Additionally, evidence points to increasing rates of death from IHD and stroke among native populations. In this study, they examined the n-3 fatty acid status of a representative sample of Nunavik Inuit and verified the relation between plasma phospholipid concentrations of n-3 fatty acids and various CVD risk factors.

Low rates of coronary heart disease in various populations with high intake of fish suggested health-preserving effects of these fatty acids. For example, mortality from coronary heart disease was found to be low among Greenland Inuits who ate large amounts of fish and whale meat (400-500g/day, 14g n-3 fatty acids/day) and in Japanese
fish eaters. "Omega-3 fatty acids are not just good fats; they affect heart health in positive ways" said "Penny-Kris-Etherton lead author". They make the blood less likely to form clots that cause heart attack and protect against irregular heartbeats that cause sudden cardiac death.

Concentrations of EPA, DHA were positively associated with total and LDL cholesterol. The reported effects of n-3 fatty acids on both of these CVD risk factors are inconsistent (Harris, 1989; Galli et al., 1994). Fish oil sometimes increases LDL-cholesterol concentrations (Kestin et al., 1990; Nestel, 2000). Although there is still controversy regarding the effects of n-3 fatty acids on the oxidative susceptibility of LDL, n-3 fatty acids may change the composition of LDL, leading to less atherogenic LDL particles with lower phospholipid and apolipoprotein-B concentrations and a higher LDL particle size (Contacos et al., 1993; Suzukawa et al., 1995; Sanchez-Muniz et al., 1999; Mori et al., 2000). It was also suggested that combining an antioxidant with n-3 fatty acids may protect against oxidative stress (Suzukawa et al., 1995; Foulon et al., 1999; Nestel, 2000). The results of one study showed that reduced LDL-cholesterol concentrations combined with antioxidant therapy improve impaired endothelium dependent coronary vasodilation (Anderson et al., 1995). LDL atherogenicity may be influenced by the presence of antioxidants such as vitamin A and E and perhaps selenium, which inactivate the atherosclerotic properties of LDL (Morel et al., 1984; Salonen et al., 1992; Hansen et al., 1994; Nestel, 2000).

White whale skin (mattak) is especially rich in selenium (5.5μg/g) and is consumed by the Inuit in large amounts when it is available (Dewailly et al., 1996). Suadicani et al., (1992) reported an increased risk of IHD in Danes who had serum selenium concentration. In a seven year follow-up study (Salonen, 1982) found an
excess risk of death by coronary disease and CVD and an excess risk of myocardial infarction among subjects with low selenium concentrations. Thus the paradoxical finding regarding the increase in LDL with increasing n-3 fatty acid concentrations in plasma phospholipids may reflect, among the Inuit an increase in LDL particle size. The antioxidant action of selenium, which enhances the antiatherogenic properties of n-3 fatty acids, may also explain the reduced mortality rate from IHD among the Inuit of Nunavik.

There is no relation between n-3 fatty acids and plasma pressure (Morris et al., 1993) reported that the hypotensive effect of high doses of fish oil may be strongest in the hypertensive subjects and in those with clinical atherosclerotic disease or hypcholesterolemia. Most studies that targeted healthy individuals with no clinical manifestation of hypertension failed to detect a hypotensive effect of n-3 fatty acids on blood pressure (Flaten et al., 1990; Ryu et al., 1990; Morris et al., 1993; Conquer et al., 1999). Considering the high prevalence of obesity and cigarette smoking which are known risk factors for high blood pressure (Kannel, 2000 and Wilson, 1997), it can be considered that the diet contributes to the low prevalence of high blood pressure.

The effect of n-3 fatty acids on glycemia, insulinemia and type 1 and 2 diabetes is not clear (Axerold, 1989; Hendra et al., 1990; Landgraf, 1992). Fatty acids (n-3) play role in enhancing glucose metabolism, insulin secretion and insulin receptor sensitivity (Lardinois, 1987; Storlien et al., 1997; Clarke, 2000). Fatty acids (n-3) were positively associated with plasma glucose, where as an increase in EPA and the ratio of EPA to AA appeared to be inversely associated with plasma insulin. A sedentary life style, the progressive abandoning of a traditional diet, an increasing intake of energy in the form of carbohydrates and the high rates of obesity found favoured this emergence (Brassard et
Obese Inuit had higher concentrations of n-3 fatty acids and HDL cholesterol and lower concentrations of insulin and triacyl glycerols and a lower ratio of total to HDL cholesterol (Dewailly et al., 1996). This suggest that n-3 fatty acids may attenuate metabolic disorders in obese subjects.

Kromhout et al., (1985) reported that mortality rates for arterial diseases were 50% lower among Dutch who consumed 30gm fish/day than among those who consumed no fish. Despite the high prevalence of obesity and smoking among the Inuit of Nunavik, the mortality rate of IHD is low, most likely because of their traditional diet rich in n-3 fatty acids. It showed some benefits of n-3 fatty acids (derived from marine sources) on CVD risk, notably increased HDL cholesterol and reduced triacyl glycerol concentrations.

Thrombosis is a major complication of coronary atherosclerosis and leads to myocardial infarction. The n-3 fatty acids from fish oil have powerful antithrombotic actions. EPA inhibits the synthesis of thromboxane A2 from arachidonic acid in platelets. Thromboxane A2 causes platelet aggregation and vasoconstriction. By blocking thromboxane A2 synthesis, fish oil ingestion by humans increases the bleeding time and decreases the number of platelets that stick to glass beads (Goodnight Jr. et al., 1981). In addition, administration of fish oil enhances the production of prostacyclin, a prostaglandin that produces vasodilation and less sticky platelets. In an In vivo baboon model, dietary fish oil prevented platelet deposition in a plastic vascular shunts (Harker et al., 1993). Injury to the intima of the carotid artery of the baboon invariably caused a marked proliferative and inflammatory lesion, greatly thickening the wall. When the animals were fed with fish oil, this damage and intimal thickening were completely blocked.
The EPA and DHA contained in fish oil inhibit the development of atherosclerosis. There is evidence in both pigs and monkeys that dietary fish oil prevents atherosclerosis by action other than the lowering of plasma cholesterol concentration (Davis et al., 1987). These actions may be associated with the inhibition of monocyte migration into the plaque, with less cytokine and interleukin-1 production and with stimulation of the endothelial production of nitric oxide.

The Atherosclerosis risk in communities study compiled data from four US communities (15000 participants, both black and white) on six hemostatic factors: fibrinogen, factor VII, factor VIII, Von Willebrand factor, protein-C and anti-thrombin III (Shahar et al., 1993). These were communities not known for their high intake of fish. Dietary intake of n-3 PUFA showed negative associations with levels of fibrinogen, factor VIII and Von Willebrand factor and a positive association with protein-C (Whites only). These findings may help explain, in part, the reduced incidence of vein graft occlusion seen in patients after coronary artery bypass grafting who receive n-3 PUFA (Eritsland et al., 1996). In a randomized controlled trial of dietary supplementation with n-3 fatty acids in bypass patients who received usual anticoagulation with aspirin or warfarin, an inverse relation between relative change in serum phospholipid n-3 fatty acids and vein graft occlusions was observed. Thus, the prevention of thrombosis remains a promising area for n-3 PUFA research.

PUFA are known in the public mind as being related to the atherosclerosis problem. This is derived from the observations in the early 1950’s that diets containing high proportions of PUFA supported lower serum cholesterol levels than did those diets containing high proportions of saturated fatty acids (SFA). This phenomenon has indeed been shown to be due to the PUFA themselves. No data has been generated to show
what level of linoleic acid would be required to hold serum cholesterol levels within the normal range, but it is likely to be a very high intake. Despite intense investigation, which shows that many factors affect serum cholesterol levels, the effect of PUFA remains one of them. The function of PUFA in producing the hypocholesterolemic effect probably is related to the maintenance of normal levels of PUFA in those lipids essential to the transport of triglycerides in the serum (Holman, 1956). Just a PUFA are necessary components to maintain the liquid crystalline properties of lipids of membrane structures, so are the PUFA necessary to maintain the physical properties of the phospholipids essential to triglyceride transport in blood serum. Large loads of cholesterol (Peifer and Holman, 1955; Holman and Peifer, 1960) or loads of dietary lipid of predominantly one type (Peifer and Holman, 1959) call forth a complement of phospholipids and cholesteryl esters required to maintain the proper physical characteristics of the circulating lipid mixture (Holman, 1958). If such a stress is maintained for any length of time, reserves of PUFA may be limited and the endogenous release of lipids to maintain the properties of the transported mixture will be impaired. Hence, abnormal composition of serum lipids may be an early manifestation of incipient EFA deficiency.

Cholesterol is important lipid belonging to the class of sterols. It is ingested from food like egg yolk and is absorbed along with other fats. It is also the precursor of steroid hormones and bile acids. The normal cholesterol content of the blood ranges from 150 to 250mg/100ml. Cholesterol occurs in the form in the cells where as in the plasma it is present as cholesterol esters.

Many of the oxidative reactions in cholesterol degradation are associated with mitochondria, which are rich in fatty acids of the polyunsaturated-methylene-interrupted
type. It is known that the turnover of cholesterol can be influenced by dietary factors such as fatty acid composition and especially the linoleic acid content of the diet (Avigan and Steinberg, 1958; Boyd and Mawer, 1959). Linoleic acid appears to be one of the acids selectively esterified to cholesterol, as in most tissues and body fluids under normal dietary conditions cholesteryl linoleate is present in high concentration. It is tempting to suggest that since cholesterol appears to esterify selectively to linoleic acid and as the latter acid can be shown to influence cholesterol turnover, the substrate for metabolism might be cholesteryl linoleate. PUFA of the linoleate type are susceptible to oxidation to yield hydroperoxides and a molecule of this sort might conceivably donate an oxygen atom to an allylic hydrogen (such as occurs at carbon-7) in the sterol structure to produce a hydroxylated analogue of cholesterol ester. Hydroxy esters have been isolated from plasma and tissues and these substances can be hydrolysed by cholesteryl esterases to yield ‘7-alpha hydroxy cholesterol’ (Boyd and Mawer, 1959).

The factors, which dictate the portioning of cholesterol between the plasma and the various tissues, are not fully understood. This makes the studies on the biological half-life of plasma cholesterol difficult to interpret unless these observations are coupled to independent assessment of cholesterol disappearance to defined tissues or products.

Thus n-3 fatty acids from fish and fish oil is natural food substances that prevent coronary artery disease and sudden death. Physicians should become acquainted with the powerful therapeutic potential of these fatty acids. The n-3 fatty acids have immense public health significance for the control of the current coronary epidemic.