THE COLLECTED PROFESSIONAL PAPERS OF FRANCIS MARION POTTENGER, Jr. M.D.

Together with a
Brief Personal Memoir
by
Thomas Myron Hotchkiss

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FRANCIS MARION POTTENGER, JR. M.D.

A Personal Memoir
by
Thomas Myron Hotchkiss

Dr. F.M. Pottenger, a native of New Baltimore, Ohio came to Monrovia in September, 1895 with an ailing wife, the former Miss Carrie Burtner of Germantown, Ohio. Here he entered into a partnership with Dr. R.D. Adams for the practice of medicine. After about a year and a half, his wife's health not being improved, the Pottengers returned to Ohio where she passed away in November 1898. Shortly afterward Dr. Pottenger came back to Monrovia and resumed his partnership with Dr. Adams. On August 29,1900 he married Miss Adelaide Gertrude Babbit , a native of Keysville, New York and a graduate of the University of Vermont, who at the time was vice-principal and teacher of Latin and Greek in the Monrovia High School which was then at the old Orange Avenue School. The Saturday Afternoon Club, predecessor of the Woman's Club, lists her as a member in its roster for 1898-99. To them three children were born:

Francis Marion, Jr.
Robert Thomas
Adelaide Marie.

Francis Marion Pottenger, Jr. the subject of this memoir, was born in Monrovia on May 29,1901, three years before his father established the famous Pottenger Sanatorium. Francis began his education in 1907 by entering the first grade at the old Ivy Avenue School where he came under the influence of that beloved teacher who taught many early Monrovians their ABCs, Miss Laura C. Barnes. I have in my possession a photograph of that class of 32 pupils. Among those in the picture who remained in Monrovia for many years are John Zerell, Ralph Slosson, Mary Moore and, of course, Francis himself.

My acquaintance with Francis began about 1912 as I remember. At that time the Pottenger family was living at "The Oaks", the home on Primrose avenue that was built by W.N. Monroe, the founder of Monrovia. It was a beautiful house for those days with spacious rooms and with ample grounds. A large fountain stood on the front lawn. The fountain jet descended on a statue of a small boy holding an umbrella and fell into the pool enclosed by walls of cut and fitted granite. At the rear of the house was a commodious barn.

Adjacent to the barn there stood a wooden tower supporting a large steel water tank which formerly supplied the house and grounds with water. Beneath the tower was a walled pit which originally contained equipment for making gas. When the Pottenger family lived at "The Oaks" the gas equipment had been removed and the water tank was no longer in use.

One day Francis conceived the idea of building a roller coaster from the top floor of the barn to the ground and decided that the best source of structural material would be the tower that carried the water tank. How to get the tank down off the tower became the first problem to be solved.

At that time Mrs. Pottenger owned a "Detroit" electric automobile for her personal use. It was a large bulky coupe enclosed with panels of plate glass and was steered and controlled by a long lever rather than a wheel. Francis decided that the best way to get the tank down was to tie a length of rope around it and pull it off the tower using his mother's electric automobile as a source of power. One Saturday afternoon a group of us boys got together with Francis and after several trials we managed to jerk the tank free and down it came with a resounding crash. It's a wonder someone didn't get hurt but we all survived. To forestall any further forays with her automobile, Mrs. Pottenger took all of us downtown to Werden's Ice Cream Parlor for ice cream sodas.

Francis was a born experimenter and innovator, a trait believed to be inherited from his mother's family. He grew up at a

time when what we now call "radio" was in its infancy and many of us boys were experimenting with "wireless" sets. The "wireless bug" never seems to have bitten him as I do not recall that he ever tinkered with this hobby. Rather, he was mechanically inclined and loved to make things with his hands both in wood and metal.

When we were boys "Meccano" sets were all the rage and Francis had a rather elaborate set. With it he made among other things, a working model of a rock crusher such as those that were to be found in the Azusa-Duarte area where the gravel resources of the San Gabriel river were being exploited by the rock companies. He set it up in the foyer of the old Wild Rose School where it was enviously eyed by many of his companions. Later, with the same set he constructed a working model of a bascule bridge complete with motor drive. Both models displayed considerable ingenuity in design and construction and were not slavish copies of models displayed in books.

This interest in things mechanical continued throughout his life. In later years he had a lathe and an assortment of machine tools which he used in making equipment for his research projects. At one time for such a project he had a need for a multi-ported valve that would divert a fluid stream in five different ways. After selecting one from a manufacturer's catalog he felt that the price was too high and decided to make one himself which he did and it worked to his entire satisfaction. It is interesting to note that on a biographical questionairre from the Los Angeles County Medical Association he listed under "Hobbies", "Machine Tool Work".

Although Francis continued for several years in the primary grades of Monrovia schools and graduated from Wild Rose in 1915, he also attended the Los Angeles Military Academy, Claremont School for Boys (later called the Webb School) and the Thatcher School for Boys at Ojai. In part, this was due to intermittent periods of poor health. Colds,coughs and fatigue plagued him as a child. Prior to entering college he spent almost three years in bed in order to gain sufficient energy to pursue a college career. Even so, it became necessary to spend two or three months

out of every school year in bed to carry out his normal scholastic activities. Later in life he recalled that this period was responsible for a somewhat darkened outlook on life and caused him to wonder why we as a people with our advanced technical knowledge could not prevent our children from suffering through childhood and adolescence as he had.

I believe that it was at about this period that Francis conceived and carried out a project which kept him outdoors and which also served a useful purpose. Many of the patients at the Sanatorium who were well on their way to recovery were urged to walk into Monrovia Canyon and as their strength returned to gradually increase the length of their walks. To assist the patients in gaging the length of their walks Francis had white stakes made and marked which indicated the distance from the Sanatorium and these he placed along the road and trails at intervals of about 100 feet. They reached as far as Emerson Flat and beyond to the falls and also up the trail into Spanish Canyon. The latter was a particularly delightful place which has, alas, succumbed to "progress" and is all but unknown to present-day Monrovians, access to it being blocked by an ill-conceived and unsightly debris basin.

Finally, Francis was ready for college having kept up his school work through correspondence courses and in 1921 he entered Otterbein College at Westerville, Ohio--his father's alma mater. He pursued his studies assiduously but in addition to his academic work he participated in many student activities. He was manager of the Glee Club, manager of the Tan and Cardinal, the college newspaper, and also manager of the Sibyl, the college annual. More important, it was here that he met his future wife, Teresa Elizabeth Saxour, who was his classmate. On June 17,1925 they received their AB degrees together and were married later in the same day. Next, Francis entered the College of Medicine at the University of Cincinatti, also his father's medical school, and graduated with the degree of Doctor of Medicine in 1929. Then followed a year in the Los Angeles

County Hospital as a resident intern.

I have before me Francis' "Lefax" pocket notebook which he must have carried with him while he was in college. It is crammed to the limit of its capacity with notes of all sorts and shows evidence of being much used over the years. One section named "Facts and Suggestions" illustrates the workings of his introspective mind. Evidently it was his habit to jot down for further consideration thoughts that had crossed his mind and questions that he had raised within himself for further exploration. Most of these are dated at the time he was in college at Otterbein and later at medical school. Here are a few random samples illustrating the scope of the field over which his mind played from time to time:

> "Is it not probable that the fineness of the hair may be an indication of the thickness of the skin? 3/14/25
>
> Why is malignancy rare in the duodenum? 1/19/28
>
> Is hunger caused by the deprivation of body tissues of carbohydrates? 1/27/28
>
> Is it possible that cancer may be produced by intestinal bacteria which liberate an enzyme that has power to cause the cells of specific tissues to proliferate. The tissue being in such a state that trauma starts the proliferation?
>
> Is the potential required to produce a spark in any way dependent upon the position of the gap in the earth's magnetic field? 2/13/25."

It would be of interest to know how he resolved the questions posed in the notebook but unfortunately he made no notes of the answers, if any were found.

It was while he was in medical school and remembering the many illnesses he suffered in his younger days that he developed a "hatred", as he expressed it, of the way that civilized man has treated himself and his children in allowing them to become victims of chronic illness. It was through that hatred that he was impelled to investigate the reasons for this state of

affairs. His point of view was developed not alone from text-books but was stimulated by certain inspiring precepts of some of his instructors during his medical school career who dared to question the advisability of certain phases of our great scientific progress and certain of the public health programs instituted by modern medicine. Thus was implanted within him the "need to know" which later led to his extensive study of nutrition and foods.

I have said that Francis was a born experimenter and had a vigorous and inquiring mind. With this endowment he made numerous improvements in medical techniques and produced at least two patentable inventions. His earliest contributions to a medical journal appeared in the Journal of the American Medical Association November 1930. They described "Rubber Flask Connectors for Hypodermoclysis, Intravenous Therapy and Other Uses" and "A New Syphon System for Maintaining Continuous Drainage Without Air Block in Thoracic Empyemas and in Infections of Other Body Cavities." These were developed while he was an intern in the Los Angeles County General Hospital. The latter system, known as the Pottenger Drainage, was adopted by the Chest Surgery Section of the Hospital and is still in use there.

On June 6,1934 Francis and James R. Balsley as co-inventors, applied for a patent covering an "Airplane Navigating Apparatus" which was an automatic position-indicating system using infra-red rays to provide guidance for the safe landing of aircraft under conditions of substantially no visibility. Twenty-two claims were allowed under the patent which was granted by the United States Patent Office on February 9,1937 as Patent No. 2070178.

In his work Francis had need for a refrigeration plant but he was bothered by the problem of keeping the refrigerant free of lubricating oil from the compressor. He devised a successful means for overcoming this problem and on August 30,1948 applied for a patent for a "Refrigeration System with Refrigerant Cleaning Means." The patent with nine claims was granted by the

United States Patent Office on February 9,1937 as Patent No. 2618132.

During the latter part of 1961 Francis became intrigued with a method for percolating coffee with cold water rather than hot or boiling water as is done with conventional percolators. In his opinion cold percolation produced a more flavorful brew than that made by the use of hot water. However, a review of prior patents by his attorneys showed that Francis' device was not sufficiently novel to warrant an application for a patent.

Again, early in 1964 Francis conceived an improvement for the ear-piece of the doctor's stethoscope which would allow its use with or without a hearing aid. However, in the opinion of his patent attorneys the device was not patentable and the application was dropped.

Prior to his untimely death Francis had underway a project wherein he attempted to develop an accurate method for producing simultaneously a photograph and X-ray of an object under study. This method was developed primarily for the study of the human skull and in particular the temporomandibular joint or the jaw hinge.He was successful in developing the photographic and X-ray equipment capable of giving the desired results, i.e. simultaneous exposure with an accurate superimposition of the X-ray and photograph. He believed this method including certain related developments should be covered by letters patent but I do not know if this was successfully completed.

This method was devised to further an investigation of changing trends in the human skull configurations over a span of four generations, roughly placing the periods at birth prior to 1900, 1920,1940 and 1960. The basis for this study consisted of X-rays of the skull, hand, foot and thorax together with anthropometric photographs and measurements on some 7000 individuals. Preliminary study suggested the change in configuration of the American from the broad-shouldered male with narrow pelvis, with a heavy short neck and his counterpart the narrow-shouldered female with

broad pelvis and relatively long neck, to the broad pelvis male, with small weak shoulders and the female with narrow pelvic girdle and broad shoulders. The greater height and weight and other anthropometric measurements that are known in our present society were also borne out.

As mentioned above, a particular phase of this study was that of the temporomandibular joint. The development and degeneration of this joint was noted in the study of several hundred cats and their diets. The human studies just mentioned appeared to suggest the degeneration of the human temporomandibular joint might have had a similar background.

Another device which Francis worked upon ca 1924 was a lawn sprinkler which produced a spray that covered a square area rather than circular as is the case with most conventional sprayers. The secret of this device depended upon shaping the orifice of the nozzle in such a way that the angle of elevation was varied with respect to azimuth in accordance with ballistic theory. I remember making a drawing for him illustrating the principle but whether he pursued the idea far enough to apply for a patent I do not know. Calculations that he made for this device are contained in the Lefax pocket notebook mentioned earlier.

Following completion of his resident internship at the Los Angeles County General Hospital he became associated with his father at the Pottenger Sanatorium in Monrovia as a full time assistant from June 1930 to May 1941 and part time assistant from 1941 to 1945. In addition to his duties as clinical assistant he at this time also began his researches in the treatment of asthma and in the field of nutrition.

In 1940 he became the owner and operator of the Francis M. Pottenger,Jr. Hospital at Monrovia for the treatment of non-tubercular diseases of the respiratory system, particularly asthma, which continued for twenty years until it was closed in 1960. He then devoted his entire time to his clinic and

office practice until his untimely death.

Pasteur once stated:"In the field of scientific experimentation chance favors only the mind which is prepared." Because his mind was prepared Francis was favored by two discoveries which happened by chance. In his search for ways to treat asthmatic patients Francis studied the work done by Drs. Pfiffner and Swingle with the adrenal gland. This led to a program of treating his asthmatic patients with high protein diets supplemented by freshly ground adrenal glands. To his surprise this treatment resulted in marked improvement in most of his patients. This led to further study of and a research program on the adrenal hormones.

Adrenal glands were obtained from cats and Francis noted that the cats having the largest adrenals were the unhealthy ones and that these were the ones that had a poor survival rate after the adrenalectomy. The more healthy cats had smaller adrenals and a better survival rate. To find out the reason for this he embarked on a program for studying the effect of the cat's diet on their health and growth.

The work that perhaps brought more fame to Francis than any other was his classic study of the effect of diet upon successive generations of cats. This exhaustive study covering a period of about ten years is reported in his paper: "The Effect of Heat-Processed Foods and Metabolized Vitamin D Milk on the Dento-facial Structures of Experimental Animals"--(American Journal of Orthodontics and Oral Surgery, Vol.32, No.8, pp 467-485, August 1946). It seems worthwhile to summarize this work briefly here:

"Feeding experiments were conducted to determine the effects of raw and cooked meat. Another series of experiments went on to compare the differences resulting from the feeding of raw and processed milks.

1 THE MEAT STUDY

Two diets were used in this study:

Adequate diet A: 1/3 Raw milk and cod liver oil plus
2/3 Raw meat.

Deficient diet B: 1/3 Raw milk and cod liver oil
2/3 Cooked meat.

2 THE MILK STUDY

Five diets were used in this study:

DIET A: 1/3 Raw meat and cod liver oil.
2/3 Raw milk.
DIET B: 1/3 Raw meat and cod liver oil.
2/3 Pasteurized milk.
DIET C: 1/3 Raw meat and cod liver oil.
2/3 Evaporated milk.
DIET D: 1/3 Raw meat and cod liver oil.
2/3 Sweetened condensed milk.
DIET E: Raw metabolized Vitamin D milk only.
1 From cows on dry feed.
2 From cows on green feed.

SUMMARY

(1) Cats fed two thirds raw meat and one third raw milk were healthy and reproduced in homogeneity. (2) This was also true of cats fed one third raw meat and two thirds raw milk.

Cooking the meat of Group (1), or substituting heat processed milks for raw in Group (2), resulted in heterogeneous reproduction and physical degeneration that increased with each generation. Kittens of the third generation failed to survive six months. Diet E produced unexpected results, i.e. rickets and early death of male kittens.

Vermin and parasites abounded. Skin diseases and allergies increased from an incidence of five percent in normal cats to over ninety percent in the third generation of cats fed on deficient diets. Susceptibility to infections rose markedly and severe osteoporosis was universal. Mortality was high. These cats suffered from most of the degenerative diseases encountered in human medicine, including endocrine dyscrasias. Autopsy findings were revealing.

Change was shown not only in the immediate generation, but

also as a germ plasm injury which manifests itself in subsequent generations of plants and animals. Four generations on raw meat and raw milk were required to bring some of the second generation of degenerating cats back to normal."

A motion picture based on this study was made and was shown before many medical and dental groups as well as before the American Medical Association as a part of the exhibit at New York and at Atlantic City. It was also shown at the Clinical Session at Los Angeles. Later, Francis was invited to discuss this subject before a meeting of the American Veterinarian Medical Association in San Francisco.

During his professional career Francis authored many papers and articles which were published in the medical literature. Appended hereto is a list of these. While I can profess no competency as a judge of merit in medical literature the list does seem to me to be impressive.

In addition to being a prolific contributor to medical literature, Francis was a member of numerous medical associations and societies as follows:

American Medical Association
California State Medical Association
Los Angeles County Medical Association, (Past President of the Foothill Branch)
American Therapeutic Society, (Editor 1941-55, President 1953)
American Association for the Advancement of Science.
American Academy of Applied Nutrition, (Past President)
Fellow of the American College of Physicians
Endocrine Society
American Geriatric Society
American College of Sports Medicine
International College of Applied Nutrition
American College of Chest Physicians
Association for the Study of Internal Secretions.

Francis was among the first in his profession to recognize the hazard to health caused by air pollution in Los Angeles County. He worked indefatigably over a period of many years to mitigate its deleterious effects upon human health. His efforts were widely recognized and as a result he became a member of the Los Angeles County Air Pollution Control District's Scientific Committee, Chairman of the Los Angeles County Medical Association's Committee on Air Pollution as well as membership on the Air Pollution Committee of the American College of Chest Physicians.

As Medical Service Chief, Civil Defense Area D, Region 1, State of California, Francis was active in Civil Defense affairs in the Monrovia area. The first portable hospital to be set up in Los Angeles County under simulated disaster conditions was a project under his direction.

In addition to the heavy demands on his time by his medical practice and other commitments he found time to be Assistant Clinical Professor of Experimental Medicine at the University of Southern California beginning in 1945. Aided by a grant from the United States Public Health Service and by donations from grateful patients he continued his study of the human temporomandibular joint and development of the face.

In the early sixties Francis became interested in the investigations done by the late Dr. Weston A. Price, a dentist, who did pioneer work in comparing the effect of primitive and modern diets of native peoples and their teeth. This work was based on a world-wide survey of native populations which demonstrated the dramatic degeneration of their teeth when "modern" foods were substituted for those upon which the populations had subsisted since time immemorial. Dr. Price reported his results in his classic book, NUTRITION AND PHYSICAL DEGENERATION.

Francis, recognizing the value of Dr. Price's findings and noting therein corroboration of his own work, became chairman of a committee which was formed for the purpose of preserving the important parts of Dr. Price's collections and promoting dissemination of his findings through exhibits, educational

programs and the printing of a new edition of his book, which had long been out of print. Later the work of this committee was taken over by the newly organized Weston A. Price Foundation, a non-profit organization, and Francis continued his interest in the new group.

Upon Francis' untimely death in 1967, the Pottenger family decided to intrust his important research data, slides and exhibit material, and reprints of his professional papers to the Foundation. In appreciation of this confidence, the Board of Directors deemed it fitting to change the name to the Price-Pottenger Foundation. More recently the name has been modified to the Price-Pottenger Nutrition Foundation to more nearly reflect its purpose. It continues to disseminate the findings of both men.

Francis was the recipient of several awards for distinguished service. In 1951 he received an award from the Texas State Dental Association for the Advancement of the Science of Dentistry in Texas. A Certificate of Appreciation was given to him by the Los Angeles County Medical Association for outstanding service as Chairman of its Smog Committee for the year 1954. In 1959 he received the State of California Certificate of Commendation for "unselfish and dedicated service in the development of non-military defense preparedness and valued assistance in providing for the maximum safety and protection of lives and property in California in the event of war-caused or local disaster."

Perhaps the award that touched Francis more deeply than any other was the Distinguished Alumnus Award presented to him at Otterbein College on Alumni Day, June 5,1965 by Dr. Harold Boda, Chairman of the Board of Trustees. In presenting the citation Dr. Boda praised Francis' distinguished career in medicine and public service.

Francis was a member of the United Brethern Church and the Masonic Order both of Westerville, Ohio. His other memberships included the University Club of Los Angeles, the Rotary Club of

Monrovia, the Alumni Association of Otterbein College and Alpha Kappa Kappa Fraternity. He served as medical advisor to the Monrovia Civil Defense Organization and the Citizen's Advisory Committee for the Monrovia High School.

This memoir would not be complete without mention of Francis' wife Elizabeth and their family. As mentioned before, Francis and Elizabeth were married on the day of their graduation from Otterbein College. During her time at Otterbein and while pursuing her academic work there, Elizabeth had been under-secretary to President Walter G. Clippinger of Otterbein for three years and it was he who officiated at their marriage ceremony. After Francis had entered medical school she attended graduate school at the University of Cincinatti for two years, receiving her master's degree in English and a number of credits toward a doctorate. Her further formal education was ended by the arrival of their first child, Francis Marion III, on July 19,1928. In all, four children were born to them, Francis III being followed by Margaret Elizabeth on December 15, 1929, Barbara Jane on March 31,1931 and Samuel Slater in 1934. The four children went on to college in their time; Francis III to Otterbein, Margaret to Stanford, Barbara to Otterbein and later to William and Mary, and Sam to Montana State.

It has been said that behind every great man there is a dedicated loving woman and for Francis, Elizabeth was that woman. Her married life was completely devoted to her husband, her family and to others. With all her cares as a mother to her children she still found time to help her husband with his researches and the writing of professional papers. With her brilliant mind she was invaluable to him as a research assistant, doing the scanning of medical literature and abstracting the significant items about which her husband should be informed. She was a good critic and often prevented material in which Francis was not as his best from reaching publication.

She took an active part in Community life. The P.E.O., the Children's Hospital Guild and the Foothill Area Auxiliary of

the Los Angeles County Medical Association--all were the beneficiaries of her interest and support.

Her full and active life was cut short by her untimely death in her sleep on December 12, 1965, deeply mourned by her family and a host of friends.

Francis continued on alone until December 21,1966 when he married Mrs. Hilda Rethlefsen, an old friend. Their married life was all too brief. Shortly afterward, on January 4,1967, Francis died suddenly in Glendora after being stricken with a heart attack.

THE PROFESSIONAL PAPERS
OF
FRANCIS M. POTTENGER,JR. MD.

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THERAPEUTIC EFFECT OF LAMB FAT IN THE DIETARY

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Fats in the diet serve four major purposes. First, they supply energy for locomotion and the maintenance of bodily temperature. Second, they supply the body with depot reserves that secondarily insulate against mechanical injury, heat and cold. Third, they provide a source of elements for a complex metabolic process. Fourth, they act as agents for the transfer of nutritional accessories.

The so-called neutral fats are glycerol esters of fatty acids. They are composed of a molecule of glycerine attached to three fatty acid radicals. Glycerine is freed from the fatty acid radical in the process of digestion by hydrolysis. On assimilation into the body, glycerine is oxidized releasing energy in a manner similar to the utilization of carbohydrate. It is changed into phosphoglycerol. The fatty acid radicals, likewise, are oxidized with a further release of energy.

Long chain fatty acids are broken down, step by step, to the so-called "2-C fragments" or acetic acid radicals. Octanoic acid, for example, is first reduced to a molecule of hexonic acid plus an acetic radical. The hexonic acid is reduced to butyric acid plus an acetic acid radical, and the butyric is reduced to 2 molecules of acetic acid by oxidation. The breakdown of this 8-carbon atom of fatty acid gives four acetic acid or C-2 fragments which in turn can be changed into 2 molecules of aceto acetic acid.

Some of the fat that is consumed in excess of body requirements is deposited in the so-called fat depots. These fat supplies serve the purpose of protecting the body from mechanical injury, of insulating against heat and cold, to act as a source of energy in case the intake of fat in the food falls below the normal nutritional requirements. These stores are constantly changing with the metabolic picture of the individual. They provide 1000 calories per kilo when released as energy.

The acetic acid or "C-2 fragments" enter into many complex

chemical processes within the body, provide the building stone for the elaboration of cholesterol, acetylated amines and many complex metabolites necessary for bodily functions. The assumed mechanism for the utilization of these fragments in the production of more highly complex radicals is known as the Krebs cycle.

The further function of dietary fats is to act as carriers for absorbed substances that are found accompanying natural fats. These substances of animal origin consist of the four fat soluble vitamins--A, D, E and K. Certain of the animal steroids, such as the ovarian, testicular, and cortical adrenal hormones and compound lipids, such as the phospholipids, sphingomyelins, and others. These lipids are usually metabolized in a manner similar to the simple lipids.

The simple fats differ greatly in their chemical composition and their physical properties. Physically, the fats are divided into the fats and fatty oils, depending upon whether or not they melt at 20^{o} C. This is determined, in part, by the number of carbon atoms in the chain of the fatty acid and whether or not the chain contains double bonded carbon atom linkages. The so-called saturated fatty acids above six-carbon atom chains are solid. On the other hand, the unsaturated fatty acids including those with as many as 22 carbon atoms are still liquid.

Depot fats vary greatly in their chemical composition, depending on the carbohydrate and fatty acid content of the ingested food. Likewise, the chemical composition of depot fats of an animal vary with its location in the body, such as the highly active depot fat of the peri-renal tissue when compared with the fat of the buttocks. In spite of these changes that can be brought about there appear to be certain physical characteristics of the depot fats of an animal of a given specie that are specific. The fat of a hog can vary from a fatty oil, when rendered as lard, to a firm, clear white substance, depending upon its feed. One would not confuse these widely variable tissues of the hog with those of the steer which tends to store a much higher melting point fat with a

greater quantity of saturated fatty acids.

These differences would be particularly evident when compared to animals of different species on similar types of ration. Besides the effects on the composition of the fatty acids of depot fats stored in the tissue of animals, due to their rations and specie, we have differences in chemical composition due to the sex of the animal. This controls not only the location of the depot deposit but to a lesser degree the composition of the fat. Age, too, has a marked effect on the character of the fat. The female of the specie tends to have a slightly softer fat than a male of the same age. In certain phases of the reproductive cycle the female tends to store much more fat than at other phases. The infant, too, has a fat of considerable different composition from the mature. The castrate differs from the normally sexed. The state of nutrition is determined by the metabolic activity of the animal. The highly active physical animal stores less fat and utilizes its fat stores in starvation. The fat of the highly active tends to be firmer than that of the less active. All fats contain some water. The lower the metabolic level of the individual the more water is stored. This is well understood by the animal husbandryman who frequently places his animals on starvation rations before putting them on his fattening diet. Farmers have likewise learned that the use of certain drugs, along with inactivity and high carbohydrate feeding, will reduce metabolism and aid him in fattening the animal. Such practices frequently produce an animal with tissues that are softer but frequently less tasty than those of an animal in better metabolism.

In attempting to get information on the variability of the fatty acid content of the tissues of the different animals, a letter from the National Livestock and Meat Board quoted a letter received from the Department of Agriculture, reading as follows:

"------about data on the unsaturated fatty acids of the various meat fats---we understand, however, that the differences

associated with the feed and nutrition of the animal as well as with the type of animal and location of the body fat are going to make it difficult to derive a 'typical' physical figure for general use."

Beside the alteration in the composition of fats above mentioned, the care with which these food elements are stored and preserved is of great importance. Saturated fatty acids are relatively stable compounds. It is for this reason that hyrdogenization of fatty oils and other fats is so widely practiced in order to preserve them. Unsaturated fatty acids, especially those with two or more double bonds are highly unstable and their breakdown in free acid--odoriferous aldehydes, organic peroxides, ketones and other volatile substances are responsible for much of the decomposition of foodstuffs. Likewise, the oxidation of the double bonded fatty acids to form ozonides and other polymers renders the substance less digestible. Some of the compounds resulting from the breakdown of fatty acids, may be not only distasteful but actually poisonous to man. The processes of rancidity can be greatly hastened by heat and other methods of handling foods. In some fats there are important antioxidants among which are the tocopherols or substances with vitamin E activity. The alpha-tocopherol, in particular, possesses this property. Although it is present in all meat to some degree, there are certain vegetable fats and oils that appear to be much richer in this type of material than others.

Hansen, who addressed the Society in 1946 fully discussed the importance of unsaturated fatty acids and their effects especially when it is administered in the form of pork fat to the eczematous child. It will be found that pork tends to concentrate unsaturated fatty acids to a degree greater than many animals. Inasmuch as cutaneous lesions in experimental animals have been shown to be due to the lack of the unsaturated fatty acids, and not the saturated, pork appeared to be an excellent source of these materials. The author's approach to the problem of the eczematoid and dermal conditions in general was stimulated by a slightly different point of view. Lamb fat offered several advantages, both theoretically and practical, over the use of pork. Lamb is a meat that cam be consumed rare and for

that matter is consumed raw by many people in many parts of the world. Raw meats contain factors that are destroyed in the usual preparation of meats, especially if they are well done. The possibility of infection from pork precluded its use as rare meat. Secondly, the sheep is naturally a fat animal, is bred for the purpose of producing meat, wool and fat. It excretes in its wool a fatty substance containing esters, cholesterol, vitamins and hormones, as well as steroids that go to make up lanolin. Inasmuch as the primary source of this highly curative wool fat must come from animal metabolism, it is reasonable to suspect that the fat depot of this animal might be expected to contain these substances in reserve supply. Thirdly, although the unsaturated fatty acid content of mutton tallow is materially greater than beef, it does not represent quite the degree of unsaturation that is found in pork. It is, likewise, found that freshly cut meat has considerable advantage over meat cut one or two days in advance, inasmuch as oxidation takes place on the surface of the meat and actually changes the flavor for as much as an eighth of an inch with pieces that have been cut not over 24 hours. Freshness of food is impprtant.

Evidence of fat deficiency in the American public has become of great concern to the physiologist as has been so expressed in recent text books dealing with the subject. Beauty experts have written on the problem extensively, especially the problem of dry skin. In my own practice, we analysed one hundred consecutive examinations representing fifty men and fifty women. Twenty-five of the fifty men had evidence of dry skin. Thirty-seven of the fifty women showed similar evidence. Simple dry skin is an index of fat dyscrasia. Although in the adult, more women appear to have dry skin than the men in our practice, the male child has greater evidence.

The deficiency in the mammalian specie is not corrected by fats composed of saturated fatty acids. It is only those unsaturated fatty acids of two or more double bonds that prevent the development of this condition, and the double bond fatty acids of more than four or more are more effective in a curative manner. The rare lamb chop has proven an excellent food source of unsaturated fatty acids and can bring about

changes noticeable in the skin of patients who have been on a low fat consumption in as short a period of time as 48 hours. This change can be detected by a softening of the skin; and as the patient continues to consume the rare lamb chop, the velvety return to the normal skin can be gradually noted. Follicular keratoses that are so common in the legs and buttocks of many fat starved individuals gradually disappear. When a lamb chop is prescribed it is understood that all of the fat is to be eaten. Although many people feel that they cannot consume fats, there are few, indeed, who are truly unable to handle this form of fat. When digestive difficulties are present, they are usually due to insufficient gastric, pancreatic or liver function. A substitution of suitable digestants can usually suffice to enable the patient to handle his meat unless natural prejudice or serious disease of the biliary tract or stomach precludes its use. The average patient, although his complaints may be multiple, who does not suffer from serious organic disturbance other than the dry skin, responds well. One can see the change in the hair as quickly as in the skin. It has been common to find boys with unruly hair who have been plastering it down with grease or other cosmetic preparations, within less than a week's time show sufficient return of natural oil to their scalp so that the texture of the hair becomes soft and the subject can be properly groomed.

These results are not obtained if the patient removes the fat from his lamb chop. If he does not consume it rare. The average one-inch chop should be cooked two minutes on a side at 450° F. Nor are the results obtained well from the use of rare beef fat. The usual fats, pasteurized butter and oleo margarine, frequently reported as being consumed in relatively large amounts, do not possess the quality necessary to correct this condition in spite of the fact that the tables of composition of many oleos and butter show the presence of unsaturated acids.

Many people in their desire to follow the fashion of the day have lost especially important depot fat pads which are of special significance, namely, the sucking pads in the cheeks,

the fat pads around the lips, the fat pads in the palmer and plantar fascia that serve to protect the metacarpal and metatarsal bones from mechanical injury. The loss of gluteal fat pads, particularly in older people is a serious problem. The return of these important fat depots is much more slowly than the cutaneous manifestations mentioned above. Although depot fats may be returned to the subcutaneous tissue relatively quickly, the return of these protective fat pads is much slower and difficult of attainment. Frequently, particularly women are unable to grasp objects firmly because of lack of these pads on the fingers or the palms of their hands. Frequently painful feet are associated with the loss of these pads and difficulty in walking may actually be experienced. Loss of protective pads over the tuberosities of the ischia renders sitting very uncomfortable for many Americans, not merely the aged. Once these pressure pads are lost, it frequently requires from one to three years in the younger individual to replace them. If, on the other hand, the individual has entered into the declining years beyond his fifties, once these protective have been resorbed, adequate fat intake over a long period may be insufficient to return these individuals to comfort. The elderly patient who has lost his fat pad may be more uncomfortable by a fat restricting diet than any fundamental condition which has made the clinician feel the necessity for such restriction.

The great fear of the production of hypercholesterolemia through the use of fats does not appear to be justified when the rare lamb chop is used for the major source of fat. The author has previously reported that a high fat diet of animal origin did not alter the cholesterol level when used in conjunction with lecithin, a lipotropic agent, but actually diminished the cholesterol level. Inasmuch as a high fat diet has not been attended with any evidence of damage, and cholesterols have not increased but have diminished in conjunction with a lipotropic agent, this source of animal fat appears to be of great value in the treatment of simple dry skin and other fat dyscrasias.

In summary, the rare lamb chop with all its fat provides an excellent source of unsaturated fatty acids that appear to be curative for the usual dry skin that is seen in such a high percentage of individuals today. It seems to be an excellent source for returning fat pads to the younger individual. It may not be successful in returning fat pads to the older person, although it may materially improve his general nutrition.

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IN DEFENSE OF FAT

Elimination of all fat from the diet, as far as is practicable, as well as a rigidly restricted animal fat intake, are a current medical trend. Like all dietary restrictions, such as protein, carbohydrates, or salt, the basic concepts have been developed by capable experimental workers. The pitfalls in the theories occur when the physiological problem is not looked at as a whole.

The purpose of this discussion is to present a case for the use of animal fat in the dietary. Let us first examine the purposes of one's fat as a protective role in the body.

Fats are present in every living cell, and are essential to its life. The human body varies in fat content, but as an average figure, the 150 pound standard man is estimated to be composed of:

Body weight	70K	100%
Fat	7K	10%
Protein	6.4K	9%
Carbohydrate	5.6K	8%
Mineral	2K	3%
Water	50K	70%

Intracellular fat is present in tissues such as muscle, brain, pancreas, and skin, as an important constituent. It is stored in the subcutaneous tissues as so-called depot fat for metabolic purposes and as bodily protection.

The fat pads of the infant protect him from breaking his bones when he falls, or impairing other parts of the body by acting as a cushion. As people grow older, they frequently lose such pads, either by design or by altered metabolism, making them more susceptible to mechanical injury of broken blood vessels, bones, or injuries to joints. Fat pads also serve as a cushion and a support for the viscera. Visceroptosis, common in young women on self-prescribed reducing diets, results from fat loss and may become very crippling. The pressure pads of the hands, especially over the metacarpal heads, are of utmost importance to comfort while working. A painful hand

results from the loss of these pads, making any work requiring pressure of a tool or other object almost impossible to perform, such as the opening of a jar with a screw-top cap. Similarly, the loss of the pads on the feet, especially those over the metatarsal heads and over the heels, can make walking painful. The loss of orbital fat and sucking pads detracts from the beauty of modern women. In older persons, diminished ischial pads make sitting very uncomfortable. Age plays an important part in whether a realignment of pressure pads can be obtained. Even in the younger person, the reestablishment of normal fat pads may be very difficult.

Muscular people who may appear to be thin, generally have good pressure pads.

Another function of subcutaneous fat is to aid an individual to resist excessive environmental temperature changes. In case of frost-bite or an accident from burning, a reasonably distributed subcutaneous adipose tissue may save a life or protect a vital structure.

Healthy skin, a mark of beauty in women and vitality in men, requires an adequate amount of unsaturated fatty acids in the diet. Adequate fat intake of the proper kind not only provides the elastic surface covering for the skin, but it provides it with bacteriacidal properties that prevent infection from the myriad of pathological organisms in the environment. It also prevents dirt and grime from penetrating the layers of the skin, as occurs to one continually immersing the hands in solvents or to one whose fat metabolism is awry.

Briefly, the difference between saturated and unsaturated fatty acids can be explained as follows: The double bond chain is one in which one or more carbon linkages are unstable (unsaturated, or essential fatty acids) and are represented chemically by HC : CH, in comparison with the stable (saturated) compound H H The unsaturated fatty acids are unstable and
·C·C·
H H
are capable of reacting at the double bond and entering into innumerable chemical reactions. Among the commonest of these

is the taking up of hydrogen and producing a saturated compound. The measurement of the degree of unsaturation is the so-called iodine number of the fat, which represents the amount of iodine that can be absorbed by the double bonds for a measured amount of fat. It is this same property that enables linseed oil to polymerize in the process of drying.

Fats differ in each specie within recognizable limits. Some of the lower forms of life produce fats that are composed of single fatty acids. Most natural fats are a mixture of triglycerides, some with saturated radicals and some with unsaturated radicals. The emulsifying property of fat is found in the triglyceride, lecithin.

Now let us consider some of the basic facts of fat metabolism as they apply to the animal produced for food. First, the animal does not possess the power to raise the unsaturated level of ingested fats more than a single double bond, and it cannot produce the so-called essential fatty acids. Second, animals tend to store within specie limitation the fat ingested. Third, fat stores are highly active. Fourth, the higher the metabolic drive of the animal, the less fat he stores. Fifth, all fat is stored with a certain amount of water. Sixth, The lower the unsaturated fatty acid content of the fat, the greater the water storage. Seventh, processes that will lessen the metabolic drive increase fat storage, such as lack of exercise, castration and drugs. Last, sex and age affect the fat storage of the animal.

Methods of processing the fats of meat and milk affect the utilization of these foods by the body. Rancidity of fat due to overheating or exposure to air make them toxic.

Emotional appeals have been directed against the consumption of fat. The vegetable contains phyto-steroids only recently shown to possess important nutritional qualities. The small amount of steroids contained in animal fats are represented by the hormones of the various endocrine glands and a small amount of cholesterol. The biochemist, however, has shown that

the so-called C_2 fragments which represent the utilization of depot fats in the animal polymerized in the process of metabolism to make cholesterol within the body and that the small amounts ingested in our foods are relatively unimportant.

To summarize, modern medical thought has made a particular taboo of animal fat in the diet. Let us recognize, however, that it is possible to alter ingested fats according to the neds of the body. A close liaison between the physiologist, the clinician, and the meat and the milk industry is needed to provide fat of adequate properties for human consumption.

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METABOLIC FACTORS OF DEVELOPMENT AS RELATED TO PHYSICAL FITNESS

Francis M. Pottenger, Jr. M.D.

Metabolism--The phenomena in synthesizing foodstuffs into complex tissue elements (assimilation) and in breaking down its complex substances into simple ones in the production of energy (disassimilation) is naturally related to physical fitness. Of the numerous effects of metabolism in the growing child, I shall limit this discussion to some metabolic factors controlling ligamentous tone and osseous maturity. I believe that these are of primary importance to athletic directors.

By the time a young man is ready to participate in a competitive sport, his physical development has largely been determined by his prenatal influences, by his health from infancy until the time you see him, and by whatever physical training he has received prior to coming out for a place on your team.

Beginning with his life in utero, the metabolism of his mother has had a bearing on the ligamentous structures and quality of his bones. Blessed is she if of superlative health from conception to delivery, for her offspring is not healthy by chance alone. If she is sub-metabolic, her diet inadequate, if she suffers from illness during gestation particularly at the time of the development of the joints, her infant will likely begin life with a disturbed metabolism indicated by poor ligaments and bones. Post-natal submetabolism and metabolic insults of early childhood, especially when the epiphyses are developing, can play a further important role in producing soft bone, loose joints and weak ligaments.

Certain cardinal signs of poor ligamentous structure that can be observed in infancy and tend to be carried through life are:

Hyperextensile joint of the elbow
Hyperextensile joint of the shoulder
Wrist bones that can be pulled apart
Waddling roll to the hip
Hyperextension and lateral play of the knee
Weak ankles
Dynamically and statically flat feet

A trained medical examiner can readily pick up these conditions on physical examination. Later in life, the X-ray will reveal these problems more clearly. At the time of the completion of the development of the bones and cartilages of the joints, mal-alignments become obvious.

It is important to understand the development of the epiphyses or growing ends of the bones, and how they indicate the adequacy of the individual's metabolic effort and physical fitness. To clarify this, let us consider two infants, one born to a mother who had relatively uneventful pregnancy, enjoying a high state of metabolic drive, the other to a mother fraught with severe metabolic problems before and throughout her pregnancy. Not only were the two children born with diametrically opposed metabolic patterns, but their lives and physical fitness have been poles apart.The one had an enviable record of physical excellence, the other, slow to mature, keeping a high soprano voice until much later than average, always shunning physical activity and sports.

Let us follow the effect of their divergent metabolism on the development of their feet, for it illustrates the points of discussion.

The healthy child was born with good osseous centers of compact bone, the other child had porous bone. The husky child continued to develop good bone, strong muscle and excellent coordination. At the age of 1½, he suffered a severe metabolic insult in the form of measles, which left its mark and took three years to heal. The other child passed through a series of continual metabolic upsets--poor assimilation of formula,

frequent colds, bouts of asthma, poor coordination causing many injuries due to falling. As these boys progressed in age, the husky boy rarely missed school, except for an occasional hooky, was interested in sports and games, rarely sustained an accident. His foot matured normally. The other boy continued to have minor accidents, was withdrawn socially, had to be forced to participate in school sports; he had flat feet with evidence of his continual metabolic insults in the scars on his bones.

The one boy was early recognized as athletically superior. He was excellent in several sports though one was best; he played it regularly, day after day. His foot continued to show the excellence of physical development, the ligaments remained tight with dense bones. He was not accident-prone. The other boy's physical exertion was thrust upon him by paid athletic tutors. His feet remained flat, he continued accident-prone. The stronger boy passed through school with unflagging interest in sports, was superior not only in his own school but in southern California. He remained non-accident prone, and his feet showed superior osseous development. His metabolic pattern showed a high level of activity. The other boy's voice had not changed until age 15. He continued to show the ligamentous failure of his feet, numerous sprained ankles. His main interest was in hot rods, and he demonstrated social maladjustments.

The healthy boy participated in his sport for four college years, still a champion, coordination superb, good student, development of feet excellent. The other never participated in college sports, remained accident prone, both with automobiles as well as with feet.

To briefly discuss the hand, generally used by anatomists to demonstrate physical development: the hand is composed of two types of bones, carpal bones in the wrist, the ends of the radius and the ulna of the forearm, and the phalanges. The latter are modified long bones similar to the radius and ulna but having epiphyses on their proximal ends only. The carpal bones mature by altering their shape and size. These bones are laid

down in a matrix of cartilage, leaving a lesser and lesser amount of cartilage as maturity proceeds while at the same time the ligaments are strengthened. Also at the same time, the phalanges grow at the epiphyseal line. The epiphyses change shape with maturity and finally fuse to the phalanges. The hand is thus mature in the young man at about 18-19 years, and two years earlier in the young woman.

The elbow is one of the most complex joints and is early composed of centers which eventually fuse to the shaft of the humerus, radius and ulna. The knee,too, is a complex mechanism, built similar to the elbow, but lacking that universality of motion.

Epiphyses are vulnerable; they can slip, but they can also heal until maturity. Injury during growth, metabolic or mechanical in origin, can leave a functionally deformed joint which may not injure the individual seriously in his youth but may lead to painful and crippling disability in later life. Each joint of the body has a period of maturity, and how it matures is an index of the adequacy of a child's metabolism.

It has been my experience with children largely drawn from middle class and professional parentage that those children who excelled physically have been slightly in advance in the maturity of the joints, especially those used in their chosen sport, and as a rule, have shown a slight total physical advance.

You who are experienced physical education directors have probably learned to judge the physical stability of your athletes. Perhaps your long experience has qualified you to make "trained guesses" that are almost as accurate as those of the physician who can demonstrate development by X-ray studies of bones and joints. I once heard a college football coach stun his subordinates and alumni backers by saying "I would rather have a freshman team of healthy boys who had never played high school football to draw from because they are less likely to have suffered joint injury and are now ready to play a man's game." He intuitively recognized the importance of mature, fused epiphyses.

Perhaps you have discovered that all-around athletes have had excellent physiques since childhood, and possibly you believe that "champions are born, not made." However, much basic truth there is in these tenets, you will also have found exceptions. You will have shown that training of good order for a determined and willing boy may strengthen his ligaments and develop him into a tough team-mate, and even a champion. But is it not also true that his spirit of perseverence to work and fight and train stubborn nerves and muscles to perform a desired feat is the mark of a "born champion"?