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FOOD IN WAR TIME

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DEDICATED
TO MY
FELLOW-COUNTRYMEN

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NOTE

The major parts of this small volume appeared under articles entitled "Food in War Time" in the *Scientific Monthly* and "Calories in Common Life" in Saunders' *Medical Clinics of North America*.

FOOD IN WAR TIME

I

A BALANCED DIET

There is no doubt that under the conditions existing before the war the American people lived in a higher degree of comfort than that enjoyed in Europe. Hard times in America have always been better times than the best times in Europe. As a student in Munich in 1890 I remember paying three dollars a month for my room, five cents daily for my breakfast, consisting of coffee and a roll without butter, and thirty-five cents for a four-course dinner at a fashionable restaurant. This does not sound extravagant, but it represents luxury when compared with the diet of the poorest Italian peasants of southern Italy. Two Italian scientists describe how this class of people live mainly on cornmeal, olive oil, and green stuffs and have done so for generations. There is no milk, cheese, or eggs in their dietary. Meat in the form of fat pork is taken three or four times a year. Cornmeal is taken as "polenta," or is mixed with beans and oil, or is made into corn bread. Cabbage or the leaves of beets are boiled in water and then eaten with oil flavored with garlic or Spanish pepper. One of the families investigated consisted of eight individuals, of whom two were children. The annual income was 424 francs, or $84. Of this, three cents per day per adult was spent for food and the remaining three-fifths of a cent was spent for other purposes. Little wonder that such people have migrated to America, but it may strike some as astonishing that a race so nourished should have become the man power in the construction of our railways, our subways, and our great buildings.

Dr. McCollum will tell you that the secret of it all lies in the green leaves. The quality of the protein in corn is poor, but the protein in the leaves supplements that of corn, so that a good result is obtained. Olive oil when taken alone is a poor fat in a nutritive sense, but when taken with green leaves, these furnish that one of the peculiar accessory substances, commonly known as vitamines, which is present most abundantly in butter-fat, and gives to butter-fat and to the fat in whole milk its dominant nutritive value. The green leaves likewise furnish another accessory substance, also present in milk, a substance which is soluble in water and which is necessary for normal life. Furthermore, the green leaves contain mineral matter in considerable quantity and in about the same proportions as they exist in milk.

Here then is the message of economy in diet, corn the cheapest of all the cereals, a vegetable oil cheaper by far than animal fat, which two materials taken together would bring disaster upon the human race, but if taken with the addition of cabbage or beet-tops they become capable of maintaining mankind from generation to generation. One can safely refer to such a diet as a balanced diet. Just as in the case of the modern experimental biological analysis of a balanced ration in which such a ration is given to rats and its efficiency as a diet is tested by its capacity to support normal growth and reproduction of the species, so here the experimental evidence is presented that corn and olive oil may become a sustaining diet when green leaves are a supplementary factor.

This preliminary sketch shows several important fundamentals of food and nutrition. If one gives an animal a mixture of purified food-stuffs, pure protein, pure starch, purified fat, and a mixture of salts like the salts of milk, the animal will surely die. But if one substitutes butter-fat for purified fat, and adds a water solution of the natural salts of milk, the animal lives and thrives.

Again, the illustration shows how corn may be so supplemented with other food-stuffs as to become extremely valuable in nutrition. It is especially valuable at the present time because corn is comparatively cheap and plentiful. But one asks how about pellagra? It must be here definitely stated that the use of cornmeal is not the cause of pellagra, provided the right kind of other foods be taken with it. Pellagra occurs in the "corn belt" of the United States, and especially among the poorer classes in the south. The disease has developed since the introduction in 1880 of highly perfected milling machinery which furnishes corn and wheat completely freed from their outer coverings. In Italy, where the milling of corn is still primitive, pellagra is not so severe as with us, because the corn offal is not completely removed and this contains the accessory food substances or vitamines which are essential to life. Pellagra is generally believed to be produced by a too exclusive use of highly milled corn and wheat flour in association with salt meats and canned goods, all of which are deficient in vitamines. The administration of fresh milk is naturally indicated. Goldberger states that after the addition of milk to the diet of a pellagrin, the typical clinical picture of pellagra no longer persists. The poor in the mill towns of the South lived too exclusively upon a corn diet without admixture of milk or fresh animal food or even of cabbage, and pellagra has been the consequence.

The Food Administrator asks us to eat corn bread and save the wheat for export. It is a very small sacrifice to eat corn bread at one meal or more a day. Indian corn saved our New England ancestors from starvation, and we can in part substitute it for our wheat and send the latter abroad to spare others from starvation. The simplest elements of patriotism demand that we do this. Therefore let us cry, "Eat corn bread and save the wheat for France, the home of Lafayette!"

The United States Department of Agriculture has estimated that only 6.6 per cent. of our corn crop is used for human food, and of this, 3.4 per cent. is consumed by the farmers and their families.

The substitution of foods is no new thing. We find that an English contemporary author thus described the food habits of the English people during the "golden days of Good Queen Bess," three hundred and fifty years ago:

> "The gentilitie commonly provide themselves sufficiently of wheat for their own tables, whylest their household and poore neighbours in some shires are forced to content themselves with rye or barleie; yea and in time of dearth many with bread made eyther of beanes, peason[1] or otes, or of altogether and some acornes among."

A difference between those days and ours is that the "gentilitie" and the "poore neighbours" are now asked to unite in reducing the consumption of wheat and to do this for the safety and welfare of all mankind.

Another point in war economy is the use of whole milk in greater quantity, and the diminution of the use of butter and cream. Cream is bought only by the wealthy, but in sufficient volume to largely reduce the amount of whole milk available. In Germany before the war 15 per cent. of the milk supply of that country was used for the production of cream. The consequent restriction of the milk supply was distinctly to the detriment of the health of the peasant farmers of Bavaria. Regarding the use of butter, a Swiss professor, himself an expert in nutrition, complains that whereas in his youth children were never given butter on their bread for breakfast, not even when there was no jam in the house, yet to-day absence of butter from the table is held to be indicative of direst poverty.

If one takes a pint of whole milk daily, or even, as we have seen, cabbage or beet-tops in its stead, one may take fat in the forms of olive oil or cottonseed oil, corn oil, cocoanut oil, peanut butter, or in other vegetable oils, without possible prejudice to health.

Osborne and Mendel, and more recently Halliburton, have pointed out that oleomargarine as prepared from beef-fat contains the fat-soluble growth-promoting accessory substance or vitamine which is present in butter-fat, but which is not contained in vegetable oils or in lard.

Halliburton and Drummond summarize the practical results of their work as follows:

> But when we approach the subject of the dietary of the poorer classes, the question is a more serious one. In ordinary times the consumption of beef dripping, which is considerable among the poor, would to a large extent supply the lacking properties of a vegetable-oil margarine. But at the present time beef itself is expensive, and the opportunities of obtaining dripping are therefore minimized. At the same time the three important foods for children already enumerated (milk, butter, eggs) have risen in cost, so as to be almost prohibitive to those with slender incomes. The vegetable-oil margarines still remain comparatively cheap, and the danger is that unless measures are taken to insure a proper milk supply for infants at a reasonable charge, these infants may run the risk of being fed, so far as fat is concerned, entirely upon an inferior brand of margarine, destitute of the growth-promoting accessory substance. It would be truer economy even for the poor to purchase smaller quantities of an oleo-oil margarine if they cannot afford the luxury of real butter.

The legal restrictions placed upon the sale of oleomargarine and the taxes enhancing its cost, now in operation in many of our states, are without warrant in morals or common sense and should be entirely abolished in times like these. A well-made brand of oleomargarine is much more palatable than butter of the second grade, and certainly for cooking purposes is just as valuable.

Whole milk contains everything necessary for growth and maintenance, protein, fat, milk-sugar, salts, water, and the unknown but invaluable accessory substances. It is of such prime importance that each family should have this admirable food that I have suggested that no family of five should ever buy meat until they have bought three quarts of milk. The insistence by scientific men upon the prime importance of milk has probably had something to do with its rapid enhancement in price. This latter factor is greatly to be regretted. I have often wondered why it was that a quart bottle of a fancy brand of milk in New York should cost about as much as a quart of *vin ordinaire* on the streets of Paris, and a quart bottle of cream as much as a quart of good champagne in Paris. Despite much denial it appears to me that milk is not sold as cheaply as it ought to be. Everything should be done to conserve our herds of cows for the increased supply of whole milk and incidentally for the manufacture of cheese and of milk powder or of condensed milk.

If one takes milk with other foods, meat may be dispensed with. Thus Hindhede advocates as ideal a diet consisting of bread, potatoes, fruit, and a pint of milk. Splendid health, both of body and mind, the peasants' comparative immunity to indigestion, kidney and liver disease, as well as an absolute immunity to gout, is the alluring prospect held out by the following dietary:

Graham bread	1 pound
Potatoes	2 pounds
Vegetable fat	½ pound
Apples	1½ pounds
Milk	1 pint

This bread-potato-fruit diet gives a very excellent basis of wholesome nutrition. The potatoes yield an alkaline ash which has a highly solvent power over uric acid, and, therefore, a good supply of these valuable tubers is needed by the nation.

To most Americans the dietary factors here described will appear to be merely attenuated hypotheses, fit only for philosophic contemplation. For, in real life, it is the roast beef of Old England, or some other famed equivalent, that makes its appeal. Far be it from me to disparage the feast following a hunt of the wild boar or other feasts famed in song and story, but that is not the question. The question is, is meat necessary? The description of the Italian dietary answers this in the negative.

But is meat desirable? The Italian experimenters believed that the addition of four or eight ounces of meat to the dietaries of some of their subjects increased their physical and also their mental powers. The increase in mental power due to change in diet has always seemed to me to be a figment of the imagination and not susceptible of demonstration. Thomas lived for twenty-four days on a diet of starch and cream, during four days of which time the very small quantity of three ounces of meat was taken daily, and he found his mental and muscular power unchanged.

A remarkable experiment on the effect of a potato diet has been reported by Hindhede. An individual partook of a diet of between four and one-half and nine pounds of potatoes daily, with some vegetable margarine, during a period of nearly three hundred days. The rule was to eat only when hungry and then the potatoes could be taken at the rate of an ounce a minute. During the last three months (ninety-five days) of the experiment severe mechanical work was performed and the total food intake for the latter period amounted to 770 pounds of potatoes and 48 pounds of margarine. What could be more simple than stocking the cellar with coal, potatoes, and a tub of margarine! Who then would worry about the complexities of modern life?

Of course, vegetarianism is no new thing. Its principal exponent was Sylvester Graham. It so happens that he was the brother of my great grandmother, and of him my father wrote in 1861, "long lanky Sylvester Vegetable Graham, leanest of men." Graham in 1829 began the advocacy of moderation in the use of a diet consisting of vegetables, Graham bread, fruits, nuts, salts and pure water, and excluding meat, sauces, salads, tea, coffee, alcohol, pepper, and mustard. The first effect of this diet, which largely eliminated the flavors, was to reduce the weight through lowering the intake of food, but the health of many followers of the diet appears to have been benefited. The "Graham System" of dieting suffered from withering criticism at the time. He published in 1837 a little book entitled, "Bread and Bread Making," bearing on its cover the scriptural quotation "Bread strengtheneth man's heart." He says in this volume:

> But while the people of our country are entirely given up as they are at present, to gross and promiscuous feeding on the dead carcasses of animals and to the untiring pursuit of wealth, it is perhaps wholly vain for a single individual to raise his voice on a subject of this kind.

The well-known work of Chittenden has shown that when the protein intake is reduced by one half or less of that which the average American appetite suggests, professional men, soldiers and athletes may be maintained in the best physical condition. One of Yale's champion intercollegiate athletes won all the events of the year in which he was entered while living on a reduced protein or Chittenden diet. Upon such a diet, or less than that, the people of Germany are now living to-day. The principle involves eating meat very sparingly, taking half a piece where one would have formerly been taken, and using it only for its flavor. The wing of a chicken has little meat on it and yet if eaten together with vegetables it gives the meal a different quality than it would have had without it, and to this extent its use is warranted. The muscles are active when hard labor is done, but the muscles do not need meat for the performance of their work. A fasting man may have considerable power. The popular idea of the necessity of meat for a laboring man may be epitomized in the statement: a strong man can eat more meat than a weak one, hence meat makes a man strong. The proposition is evidently absurd.

Not only is the taking of meat without beneficial relation to the capacity for muscular work, but, in fact, an exclusive meat diet results in the sensation that work is being accomplished with difficulty. When meat is metabolized it stimulates the body to a higher heat production, as great an increase as 55 per cent. having been observed in a resting man. No other food-stuff will accomplish so great an increase. It is especially worthy of note that this increase in the heat production, due to the *specific dynamic action* of protein, as it is called, cannot be utilized in the execution of mechanical work. When the organism of a laborer at work in a hot environment is called upon to eliminate extra heat, due to the work he is performing, he must also eliminate the quota of heat which is derived from any large ingestion of meat. Hence, the American farmer in the hot weather can eat little meat.

So far as is known, taking meat even in large excess is not harmful, but it represents luxury and waste. According to an oral statement by A. E. Taylor, the results of many thousand urinary analyses in Germany during the second year of the war showed about 7 grams of nitrogen excreted, which would correspond to a dietary containing about 45 grams of protein. As a matter of fact, this is the equivalent of the reduced protein dietary of Chittenden, and it is reported that no ill effects can be attributed to it. The flavor of meat is such that it lends itself to the easy preparation of a palatable meal, but this flavor could undoubtedly be as well obtained if the present consumption of meat were cut in two. It is a question of habit, but with the present reduced supply of meat one must adopt new habits. It would be highly desirable if the grain now fed to fatten beef were given to maintain herds of milch cows.

Indulgence in meat is due to the desire for strong flavor. With the increased distribution of wealth, the demand for meat grows. Its consumption by all classes had vastly increased in all prosperous countries prior to the war. It is well, however, to remember that its use has been excessive and unnecessary, and its price can be cut by wholesale voluntary abstinence. The British people have suffered no hardship in the recent reduction of their meat ration.

A British Commission has reported to Parliament that it takes three times as much fodder to produce beef as it does to produce milk or pork of the same food value. Since cows eat chiefly hay and grass and pigs eat grain the cost of the production of a unit value of milk is much less than the cost of the same value in the form of pork. It takes only fifty per cent. more fodder to produce veal than to produce pork. Milk, pork, and veal have long been the established protein-containing foods of nations on the continent of Europe. According to these figures beef should cost in the market twice what veal costs, and yet the butcher charges nearly the same for the two. It would save food for milk production if steers were eaten as veal and not fed up into beef cattle. A suitable tax on all steers over a year old would accomplish this result. If all heifers were developed into milch cows and no cow capable of giving milk in quantity were slaughtered, the country would be placed on a much better basis than at present. It might make beef expensive, but there is every reason why it should be expensive. It would increase the dairy business, which is evidently a need of the times, something for the protection of the welfare of mankind. For it must be remembered that a well-nourished cow during a single year will give in the form of milk as much protein and two and a half times the number of calories as are contained in her own body.

This was written before the publication of the following words of Armsby, the foremost authority on animal nutrition:[2]

> Roast pig, to those who like it, is not only a delicacy but a valuable article of diet, but nevertheless, it is possible to pay too high a price for it, and while a proposal to restrict rather than to promote meat production in the present crisis may appear both irrational and unpatriotic it may nevertheless be in the interest of true food economy....
>
> It may be roughly estimated that about 24 per cent. of the energy of grain is recovered for human consumption in pork, about 18 per cent. in milk and only about 3.5 per cent. in beef and mutton. In other words, the farmer who feeds bread grains to his stock is burning up 75 to 97 per cent. of them in order to produce for us a small residue of roast pig, and so is diminishing the total stock of human food....
>
> The task of the stock feeder must be to utilize through his skill and knowledge the inedible products of the farm and factory, such as hay, corn stalks, straw, bran, brewers' and distillers' grains, gluten feed, and the like, and to make at least a fraction of them available for man's use. In so doing he will be really adding to the food supply and will be rendering a great public service. Rather than seek to stimulate live stock husbandry the ideal should be to adjust it to the limits set by the available supply of forage crops and by-product feeding stuffs while, on the other hand, utilizing these to the greatest practicable extent, because in this way we save some of what would otherwise be a total loss....
>
> The hog is the great competitor of man for the higher grades of food, and in swine husbandry as ordinarily conducted we are in danger of paying too much for our roast pig. Cattle and sheep, on the other hand, although less efficient as converters, can utilize products which man can not use and save some of their potential value as human food. From this point of view, as well as on account of the importance of milk to infants and invalids, the high economy of food production by the dairy cow deserves careful consideration, although of course the large labor requirement is a counterbalancing factor.
>
> At any rate, it is clear that at the present time enthusiastic but ill-considered "booming" of live stock production may do more harm than good. If it is desirable to restrict or prohibit the production of alcohol from grain or potatoes on the ground that it involves a waste of food value, the same reason calls for restriction of the burning-up of these materials to produce roast pig. This means, of course, a limited meat supply. To some of us this may seem a hardship. Meat, however, is by no means the essential that we have been wont to suppose and partial deprivation of it is not inconsistent with high bodily efficiency. Certainly no patriotic citizen would wish to insist on his customary allowance of roast pig at the cost of the food supply of his brothers in the trenches.

The United States Department of Agriculture has estimated that a pig that has reached the weight of 150 pounds should be slaughtered, because beyond that weight the cost of the quantity of feed required to maintain the animal is out of proportion to the gain in food value of the pig. One might, therefore, call a pig weighing 150 pounds a *maximal economic hog*.

Footnotes:

[1] An obsolete plural of pease.

[2] "Roast Pig," *Science*, 1917, xlvi, 160.

II

CALORIES IN COMMON LIFE

A person is properly nourished who receives adequate energy in the form of carbohydrate and fat (and incidentally protein); adequate material for repair of wornout parts, such as protein and mineral salts; and the diet must contain certain accessory food substances known as food hormones or "vitamins." Also, it must contain water. But this is not all, for the food offered must be acceptable to the palate of the individual. A member of the French Scientific Commission which visited the United States in the summer of 1917, when questioned regarding the use of corn bread in France, replied "on ne peut pas changer des habitudes." The proper nutrition of an individual depends, therefore, not only upon a sufficient supply of food from a mechanistic standpoint, but also upon the reasonable satisfaction of the sense of appetite. These dual fundamentals of proper nutrition should be ever borne in mind.

Heat from the sun enters into the composition of the food substances when they are being built up in the plants, and this energy, which is latent in the food, is set free in the animal body and is used as the source of power behind all the physical activities of the body. The energy can all be recovered as heat and measured in the form of calories. According to the principles of the law of the conservation of energy, heat is not destructible. The understanding of the value of a calorie is indispensable for the comprehension of nutrition. A calorie is the measure of a unit of heat, or the quantity of heat necessary to raise a liter of water from 0° to 1° Centigrade. Apparatus has been invented for measuring the heat production of a man, an apparatus which is called a calorimeter or a measurer of calories. If one puts a man weighing, say, 156 pounds in the box of such an apparatus, so that he lies comfortably on a bed in complete muscular relaxation, and before his breakfast, one finds that he produces 70 calories an hour. Only in certain types of disease is there any variation from this normal, though of course the weight of the man makes a difference in his requirement for energy. If, at the same time the subject is in the box, the quantity of oxygen which he absorbs is measured and if certain other chemical analyses be carried out, one can calculate the exact amounts of protein, fat, and sugar which have been oxidized by this oxygen.

Now, if one calculates how much heat ought to have been set free from the oxidation of these quantities of protein fat and carbohydrate, it is discovered that the heat which ought to have been produced is exactly that quantity which was measured as having been produced by the man. This measurement represents the *basal metabolism* of a man at complete rest, when his oxidative activities are at their lowest ebb.

The basal metabolism as measured by 70 calories per hour in the case of this individual represents the sum of the fuel needed—(1) to maintain the beating of the heart, which every minute of a man's life moves the blood or one-twentieth part of the weight of the body, in a circle through the blood-vessels; (2) to maintain the muscles of respiration that the blood may be purified in the lungs; (3) to maintain the body temperature at that constant level which is so characteristic that a slight variation signifies illness, and (4) to maintain in the living state the numerous tissues of the body. Any extraneous muscular movements are carried out in virtue of an increased oxidation of materials and the heat production rises above the level of the basal metabolism with increased muscular effort. For a long time the power for the maintenance of the human machine can be furnished by its own body fat, as is seen in cases of prolonged fasting, but usually the power is derived instead from the food-fuel which is taken. The great question in the world to-day is whether or not a sufficient quantity of food-fuel is available to support the human family. The question of calories is not an academic one, but an intensely practical one.

Science strives to express itself in mathematic terms, and this paper is written with that end in view.

Phenomena of life are phenomena of motion. These motions are maintained at the expense of chemical energy liberated in the oxidative breakdown of carbohydrate, fat, and protein. Furthermore, the protein structure of the body cells and the salts of the bones and other tissues are in a constant state of wearing down. The energy for the human machine and the materials for its self-repair are taken in the form of food. The general term *metabolism* includes all the chemical activities which take place under the influence of living cells.

The total quantity of heat produced by the body is a measure of the intensity of the oxidation of carbohydrate, fat, and protein within the body.

It is important to know definitely whether there is any constant measure of the level of the basal metabolism in normal people, so that one may determine in cases of disease whether the heat production is normal or increased or decreased.

Rubner discovered that the heat production of mammalia during rest was the same per square meter of surface whether the being was a horse, a man, a dog, or a mouse. The proposition has appeared so improbable as to call forth much antagonism. DuBois deserves the credit of having established this relationship for man beyond the possibility of a doubt. He was able to do this on account of his discovery of a new and accurate method of measuring the area of the body surface. It appears from his work that the *basal metabolism* for men between twenty and fifty years old is approximately 40 calories per hour per square meter of body surface, within a ± error of 10 per cent.

Boothby has found that the metabolism of patients who have recovered their health after hospital operations and who have been confined in the hospital between twenty and fifty days does not vary from the normal standard of DuBois.

It has been found by DuBois that the basal metabolism in boys of twelve is 25 per cent. higher than for an adult of the same height and weight, or **50** calories per square meter of body surface; and that in boys of fifteen the metabolism is 11 per cent. higher than for the adult of the same size and shape, or **44** calories per square meter of body surface (unpublished work of DuBois). These results explain the large appetites of boys.

Women show a metabolism which is 7 per cent. lower than that of men, or **37** calories per hour per square meter of surface.

From the charts of the average heights and weights of men varying between fifteen and fifty-five years old, given by American life insurance companies, Mr. H. V. Atkinson, of my laboratory, has calculated the basal metabolism in a table here presented. Unfortunately, the weights given in these statistics include clothes worn by the individuals. The calculated heat production, however, is in each case based upon the weight without clothes. The table is computed from the following values:

Age in years	Calories per square meter of surface
15	44
20-50	40
55	37

The table may also be used as follows:

To find the metabolism of—

Women between twenty to fifty years, multiply values for man by 0.93.

Boys of twelve to thirteen years, multiply values for boys of fifteen years by 1.10.

THE BASAL METABOLISM OF MEN

Calculated from values of the basal metabolism determined by the methods of DuBois and applied to a table showing the average weights of 221,819 men of different ages and heights compiled from the statistics of the medico-actuarial investigation of 1912.

Age. Heat per square meter of surface	5 ft. 0 in.	5 ft. 2 in.	5 ft. 4 in.	5 ft. 6 in.	5 ft. 8 in.	5 ft. 10 in.	6 ft. 0 in.	6 ft. 2 in.	6 ft. 4 in.
	Lbs. Cals.	Lbs. Cals.	Lbs. Cals.	Lbs. Cals.	Lbs. Cals.	Lbs. Cals.	Lbs. Cals.	Lbs. Cals.	Lbs. Cals.
15 years	107	112	118	126	134	142	152	162	172
44 calories	**1510**	**1584**	**1658**	**1753**	**1837**	**1922**	**2006**	**2096**	**2186**
20 years	117	122	128	136	144	152	161	171	181
40 calories	**1430**	**1498**	**1565**	**1647**	**1719**	**1796**	**1868**	**1949**	**2035**
25 years	122	126	133	141	149	157	167	179	189
40 calories	**1459**	**1517**	**1594**	**1671**	**1738**	**1820**	**1896**	**1992**	**2083**
30 years	126	130	136	144	152	161	172	184	196
40 calories	**1478**	**1536**	**1604**	**1685**	**1757**	**1839**	**1920**	**2007**	**2112**
35 years	128	132	138	146	155	165	176	189	201
40 calories	**1488**	**1556**	**1613**	**1695**	**1767**	**1853**	**1939**	**2035**	**2136**
40 years	131	135	141	149	158	168	180	193	206
40 calories	**1498**	**1565**	**1623**	**1709**	**1781**	**1863**	**1959**	**2055**	**2160**
45 years	133	137	143	151	160	170	182	195	209
40 calories	**1507**	**1570**	**1632**	**1719**	**1791**	**1872**	**1968**	**2064**	**2169**
50 years	134	138	144	152	161	171	183	197	211
40 calories	**1517**	**1575**	**1642**	**1724**	**1796**	**1881**	**1973**	**2074**	**2184**
55 years	135	139	145	153	163	173	184	198	212
37 calories	**1449**	**1485**	**1548**	**1620**	**1692**	**1773**	**1854**	**1949**	**2052**

The basal metabolism of an average boy of thirteen years of age weighing 80 pounds and of a height of 4 feet, 10 inches, may be calculated as 1525 calories per day. This is the same as that of a man twenty-five years old, weighing 126 pounds and 5 feet, 2 inches tall.

A boy thirteen years old and weighing 156 pounds, his height being 6 feet, 1 inch (there are such cases), would have a basal metabolism of 2300 calories, or larger than that of any grown man given in the table—larger than a man weighing 211 pounds and 6 feet, 4 inches in height. I personally know a boy of this age and size. His parents are said to have sent him to boarding school in order to reduce their food bills.

It is evident from this discussion that the food requirement of boys over twelve years old is about the same as that of men. The emaciation of the children of the poor probably reduces their requirement of food. It is not generally recognized that the boy needs as much food as his father. The requirements of girls have not been investigated, but they probably need as much as their mothers.

These data will give with close scientific precision the *minimal requirement for energy* which is necessary for the maintenance of the bed-ridden.

Ordinary life, however, is not constituted after this fashion. "By the sweat of thy brow shalt thou eat bread."

From the work of F. G. Benedict one may calculate the increase in the basal metabolism, as follows:

Occupation	Increase in the basal metabolism in per cent.
Sitting	5
Standing, relaxed	10
Standing, hand on a staff	11
Standing, leaning on support	3
Standing, "attention"	14

If one wishes to determine from the basal metabolism table the heat production of a person who is confined to his room, one should add to the metabolism of the twenty-four hours the increase above the basal for those hours of the day during which he is sitting in a chair or standing.

Passing to a consideration of the subject of mechanical work done by a man, one finds that it requires about 1.1 calories to transport a pound of body weight three miles during an hour, and that increasing power must be generated if the speed is increased above this rate of *maximal economic velocity*.

These relations are shown below:

Rate of movement	Extra calories per hour required to move 1 pound of body
Walking 3 miles per hour	1.1
Walking 5.3 miles per hour	3.6
Running 5.3 miles per hour	3.1

If one wishes to determine the heat production of a man weighing 156 pounds and 5 feet, 7 inches in height, and who is walking or running, the following calculations can be made:

Rate of travel per hour in miles	3[3] Cals.	5.3[3] Cals.	5.3[4] Cals.
Metabolism for transporting 156 pounds	172	562	484
Basal metabolism	70	70	70
Add for standing	7	7	7
	249	639	561

If the man's food cost 10 cents a thousand calories, it may be calculated that he would have to walk over eight miles at a rate of three miles per hour in order to save money when he pays a 5-cent carfare. (This, however, does not include the cost of shoe leather.)

The carrying of a load of 44 pounds is done at the same expenditure of energy as the carrying of one's own body weight when the rate is three miles an hour, so the soldier's equipment would call for the added expenditure of 48 calories (44 × 1.1), making his total hourly expenditure of energy nearly 300 calories (249 + 44) during a hike on a level road. His daily requirement for energy might be:

	Calories
Sleeping 8 hours at 70 calories per hour	560
Resting in camp 6 hours at 77 calories per hour	462
Hike of 30 miles, 10 hours at 300 calories per hour	3000
	4022

This would be the heat production of a soldier on a day of a "forced march." The ordinary day's march is only fifteen miles.

This assumes a level road. If, however, there are hills to climb and the body weight and the pack are lifted 1000 feet during the hike, this is done at the additional expense of approximately 0.96 calory of energy per pound of weight lifted. If the man weighed 156 pounds and the pack 44 pounds, the additional fuel requirement would be 192 calories (200 × 0.96). The total energy requirement for this kind of a hike would have been 4200 calories. Walking down hill is accomplished at an expenditure of slightly less energy than walking on the level, but this factor need not concern one.

Supposing, however, this individual were running, lightly clad, on a level road in a race for a distance of 40 miles at the rate of 5.3 miles per hour, he would complete the distance in seven hours and thirty-three minutes, which is a reasonable record. His metabolism might thus be calculated:

	Calories
Sleeping 10 hours at 70 calories per hour	700
Resting 6 hours, 23 minutes, at 77 calories per hour	497
Running 7 hours, 33 minutes, at 561 calories per hour	4236
	5433

It is a matter of record that a man has run between Milwaukee and Chicago, a distance of 80 miles, in about fifteen hours. Such an amount of work would have required over 9000 calories for the day.

These calculations are all based upon experimental results obtained in various laboratories in different parts of the world and can be accepted as being free from any gross error.

It is evident that the energy requirement is proportional to the amount of mechanical energy expended.

One may turn now to the fuel needs in terms of calories in certain industrial pursuits. According to Becker and Hämäläinen, the quantity of extra metabolism per hour required in various pursuits is as follows:

	Extra calories of metabolism per hour due to occupation
Occupations of women:	
Seamstress	6

Typist[5]	24
Seamstress using sewing machine	24-57
Bookbinder	38-63
Housemaid	81-157
Washerwoman	124-214
Occupations of men:	
Tailor	44
Bookbinder	81
Shoemaker	90
Carpenter	116-164
Metal worker	141
Painter (of furniture)	145
Stonemason	300
Man sawing wood	378

To use this table one may seek the basal metabolism of the individual, add 10 per cent. for sixteen hours of wakefulness when the person is sitting or standing, and then multiply the factors in the last table by the numbers of hours of work. For example, if one takes the individual weighing 156 pounds, one obtains the following requirements of energy if his business were that of a tailor and he worked eight hours a day:

	Calories
Sleeping 8 hours at 70 calories per hour	560
Awake 16 hours at 77 calories per hour	1232
Add for work as tailor 8 hours at 44 calories	352
	2144

After this fashion one might calculate his food requirements had he followed occupations other than that of tailor:

Occupation	Calories of metabolism per day
Bookbinder	2440
Shoemaker	2510
Carpenter	3100
Metal worker	2900
Painter	2950
Stonemason	4200
Man sawing wood	4800

These figures make no allowance for walking to or from the place of employment.

The data here given are inadequate to cover the industrial situation, but they show clearly that heavy work cannot be accomplished without a sufficient amount of food-fuel.

The food-fuel with which to accomplish work is necessary not only for the soldier, but for the workman behind the line, and it should be adequate in quantity, satisfactory in quality, and not exorbitant in cost.

In virtue of the world-wide scarcity of food, the work of the individual should be worthy of the food which he eats.

Tables showing the cost of various wholesome food-stuffs about July 1, 1917, are here reproduced for the benefit of the reader. The tables were prepared by Dr. F. C. Gephart and issued by the Department of Health of the City of New York in a leaflet edited by Doctors Holt, La Fetra, Pisek, and Lusk on the subject of food for children. If the world is seeking after energy in the form of food-fuel, the world is rightly entitled to understand the value of its purchases. It must be clearly understood that people are always destined to look with hopeful anticipation toward the enjoyment of a meal. They will instinctively "eat calories" just as they instinctively "eat pounds." They *buy pounds* of food, and they could buy more intelligently if they knew the energy value of what they buy.

	Cost of 1000 calories, cents	Price per pound, cents
TABLE 1—*Cost of Fats.*		
Cottonseed oil	7.3	31
Oleomargarine	8.5	30
Peanut butter	8.8	25
Butter	11.9	43
Olive oil	12.1	51
Bacon	13.8	37
Bacon, sliced, in jars	23.8	65
Cream (extra heavy, 40 per cent.)	37.7	65 (1 pint)
TABLE 2—*Cost of Cereals.*		
Cornmeal, in bulk	3.6	6
Hominy, in bulk	3.6	6
Broken rice, in bulk	3.7	6
Oatmeal, in bulk	3.8	7

Samp, in bulk	4.2	7
Quaker Oats, in package	4.4	8
Macaroni, in package	4.5	8
Wheat flour, in bulk	4.6	8
Malt breakfast food, in package	4.8	8
Pettijohn, in package	5.3	9
Cream of Wheat, in package	5.7	10
Farina, in package	5.9	10
Cracked wheat, in bulk	5.9	10
Pearl barley, in package	6.0	10
Barley flour, in bulk	6.1	10
Whole rice, in bulk	6.1	10
Wheatena, in package	8.1	14

TABLE 3—*Cost of Ready-to-serve Cereals.*

Shredded Wheat Biscuit	7.8	13
Grape-nuts	8.6	15
Force	9.4	16
Corn Flakes	11.7	20
Puffed rice	23.5	38

TABLE 4—*Cost of Vegetables.*

White potatoes	12.9	4.0
Turnips	20.0	2.5
New beets	27.6	5.0
Onions	29.3	6.0
Spinach	30.0	3.3
Green peas	39.2	10.0
Lima beans	39.2	10.0
Cauliflower	42.9	6.0
Carrots	50.0	8.0
String-beans	55.6	10.0
Squash	76.2	8.0
Lettuce	89.4	7.0
Celery	214.0	15.0

TABLE 5—*Cost of Breadstuffs.*

Ginger-snaps	6.3	12.0
Graham bread	8.2	10.3
White bread	8.5	10.3
Rye bread	8.7	10.3
Graham crackers	9.2	18.0
Soda crackers	9.4	18.0
French rolls	10.8	14.0
Uneeda Biscuit	12.4	24.0

TABLE 6—*Cost of Proteins.*		
Milk (Grade A)	20.0	13.0 (1 quart)
Roast beef (rib)	23.4	26.0
Buttermilk	26.5	9.0 (1 quart)
Lamb chops (loin)	32.7	43.0
Lamb chops (rib)	34.9	38.0
Young codfish (fresh)	38.6	12.0
Chicken (roasting)	41.3	32.0
Eggs	44.7	45.0 (1 dozen)
Beefsteak (round)	50.4	34.0
TABLE 7—*Cost of Fruit.*		
Fresh (in season):		
Bananas	23.0	6
Apples	23.7	5
Oranges	65.0	10
Dried:		
Prunes	8.4	10
Apples	11.1	15
Peaches	12.5	15
Apricots	15.5	20
TABLE 8—*Cost of Syrup.*		
Cane sugar	4.5	8
Karo corn syrup	5.7	8

A British scientific commission has reported to Parliament that if the workman be undernourished he may, by grit and pluck, continue his labor for a certain time, but in the end his work is sure to fail. It makes no difference what the nutritive condition of the person is, if a certain job involving muscular effort is to be done it always requires a definite amount of extra food-fuel to do it. Rubner, the greatest German authority on nutrition, excited grossly inappropriate hilarity in the comic press of his country by showing that a poor woman who waited several hours in line in order to receive the dole of fat allowed her by the government actually consumed more of her own body fat in the effort of standing during those hours than she obtained in the fat given her when her turn to receive it came at last.

A method by which food-fuel can readily be saved with benefit to the nation and to the individual is for the overfat to reduce their weight. This has been done with drastic severity in Germany. I have heard from unquestioned sources how a man who had weighed 240 pounds lost 90 pounds since the war began; how a corpulent professor at Breslau lost greatly in weight, but during the second summer of the war regained his former corpulence during a sojourn in the Bavarian Tyrol, a joy not now tolerated; and how an American woman lost 40 pounds in weight last winter in Dresden. There is every reason why a man who is overweight at the age of fifty should reduce his weight until he reaches the weight he was when he was thirty-five. According to Dr. Fisk he is a better insurance risk if after thirty-five he is under the weight which is the average for those of his years. Reduction in weight reduces the basal requirement for food, and reduces the amount of fuel needed for moving the body in walking. The most extreme illustration of the effect of emaciation upon the food requirement is afforded by a woman who after losing nearly half of her body weight was found to need only 40 per cent. of the food-fuel formerly required. This represented a state not far from the border line of death from starvation, but it indicates how a community may long support itself on restricted rations. It must be strictly borne in mind, however, that if any external muscular work is to be accomplished it can only be effected at the expense of a given added quantity of food-fuel, whether the person be fat or thin.

It is not at all difficult to reduce the body weight. Suppose a clergyman or a physician requires 2500 calories daily in the accomplishment of his work and takes 2580 calories per day instead. The additional 80 calories is the equivalent of a butter ball weighing a third of an ounce, or an ounce of bread or half a glass of milk. It would seem to be the height of absurdity to object to such a trifle. But if this excess in food intake be continued for a year, the person will gain nine pounds and at the end of ten years ninety pounds. Such a person would find that he required a constantly increasing amount of food in order to transport his constantly increasing weight. In instances of this sort a motto may be applied which I heard the last time I was in Washington: "Do not stuff your husband, husband your stuff."

Now it is evident that, if instead of taking more than the required amount of food a little less be taken than is needed, the balance of food-fuel must be obtained from the reserves of the body's own supply of fat. By cutting down the quantity of fat taken, or by eliminating a glass of beer or a drink of whiskey, and not compensating for the loss of these by adding other food stuffs, the weight may be gradually reduced. The amusing little book entitled "Eat and Grow Thin" recommends a high protein and almost carbohydrate-free diet for the accomplishment of this purpose, but its advice has made so many of my friends so utterly miserable that I am sure in the end it will counteract its own message.

The work of the world is accomplished in largest part by the oxidation of carbohydrates, that is to say, of sugars and starches. Bread, corn, rice, macaroni, cane-sugar, these are *par excellence* the food-fuels of the human machine. In the dinner-pail of the laborer they testify as to the source of his power. They are convertible into glucose in the body, which glucose gives power to the human machine. They may be used for the production of work without of themselves increasing the heat production of the worker, as happens after meat ingestion. (See p. 18.) Fat also may be used as a source of energy, but unless carbohydrate is present a person can not work up to his fullest capacity.

Cane-sugar is a valuable condiment, and when taken in small quantities every half hour, may delay the onset of fatigue. It is more largely used in the United States than in other countries in the world. As a substitute, glucose may be used. This is found in grapes and in raisins and it is also produced in large quantities by the hydrolysis of starch and sold under the commercial name of corn syrup or Karo. This substance is entirely wholesome and may be freely employed in the place of sugar, which is scarce.

As to the use of alcoholic beverages, the question resolves itself into several factors. Alcohol gives a sham sensation of added force and in reality decreases the ability to do work. Alcohol is the greatest cause of misery in the world, and as Cushny has put it, if alcohol had been a new synthetic drug introduced from Germany, its importation would long since have been forbidden. On the other hand, good beer makes poor food taste well. It also frequently leads to overeating. The cure for bad food is to have our daughters taught how to cook a decent meal. After that we can talk about prohibition.

In some parts of the world whole nations are starving to death. In most countries of the world people are short of food. In America we have more food than in any other land, and we must, therefore, be careful in our abundance, saving it to the utmost, while, at the same time, conserving the safety of our own people.

Footnotes:

[3] Walking.

[4] Running.

[5] Observation of Carpenter.

III

RULES OF SAVING AND SAFETY

1. Let no family (of five persons) buy meat until it has bought three quarts of milk, the cheapest protein food. Farmers should be urged to meet this demand.

2. Save the cream and butter and eat oleomargarine and vegetable oils. Olive oil or cottonseed oil, taken with cabbage, lettuce, or beet-tops, is excellent food, in many ways imitating milk.

3. Eat meat sparingly, rich and poor, laborer and indolent alike. Meat does not increase the muscular power. When a person is exposed to great cold, meat may be recommended, for it warms the body more than any other food. In hot weather, for the same reason, it causes increased sweating and discomfort. In general, twice as much meat is used as is now right, for to produce meat requires much fodder which might better be used for milk production.

4. Eat corn bread. It saved our New England ancestors from starvation. If we eat it we can send wheat to France. Eat oatmeal.

5. Drink no alcohol. In many families 10 per cent. of the income is spent for drink, or a sum which, if spent for real food, would greatly improve the welfare of the family.

6. Eat corn syrup on cereals. It will save the sugar. Eat raisins in rice pudding, for raisins contain sugar.

7. Eat fresh fish.

8. Eat fruit and vegetables.

Since the total energy for the maintenance of our bodies can be measured in calories, and since this energy serves for the maintenance of the nations of the world, is it not surprising how little even educated people know about the subject?

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Transcriber's Note:

The following corrections were made to the text: Du Bois to DuBois (p. 45, Index entry) and Oleomargarin to Oleomargarine (p. 46, Index entry).

The variant spelling "calory" (p. 32) has been retained.

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