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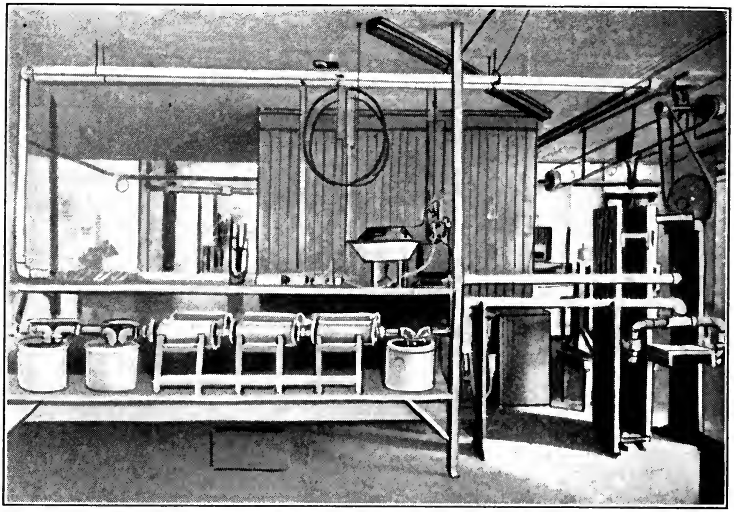

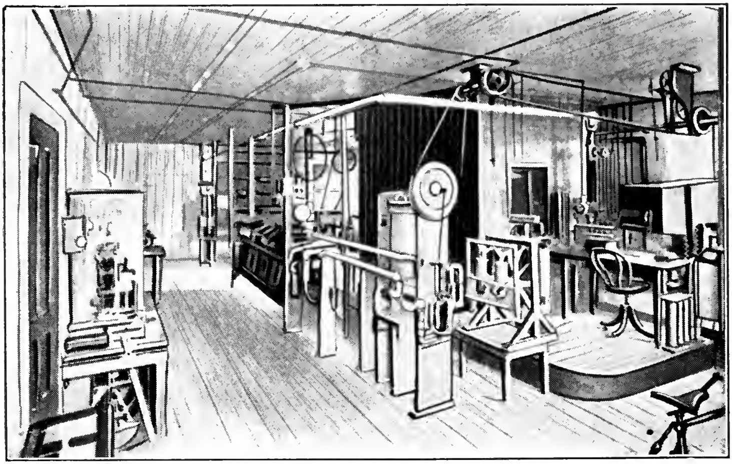

Frontispiece

Views of the Calorimeter Laboratory, Wesleyan University, where Professor Atwater made His Famous Experiments in Nutrition. See Plan facing Page 49. From Yearbook, 1904, U. S. Dept. of Agriculture

NUTRITION AND DIET

A TEXTBOOK

FOR

SECONDARY SCHOOLS

BY

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CONLEY, NUTRITION AND DIET.
W. P. I

PREFACE

Domestic Science as taught in the schools of this country has three distinct phases: practical work in foods, commonly called cooking, and taught in the school kitchen; experimental work in foods, taught in the chemical laboratory; and the acquisition of knowledge concerning foods, nutrition, and diet, and its correlation with the knowledge gained in the kitchen and laboratory.

The first phase of the work is usually formulated in some type of cook book, the second in a laboratory manual, and the third phase, because of the lack of suitable textbooks for secondary schools, has been presented by the lecture method.

While several good college texts are published, there has been no book suited to the needs of high school pupils, and the result has been that the teacher has been obliged to dictate her college notes, adapted in some form, to her pupils. These notes, in subject matter and language, have been hard for the immature mind to grasp, and so much time had to be given to dictation that no time was left for recitation or for practical work in carrying out the plans formulated by the teacher.

The lecture method has no place in the secondary school. Time spent in copying notes in class, and then recopying in ink into a notebook is worse than wasted, and it leaves no time for supplementary reading matter to which the teacher could refer the pupil.

Such has been the experience of the author of this book, and as a result of this experience, the subject matter prepared, formerly dictated to classes, copied into notebooks, and learned for recitation by the pupils, has been put into form and appears in this volume.

The subject matter is intended for classes that have had at least one half-year's work in practical cooking and some knowledge of foods. If cooking is taught as a high school subject, this book may be used to complement the work in cooking. In many schools a certain number of periods a week are allowed for study and recitation, and a certain number for practical work, in kitchen or laboratory.

This little volume, "Nutrition and Diet," is designed to supplement the practical and experimental work and unify the whole so that the student will know proper foods and the relation of food to health, strength, and efficiency.

Many tables used in this volume are taken from United States Government bulletins; in fact, unless credit is otherwise given, all the percentage composition tables are taken from the Government publications, as are also the tables called the Atwater Tables. All tables and menus in Chapter VI, Part One, were worked out by the author's classes in 1912, and the meals were served exactly as they are outlined.

EMMA CONLEY.

OSHKOSH, WISCONSIN.

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PART ONE

NUTRITION AND DIET

PART I

CHAPTER I

COMPOSITION OF THE HUMAN BODY AND OF FOODS

Introductory. — The medicine of the future is prevention. The time is coming when it will be considered as gross ignorance or carelessness to be sick as it now is to be unable to read and write. Almost every magazine and newspaper maintains a department, conducted, not as of old, to prescribe popular remedies for common ills, but to teach people how to keep well.

To-day we have little sympathy for the dyspeptic after we see him consume foods that are almost indigestible to the average person. We know that every case of typhoid fever is due to criminal carelessness on the part of some one. We know that if the sufferer had had plenty of nourishing food and an abundance of fresh air, nearly every case of tuberculosis could be prevented. We know that many diseases are due to lack of attention to the proper elimination of the wastes of the system, and that rheumatism is tissue poisoning. In fact, some one has well said, that if we looked after breathing, digestion, and elimination of waste, we should never be sick.

It is necessary to have some knowledge to look after the different functions of the body. We must know the composition of the body and what substances it is made of, how the body secures these substances, in what form they are best supplied, where they are found, how they act when taken into the body, how the body rids itself of their oxidation products, and in what foods substances which the body lacks are to be found.

To acquire this knowledge we must take short journeys into the fields of biology, physiology, chemistry; but the facts are easily learned and the reward is health.

Domestic science is no longer mere cooking. It is a mastery of the principles of cooking and their application to foods. It is vastly more than that. It is a study of foods, — their composition, structure, nutritive value, and place in the diet, — so that when a food is to be served, we know what it furnishes to the body, what effect heat has upon it, what conditions affect its digestibility, and in what proportions it is best to serve it. In short, domestic science is the study of foods so as to know how to nourish the body.

To find how the body is best served, we must know its composition, the composition of the substances with which we expect to nourish it, and how these substances act in the body. If we do not know these things, all knowledge of cooking is of little avail.

Food Defined and Classified. — Food is any substance which, when taken into the body, supplies it with energy or builds tissue. Foods are oxidized or burned in the body, just as wood or coal is burned outside the body, and that oxidation produces energy. They produce just as much energy when burned in the body as fat or sugar would produce if burned in a stove or in the chemical laboratory. The energy produced in the body by the oxidation of foods is used to maintain the normal temperature of the body;

and to carry on the vital processes, — as digestion, circulation, respiration; and for work and activity.

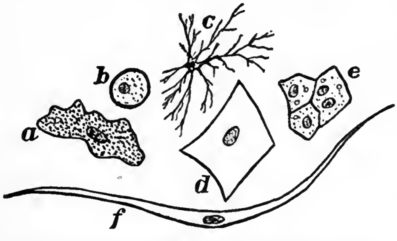
The body is made up of an aggregation of cells, and collections of these cells, having special functions, make up the tissues and organs of the body. The cells and tissues of the body are being constantly worn out, and new ones must be built up from, or out of, the food taken into the body. The burning of food and cells in the body is called oxidation, and constitutes the vital process called life.

Not all foods can build tissue. The cells and tissues of the body contain nitrogen, and hence the only foods that will build tissues are those which contain nitrogen. A food which contains carbon will yield energy when oxidized.

Foods are grouped into five classes: proteins, fats, carbohydrates, mineral matter, and water. Proteins contain carbon, hydrogen, oxygen, nitrogen, and sulphur. Fats and carbohydrates contain carbon, hydrogen, and oxygen. Proteins, mineral matter, and water build tissue; fats, carbohydrates, and proteins yield energy.

Foods are also classified as animal and vegetable foods. Examples of animal foods are meat, fish, eggs, cheese, milk, fat. Examples of vegetable foods are potatoes, carrots, rice, wheat, peas, apples.

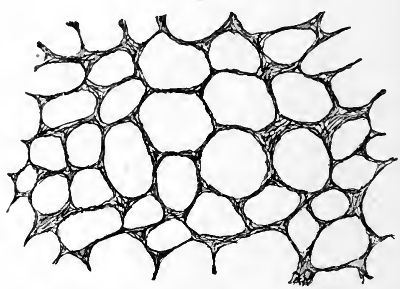
Structure of Foods. Animal and Vegetable Cells. — All foods, whether animal or vegetable, are similar in structure in that they are made up of innumerable cells held together by some intercellular substance. An animal cell consists of a tiny mass of protoplasm having a center called a nucleus and sometimes surrounded by a cell wall. The nucleus may be called the life center of the cell, because it controls growth and reproduction; the protoplasm contains the nourishment. The protoplasm and the nucleus are composed of protein, mineral matter, and water, and they get these substances for their growth and reproduction from the blood. The digested food is absorbed and becomes part of the blood, and thus reaches the cells, where it becomes new cells, or is oxidized and produces energy.



CELLS FROM HUMAN BODY (Magnified).

a, a colored cell from the eye; *b*, a white blood cell; *c*, a connective tissue cell; *d*, a cell from lining of the mouth; *e*, liver cells; *f*, a muscle cell from the intestine. (From Overton's *Applied Physiology.*)

Animal cells are held together by an intercellular substance called connective tissue. Sometimes fat is found between the cells. Fat is stored in cell walls of connective tissue, and forms adipose or fatty tissue. All animal tissue, whether bone, nerve, or muscle, is made up of cells, composed of substances which are formed from the food which is eaten and which is carried to the cells in the blood.

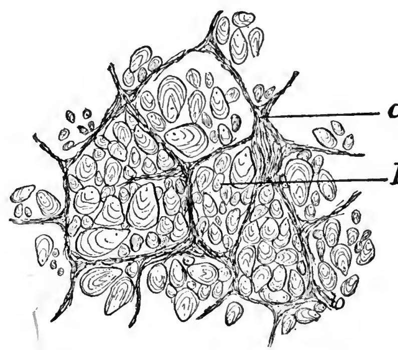


FAT TISSUES (Magnified).

Connective tissue cells from pockets in which the liquid fat is stored.

Vegetable cells consist of a nucleus or life center, and a network of protoplasm; inclosed in this network are starch grains, mineral matter, and water. The whole is surrounded by a wall of cellulose—a substance similar in composition to starch, but unlike it in structure. Cellulose also holds vegetable cells together.

The protoplasm in vegetable cells consists of protein, and is similar in structure to that in animal cells. In some foods it is so slight that there is scarcely a trace of it, in others it makes up from one seventh to one half of the solid nutrients. Starch or sugar, and some mineral matter, are found in all vegetable cells. Starch is the form in which the nourishment is stored in the plant for the seed. When the seed germinates, the starch is turned to sugar, and in this form it circulates in the plant. Starch may be called stored nourishment and sugar circulating nourishment. Vegetable foods are best for human consumption before they begin to germinate. Fat is found in some vegetable cells. The cellulose which surrounds the cell cannot be digested in the human stomach and must be softened by cooking to free the inclosed starch and protein.



A THIN SLICE OF POTATO (Magnified).

a, albuminous pockets; *b*, starch grains in the pockets. (From Overton's *Applied Physiology*.)

Uses of Foods. — Every cell in the body is constructed out of the food taken into the body. Food is made over in the body into flesh, bone, nerve, and blood. Food is also oxidized in the body and furnishes energy needed for work and activity and to carry on the vital processes, and to maintain the right bodily temperature. The complete food for any animal must contain all the elements of which its tissues and all the fluids of its body are composed, and it must contain them in the right proportion. If they are not supplied in the proper proportion, the body will be weakened because of the deficiency. A familiar example of this impairment of tissues is seen in the disease called rickets. In this disease not enough mineral matter is supplied to children, and the bones are soft and cannot bear the weight of the body without bending out of shape. When lime is supplied in the right proportion, the bones become hard.

The words **Element** and **Compound** are terms used in chemistry to distinguish different forms of matter. An element is a substance which has not been separated into other substances. A compound is a substance composed of two or more elements united in definite proportion: Example. Iron is a substance which has not been separated into other substances. Water is a combination of two substances, hydrogen and oxygen, united in the definite proportion of two parts of hydrogen to one part of oxygen (H_2O). Iron is an element; water is a compound.

Elements found in the Body. — There are eighty or more elements known to the chemical world, and thirteen of these are found to make up the human body. They are oxygen ($62\frac{1}{2}\%$), carbon ($21\frac{1}{2}\%$), hydrogen (10%), nitrogen (3%). Calcium, phosphorus, potassium, chlorine, sodium, magnesium, iron, sulphur, and fluorine make up the remaining 3 per cent. There are, also, traces of iodine, silicon, and several other elements. All these elements are derived from the food taken into the body, and each one has its use and is necessary for the maintenance of a healthy body.

Occurrence in the Body. — Though the body is made up of these thirteen elements, they do not occur as elements, but as compounds, and as compounds they form the various cells and tissues of the body. Albumin, composed of carbon, hydrogen, oxygen, nitrogen, sulphur, and sometimes phosphorus, is found in all the cells of the body. It enters into the structure of the brain, nerves, muscles, and blood. Fat, composed of carbon, hydrogen, and oxygen, is found all over the body, covering the muscles, surrounding internal organs, and between the cells. Sugar, composed of carbon, hydrogen, and oxygen, is found in the blood, liver, and tissues. Lime, composed of calcium and oxygen, is found in the bone, blood, and nerves. Salt, composed of sodium and chlorine, is found in the tissues and fluids of the body. Iron is found in the hæmoglobin of the red blood corpuscles, and gives them power to carry oxygen to all the cells of the body.

Occurrence in Foods. — All foods which we eat, whether animal or vegetable, are also compounds of some of the thirteen elements united in different forms and proportions. Proteins contain carbon, hydrogen, oxygen, nitrogen, and sulphur. Carbohydrates contain carbon, hydrogen, oxygen. Fats contain carbon, hydrogen, and oxygen. Water contains hydrogen and oxygen. The mineral matter occurs in combination with the organic substances, as proteins and carbohydrates. These foods are taken into the body through the mouth and carried to the stomach and intestines, where they undergo chemical change and are reduced to a soluble form, so that they can enter the blood and be carried to the cells, where they are made into the tissues of the body or are oxidized for energy.

The only way that the body can receive the materials out of which to build its tissues, supply the energy needed for living, and secure enough heat to maintain normal temperature, is through the food eaten. These demands of the body must be supplied, or the health and the working efficiency of the individual are impaired. For these reasons, it is of the utmost importance that all people should have some knowledge of the composition of the various foods and what elements they will supply. The best example of the service such knowledge would render to the individual can be seen from the fact that growing girls are subject to anemia, a disease or condition due to the lack of iron in the red blood corpuscles. Almost the only way that the human body can assimilate iron is when it is in combination with some organic substance, as in food. A study of foods would show which contain the desired iron, and the diseased or abnormal condition could be readily remedied.

Another example which shows the importance of this knowledge is furnished by the fact that if any element is not supplied in the right proportions needed for all the vital processes and tissues, the amount supplied is first used for the vital processes, and the tissues suffer. Moreover, if not enough is supplied for the vital processes, it is taken from the tissues, and they are weakened to that extent. Lime, for instance, is needed for bone, nerve, and muscle. It is also needed in the blood and digestive ferments, and will be taken first by the blood and ferments. The result of an insufficient supply would be soft bones, twitching nerves, or flabby muscles. Lime is needed for infants and growing children in much greater abundance than for those who have attained growth, and mothers should know what foods supply an abundance of lime.

Chemical Change or Action. — In various substances the elements are held together more or less loosely, so that if two substances are brought together, the elements tend to separate and unite again with other elements to form new and more stable substances. This is called chemical change or action, and is constantly going on, transforming inert waste substances into plants and animals, and breaking down living matter into lifeless matter. Plants take in carbon dioxide, — a waste substance given off by animals, — water, and mineral matter, and from them construct starch and other substances found in plants. Certain bacteria feed on living matter, as tissues in the human body, and decompose it. Yeast plants break down sugar and change it into alcohol and carbon dioxide. Iron has a strong attraction for the oxygen in the air. In the presence of moisture, the iron unites with the oxygen, forming a new substance called oxide of iron or iron rust.

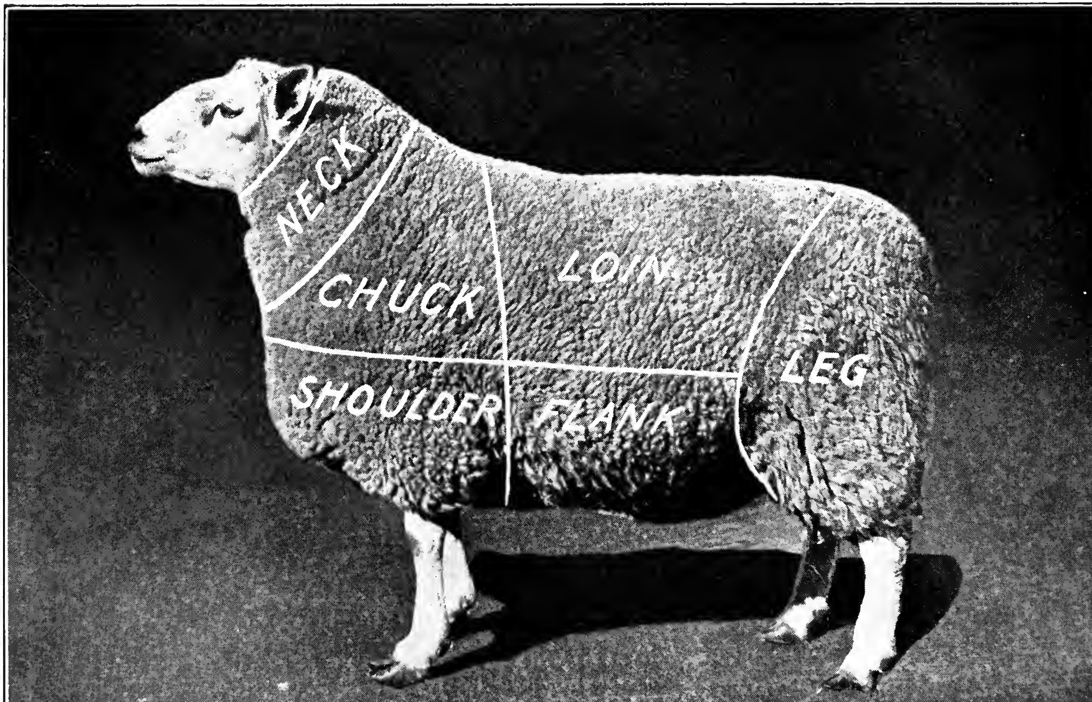
Probably the most familiar example of chemical change is the one usually cited because of its similarity to the chemical change which takes place in the body when foods are oxidized. That is, the burning of any fuel outside the body, as wood.

Wood is composed of carbon, hydrogen, oxygen, and mineral matter. When air is present, and the wood is brought to the kindling point, the carbon in the wood unites with the oxygen in the air, forming carbon dioxide (CO_2), and the hydrogen and the oxygen unite to form water (H_2O). The mineral matter remains in the form of ash. In this way, from wood and air are formed two new substances unlike either of them, carbon dioxide and water. These are the products of combustion, and they are formed whenever a substance containing carbon is burned. Whenever chemical change takes place, energy is involved.

Heat is a form of energy. Any form of energy can be changed into another form without loss. Thus, electric energy may be transformed into light, power, or heat. The energy of burning coal may be used to run an engine or heat a train. When any substance is burned, energy is released as heat. Different substances yield different amounts of energy, — a pound of coal will yield more energy than a pound of wood; a pound of fat will yield more energy than a pound of sugar. The unit for measuring heat is called the *calorie*. It is the amount of heat that would be required to raise 1 pound of water 4° F.; it is equivalent to the amount of energy required to raise 1 ton 1.54 feet.

Oxidation. — Oxidation is the name given to one of the chemical changes which take place in the cells of the body. The red corpuscles of the blood carry oxygen to the cells. The plasma of the blood carries albumin, fat, and sugar to the cells. This oxygen unites with the cells and the substances brought by the plasma, and slowly burns or oxidizes them, producing as much energy as these substances would yield if burned outside the body. Some of this energy manifests itself in the form of heat, and is used to maintain the normal temperature of the body (98.6° F.). Some of the energy enables the body to carry on its vital processes.

Oxidation is necessary for the life and growth of the cell. It is the process by which the old cells are broken down so that new ones may be rebuilt. The cells are built from the albumin and mineral matter brought to them in the plasma. The breaking down of the old cells and the building of the new is called metabolism, and it includes also the production of energy during oxidation of the organic material brought to the cells. These processes are inseparable because we should consider the fat and sugar as fuel needed for carrying on the work of upbuilding and



Cuts of Mutton

repairing of cells, though the building material must be protein.

By oxidation of foods, energy is produced; but by this oxidation or chemical change of food, new substances are formed called end products, and these products must be eliminated, as the body has no further use for them.

By oxidation of fats and sugar, carbon dioxide and water are produced. By oxidation of albumin, carbon dioxide, water, and the nitrogenous waste, urea, are produced. These waste products are eliminated through the lungs, skin, and kidneys.

The food as it is taken into the body must go through a series of changes before it can be taken into the blood and carried to the cells. This process is called digestion, and will be considered in another chapter. Metabolism includes the changes which take place in the cells, as distinguished from the changes which take place in the digestive tract.

CHAPTER II

CLASSIFICATION OF FOODS. OCCURRENCE AND USES

A. NITROGENOUS FOODS.

I. TRUE PROTEINS.

Build tissue and yield energy.

All coagulated by heat or acid or ferment.

Coagulation temperatures.

Heat about 165° F.

Ferment 98.6° F.

Forms of Protein

Albumin in egg.
Soluble in cold water.

Fibrin in meat.
Myosin in meat.
Soluble in dilute salt solution.

Casein in milk.
Soluble in dilute alkali.

Gluten in wheat.
Legumin in beans.

II. ALBUMINOIDS.

Do not build tissue, but yield energy.

Softened and dissolved by hot and boiling water.

Form gelatin on cooling.

Hardened by heat and evaporation.

Forms of Albuminoids

Elastin in cell walls.
Ossein in bone.
Collagen in connective tissue.

III. EXTRACTIVES.

Neither build tissue nor yield energy.

Stimulate, and aid in the assimilation of proteins.

Forms of Extractives

Kreatin, xanthin, etc.

Products of decomposition of muscle tissue.

Found in meats and some vegetables.

IV. NITROGENOUS FATS.

Lecithins, peculiar nitrogenous fats found in different cells of the body, as brain, nerves, liver.

Nitrogenous Foods. — The *proteins*, or albumins, as they are sometimes called, are the most important of all foods because they form the essential part of the protoplasm of every cell of the body. The same might be said of such mineral substances as phosphorus and iron, but these occur in combination with the various proteins, as nucleoprotein, chromoprotein, etc. All life originates in a single cell; all tissues and organs are collections of cells. The cell then constitutes the unit of all animal and vegetable life. The cell consists of a tiny mass of protoplasm, — a jellylike substance, more or less granular, having in the center a denser mass called the nucleus. Cells differ according to their various functions, but all cells are composed of 80 to 85 per cent water, a small amount of mineral matter, and proteins.

The proteins are albumins, globulins, but mostly compound proteins as nucleoprotein, chromoprotein, and lecithoprotein.

It can be said, then, that the proteins are the most important of all foods because they form the essential part of the tissues in the body, and occur in the blood, lymph, and all secretions.

Proteins are also oxidized in the body and furnish energy for work and activity.

The chemical formula of proteins is only approximately known; very little is known of their molecular structure; there is no universal agreement as to name, and no uniform classification, because physiological chemistry is adding to our knowledge of their differences from day to day. No field of study furnishes more interesting and valuable research, information, and data.

Chittenden has defined protein as a substance which contains carbon, hydrogen, oxygen, nitrogen, and sulphur, — the nitrogen being in a form to serve the physiological needs of the body. That is, in such form that it will build tissue.

The proteins contain about 16 per cent nitrogen, though the amount varies from $15\frac{1}{2}$ per cent to 19 per cent. The compound proteins contain phosphorus, also. Some contain iron and other elements. For the purpose of study nitrogenous foods may be classified as True Proteins, Albuminoids, and Extractives (see page 18), but to get even a faint idea of the uses of the various foods as nutrients for the body, familiarity with the general classification of proteins is necessary. For example, wheat flour as commonly purchased is made from the part of the wheat that contains the protein in the form of glutelin; the germ and outer coats, removed in milling, contain different proteins, as nucleoprotein and others. If, even in a grain of wheat, the character of the protein varies in the different parts because each part has different work in the growth and development of the young plant, it is evident that man should have some knowledge of the different proteins to know which foods contain those needed for the growth and development of his various tissues and organs.

True proteins, as classified on page 18, or simple, derived and compound proteins as classified on page 34, contain nitrogen in a form to serve the physiological needs of the body for tissue building. They also furnish energy. No one of these proteins will build all kinds of tissue, however. An erroneous idea prevails that any form of protein is as good as several forms. That this is not true is seen from experiments where animals have been fed on one kind of protein and the deteriorating effects of such diet noted. It is also seen in the evil effects of excessive consumption of meat.

It may be said that the opinion is gaining ground that it is not the quantity of protein consumed that is harmful, but the kind of protein. It might be added also, that it is the lack of certain mineral ingredients in some proteins.

Albuminoids do not contain nitrogen in the form to serve the physiological needs of the body for tissue building, but they yield energy. For this reason they are spoken of as protein sparers, because if other foods are used as sources of energy, the proteins can be used simply for tissue building. Extractives are decomposition products of muscle tissue or proteins, and neither build tissue nor yield energy. They furnish flavor to meat, act as stimulants to appetite, and call out the digestive juices.

The commonest proteins in food are albumin as found in egg and blood, casein in milk, glutens in wheat, legumin in peas and beans, fibrin and myosin in meat. Under the action of certain ferments normally present, they assume slightly different form and composition. Ferments change liquid myosinogen, fibrinogen, and caseinogen to the coagulated forms myosin, fibrin, and casein. Foods containing the most proteins are cheese, legumes, meat, fish, egg, milk, and cereals.

The true proteins are all coagulated by heat or acid or ferment and rendered less easily digestible. The higher the temperature at which they are coagulated, the harder they are to digest. Proteins cannot diffuse through animal membrane and are changed during digestion from insoluble proteins to a soluble form,—peptone,—and in that form they enter the blood. They are used in the body to build tissue and yield energy, and in this process they are broken down into simple compounds, their ultimate products of decomposition being the nitrogenous wastes, carbon dioxide, and water.

The proteins are being constantly decomposed or broken down in the body as a result of cell activity. If these decomposition products are not immediately removed from the cells, they act as poisons or toxins, producing fatigue or pain or lowering the vitality. These products are normally removed through the kidneys in the form of urea, and it will be readily seen that if more protein is consumed than is needed for tissue renewal, it either accumulates in the tissues, or is not fully oxidized to urea, and intermediate products are formed that may be harmful to the body, or may impose extra work on the excretory organs.

Too much importance cannot be given to the fact that the system must rid itself of waste products, or they accumulate and lower resistant power or working efficiency. It is because the decomposition products of protein metabolism are so harmful if not neutralized, or if not fully oxidized, that so much is written concerning excessive consumption of protein foods.

Albuminoids occur in the various animal tissues. All forms of connective tissue, such as the cell walls and the substance that holds cells together, are albuminoids. The common forms are: elastin in cell walls; ossein in bone; collagen in tendons and ligaments. The albuminoids are hardened by heating and drying, but are softened and dissolved by heat and moisture, and when cooled, form gelatin. This knowledge of the action of heat on cell walls and connective tissue is of great value in the cooking of meats and fish. By boiling meat in water the cell walls and the substance holding the cells together are dissolved, the protein inside the cells is coagulated and toughened, and the result is a stringy mass of fibers. This condition can be avoided by cooking the meat at a temperature that will soften, but not dissolve, the connective tissue. This connective tissue is so delicate in most fish that the flesh will fall apart if the fish are boiled.

Extractives, as kreatin, kreatinin, xanthin, are found in meat juice and meat extract, also in some vegetables, as asparagin in potato. They are soluble in hot and cold water and are often lost in cooking. They give to meat its flavor. Those meats, like beef and mutton, having the greatest amount of flavor contain more extractives than veal, pork, and chicken.

Extractives are present in greatest quantity in muscles that are exercised most; game has more than tame fowl.

Extractives neither build tissue nor yield energy, but act as stimulants to digestion, and they may aid in the digestion of proteins.

Lecithin is a peculiar nitrogenous fat, containing phosphorus, found in nerves, brain, and bile. Combined with albumin it forms lecithoprotein and is found in the lungs and liver. In foods it is found principally in milk and eggs and in the seeds of plants.

B. NON-NITROGENOUS FOODS.

I. CARBOHYDRATES.	*Forms of Carbohydrates*
Softened by heat or acid or ferment.	1. Starch. As in potato, rice, corn, and all other vegetables.
Oxidized in the body and furnish energy.	2. Sugar. As in cane, beet, maple, milk, and fruit.
May be transformed into fat and stored as fatty tissue.	3. Cellulose. Cell walls of plants.
	4. Pectose. Changed to pectin

	by the ferment pectase. Causes fruit juice to gelatinize.
II. FATS.	*Forms of Fat*
Oxidized in the body and furnish energy.	Fats and oils.
Stored in cell walls, and freed from cell wall by heat.	As butter, lard, olive oil.
Separated into fatty acid and glycerin by steam or alkalies.	

III. VOLATILE OILS. In orange and lemon skins; also in other fruits, flowers and vegetables.

IV. VEGETABLE ACIDS. Malic in apples, oxalic in tomatoes, citric in lemons, tartaric in grapes.

Decomposition products of starch and sugar. They are decomposed in the body, forming alkaline carbonates and help to preserve the alkalinity of the blood.

V. MINERAL MATTER.	*Forms*
In tissues and fluids of the body.	Lime in milk; iron in eggs, green vegetables, and legumes; phosphorus in wheat, eggs, milk; sulphur in eggs; soda and potash in vegetables.
	Salt.

VI. WATER.

Carbohydrates. — By the term carbohydrates is meant the large class of vegetable foods commonly referred to as starches and sugars. They are composed of carbon, hydrogen, and oxygen, the last two usually in the proportion to form water. They are transformed in the body into glucose, and then oxidized, being sources of energy. Carbohydrates may be converted in the body into fats and form fatty tissue. Carbohydrates are classified as:—

1. *Amyloses* ($C_6H_{10}O_5$), which include starch, dextrin, cellulose, gum, glycogen, and pectin.

2. *Sucroses* ($C_{12}H_{22}O_{11}$), which include sucrose or cane sugar, lactose or milk sugar, maltose or malt sugar.

3. *Glucoses* ($C_6H_{12}O_6$), which include dextrose or grape sugar, levulose or fruit sugar, and invert sugar, a mixture of the two.

4. *Vegetable Acids*, decomposition products of sugar; the commonest are, — citric acid in lemons, malic acid in apples, tartaric acid in grapes, oxalic acid in tomatoes.

Amyloses. — *Starch* is the nourishment, or reserve food for the young plant, stored in the roots or seeds until it is needed. It is found in all vegetables and in all parts of the plant, but is most abundant in cereals, legumes, roots, and tubers. It occurs in minute cells or granules, which consist of a wall of cellulose, inclosing starch and water. The granules, or cells, of various plants have definite markings, shape, and structure, so that the potato starch is easily distinguished from the corn or other starch granules. The cell walls vary in thickness, and that accounts for the length of time which it takes to soften some vegetables in cooking. The plants containing most starch are rice, wheat, corn, tapioca, sago, potato, and arrowroot.

Starch is insoluble in cold water, but is dissolved or gelatinized in boiling water, forming a paste. Heat at 320° F. changes dry starch to dextrin; heat and moisture cause starch grains to swell and burst the cell walls which inclose them, and this frees the digestible starch from the indigestible coating of cellulose. During digestion the ferments ptyalin and amylopsin change starch to sugar. Invertin changes cane sugar to glucose, — the form in which it is soluble in the body. In the ripening of fruit, heat and acid change starch to sugar. In grains the ferment diastase changes starch to a form of sugar called maltose. Commercially starch is changed to glucose by the action of strong acid, as in the manufacture of glucose products from corn, with hydrochloric acid, or sulphuric acid.

Dextrin is formed when starch is heated to 320° F. It is soluble in cold water and is more easily digested than starch. It is the first change which starch undergoes in its conversion into glucose. It is familiar to us in the crust of bread, in the browned flour used in gravies, and in the prepared breakfast foods and cereal coffees.

Cellulose is the substance which forms the cell walls of plants. It has the same chemical composition as starch, but is insoluble in all common solvents. It surrounds the starch in such a way that it must be broken down to set the starch free. This is done by heat and moisture. Though ferments in the human stomach cannot act on cellulose, it plays an important part in digestion; and to it green vegetables and fruits owe much of their dietetic value.

The alimentary canal is twenty-five feet long and food moves down it rather sluggishly. If this movement is delayed or retarded, bacteria, always present in food, become active in the large intestine and undesirable fermentation takes place. Sometimes the undesirable food remains in the body and the poisons from its fermentation enter the blood, and affect general health conditions. They lower vitality or general tone of the body, and deplete energy.

Cellulose stimulates the walls of the intestines so that the food moves down it rapidly enough to prevent the accumulation of waste. For this reason, foods which contain cellulose should be added to the diet, preferably green vegetables and fruits, because they also contain valuable mineral salts and acids.

Vegetable acids are decomposition products of starch and sugar and are formed by the action of a ferment. They are oxalic, tartaric, citric, malic, acetic. Lactic acid is formed during the souring of milk by the action of lactic acid bacteria on milk sugar. Vegetable acids are present in all fruits and are of great value to the body because they are decomposed in the body, forming alkaline carbonates, and help to preserve the alkalinity of the blood and tissues.

Glycogen. — In the body starch and sugar are transformed into glucose. This glucose is carried to the liver and there converted into animal starch, or glycogen, and stored until needed. When needed, it is reconverted into glucose and enters the blood and is carried to the cells and oxidized. Glycogen is the form in which digested starch is stored in the body, glucose the form in which it circulates.

Food Value of Starch. — Starch is easily and thoroughly digested by the average individual. Its coefficient of digestibility is 98 per cent, which means that 98 per cent of it is digested and only 2 per cent escapes digestion. When oxidized outside the body, one pound of starch yields 1860 calories; when oxidized inside the body it yields 1820 calories or 4 calories per gram.

Starch Test. — If a solution of iodine is added to a food containing starch, it will turn blue.

Sucroses. — Sucrose, or cane sugar, is found in the juice of the sugar cane, beets, and maple trees. There is no chemical difference in these sugars, but maple sugar contains certain ethereal substances which give it its peculiar flavor. Sugar is soluble in water, melts at 320° F., turns to barley sugar at 356° F., and is caramelized at 420° F. Sucrose is converted in the body into glucose by the action of ferments. Outside the body it is converted into glucose by the action of heat and acid.

Food Value of Sugar. — Sugar has the same food value to the body that starch has, but as it has undergone one step in digestion it takes less energy to convert it into glucose. For this reason it is of use to persons who have little or no power to digest starch, and is also a good food in times of great exertion or labor, when extraordinary demands are made on the body for an immediate supply of energy, such as in times of war when soldiers are on the march. Because it can be assimilated so rapidly there is danger that those who are fond of sugar will consume excessive amounts and that the fats and proteins will not be fully oxidized. If sugar is taken in too concentrated a form, it irritates the mucous membrane of the stomach, causing a great outpouring of mucus, which interferes with the secretion of gastric juice and gastric digestion. If taken in too great quantities, it may cause fermentation in the stomach. Contrary to current opinion, which seems to be that no warning is needed because of excessive consumption of sugar, observation has shown that girls who consume excessive amounts of candy and foods containing much sugar — and there are many such girls — have no appetite for nutritious foods which they need, and are subject to indigestion, and its train of ills. Sugar contains no mineral matter.

Lactose. — Lactose, or milk sugar, is the form of sugar which occurs in milk. It can be separated from the other ingredients in milk whey, and is sold for medicinal use, or to add to cow's milk for infant feeding in place of cane sugar. In fermentation of sucrose, carbon dioxide and alcohol are formed, while the product of lactic fermentation is lactic acid.

Maltose. — Maltose, or malt sugar, does not occur in nature, but is the result of the action of the ferment diastase on starch in grains. During germination, diastase changes the starch to maltose; this is done during the process of liquor making. Maltose is formed during digestion by the action of ptyalin and amylopsin on starch.

Glucoses. —

$$C_{12}H_{22}O_{11} \text{ plus } H_2O = (C_6H_{12}O_6) \; \& \; (C_6H_{12}O_6)$$

Sucrose plus water = dextrose and levulose.

Glucose is the form of sugar that is soluble in the body and the form in which it circulates. All starch and sugar taken into the body must be converted into glucose before it can be assimilated. Glucoses are colorless, odorless substances of sweetish taste and neutral reaction. They are soluble in water and diffuse through animal membrane. They occur in three forms, dextrose, levulose, and invert sugar, a combination of the two. Dextrose occurs in nature in grapes. When they are dried, it separates out into yellow granules. Levulose occurs in fruits, roots, and seeds of vegetables.

Commercial Glucose. — Glucose is manufactured from starch, usually corn starch, by the action of hydrochloric acid. This glucose is about three fifths as sweet as cane sugar and is sold as a thick, colorless, transparent liquid under the name of corn sirup. It is the basis of many sirups, to which something is added for flavor and color. It is also used in making cake frostings, creams, and candy where a non-crystalline sugar is desirable. It seems to be harmless to the human system if properly made, despite the fact that there is much said against it. Cane sugar may be converted into glucose by the addition of a small amount of acid, as in the making of fondant. It is converted into glucose and loses some of its sweetening power when it is added to fruits in cooking. For this reason some people prefer to add the sugar after the fruit is cooked.

Fats and Oils. — Fats are substances composed of carbon, hydrogen, and oxygen; and when they are oxidized in the body, they yield energy. The chemical formula for stearin, one of the fats, is $(C_{17}H_{35}COO)_3C_3H_5$. This shows that fats contain so little oxygen and so much carbon that more oxygen is needed for their oxidation than for either protein or carbohydrate, and hence one pound of fat yields two and one fourth times as much heat as either of the other organic foods. For this reason fats are sometimes referred to as the heat-producing foods.

In addition to yielding energy, fats occur in the body as fatty tissue, though carbohydrates and proteins are thought to be the sources from which fatty tissue is formed.

Fats occur in the body, under the skin, in the muscles, and around certain organs to protect them from injury, and they serve as a reserve supply of fuel when needed in case of sickness or when food cannot be taken. They save the tissues from being used at such times, because, if food cannot be taken, the demand of the body for heat and energy to carry on vital processes is imperative and must be met by fats stored in the body or by the tissues, just as when wood and coal are not attainable, furniture must be sacrificed to furnish fuel to keep people from freezing.

Fats are liquid in the living body and are stored in albuminous cells or pockets. These cell walls must be ruptured by heat or by the action of the digestive juices to set the fat free. Fats are decomposed by steam, by boiling with an acid or an alkali, or by the digestive ferments, lipase and amylopsin, into fatty acid and glycerin. All fats are compounds of one or more fatty acids and glycerin. When fats are decomposed into fatty acid and glycerin and either soda or potash is added, the fatty acid unites with the alkali and forms soap.

The commonest fats are: stearin, composed of stearic acid and glycerin; palmitin, composed of palmitic acid and glycerin; olein, composed of oleic acid and glycerin. Most fats are mixtures of several fats and glycerin; the predominating one gives the general character to the fat, as olein in lard, and stearin in beef fat.

There is no chemical distinction between fats and oils. An oil is fat which is liquid at ordinary temperature. Fat is found in all animal foods, as meat, fish, eggs, milk, butter, and cheese. It occurs in some vegetables, as olives, cottonseed, cocoa, oats, and an inappreciable amount in roots and tubers, green vegetables, and fruits.

Volatile or Essential Oils. — A substance present in fruits, flowers, and some vegetables, which gives to them their characteristic flavor or odor, is called essential or volatile oil. It occurs in orange, lemon, and grapefruit rind, also in almonds, vanilla beans, onions, garlic, coffee, and other foods. It volatilizes in cooking and is frequently lost. Foods with great quantities of it are often cooked in uncovered dishes so as to allow it to escape, or the water in which the food is cooked is changed several times.

Water. — The human body is nearly 60 per cent water. It enters into the formation of every tissue. Even the enamel of the teeth, the hardest substance in the body, contains water. All fluids of the body are chiefly water. It is usually taken into the body as a drink, though most foods are over 50 per cent water. It is formed in the body during oxidation of hydrogen compounds, which would mean fats, carbohydrates, and proteins. About four pints of water are excreted daily from the body through the kidneys, skin, lungs, and intestines, so it will be readily seen that more water is needed by the body than the average person consumes.

Water has many important uses. As has been said, every tissue contains water and cannot exist without it. Water is a solvent, it reduces the food to a liquid condition so that it can be easily swallowed, digested, and absorbed. It dilutes the digestive juices so that they can reach every particle of food and act on it. It dilutes the blood and lymph, and aids in carrying nutrition to the cells and in the removal of waste products of metabolism. It aids in the excretion of urea and excites peristalsis. It distributes the heat over the body by promoting circulation, and through perspiration it regulates the temperature of the body by carrying away surplus heat. It moistens all membranes of the body.

Water is not absorbed from the stomach, but enters the intestines and aids and excites peristalsis there. When water is not taken into the body in sufficient quantity, it leaves the tissues to supply the blood, resulting in imperfect circulation, imperfect removal of waste, and loss of bodily weight. Warm or hot water has several important uses. It washes away mucus that sometimes covers the tubes which secrete gastric juice, and by promoting its flow aids and stimulates gastric digestion. It is used medicinally also.

Mineral Matter. — The tissues and fluids of the body contain 97 per cent carbon, oxygen, hydrogen, and nitrogen; and the remaining 3 per cent consists of various mineral substances, as iron, sulphur, phosphorus, potassium, sodium, calcium, magnesium, chlorine, and fluorine. These minerals are combined with the organic substances forming the various tissues and fluids; and when these are oxidized, the mineral matter remains as ash or inorganic solids, and is eliminated as waste, mainly through the kidneys. They usually occur in foods, as acids or salts, in combination with the organic substances. They are most abundant in vegetable foods, and also occur in eggs, milk, and meat.

They are absolutely essential for all vital processes, — as digestion, assimilation, oxidation, growth of cells, reproduction, and all processes of metabolism.

Uses of Mineral Matter. — Mineral matter occurs in all digestive juices and enters into the composition of all tissues. Calcium phosphate is found in the bone, and calcium salts are necessary for coagulation of blood. Iron is found in the hæmoglobin of red blood corpuscles and gives them their power to carry oxygen to the cells of the body. It is also found in the chromatin substance of the cells, which is necessary for reproduction and development. Phosphorus is found in the nucleus of every cell, and is essential for metabolism. It is most abundant in brain and nerve cells. The chlorides are necessary for the production of hydrochloric acid in the gastric juice, and sodium chloride (common salt) is found in all the tissues of the body.

Mineral matter regulates the chemical reaction of the blood, all secretions, and excretions. It regulates the specific gravity of the blood, and aids absorption and excretion.

In protein metabolism acids are formed, and base-forming elements, as sodium, potassium, calcium, magnesium, are necessary to neutralize the acids and maintain the normal alkalinity of the blood and tissues. These elements occur in greatest abundance in vegetables and fruits.

General Classification of Proteins (For Reference)

1. Simple Proteins.
   - *A*. Albumins. Lact, ov, serum, muscle albumin. Coagulated by heat; soluble in cold water, dilute salt, acid or alkali solution. Drawn out of meat by soaking in cold water.
   - *B*. Globulins. Milk, blood, egg, vegetable globulins. Fibrin, myosin, zein, edestin, legumin. Coagulated by heat. Insoluble in water. Soluble in a dilute salt solution.
   - *C*. Glutelins. Glutens in wheat. Insoluble.
   - *D*. Phosphoalbumin. Found in the nucleoalbumin of cells. Vitellin of egg yolk, casein in milk. Coagulated by acid or ferment. Soluble in dilute alkalies.
2. Derived Proteins.
   Derived from simple proteins by action of heat or acid or ferment.
   - *A*. Albuminates. Formed by action of acid or alkali on albumin, as syntonin.
   - *B*. Coagulated proteins. Formed by the action of heat or acid or ferment on albumin.
   - *C*. Peptones. Formed by ferment action during digestion.
3. Compound Proteins.
   Simple proteins plus some other molecule.
   - *A*. Nucleoprotein. Found in nucleus of cells. Albumin plus nucleic acid.
   - *B*. Glycoprotein. Found in mucin and mucoid. Albumin plus a carbohydrate.

C.	Chromoprotein.	Found in hæmoglobin.
		Albumin plus iron.
D.	Lecithoprotein.	Found in cells.
		Albumin plus lecithin.

4. ALBUMINOIDS.

Ossein in bone, elastin in cell walls, collagen in connective tissue. Insoluble in water or salt solution.

Dissolved by boiling. Gelatinizes when cooled.

CHAPTER III

DIGESTION

Digestion is the process by which food is changed from an insoluble to a soluble substance so that it can diffuse through the walls of the stomach and intestines and reach the blood vessels and lymphatics. This is accomplished by mechanical and chemical action. Thorough grinding by the teeth is necessary to reduce it to pulp so that it can be easily swallowed and so that every part of it can be mixed with the saliva. The muscular walls of the stomach and intestines also produce mechanical action or movement, called peristalsis, which brings the food into contact with the gastric juice and hastens it along the intestine.

The chemical action is brought about by ferments.

Ferments are a class of substances existing in the animal and vegetable world that have the power to bring about a chemical change in a substance while remaining unchanged themselves. Each ferment acts only on one certain substance; some act best in an acid medium, some in an alkaline; some ferments are so strong that they destroy others present or render them inert. Animal ferments are killed at a temperature about 167° F., vegetable ferments at a temperature about 176° F.

The most important ferments concerned with digestion are ptyalin in the saliva; pepsin and rennin in the gastric juice; amylopsin, trypsin, and steapsin in the pancreatic juice; and invertin in the intestinal juice.

There are also several well-known coagulation ferments, — the fibrin ferment, which causes coagulation of the blood, the milk ferment rennin, pectase which coagulates pectin in plants, and others. Oxidation ferments in every cell seem to be responsible for the vital processes. In fact, Simon says, "There is a tendency to assume that all vital phenomena are due to certain ferments."

Digestion in the Mouth. — Food first enters the mouth and is thoroughly ground by the teeth and mixed with a colorless, odorless, liquid of alkaline reaction called saliva. The saliva is produced and secreted by three pairs of glands called salivary glands, which are located in front of the ear, below the tongue, and in the cheeks, and which pour their secretion into the mouth when it is needed.

Saliva consists of about 995 parts water, 5 parts of solid, which consists of mucin, mineral salts, and a ferment called ptyalin which changes starch to sugar. The amount secreted varies greatly. When the food is thoroughly masticated, more saliva is called out, and the food is liquefied so that it is prepared for stomach digestion. Dry foods call out more saliva than moist foods, and for this reason thin and soft breakfast foods are not so readily digested as the dry or more solid ones that must be masticated and mixed with the saliva. A pleasant frame of mind and freedom from excitement will result in an abundant secretion of saliva when food is presented, while anxiety, worry, or anger will retard it. The importance of thoroughly masticating the food, so that the saliva can reach all parts of it and have a chance to act on it, cannot be overestimated. The more saliva there is mixed with the food, the greater will be the quantity of gastric juice called out to neutralize it.

The action of the ptyalin continues for about an hour after the food reaches the stomach. As soon as the acid gastric juice is thoroughly mixed with the food, the ptyalin ceases to act. The result of mouth digestion, then, is that the food is finely ground, mixed with the watery saliva so that it may be easily swallowed, and the digestion of the carbohydrates is begun by the action of the ptyalin on the starch.

Peristalsis. — The food passes through the pharynx and esophagus and enters the stomach, where its presence causes a continuous and regular movement of the muscular walls. This movement, called the peristaltic movement of the stomach, keeps the food in constant and regular agitation so that it is thoroughly mixed with the digestive juice. The gastric juice is secreted by the glands in the stomach, and its flow is promoted by the steady intake of food and by the presence of the alkaline saliva which it neutralizes. The gastric juice is a colorless fluid of acid reaction, containing hydrochloric acid and two ferments, rennin and pepsin.

The ferment rennin coagulates milk; the pepsin, when mixed with hydrochloric acid, softens and dissolves the proteins, changing them to proteoses and peptones, — forms of protein that can diffuse through the walls of the stomach and intestines and reach the blood. Pepsin dissolves the albuminous pockets in which fat is stored and sets it free. It acts only in the presence of an acid, and so hydrochloric acid is necessary for its complete action. If the acid is deficient, stomach digestion is retarded. Hydrochloric acid also destroys such germs of fermentation as may enter the stomach in food.

The result of stomach digestion is the reduction of the food to a liquid form, the coagulation of milk by rennin, the beginning of protein digestion by the action of pepsin which reduces the protein to the proteoses and peptones, and the prevention of fermentation by the action of the hydrochloric acid.

Intestinal Digestion. — The main work of digestion is carried on in the small intestine. A slow peristaltic movement produced by the contraction and relaxation of the muscle fibers of the intestine moves the food downward. Three different alkaline digestive juices are found in the small intestine, — bile secreted by the liver, pancreatic juice secreted by the pancreas, and intestinal juice secreted by the intestines.

The pancreatic juice is by far the most important of all the digestive juices and carries on the main work of digestion. It is secreted by the pancreas, enters the intestine about one inch from the pyloric or stomach entrance, as does also the bile. The food is mixed with the pancreatic juice and bile during the entire intestinal digestion. The pancreatic juice contains three ferments: steapsin, which splits the fats into fatty acid and glycerin so that they are ready for absorption; amylopsin, or pancreatic ptyalin, which converts starch to maltose; trypsin, which acts on the proteins, breaking them into proteoses and peptones, and possibly still further. The bile and intestinal juices aid and strengthen the power of the pancreatic juice. The intestinal juice contains several ferments, — the most important being the invertins, which change the sucroses to glucoses, so that they can be absorbed and reach the blood. The result of intestinal digestion is that all food which the individual is able to digest is dissolved and reduced to a form in which it can diffuse through the walls of the intestines and be taken up by the blood. Proteins have been changed to peptones, and probably by the time they reach the blood to serum albumin and globulin, carbohydrates have been converted into glucoses, fats have been saponified and emulsified.

Work of the Large Intestine. — The indigestible or undigested food remaining in the small intestine passes on into the large intestine, where the liquid part of it is absorbed. After traversing the large intestine it is expelled from the body as waste. If it remains too long in the intestine, fermentation sets in and the gases formed during the fermentation are absorbed into the blood and are harmful to the body.

Absorption. — The digested food diffuses into the epithelial cells lining the small intestine, and there in some manner yet unknown is made ready to enter the blood. The work is probably done by special ferments. Fat is probably reconstructed into neutral fat, but at any rate it is taken up by the lacteals, carried to the thoracic duct, and poured into the blood, which carries it to the cells where it is oxidized to carbon dioxide and water.

Glucose is taken by the portal vein to the liver, where it is converted into glycogen and stored until needed. When needed, it is again converted into glucose, the form in which it can circulate, and it enters the blood in a steady stream. It is also carried to the cells and completely oxidized, forming carbon dioxide and water.

The peptones, changed to body albumin, are taken by the blood to the cells. The plasma of the blood contains albumin, mineral matter, and water, and it diffuses through the capillaries and bathes the cells. Each cell takes what it needs for building material. Oxygen is brought to the cells by the red corpuscles, and the albumin of the cells is broken down by oxidation, and new cells are built out of the material brought by the plasma.

The building up and breaking down of the cells is called metabolism. The final decomposition products of cell metabolism are carbon dioxide, water, and urea. The carbon dioxide is carried back to the lungs. The other waste products are removed through the lymph. The organs of elimination are the skin, kidneys, lungs, and large intestine.

Alkalinity of the Blood. — Certain mineral substances are present in all the tissues and fluids of the body, and in nearly all foods. They are essential for the life and growth of the tissues and for all the vital processes of the body. Several of these elements are combined with carbon, hydrogen, oxygen, and nitrogen to form the solid part of the tissues of the body, as sulphur in all proteins; phosphorus in phosphoalbumin, and lecithoprotein; iron in chromoprotein. The tissues could not exist without them. The blood contains sodium, potassium, calcium, magnesium, in the form of carbonates, phosphates, and chlorides.

Most foods contain these elements in varying amounts; and it will be remembered that all foods are decomposed in the body into simpler compounds, and that during metabolism the cells are oxidized and that various end products are formed.

These decomposition products are either acid or alkaline in reaction, and so we may call certain foods acid-forming, or base-forming, according to the predominance of certain elements in them. Foods having a predominance of chlorine, sulphur, or phosphorus are acid-forming foods; those having a predominance of sodium, potassium, calcium, and magnesium are base-forming. In general it may be said that meats of all kinds, eggs, and cereals belong to the first class; and fruits, green vegetables, legumes, and milk, to the second class.

All these elements must be supplied to the body because they are all essential to life, growth, and health of the body; but the base-forming elements should be supplied in greater abundance, because the blood and tissues are slightly alkaline in reaction and the acidity of the urine must be controlled.

One of the oxidation products, carbon dioxide, is removed from the cells by the blood plasma. The soda and potash in the blood dissolve the carbon dioxide so that it is carried to the lungs and removed from the body. If the alkalies, soda and potash, were not present in sufficient amounts to neutralize the acids, the carbon dioxide could not be dissolved, and it would remain in the tissues and cause tissue suffocation. If not enough base-forming elements are supplied in the foods the alkalies are withdrawn from the tissues, secretions, and excretions, and the nitrogenous end products are not broken down to urea, and tissue poisoning results.

During the oxidation of cells, tissues, and nitrogenous foods containing sulphur, phosphorus, and chlorine, acids are formed, and base-forming substances must be present in sufficient quantity to neutralize them.

Green vegetables and fruits contain the base-forming elements in abundance. In green vegetables they are present in the form of salts; in fruits, in the form of vegetable acids. A vegetable acid is an organic acid usually combined with potash or calcium in the form of potassium citrate, potassium tartrate, calcium citrate; and during oxidation they are converted into alkaline carbonates, as carbonate of potassium, and so help to render the blood alkaline.

CHAPTER IV

NUTRITIVE AND FUEL VALUE OF FOODS. DIGESTIBILITY

Nutritive and Fuel Value of Foods. — If the uses of food to the body are to build tissue and yield energy, the all-important question is, how much of each food is needed to supply these demands and in what proportion can they best serve the physiological needs of the body?

The value of any food to the body depends on three things, — the amount of nitrogen which it contains in the form of protein, the amount of heat which it will yield on combustion, and its ease and completeness of digestion, — in other words, its digestibility.

Amount of Protein Needed. — To be able to build tissue a food must contain nitrogen in a form available for use in the body. The proteins alone contain nitrogen in this form, and hence they are of first importance in food value, because they are the only foods available for tissue building.

The first question to determine, then, is, how much protein must be eaten to supply the needs of the body for building and repair of tissues. As practically all the protein digested is oxidized, either before it reaches the cells or in cell metabolism, and as its nitrogenous waste product leaves the body in the form of urea, the daily loss of nitrogen can be readily calculated, and this loss would show just how much protein is oxidized daily in the body, and how much would be needed to replace it. The daily intake of nitrogen, in the form of protein, should at least equal the amount of nitrogen excreted in the urea. This is called maintaining nitrogenous equilibrium.

Probably no more extensive and valuable studies have been made in human nutrition than those made in protein requirements. The conclusions drawn by the American experimenters will be given in this chapter; but it may be said here that the question as to how much protein is required by the average person is not so easily settled as is that of energy-yielding foods.

Experiments show that if the amount of nitrogen taken in, in the form of protein, is below a given amount, more nitrogen is excreted than is taken in the food. This would mean that the tissues are being used up and that there is a loss of bodily weight. If the normal bodily weight remains the same, and the amount of nitrogen taken in equals the amount excreted, nitrogenous equilibrium is maintained, and that should be the amount of protein needed by that individual. The amount of nitrogen lost is a fairly constant quantity, and does not appreciably increase with muscular exercise or work; and so when it is once determined for an individual, the protein requirements can be determined.

Atwater's experiments and calculations show that a man engaged in moderately active muscular work excretes 18 grams of nitrogen daily. A protein food is about 16 per cent nitrogen, which would mean that to supply this man with the amount of nitrogen needed to maintain nitrogenous equilibrium, he would have to consume about 112 grams of digestible protein (16 per cent of 112 grams protein = 18 grams nitrogen) or about 4 ounces protein (28.4 grams = 1 ounce.) for growth and repair of tissue. As a gram of protein yields about 4 calories, 112 grams would equal 448 calories of protein to be consumed daily. (For ease in calculating 450 calories are used.)

Chittenden, who has made some valuable studies in nutrition and conducted many experiments, arrived at the conclusion that the average person consumes too much protein, and that 60 grams, or 240 calories, daily will supply the needs of the average worker. Langworthy and Sherman agree that 100 grams are needed by the person engaged in moderately active muscular work. Atwater's conclusions, drawn after years of exhaustive dietary studies and practical investigations, do not differ greatly from Langworthy's and Sherman's, and it seems best to abide by these decisions until more conclusive evidence is given that growing or working men can maintain health, strength, and resistant power on a lower intake of protein.

Fuel Value of Foods. — The body needs a certain amount of food daily to supply it with the energy needed to maintain normal bodily temperature and for work and muscular activity, since all the energy used in the body, or by the body, comes from the food eaten. Even when a person is in a warm room, the body receives no heat from outside sources, but not so much heat is lost to the surrounding air. Clothing does not keep the body warm, but prevents loss of heat; the greater the surface of skin, or body exposed to the air, the greater will be the loss of heat. It is important to remember this when considering the question of dress for summer and winter, — that is, that all bodily heat comes from the food eaten and digested, and that if little clothing is worn in cold weather, the body must produce enough heat to make good the loss. If not enough food is taken to produce the energy needed to maintain normal bodily temperature (98.6° F.), and for vital processes, the tissues will be oxidized for that purpose.

All organic foods, namely, proteins, fats, and carbohydrates, yield energy when oxidized, but in varying amounts and hence have different food values. Experiments have been made to show what percentages of the various foods are digested and how much escapes digestion. The figures showing the coefficient of digestibility of the various foods will be given later. Experiments have also been made which show how much energy the foods will yield when oxidized in the body.

Excepting the amount of food which escapes digestion, it is found that the various foods will yield the same amount of heat when oxidized inside the body as they do when oxidized outside the body. Experiments with the bomb calorimeter in which foods are burned, and the heat evolved is measured, have given a way to measure the fuel value of the various foods. The amount of heat given off during oxidation is measured, and this shows the potential energy of the food. Account may then be taken of the difference between the amount lost during digestion and the total fuel value of the food, and by this method the fuel value of all foods can be ascertained.

The unit for measuring heat is the calorie, the amount of heat required to raise one pound of water 4° F. It is estimated that the fuel value of one pound of protein or carbohydrate is 1820 calories, and one pound of fat 4040 calories, when oxidized in the body.

ENERGY ACTUALLY AVAILABLE TO THE BODY

	1 GRAM	1 OUNCE	1 POUND
Protein	4 Cal.	114 Cal.	1820 Cal.
Carbohydrate	4 Cal.	114 Cal.	1820 Cal.
Fat	9 Cal.	253 Cal.	4040 Cal.

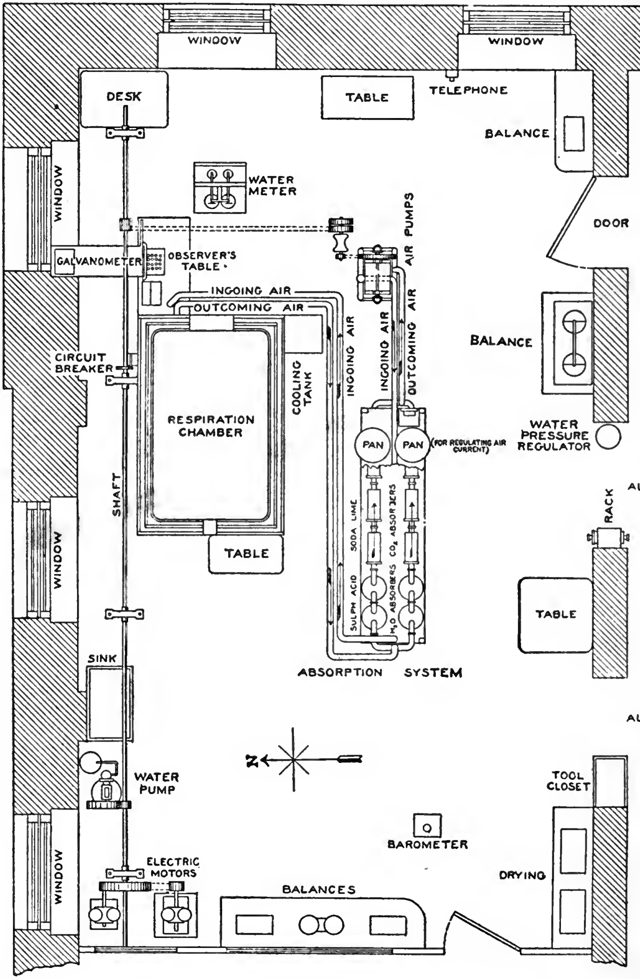
When oxidized in the calorimeter one pound of protein or carbohydrate yields 1860 Cal. and one pound of fat yields 4220 Cal. The difference is due to losses in digestion.

Proteins as Fuel. — It will be seen from these figures that the proteins, in addition to repairing muscular waste, may also be oxidized for energy. As proteins are needed for the first purpose, and are the only foods that can build tissue, the fats and carbohydrates are termed protein sparers and should be supplied in the right proportion and quantity, so that the proteins will not be oxidized as fuel. Proteins are the most expensive foods, and they form high-priced fuel; fats and carbohydrates are abundant in the cheaper foods. Then, too, fats and carbohydrates are completely oxidized in the body, leaving no waste substance, while the proteins leave the nitrogenous waste, urea, entailing extra work on the excretory organs to rid the system of it. From this it will be seen that it is of first importance that the fats and carbohydrates should be furnished in the right proportion to supply the potential energy needed and leave to the proteins the work of tissue building.

Amount of Energy Needed. — Atwater's and other experiments with the respiration calorimeter have given valuable data as to the amount of food needed by different persons to supply bodily needs. Unlike the amount of protein needed, which is a fairly constant quantity in any individual, the amount of energy needed is a variable quantity and increases with work and muscular activity. The following are the standards accepted by well-known American authorities as to the protein, energy, total food requirements, and nutritive ratio. They are planned for a man engaged in moderately active muscular work or, as Chittenden expresses it, a man weighing 154 pounds.

Name	Protein in Grams	Protein in Calories	Fat and Carbohydrate in Calories	Total in Calories	Ratio
Atwater	112	450 (nearly)	2950	3400	1 : 6½
Langworthy	100	400	3100	3500	1 : 7¾
Sherman	100	400	2600	3000	1 : 6½
Chittenden	60	240	2560	2800	1 : 10

Atwater's calculations as to the amount of nitrogen and also as to number of heat units needed by various individuals were arrived at after a series of dietary studies showing the amount of food actually consumed by normal people in various occupations, and of different nationalities, and different dietary standards; also after a series of experiments with the respiration calorimeter (described fully in Farmer's Bulletin, No. 142, U. S. Department of Agriculture) where an account was taken of the heat given off from the body, and of work expressed in terms of heat, and of loss through excreta. By these methods the actual income and expenditure of the body can be estimated or measured and the needs known. The needs were found to vary with the work, activity, age, and sex, — other factors also affecting the requirements.



Plan of Respiration Calorimeter Laboratory. See Frontispiece. From Yearbook, 1904, U. S. Department of Agriculture

He estimates that a man at absolute rest in bed would need 2000 calories daily to supply the imperative needs of the body, — namely, to carry on the vital processes of respiration, digestion, circulation, etc., and to maintain normal bodily temperature. It may be said, then, that every man, no matter what his physical condition or activity may be, needs 2000 calories daily. Any exertion, even to sitting up in bed, requires more energy and hence calls for more calories of food. From this it will be seen that a certain amount of food must be consumed when no work is performed and no apparent energy expended. If not enough food is taken to supply these demands, as in the case of sickness, the tissues are used for this purpose.

The following table will show how the needs of various individuals may be calculated. By counting the number of hours spent in various ways during the twenty-four hours of the day, the energy needed may be computed.

Hourly Outgo of Energy from the Human Body as determined in the Respiration Calorimeter by the U. S. Department of Agriculture

Average Weight (154 lb.)	Calories
Man at Rest (asleep)	65
Sitting Up (awake)	100
Light Exercise	170
Moderate Exercise	190
Severe Exercise	450
Very Severe Exercise	600

By this method Atwater estimated that a man engaged in moderately active muscular work needs about 3400 calories of heat daily. As this man would need 112 grams of protein daily, which is equal to 448 calories, he would need foods containing fats and carbohydrates in quantity to yield 2952 calories, or in proportion of 1 : $6\frac{1}{2}$.

Food requirements differ not only with the amount of activity manifested by the individual in different occupations during the day, but they also vary according to age, sex, and kind of work performed by different individuals. The requirements of a man engaged in moderately active muscular work are taken as a basis for the requirements of others.

FACTORS USED IN CALCULATING MEALS CONSUMED IN DIETARY STUDIES

Man at moderately active muscular work (Atwater).

Daily requirement 112 grams (450 Cal.) protein, 3400 total calories.

A man at hard muscular work requires 1.2 the food of a man at moderately active muscular work.

A man with light muscular work and a boy 15 to 16 years old each requires 0.9 the food of a man at moderately active muscular work.

A man at sedentary occupation, a woman at moderately active work, a boy 13–14, and a girl 15–16 years old each requires 0.8 the food of a man at moderately active muscular work.

A woman at light work, a boy 12, and a girl 13–14 years old each requires 0.7 the food of a man at moderately active muscular work.

A boy 10–11 and a girl 11–12 years old each requires 0.6 the food of a man at moderately active muscular work.

A child 6–9 years old requires 0.5 the food of a man at moderately active muscular work.

A child 2–5 years old requires 0.4 the food of a man at moderately active muscular work.

A child under 2 years requires 0.3 the food of a man at moderately active muscular work.

Nutritive Ratio of Foods. — In the dietary standards quoted, it will be noted that the proteins bear a certain relation to the fats and carbohydrates, that each man has selected according to his judgment or experiments the proper ratio in which tissue-building and energy-yielding foods should be taken so as to secure the best diet, that is, the diet which will produce the greatest efficiency with the least nitrogenous waste. Atwater's ratio is $1:6\frac{1}{2}$, Chittenden's is $1:10$. This relation of the proteins to the carbohydrates and fats is called the nutritive ratio or the nutrient ratio of foods, and is of value in determining the place which any food or any class of foods can take in the diet, or whether a meal or ration, when planned, is properly balanced.

The nutritive ratio of any food may be found in two ways. It may be found by taking the chemical composition of the food as given in the Atwater tables and expressing the ratio of the protein to the carbohydrate plus the fat multiplied by $2\frac{1}{4}$, or the fat in terms of carbohydrate. The fat must be multiplied by $2\frac{1}{4}$ to express it in terms of carbohydrate, because when oxidized in the body a pound of fat will yield $2\frac{1}{4}$ times as many calories as a pound of carbohydrate will yield.

EXAMPLE. — Milk contains $3\frac{1}{2}$ per cent protein, 4 per cent fat, 5 per cent carbohydrate. $3\frac{1}{2} : 5$ plus (4 times $2\frac{1}{4}$) $:: 1:4$. The nutritive ratio of milk, then, is $1:4$. This shows that milk contains too much protein, in proportion to its carbohydrate and fat, to be a perfectly balanced food.

The nutritive ratio may be found in another way. If, in addition to caring to know the proportion of tissue-building to energy-yielding ingredients in a food, we wish also to know its actual fuel value, we may reduce the chemical composition proportion to calories, and find the ratio, by comparing the protein to the carbohydrate plus the fat, all having been reduced to calories.

EXAMPLE. — Milk contains $3\frac{1}{2}$ per cent protein, 4 per cent fat, 5 per cent carbohydrate. If one pound of protein yields 1820 calories, $3\frac{1}{2}$ per cent of the milk would yield 64 calories; 4 per cent of fat would yield 160 calories, 5 per cent of carbohydrate would yield 91 calories, a total of 315 calories in one pound of milk.

The nutritive ratio would be 64 calories: 160 calories plus 91 calories : : 1 : 4.

From these figures it will be seen that one pound, or two cups, of milk will yield 315 calories, and that it would take nearly eleven pounds, or twenty-two cups of milk alone, to supply the daily needs for heat and energy of a man engaged in moderately active muscular work. One pound of milk contains one half ounce of protein, and it would take eight pounds of milk to supply the nitrogen needed daily. Milk contains so much water, that too great quantities would have to be consumed if one were to try to live on milk alone.

Its nutritive ratio is too high in protein to make it a properly balanced food.

Digestibility. — The third factor which affects the value of any food is its digestibility. By this is meant, not ease of digestion, but completeness of digestion, or how much escapes digestion. A food may contain proper nutritive ingredients in the right proportion to supply the needs of the body, but because of its structure, or because of the changes which have taken place in cooking, or because of individual inability, the body may not be able to digest it. A food is of no use to the body until it has passed out of the intestines into the blood. Only then is it available as food.

Because of this factor, digestibility, it would seem that a knowledge of the structure of foods, the effect of heat on them, the various physical and chemical changes which take place during cooking, and the effect of each on digestibility is of utmost importance.

Structure and Cooking. — The starch and protein in vegetable cells are inclosed in a wall of cellulose. This cellulose is indigestible to man, but is valuable in that it furnishes bulk which stimulates the walls of the stomach and intestines, aids in bringing out the juices, and increases peristaltic movement. Before the inclosed starch or protein can be digested some means must be found to free it from its cell walls. Cooking will do this by softening the walls and by causing the inclosed starch to swell and burst the walls. For this reason, cooking is necessary before starchy foods can be digested.

In some foods, as in the legumes, the starch and protein and cellulose are so intermixed that the digestive juices cannot readily act on the protein, and much escapes digestion. The heat, which renders starch digestible, renders the protein less so. Animal proteins, because they are not mixed with other foods, and because they are like the human body in structure, are more completely digested than vegetable protein; 97 per cent of the former is digestible and 87 per cent of the latter.

Many experiments have been made to test the digestibility of the various foods. The food taken in and the food given off from the large intestine have been weighed and analyzed, and the difference between them would equal (practically) the amount digested, and available to the body. This amount is called the coefficient of digestibility of the foods.

The following, taken from Farmer's Bulletin, No. 142, sums up the conclusions arrived at by the U. S. Department of Agriculture as a result of investigation: "It has been found that in the total food of the ordinary mixed diet, on the average, about 92 per cent of the protein, 95 per cent of the fats, and 97 per cent of the carbohydrates are retained by the body. In the average proportions in which the different animal and vegetable foods are combined in the diet about 97 per cent of the protein, 95 per cent of the fat, and 98 per cent of the carbohydrate of the animal foods are digested; while only 84 per cent of the protein, 90 per cent of the fat, and 97 per cent of the carbohydrates of the vegetable foods are digested.

"The digestibility of a given article of food depends upon the digestibility of the classes of nutrients, and the relative proportion in which these nutrients occur. Thus, of two cereals containing about the same amount of dry matter, but with different proportions of protein and carbohydrates, the one with the larger proportion of less digestible protein and the smaller proportion of more digestible carbohydrates will be, on the whole, less completely digested."

Proportion of Carbohydrates to Fat. — While it has been stated that fats and carbohydrates are both sources of energy to the body and may be used interchangeably, such is not the case, because they vary in digestibility. There is a limit to the amount of fat which any individual can digest, and while the limit varies with different individuals, fat could not be depended on for the total supply of energy. On the other hand, the amount of carbohydrates which would supply the energy needed would prove too bulky for the digestive organs and would leave too much waste or excreta. It has been found that the best proportion of fat to carbohydrate, as regards digestibility, is about 1 to 2½, or 1 part fat to 2½ parts carbohydrates, by weight.

Mineral Matter.— It is customary to consider only the amount of protein, fat, and carbohydrate in the diet, and to conclude that if those foods are in the right proportion, they will also supply the required amount of mineral matter. This would probably be true if foods were taken in their natural state, as green vegetables and fruits are eaten, but many foods are prepared for the diet in such a way that much of the mineral matter is lost. This is true of wheat, rice, corn, and the other cereals, and they form 30 per cent of our diet. Sugar and fats containing no mineral matter would furnish 10 per cent more. It would seem that because of the methods of preparing foods for market more careful attention should be paid to the quantity of mineral matter supplied. As will be seen by referring to page 33, mineral matter is as necessary to health as are the organic foods, and as it aids all vital processes it can be said that it is essential to all vital processes. Oxygen and carbon dioxide cannot be carried without it, so it is essential for respiration; it is found in all digestive juices, so it is necessary for digestion; it aids absorption and excretion; is essential for coagulation; and no tissue can be built without it. The mineral matter needed by the body is of too great importance to be left to chance to supply. Foods should be selected that contain iron, phosphorus, calcium, and the other elements in greatest abundance.

ESTIMATED AMOUNT OF MINERAL MATTER REQUIRED DAILY BY A MAN AT MODERATELY ACTIVE MUSCULAR WORK (Langworthy)

Phosphoric Acid	3–4 grams
Sulphuric Acid	2–3.5 grams
Potassium Oxide	2–3 grams
Sodium Oxide	4–6 grams
Calcium Oxide	.7–1 gram
Magnesium Oxide	.3–.5 gram
Iron	.006–.012 gram
Chlorine	6–8 grams

FOODS RICHEST IN MINERAL MATTER

IRON	PHOSPHORUS	CALCIUM	SODIUM	POTASSIUM
lima beans, dried	navy beans	almonds	beans	beans
navy beans	egg yolk	beans	peas	peas
peas, dried	peas, dried	egg yolk	lentils	lentils
entire wheat flour	entire wheat flour	milk	eggs	figs
spinach	peanuts	peas	spinach	cocoa
lean beef	oatmeal	oatmeal	carrots	molasses
oatmeal	almonds	walnuts	celery	bananas
raisins	walnuts	peanuts	cauliflower	lemons
eggs	lean beef	eggs	endive	limes
prunes	eggs	parsnips	leeks	pineapples
beef, medium fat	low grade flour	carrots	radishes	oranges
string beans	prunes	oranges	beets	apricots
flour, patent	milk	prunes	turnips	cherries
potatoes	rice	entire wheat flour	rutabagas	apples
corn meal	patent flour	low grade flour	oatmeal	nuts
cabbage	parsnips	beets	corn	rhubarb
sweet corn	potatoes	potatoes	wheat	tomato
turnips	turnips	pineapple	raisins	parsnips
			prunes	beets

Foods containing Little or No Iron

All forms of fat, as pork, bacon, lard, butter, olive oil, also sugars, starches, candies.

If enough protein is supplied, there will be enough sulphur in the diet; sodium and chlorine are supplied in common salt.

CHAPTER V

THE BALANCED MEAL

Reasons for Balanced Meals. — All meals, no matter how meager, insufficient, or poorly balanced, should have some little attention given to their planning for one or more reasons.

Variety in Diet. — The first reason for planning meals is to satisfy the hunger of the various members of the family. This would be an easy matter if all members were in good health, worked all day, and liked most of the foods in the market. Hunger is the best sauce, and mere abundance of food will soon satisfy a ravenous appetite. Such conditions are seldom found, however; and in many families much needless worry and planning are occasioned the housekeeper because some members of the family have prejudices against certain foods, and what one member is especially fond of another may loathe. The prejudices, unless well founded, should be overcome, because when the finical person is obliged to live away from home, where his peculiar tastes cannot be studied and catered to, he is apt to suffer. But even when the members of the family are not hard to please, the planning of meals requires some thought so as to vary the diet and provide the unexpected, as the same food, day after day, or on regular days in the week, becomes monotonous and loses savor.

Cost. — A factor which constantly enters into the calculations when planning meals is cost. This includes not only the cost of the food, but the cost of the fuel used in cooking and the time and labor spent in the service of the meals. The problem of cost of foods is a serious one, is threatening to become more serious every year, and demands greater consideration than most people give it. The probabilities are that the increased cost of living is not due to consumption overtaking production, but that people demand as necessaries of life what were once considered luxuries. If some attention and study could be given to the factors which enter into the fixing of the market price of various foods, and cheaper foods, equally nutritious and wholesome, could be substituted for the necessarily high-priced foods, it would decrease the cost of living materially.

Judicious marketing is an art in itself. It implies a knowledge of the proper cuts of meat, their various uses, the distinction between a cheap cut with much refuse in the form of bone and fat or a higher-priced cut that is nearly all flesh; also a knowledge of the various vegetables, when they are in season, in what quantities it is best to purchase them, their food value and place in the diet, and the effect of size on flavor, time of cooking, and nutritive value.

There is great need for economy and judicious buying in foods as in everything, but there is a marked distinction between true and false economy in foods. It is a great mistake to stint the table and nourish the family poorly and thus lose from the family income many times that amount in doctor's bill, medicine, and money spent by various members of the family elsewhere to satisfy the demands of hunger or a craving for unwholesome food.

Supply Needs of the Body. — The most important reason why meals should be carefully planned is because health, strength, and working capacity depend on the food which we eat. It is no exaggeration to say that if people understood and looked after three vital processes, they would never be sick; these processes are breathing, digestion, and elimination of waste. Imperfect digestion and assimilation, and accumulation of waste products in the system are the cause of nearly three fourths of all diseases.

The human body can, under normal conditions, digest and assimilate a certain amount of food. If more is taken than can be digested, it accumulates as waste. All foods undergo chemical change in the body; they are broken down into simpler substances which the body can more easily take care of. The decomposition products of proteins are removed through the kidneys, and if too much protein food is taken, the kidneys are overworked. It has been found that there is a certain amount of protein food that an individual needs; anything in excess of this is harmful because it means an unnecessary waste of energy to rid the system of it. This can be avoided by a study of the composition and digestibility of foods, the bodily needs supplied by the various foods, and the amount of each kind of food needed by the individual to maintain bodily weight and furnish energy needed for work and activity.

A diet must furnish protein enough to build and repair the tissues of the body. The need for protein is greater in childhood and youth, than in maturity and old age, because the tissues wear out more rapidly in these periods and they are also periods of growth. Protein and mineral matter should be supplied so that tissues will not suffer and growth will not be stunted. Weak, stunted, and diseased bodies are more apt to be due to insufficient and poorly balanced meals than to inherited weakness. Mother Nature is too often blamed for imperfection, when a little knowledge of the needs and demands of the growing body, and what foods would supply these demands, would have prevented the weakness or deformity.

Much is said and written about the excessive consumption of protein foods. While men may consume excessive amounts of protein, observation and dietary studies show that the average girl and working woman do not consume enough protein, but consume excessive amounts of starchy foods and sugar. For this reason, vitality and resistant power are lower than they should be. Then, too, iron, phosphorus, and calcium, the former needed in greater quantities by growing girls and women than by men, are lacking in the starchy foods and sugar, but are abundant in protein foods, and in green vegetables and fruits. If this statement as to the diet of working girls and women seems exaggerated, one has but to observe the meals ordered in cafés and restaurants in cities where women take their meals. There is a marked difference between the lunches ordered by a man and by a woman, and the difference is not so much that of quantity, which would be natural, but in the predominance of proteins in the man's meal, and of sugar and starchy foods in the woman's.

The diet must contain enough fat and carbohydrate to maintain temperature, and for energy to carry on the vital processes, and for work and activity. It must contain sufficient bulk in the form of cellulose to stimulate the intestine so that the intestinal juice will be secreted in the proper amount, also to stimulate the muscular walls so that the food will move rapidly enough so that putrefaction will not take place and the indigestible food can be expelled from the body. It must contain sufficient water to supply the needs of the tissues and fluids of the body and to aid in the elimination of waste through the excretory organs. It should have enough mineral matter to supply the needs of the tissues and fluids and to maintain normal alkalinity of the blood and tissues. It must not be too difficult to digest, or it will overtax the digestive organs. Indigestibility may be due to the food itself, to the method or manner of cooking, or to the mental or physical condition of the individual.

People suffering from nervous troubles have difficulty in digesting foods, and the trouble is augmented by the fact that they do not take in enough food to feed the starved nerves and build up the system, or to give energy. Nervous indigestion is not cured by taking liquid foods or small quantities of food, but by building up the general health and by decreasing nerve strain. General health is improved by a good, wholesome, easily digested, and balanced daily ration.

It would seem that too much attention is given to the overfeeding of the better classes and not enough emphasis laid on the pernicious underfeeding and excessive consumption of baker's bread and other starchy foods and sugar, by the middle and lower classes. Enormous quantities of bakeshop food are sold to people who do not know the needs of the body for building material and who desire to satisfy the appetite at the lowest cost and in the quickest and easiest way.

Wheat made into white flour has lost over two thirds of its mineral matter and over 2 per cent protein in milling; and from dietary studies made by Langworthy it would seem that white flour furnishes over 10 per cent of our diet, and refined corn products furnish over 8 per cent.

Even though meat, butter, eggs, and milk are high-priced they are cheap when compared with the cost of medicine, medical attention, and loss of wages during sickness occasioned by underfeeding. Tuberculosis, the disease responsible for one third of all deaths in America, between the ages of 15 and 45, is due to under nutrition and lack of protein foods, as well as to foul air and tuberculosis germs.

Men have greater resistant power than women, more energy, more vitality, less sickness. This is due, in part at least, to the fact that they eat wholesome and nutritious foods in quantity to supply the needs of the body, when they can get it, and consume but little sugar. It is noted that women with strong vitality and energy consume much the same diet as men, though not in as great quantities, while those with less vitality consume more starchy foods, especially foods lacking in mineral matter. Why may not the increased vitality be due to proper diet, instead of the taste for wholesome foods being due to bodily vigor? At any rate, the taste for nutritious foods could easily be cultivated if the general effect of such a diet on health were known and heeded.

Practical Value of Balanced Meals. — The question might be asked, of what practical value to the busy housekeeper is the planning of meals, and can any family live according to a standard set arbitrarily?

It does not mean that any dietary standard should be selected, and all members of the family compelled to live according to that standard. It will be found, however, that the Atwater standard is ample for all needs, that a little less than the standard may suffice some, but that if a family attempts to live according to a standard it will soon become accustomed to it and adopt it. Standards are not arbitrary figures, but guides to the best means of supplying the needs of the body. They are made for those who must take the knowledge and investigations of men who have devoted their lives to the study of questions of nutrition, until they can find out that certain changes are necessary.

The planning of balanced meals is a method of conducting the business of housekeeping on an accurate and scentific basis, and that is the basis on which every other business is conducted. First, it lessens the cost of the meal. If the amount actually needed by each individual is prepared and served, there will be no waste, and from the dietary studies made by Langworthy it was found that in the average American home "waste ranges from nothing to 20 per cent of the total food."

When the amount to be spent on a meal is decided on, more attention is paid to the cost of such items as fruit, cream, butter, meat, etc., and goods are purchased in season, and in quantities so as to save expense. The table of nutritive values is studied, and less expensive foods, equally nutritious, are substituted for the high-priced foods.

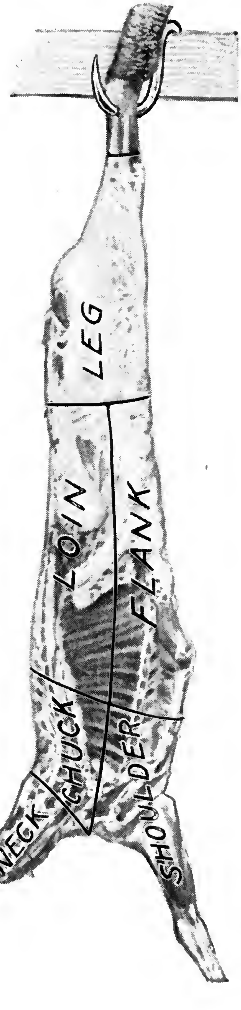
Second, the planning of balanced meals saves time in preparation. When meals are planned one day or more ahead, time and labor are economized in marketing and in preparation, because they are planned with reference to other meals, and many foods are prepared the day before they are to be used.

More important still, when meals are planned according to some accepted standard to serve the food requirements of the body, a study may be made as to how such meals satisfy the sense of hunger and please the taste, for that is the first demand of the meal. It can be ascertained whether the members of the family are gaining or losing weight,

Loin

Fore quarter

Hind quarter



Cuts of Mutton

whether strength and working power are maintained, and if the resistant power of the body to colds and common diseases is strong. The effect of the diet on the organs of elimination can be ascertained. Constipation is one of the causes of low vitality, feeble resistant power, appendicitis, liver and intestinal troubles, because the blood and muscles become saturated with decomposition products, as gases and poisons, which are absorbed by the capillaries of the large intestine and enter the blood; it can be remedied by diet.

Properly balanced meals which serve the food requirements of each individual will maintain a person in perfect health for a normal life, if pure air is supplied, and waste products are properly eliminated from the body.

CHAPTER VI

PLANNING OF MEALS

For the purpose of this book, it matters little what dietary standard is used in planning meals. When the method of planning is learned, each person can decide for himself which standard to follow. The important point is to learn how to plan meals easily, quickly, and accurately according to any standard.

The meals should supply all the needs of the body and satisfy the sense of hunger. They should be attractive, appetizing, and planned so that they may be served in a simple manner. The cost of meals should be moderate. Most of the drudgery of housework results from an attempt to serve too many different kinds of foods at a meal and to serve the food in too many courses. If one person is preparing and serving the meal, it is difficult for her to get all foods prepared at the right time and to keep them warm until needed; and when many courses are served, there is an increase in the number of dishes to be washed. A few foods, well cooked and served in a dainty and appetizing form, please better than a dozen poorly cooked foods served cold when they should be served hot.

The serving should be taught in such a manner that it can be practiced in any home, the object of all the work in the school being to improve home conditions, and for this reason all directions are given in terms that the average girl can understand.

Nothing is said of the 100-calorie portion, or method of planning meals, because while that method is useful in planning meals for individuals or to show graphically the amount of nutrients in a portion of food, it is of little value to the busy housekeeper who is planning the family meals.

All values are given in pounds, not grams, because the gram means nothing to a person outside of a chemical laboratory. Foods are bought and sold by the pound, and the scales used in the home weigh pounds.

For the same reason — familiarity — all temperatures used are Fahrenheit. Until the Centigrade thermometer is used in the home it is useless and confusing to give temperatures which the average girl cannot translate.

SUGGESTIONS FOR PLANNING MEALS

Planning a Breakfast

A breakfast should consist of, —

I. Fruit in some form, preferably fresh.

II. Cereal, best from the whole of the grain, and cheapest if purchased unprepared for use.

III. Some protein dish, as eggs, fish, hash, or a small quantity of meat. Unless eggs are very high in price they are always better and cheaper than meat for breakfast.

IV. Some form of bread, as toast, bread, muffins, biscuit, popovers, griddle cakes, rolls, etc.

V. A hot drink, as coffee or cocoa, if desired.

The cost of the food should not exceed eight cents per person, and the meal may be planned so that the cost will not exceed five cents per person. Fruits and eggs should be served in season, for then the prices are moderate. Uncooked breakfast foods cost less than half what prepared foods cost, and they may be cooked in the fireless cooker the day before, thus saving time in preparation. Dried fruits, as dates, figs, and prunes, may be chopped and added to the cereal.

Toast, rolls, and griddle cakes take less time to prepare than muffins, popovers, and biscuits.

A breakfast should not take more than thirty minutes to prepare. This should include laying the table and all preparatory work. Unless in case of sickness, all members of the family should eat breakfast together. If several breakfasts must be prepared, it adds to the labors of the housekeeper. No child should be allowed to go to school without breakfast.

Planning a Dinner

A dinner should consist of, —

I. Meat. May be served as roast, stew, meat loaf, meat pie, or in any other convenient form.

II. Potatoes and one other vegetable, as peas, beans in fresh form, a root or tuber, or one of the green vegetables that require cooking. These may be served mashed, creamed, fried, scalloped, or baked. Bread.

III. Salad, when possible. It should be a green vegetable with some kind of salad dressing. Heavy salads should not be served with dinner, but may form the principal dish at lunch or supper.

IV. Dessert.

V. Tea or coffee, if desired.

Soup is not necessary at dinner and may well be omitted, as it takes some extra work to prepare it and it is hard to keep the remainder of the dinner in condition while soup is being served unless some one is in the kitchen.

The cost of dinner will range from ten to sixteen cents a person. It depends primarily on the amount spent for meat.

Planning Lunch or Supper

A lunch, served at noon when dinner is served at night, or supper should consist of, —

I. A hot meat dish, as chops, meat pie, etc.; or a cheese dish, as macaroni and cheese, cheese fondue, or rarebit; or cold meat; or a salad; or a cream soup.
II. Potatoes. Bread.
III. Sauce and some form of cake.
IV. Tea, cocoa, or milk, if desired.

As will be seen by referring to the table of "Calories per Recipe," page 100, a cream soup contains enough nutrients to supply the food requirements for lunch or supper, if served with bread.

Lunch or supper should cost from six to ten cents per person.

The standard used in planning meals is the Atwater standard for food requirements for a man engaged in moderately active muscular work. Atwater estimated that such a man would require 450 calories protein, 2950 calories fat and carbohydrate.

One fourth of this amount would make a fair proportion for breakfast or supper, and one half the amount for dinner. Some people eat a very light breakfast and a heavy dinner and supper; some prefer the heavy meal at night or dinner, and a light breakfast and supper, or lunch. It is not necessary that every meal should be balanced, though it is desirable, but the daily ration should supply the right number of calories in the right proportion.

If the Atwater standard is taken as a basis, or any standard for that matter, by using the table on page 50, the amount of food needed by the different members of the family can be ascertained. The sum of the requirements of the members of the family will be the amount to be prepared, and the food may be served in the portions required.

To simplify the work of calculating dietaries, a table has been prepared showing the calories per pound in the common foods. All calculations for meals can be made on the basis of a pound or ounce or the fractions thereof. A few common recipes, as biscuit, muffins, bread, pie crust, etc., have been worked out and are given in the table, "Calories per Recipe." (See page 100.)

The number of calories in any food not given in the table may be found by multiplying 1820 by the percentage composition of protein or carbohydrate, and 4040 by the percentage composition of fat; the figures given above are the number of calories in a pound of protein, fat, or carbohydrate.

Bulletin No. 28, Office of Experiment Stations, Washington, D.C., contains tables showing the percentage composition of all foods in use in the average home. Farmers' Bulletin, No. 142, also gives the composition of many of the common foods. This bulletin may be obtained free of charge from the U. S. Department of Agriculture.

A few measurements that will be found useful in planning and preparing meals are given to simplify the work of calculating. A table grouping foods according to equivalent nutritive values is supplied so that substitutions may be suggested to the housekeeper.

At the close of the chapter a few sample menus are given that were prepared and served according to the plans formulated in this book. They were part of the domestic science work of a class of students. Each student was given a certain amount of money with which to purchase the food. She planned and balanced the meals, did the marketing, cooking, serving, and washed the dishes afterwards, leaving the kitchen and dining room in order. Each girl was responsible for three meals. The meals were served to fellow students and teacher as guests. The practice and training form the most valuable part of a domestic science course, as the pupils are limited in money and in time spent in preparing the meal to the same limitations which exist in the average home.

FOODS GROUPED ACCORDING TO FAIRLY EQUIVALENT NUTRITIVE VALUES

ROOTS AND TUBERS. Food value. Carbohydrate and mineral matter.
Include potatoes, sweet potatoes, onions, rutabagas, turnips, beets, parsnips, celeriac, artichokes, etc. Served boiled, mashed, creamed, scalloped, fried.

CEREALS. Food Value. Protein and carbohydrate in proportion of about 1 : 6. Include wheat, oats, corn, rye, barley, rice, buckwheat. Prepared mostly as flours, meals, and breakfast foods.

LEGUMES. Food value. Protein and carbohydrate in proportion of about 1 : 3.
Include peas, beans, lentils, peanuts.
Contain so much protein that they are a substitute for meat.
Served boiled, creamed, in soups, and in other forms.

GREEN VEGETABLES. Food value. Chiefly in the mineral salts and cellulose.
Include celery, lettuce, cucumbers, endive, cress, cabbage, tomatoes, spinach, green corn, egg plant, salsify, squash, Brussels sprouts, etc.
First seven are best served green as salad. All but lettuce, endive, and cress may be boiled and served in various ways.

FRESH FRUITS. Food value. Mostly in the vegetable acids.
Include apples, oranges, lemons, grapefruit, grapes, bananas, berries, plums, cherries, peaches, pears, etc.
Served fresh, also canned and used as sauce, etc.

DRIED FRUITS. Food value. Mostly sugar and cellulose.

Include figs, dates, raisins, currants, fresh fruits dried.

Served in a variety of forms.

FATS. Nutritive value in the fat.

Include all animal fats, as butter, lard, etc., also vegetable fats, as olive oil, cottonseed oil, peanut oil, corn oil, cocoa fat, and butterine, and other prepared fats.

MILK. Food value. Protein, carbohydrate and fat in proportion of 1 : 4.

CHEESE. Food value. Protein and fat, in proportion of 1 : 2½. Substitute for meat.

MEATS. Food value. Mostly protein. They all contain fat in varying amounts, and much fat is lost in cooking or is not served, so the nutritive ratio cannot be given.

Served as steaks, chops, roasts, stews, or as meat loaf, etc.

FISH. Food value. Same as meat.

Served boiled, fried, baked, creamed, and in other forms.

MEASUREMENTS FOR PLANNING MEALS

	QUANTITY IN ONE LB.	QUANTITY IN ONE OZ.
Flour, sifted	3¾ cups	3¾ tablespoons
Flour, unsifted	3 cups	3 tablespoons
Sugar	2 cups	2 tablespoons
Butter	2 cups	2 tablespoons
Lard	2 cups	2 tablespoons
Oatmeal	4 cups	4 tablespoons
Cream of Wheat	2 cups	2 tablespoons
Shredded Wheat	16 biscuits	1 biscuit
Milk	2 cups (about)	2 tablespoons
Cream	2 cups (about)	2 tablespoons
Eggs	9 large	1 egg $1\frac{7}{9}$ oz.

Quantity in one pound:
- Oranges, 2 large, as purchased.
- Apples, 4 medium, as purchased.
- Bananas, 4 medium, as purchased.
- Potatoes, 2 large, as purchased.

The following meals were planned and served by girls over fifteen years of age; each meal was planned for six people.

The amount required was first ascertained; then the meals were planned to furnish the required amount. The amount needed for six girls was then prepared, served in equal portions, and consumed.

All calculations were made on the basis of a pound or ounce or fraction thereof. Meat and fish were weighed as purchased, vegetables were weighed as prepared for cooking.

Girls over fifteen years of age would require $\frac{8}{10}$ of the standard accepted. According to the Atwater standard they would require 360 calories protein, and 2360 calories fat and carbohydrate daily. One fourth of this amount, 90 calories protein, and 590 calories fat and carbohydrate, would be the amount prepared for breakfast, lunch, or supper, and one half of this amount, 180 calories protein, and 1180 calories fat and carbohydrate, for dinner.

In the meals given in the following pages this proportion was followed as closely as possible.

The meals in the last menu were divided so as to furnish a heavier meal for supper and a lighter meal for dinner than in the preceding menus. The total calories are the same, however.

In several breakfast menus the time for preparation is given to show how the detailed work is planned and carried out. It is not considered necessary to give the plan of work for each meal.

DAILY MENUS

STANDARD: 360 CALORIES PROTEIN, 2360 CALORIES FAT AND CARBOHYDRATE

$\frac{1}{4}$ for breakfast, $\frac{1}{2}$ for dinner, $\frac{1}{4}$ for supper

Menu Number One

	Calories Protein	Calories Fat and Carbohydrate
Breakfast	85	596
Dinner	178	1181
Supper	90	574
	353	2351

Menu Number Two

	Calories Protein	Calories Fat and Carbohydrate
Breakfast	88	589
Dinner	183	1176
Supper	90	594
	361	2359

Menu Number Three

	Calories Protein	Calories Fat and Carbohydrate
Breakfast	90	583
Dinner	175	1189
Supper	91	598
	356	2370

Menu Number Four

	Calories Protein	Calories Fat and Carbohydrate
Breakfast	87	593
Dinner	180	1166
Supper	94	607
	361	2366

Menu Number Five

	Calories Protein	Calories Fat and Carbohydrate
Breakfast	88	593
Dinner	183	1178
Supper	89	587
	360	2358

Menu Number Six

	Calories Protein	Calories Fat and Carbohydrate
Breakfast	86	584
Dinner	194	1184
Supper	83	596
	363	2364

Menu Number Seven

	Calories Protein	Calories Fat and Carbohydrate
Breakfast	90	590
Dinner	184	1184
Supper	83	587
	357	2361

$\frac{1}{4}$ for breakfast, $\frac{7}{16}$ for dinner, $\frac{5}{16}$ for supper

Menu Number Eight

	Calories Protein	Calories Fat and Carbohydrate
Breakfast	82	589
Dinner	161	1008
Supper	117	759
	360	2356

MENU

BREAKFAST

Bananas
Wheat Breakfast Food and Cream
Creamed Dried Beef Biscuit
Coffee

Food	Quantity	Calories Protein	Calories Fat	Calories Carbo-hydrate
Bananas	$1\frac{1}{2}$ lb.	36	36	573
Wheat Breakfast Food .	6 oz.	69	27	506
Cream	4 oz.	12	187	21
Milk	4 oz.	15	41	23
Dried Beef	8 oz.	240	140	. . . .
White Sauce	1 R.	37	297	89
Sugar	2 oz.	. . . .	. . . .	228
Butter	2 oz.	2	429	. . . .
Coffee	1 oz.	. . . .	. . . .	. . . .
Biscuits	$\frac{3}{4}$ R.	98	341	641
Total . . .		509	1498	2081

For six people: 509 Cal. Protein.
3579 Cal. Fat and Carbohydrate.

Per person: 85 Cal. Protein.
596 Cal. Fat and Carbohydrate.

Breakfast to be served at 7.30 A.M.

7.10 — Make biscuit.

7.15 — Take wheat from fireless cooker and put it on the stove, set table, put on fruit.

7.25 — Make coffee.

7.30 — Serve breakfast.

Cost $.48.

TIME FOR PREPARATION

Bananas — 1 min.
Wheat flakes (day before) in fireless cooker.
Dried beef — 10 min.
Biscuit — 20 min.
Coffee — 5 min.

MENU

DINNER

Beef Loaf — Tomato Sauce
Browned Potatoes — Creamed Onions
Fruit Salad — Bread
Washington Pie — Coffee

Food	Quantity	Calories Protein	Calories Fat	Calories Carbohydrate
Beef Loaf	4/5 R.	590	1562	48
Tomato Sauce	1 R.	41	441	186
Potatoes	2 1/4 lb.	90	9	738
Onions	1 5/16 lb.	38	16	216
White Sauce	1 R.	44	296	130
Oranges	1 1/4 lb.	21	10	263
Bananas	3/8 lb.	18	18	286
Salad D.	1/2 R.	36	232	72
Bread	8 oz.	84	26	482
Butter	2 oz.	2	428	....
Cake	1/2 R.	86	286	808
Cream	6 oz.	17	280	31
Sugar	2 oz.	....	....	227
Coffee	1 oz.	....	....	....
Total		1067	3604	3487

Per person: 178 Cal. Protein; 1181 Cal. Fat and Carbohydrate.
Cost, $.72.

MENU

SUPPER

Cold Roast Pork Potatoes in Half Shell
Bread
Canned Peaches Plain Cake

Food	Quantity	Calories Protein	Calories Fat	Calories Carbo-hydrate
Pork	1 lb.	282	586	. . . .
Potatoes	1 lb.	40	4	328
Bread	12 oz.	125	40	725
Plain cake	¼ R.	42	143	404
Peaches	1 lb.	13	4	179
Sugar	2 oz.	. . . .	. . . .	228
Butter	2 oz.	2	428	. . . .
Milk	8 oz.	30	81	46
Frosting	¼ R.	6	. . . .	227
Total . . .		540	1286	2155

For six people: 540 Cal. Protein.
3441 Cal. Fat and Carbohydrate.

For one person: 90 Cal. Protein.
574 Cal. Fat and Carbohydrate.

MENU

BREAKFAST

Baked Apples
Oatmeal and Cream
Scrambled Eggs and Muffins
Coffee

Food	Quantity	Calories Protein	Calories Fat	Calories Carbohydrate
Baked apples . . .	$1\frac{1}{2}$ lb.	11	30	356
Oatmeal	6 oz.	114	111	451
Cream	4 oz.	12	187	22
Milk	4 oz.	15	42	23
Eggs	12 oz.	179	282	....
Muffins	1 R.	197	624	855
Sugar	2 oz.	....	....	228
Butter	$1\frac{1}{2}$ oz.	2	320	....
Coffee	$1\frac{1}{2}$ oz.	....	....	....
Total		530	1596	1935

For six people: 530 Cal. Protein.
3531 Cal. Fat and Carbohydrate.

Per person: 88 Cal. Protein.
589 Cal. Fat and Carbohydrate.

TIME FOR PREPARATION

Baked apples, prepared the day before.
Oatmeal cooked in fireless cooker the night before.
Muffins — 30 min.
Coffee — 5 min.
Scrambled eggs — 5–10 min.
Breakfast to be served at 7.30. Start breakfast at 7.00.

Cost, $.50.

MENU

DINNER

Leg of Lamb Riced Potatoes
Squash Cabbage Salad
Bread
Banana Pie Coffee

Food	Quantity	Calories Protein	Calories Fat	Calories Carbo-hydrate
Lamb	2¼ lb.	650	1235	....
Cabbage	1 lb.	25	8	97
Squash	1½ lb.	39	30	246
Bananas	8 oz.	12	12	191
Potato	2½ lb.	100	10	820
Eggs	3½ oz.	52	82	....
Sugar	9 oz.	....	....	1023
Cream	12 oz.	34	560	61
Bread	9 oz.	94	30	542
Salad	½ R.	36	232	72
Butter	4 oz.	4	858	....
Milk	2 oz.	7	20	11
Pie crust	⅔ R.	44	513	303
Corn starch	1 oz.	....	....	102
Total		1097	3590	3468

Per person: 183 Cal. Protein; 1176 Cal. Fat and Carbohydrate.
Cost, $.90.

MENU

SUPPER

Baked Macaroni and Cheese
Lettuce and Egg Salad
Bread
Canned Pears Cake

FOOD	QUANTITY	CALORIES PROTEIN	CALORIES FAT	CALORIES CARBO-HYDRATE
Macaroni	¼ lb.	62	9	337
Cheese	3/16 lb.	88	255	8
Lettuce	8 oz.	11	6	26
Cake	⅜ R.	64	214	606
Pears	1 lb.	9	16	231
Bread	8 oz.	84	26	483
Butter	2 oz.	2	429	....
White sauce (no butter)	1½ R.	66	232	196
Salad dressing	½ R.	37	232	72
Eggs	8 oz.	119	188	....
Total		542	1607	1959

Per person: 90 Cal. Protein; 594 Cal. Fat and Carbohydrate.

MENU

BREAKFAST

Oranges
Cream of Wheat and Cream
Omelet Muffins
Coffee

Food	Quantity	Calories Protein	Calories Fat	Calories Carbo-hydrate
Cream of wheat	6 oz.	83	27	513
Oranges	2 1/8 lb.	32	17	448
Cream	4 oz.	12	187	21
Milk	4 oz.	15	41	23
Muffins	1 R.	189	612	844
Butter	1 1/2 oz.	2	322	....
Eggs	14 oz.	208	329	....
Sugar	1 oz.	....	....	114
Coffee	1 oz.	....	....	....
Total		541	1535	1963

For six people: 541 Cal. Protein.
3498 Cal. Fat and Carbohydrate.

Per person: 90 Cal. Protein.
583 Cal. Fat and Carbohydrate.

TIME FOR PREPARATION

Cream of wheat — 30 min.
Muffins — 30 min.
Omelet — 10 min.
Coffee — 5 min.
Breakfast to be served at 7.30. Start breakfast at 7 A.M.

Cost, $.47.

MENU

DINNER

Mutton Stew and Dumplings Potatoes
Onions Carrots Rutabagas in Stew
Bread Tea
Caramel Ice Cream Cake

Food	Quantity	Calories Protein	Calories Fat	Calories Carbo-hydrate
Mutton stew . . .	$1\frac{1}{2}$ lb.	483	1204	. . . .
Potato	$1\frac{1}{2}$ lb.	60	6	472
Carrots	1 lb.	20	16	168
Onions	5 oz.	9	4	52
Rutabagas	1 lb.	24	8	133
Bread	6 oz.	63	20	363
Butter	$1\frac{1}{2}$ oz.	2	321	. . . .
Milk	1 lb.	60	162	91
Cream	1 lb.	46	747	82
Eggs	4 oz.	59	94	. . . .
Flour	$\frac{2}{3}$ lb.	138	27	910
Lard	1 oz.	. . . .	252	. . . .
Sugar	8 oz.	. . . .	. . . .	910
Cake	$\frac{1}{2}$ R.	86	286	808
Tea	. . . .	. . . .	. . . .	. . . .
Total . . .		1050	3147	3989

Per person: 175 Cal. Protein; 1189 Cal. Fat and Carbohydrate.
Cost, \$.65.

MENU

SUPPER

Cold Roast Beef — Fried Potatoes
Bread
Peaches — Nut Cake
Tea

Food	Quantity	Calories Protein	Calories Fat	Calories Carbo-hydrate
Beef	1 lb.	293	707	....
Potatoes	1 lb.	40	4	328
Bread	12 oz.	125	43	725
Peaches	1 lb.	13	4	197
Lard	1 oz.	....	253	....
Butter	3 oz.	3	644	....
Sugar	2 oz.	....	....	228
Cake	$\frac{1}{4}$ R.	42	142	404
Milk	8 oz.	30	81	46
		545	1658	1928

For six people: 545 Cal. Protein; 3586 Fat and Carbohydrate.
For one person: 91 Cal. Protein; 598 Fat and Carbohydrate.

Cost, $.48.

MENU

BREAKFAST

Bananas Cream of Wheat
Poached Eggs on Toast
Coffee

Food	Quantity	Calories Protein	Calories Fat	Calories Carbo-hydrate
Bananas	1 lb.	24	24	382
Cream of wheat	½ lb.	110	36	684
Bread	1 lb.	167	52	966
Butter	2 oz.	2	429	....
Cream	8 oz.	23	374	41
Milk	4 oz.	15	40	23
Eggs	12 oz.	178	282	....
Sugar	2 oz.	....	....	227
Coffee	1 oz.	....	....	....
Total		519	1237	2323

Per person: 87 Cal. Protein; 593 Cal. Fat and Carbohydrate.
Cost, $.43.

MENU

DINNER

Fried Chicken Mashed Potatoes
Jelly Rutabagas Bread
Banana Salad
Frozen Pudding Coffee

Food	Quantity	Calories Protein	Calories Fat	Calories Carbo-hydrate
Chicken	$2\frac{1}{2}$ lb.	650	1242	....
Rutabagas	$1\frac{5}{6}$ lb.	44	15	244
Bread	5 oz.	52	16	302
Milk	12 oz.	45	121	63
Eggs (2)	5 oz.	74	117	....
Sugar	10 oz.	....	....	1137
Oranges	8 oz.	7	4	105
Cream	8 oz.	23	373	41
Potato	2 lb.	80	8	656
Bananas	$\frac{3}{4}$ lb.	18	18	286
Salad	$\frac{1}{4}$ R.	36	232	72
Walnuts	1 oz.	18	160	18
Butter	4 oz.	4	858	....
Flour	1 oz.	13	3	85
Cream	2 oz.	6	93	10
Coffee	1 oz.	....	....	....
Jelly	8 oz.	10	....	702
Total		1080	3260	3736

Per person: 180 Cal. Protein; 1166 Cal. Fat and Carbohydrate.
Cost, $1.00.

SUPPER OR LUNCH

Potato Soup and Croutons

Food	Quantity	Calories Protein	Calories Fat	Calories Carbohydrate
Potato	1 lb.	40	4	328
Milk	2 lb.	120	324	182
Butter	1 oz.	1	214	. . . .
Flour	½ oz.	6	1	43
Salt	. . . .	. . . .	. . . .	. . . .
Bread	2 oz.	21	7	121
Total . . .		188	550	664

½ amount or 1 pint of potato soup would furnish all nutrition needed for a supper or lunch for one person, or

94 Cal. Protein; 607 Cal. Fat and Carbohydrate.

MENU

BREAKFAST

Baked Apples

Shredded Wheat Biscuit Boiled Eggs

Toast Cocoa

Food	Quantity	Calories Protein	Calories Fat	Calories Carbohydrate
Apples	2 lb.	14	40	472
Shredded wheat biscuit .	6 oz.	72	21	519
6 Eggs	11 oz.	164	250	. . . .
Bread	1 lb.	167	53	966
Cream	¼ lb.	11	187	20
Milk	1¼ lb.	75	202	114
Butter	2 oz.	2	429	. . . .
Sugar	1½ oz.	. . . .	. . . .	169
Cocoa	1 oz.	25	73	43
Total . . .		530	1255	2303

Per person: 88 Cal. Protein; 593 Cal. Fat and Carbohydrate.

Cost, $.40.

MENU

DINNER

Roast Beef   Mashed Potatoes
Canned Peas
Bananas rolled in Nuts
Lemon Pie   Coffee

Food	Quantity	Calories Protein	Calories Fat	Calories Carbohydrate
Beef	2½ lb.	633	2140	....
Potato	2 lb.	80	8	656
Peas	1 lb.	65	8	178
Bananas	1½ lb.	36	36	573
Nuts	4 oz.	59	180	56
Pie filling	1 R.	54	192	855
Crust	½ R.	35	385	228
Bread	6 oz.	63	20	362
Butter	3 oz.	3	644	....
Salad dressing	½ R.	37	233	73
Milk	8 oz.	30	81	46
Sugar	1 oz.	....	....	114
Total		1095	3927	3141

For six people: 1095 Cal. Protein.
7068 Cal. Fat and Carbohydrate.

For one person: 183 Cal. Protein.
1178 Cal. Fat and Carbohydrate.

Cost, $.87½.

Dinner to be served at 12.00. Start preparation at 10.30 A.M.

MENU

SUPPER

Pork Chops Baked Potatoes
Bread
Sliced Fruit Sponge Cake
Tea

Food	Quantity	Calories Protein	Calories Fat	Calories Carbo-hydrate
Pork	1 lb.	282	586	. . . .
Potatoes	1 lb.	40	4	328
Cake	$\frac{1}{4}$ R.	49	30	531
Bread	12 oz.	125	39	725
Butter	2 oz.	2	428	. . . .
Oranges	$\frac{1}{2}$ lb.	8	4	105
Bananas	$\frac{1}{2}$ lb.	12	12	191
Sugar	2 oz.	. . . .	. . . .	228
Total . . .		536	1151	2370

For six people: 536 Cal. Protein.
3521 Cal. Fat and Carbohydrate.

For one person: $89\frac{1}{3}$ Cal. Protein.
587 Cal. Fat and Carbohydrate.

MENU

BREAKFAST

Oranges Oatmeal and Cream
Bacon and Eggs
Toast Coffee

Food	Quantity	Calories Protein	Calories Fat	Calories Carbohydrate	Cost
Oranges	2 lb.	28	16	422	.12½
Oatmeal	6 oz.	116	111	451	.02
Eggs	12 oz.	179	282	....	.15
Toast	12 oz.	125	40	725	.05
Coffee	....	....	....	....	.02
Sugar	3 oz.	....	....	342	.01
Cream	4 oz.	12	187	21	.03¾
Milk	4 oz.	15	41	23	.01½
Butter	1 oz.	1	215	....	.02½
Bacon	4 oz.	42	628	....	.06
Total . .		518	1520	1984	$.51

For six people: 518 Cal. Protein; 3504 Cal. Fat and Carbohydrate.

For one person: 86 Cal. Protein; 584 Cal. Fat and carbohydrate.

MENU

DINNER

Chicken Pie Mashed Potatoes
String Beans Juno Salad
Custard

Food	Quantity	Calories Protein	Calories Fat	Calories Carbo-hydrate
Chicken	2½ lb.	623	1243	....
Potatoes	2 lb.	80	8	656
Beans	1 lb.	42	12	135
B. P. biscuit	¾ R.	80	338	513
Flour	1 oz.	13	3	85
Butter	2 oz.	2	428	....
Sugar	2 oz.	....	....	228
Custard	1½ R.	69	368	1160
Salad	1 R.	185	1072	128
Cream	2 oz.	3	47	5
Bread	6 oz.	63	22	362
Jelly	⅛ lb.	3	....	176
Coffee	1½ oz.	....	....	....
Total		1163	3541	3562

For six people: 1163 Cal. Protein; 7103 Cal. Fat and Carbohydrate.

For one person: 194 Cal. Protein; 1184 Cal. Fat and Carbohydrate.

Cost, $1.00.

MENU

SUPPER

Deviled Eggs Scalloped Potatoes
Bread
Sliced Oranges and Bananas Cake

Food	Quantity	Calories Protein	Calories Fat	Calories Carbo-hydrate
Oranges	1 lb.	15	8	211
Bananas	¼ lb.	6	6	95
Eggs	1 lb.	238	376	....
Potatoes	2 lb.	60	6	492
Butter	2½ oz.	3	536	....
Milk	8 oz.	30	81	45
Bread	6 oz.	63	20	363
Flour	½ oz.	6	2	85
Sugar	2 oz.	....	....	227
Cake	⅜ R.	78	391	634
Total		505	1426	2152

Per person: 83 Cal. Protein; 596 Cal. Fat and Carbohydrate.

MENU

BREAKFAST

Oranges
Oatmeal and Cream
Creamed Dried Beef Popovers
Toast Coffee

Food	Quantity	Calories Protein	Calories Fat	Calories Carbo-hydrate
Popovers	1 R.	152	176	502
White sauce	1 R.	60	445	153
Oatmeal	¼ lb.	76	74	301
Bread	5 oz.	52	16	302
Oranges	1½ lb.	22	12	316
Butter	2 oz.	2	429	....
Cream	½ lb.	23	373	41
Sugar	2¾ oz.	....	....	311
Beef	5 oz.	150	87	....
Coffee	1 oz.	....	....	....
Total		537	1612	1926

Per person: 89½ Cal. Protein; 589½ Cal. Fat and Carbohydrate.
Cost, $.50.

MENU

DINNER

Roast Pork Mashed Potatoes and Gravy
Creamed Carrots Cabbage Salad
Apple Pie

Food	Quantity	Calories Protein	Calories Fat	Calories Carbo-hydrate
Potatoes	2 lb.	80	8	656
Pork	2½ lb.	705	1465	. . . .
Carrots	1½ lb.	29	24	204
Cabbage	1 lb.	29	12	102
Apples	2 lb.	14	40	474
Milk	2 oz.	8	20	11
Butter	3 oz.	3	645	. . . .
Bread	6 oz.	63	20	455
Pie crust	1 R.	69	770	362
White sauce	1 R.	37	405	89
Salad dressing	1 R.	73	465	145
Sugar	6 oz.	. . . .	. . . .	682
Total		1110	3874	3230

For six people: 1110 Cal. Protein.
7104 Cal. Fat and Carbohydrate.

For one person: 184 Cal. Protein.
1184 Cal. Fat and Carbohydrate

Cost, $.95.

MENU

SUPPER

Cheese Souffle Riced Potato
Bread
Canned Peaches Spanish Buns

Food	Quantity	Calories Protein	Calories Fat	Calories Carbo-hydrate
Buns	$\frac{3}{8}$ R.	91	424	992
Potato	$1\frac{1}{2}$ lb.	49	6	400
Milk	$\frac{1}{2}$ lb.	30	81	45
Butter	2 oz.	2	428	....
Cheese	$\frac{1}{4}$ lb.	118	340	11
Canned peaches	1 lb.	13	4	197
Bread	6 oz.	63	20	363
Eggs	9 oz.	134	211	....
Tea	....	....	....	....
Total		500	1514	2008

Per person: 83 Cal. Protein; 587 Cal. Fat and Carbohydrate.

MENU

BREAKFAST

Stewed Prunes
Toasted Corn Flakes Hash
Muffins Coffee

Food	Quantity	Calories Protein	Calories Fat	Calories Carbo-hydrate
Prunes	$\frac{1}{3}$ lb.	13	....	444
Corn flakes	3 oz.	35	14	263
Cream	4 oz.	11	187	20
Sugar	$1\frac{3}{4}$ oz.	....	....	198
Beef	$\frac{1}{2}$ lb.	173	258	....
Potatoes	$\frac{7}{8}$ lb.	35	4	287
Butter	2 oz.	2	429	....
Muffins	1 R.	205	375	989
Milk	4 oz.	15	41	23
Total		489	1308	2224

Per person: 82 Cal. Protein; 589 Cal. Fat and Carbohydrate.
Cost, $.38.

MENU

DINNER

Roast Pork Gravy
Mashed Potatoes Creamed Carrots
Bread
Maple Bavarian Cream

Food	Quantity	Calories Protein	Calories Fat	Calories Carbo-hydrate
Pork	2 lb.	564	1172	....
Potatoes	1½ lb.	80	8	656
Carrots	1½ lb.	29	24	254
White sauce	1½ R.	56	446	134
Bread	½ lb.	84	27	403
Butter	3 oz.	3	644	....
Bavarian cream	1 R.	119	780	1047
Flour	1 oz.	13	3	85
Milk	4 oz.	15	41	23
Cream	2 oz.	6	94	11
Sugar	1 oz.	....	....	114
Total		969	3239	2807

For six people: 969 Cal. Protein.
6046 Cal. Fat and Carbohydrate.

For one person: 161½ Cal. Protein.
1008 Cal. Fat and Carbohydrate.

MENU

SUPPER

Cold Roast Pork
Scalloped Potatoes Asparagus Salad
Bread
Orange Cake Peach Sauce

Food	Quantity	Calories Protein	Calories Fat	Calories Carbo-hydrate
Pork	1½ lb.	423	879	....
Potatoes	1 lb.	40	4	328
Bread	12 oz.	125	40	725
White sauce	1 R.	37	297	89
Butter	2 oz.	2	429	....
Asparagus	½ lb.	17	4	30
Olive oil	2 oz.	....	757	....
Cake	¼ R.	43	143	404
Peaches	1 lb.	13	4	197
Sugar	2 oz.	....	....	228
Total		700	2557	2001

For six people: 700 Cal. Protein.
4558 Cal. Fat and Carbohydrate.

For one person: 117 Cal. Protein.
759 Cal. Fat and Carbohydrate.

Foods as Purchased

Calories per Pound

Name of Food	Calories Protein	Calories Fat	Calories Carbo-hydrate	Mineral Matter %	Cellu-lose
Eggs:					
Eggs, as purchased	238	376	....	.9	..
White, egg	244	8	....	.6	..
Yolk, egg	286	1345	....	1.1	..
Milk and its Products:					
Milk	60	162	91	.7	..
Cream	46	747	82	.5	..
American Cheese	471	1361	44	3.8	..
Neufchatel Cheese	340	1107	27	2.4	..
Butter	18	3434	....	3.	..
Meat:					
Beef, round	346	517	....	1.	..
Beef, rib	253	857	....	.5	..
Beef, loin	294	707	....	1.	..
Lamb, shoulder	262	953	....	.8	..
Lamb, leg	289	549	....	1.	..
Mutton, shoulder	322	803	....	.6	..
Mutton, loin	246	1143	....	.7	..
Mutton, leg	275	594	....	.8	..
Pork, loin, lean	282	586	....	.8	..
Pork, loin, fat	244	978	....	.8	..
Pork, salt, fat	35	3482	....	5.	..
Pork, salt, lean	134	2407	....	5.	..
Sausage	236	1785	....	6.	..
Ham	259	1349	....	5.	..
Bacon	166	2513	....	4.	..
Dried Beef	480	279	....	9.	..
Chicken	260	497	....	.7	..
Fish, Fresh:					
Pickerel	180	8	....	.6	..
Salmon	278	360	....	.8	..
Trout	166	206	....	.6	..

FOODS AS PURCHASED — *Continued*

Name of Food	Calories Protein	Calories Fat	Calories Carbo-hydrates	Mineral Matter %	Cellu-lose
Fish, Salted:					
Codfish, salted	462	12	. . . .	23.5	. .
Fats:					
Lard	. . .	4040	. . . .	. .	. .
Olive Oil	. . .	4040	. . . .	. .	. .
Sugars:					
Granulated Sugar . .	. . .	. . .	1820	. .	. .
Maple Sirup	. . .	. . .	1300	. .	. .

FOOD AS PREPARED

Calories per Recipe

Name of Food	Calories Protein	Calories Fat	Calories Carbohydrates
Biscuit	131	454	854
Nut Bread	283	430	2147
Popovers	152	176	502
Waffles	204	402	843
Muffins	189	612	844
Rolls	290	345	1809
Doughnuts	342	427	2663
Cake, plain	173	572	1616
Cake, chocolate	208	1046	1692
Pie Crust	69	770	455
Chocolate Pie Filling . . .	164	426	682
Lemon Pie Filling	54	192	855
Beef Loaf	738	1952	60
Salad Dressing	73	465	145
White Sauce	37	297	89
Tomato Sauce	41	441	186
Potato Soup	167	543	543

Foods as Prepared for Cooking

Calories per Pound

Name of Food	Calories Protein	Calories Fat	Calories Carbohydrates	Mineral Matter %	Cellulose %
Roots and Tubers:					
Potatoes	40	4	328	1.	.4
Sweet Potatoes	33	28	476	1.1	1.3
Beets	29	4	177	1.1	.9
Carrots	20	16	168	1.	1.1
Onions	29	12	165	.6	.8
Parsnips	29	20	200	1.4	2.5
Rutabagas	24	8	133	1.1	1.2
Cereals:					
Flour, patent	207	40	1366	.3	.1
Bread	167	53	966	1.	.2
Rice	146	12	1438	.4	..
Oatmeal	304	294	1205	1.9	.9
Cream of Wheat	220	73	1369	1.3	..
Wheat Bk. Food	185	72	1349	1.5	1.8
Corn Meal	167	77	1372	1.	1.1
Shredded Wheat Biscuit	193	57	1383	2.1	1.7
Corn Flakes, toasted	184	73	1405	.7	.4
Macaroni	244	36	1349	1.3	..
Corn Starch	..	..	1638	..	..
Legumes:					
Lima Beans	329	61	1199	4.1	4.
Navy Beans	410	73	1085	3.5	4.4
Peas, green, shelled	127	20	308	1.	1.2
Peas, canned	66	8	178	1.1	1.2
Beans, string, fresh	42	12	135	.8	1.9
Beans, string, canned	20	4	69	.9	..

FOODS AS PREPARED FOR COOKING — *Continued*

NAME OF FOOD	CALORIES PROTEIN	CALORIES FAT	CALORIES CARBO-HYDRATES	MINERAL MATTER %	CELLU-LOSE %
GREEN VEGETABLES:					
Asparagus	33	8	60	.7	.8
Cauliflower	33	20	86	.7	1.
Celery	20	4	60	1.	..
Cabbage	29	12	102	1.	..
Corn, green	56	44	359	.7	.5
Corn, canned	51	48	346	.9	..
Cucumber	15	8	56	.5	.7
Lettuce	22	12	53	.9	.7
Squash	26	20	164	.8	.8
Spinach	38	12	58	2.1	.9
Tomatoes	16	16	70	.5	.6
Pickles	9	12	49	..	..
FRUITS:					
Apples	7	20	236	.3	1.2
Oranges	15	8	211	.5	..
Peaches	13	4	171	.4	3.6
Pineapple	7	12	177	.3	.4
Strawberries	18	24	135	.6	1.4
Lemons	18	28	154	.5	1.1
Bananas	24	24	382	.8	1.
Grapes	18	48	262	.4	..
DRIED FRUITS:					
Dates	38	113	1591	1.3	..
Figs	78	12	1350	2.4	6.2
Raisins	47	133	1385	3.4	2.5
Apricots	86	40	1138	2.4	..
Prunes	38	..	1334	2.3	2.1
Chocolate	234	1967	551	.7	..
Cocoa	393	1168	686	7.2	..
NUTS:					
Walnuts	302	2561	293	1.4	2.6
Peanuts	470	1559	444	2.	2.5

PART II

CHAPTER I

CLASSIFICATION OF FOODS FOR DETAILED STUDY

Value of Dietary Studies. — The relative importance of the different foods used in the country may be estimated from crop statistics showing the amount of the various foods produced and consumed by the American people.

A better idea of the importance of the various foods in the American diet can be obtained from an analysis of the dietary studies conducted by Dr. Langworthy, in charge of the nutritive investigations of the United States Department of Agriculture.

Over four hundred of these studies were made, showing food consumed by normal people, in good health, in the average American home, and by people engaged in diversified industries.

These studies are of great value for several reasons. They show the habits and customs of people of different nationalities, occupations, and conditions; their peculiar tastes, and the prevalence of any class of foods in their diet. They furnish valuable data for investigation as to the high cost of living, whether it is due to the use of those foods where consumption is overtaking production, where the cost of production and distribution is necessarily high, or whether it is due to the neglect or avoidance of foods that are wholesome and nutritious, and can be obtained at a low cost.

The studies show why certain defects or faults of nutrition can occur in families or in classes of people. An example of this may be seen in the tendency to use foods from which much of the mineral matter has been removed in milling, as in patent flours, or from which mineral salts have been lost by improper cooking. All members of the family, or group of families, may suffer from malnutrition, and the reason usually given is that the weakness or tendency is inherited, and no effort is made to locate the cause. Often the weakness is due to a lack of the mineral salts needed by the body, and could be remedied by a study of what nutritive ingredients are furnished by the different foods.

The following figures, obtained from the dietary studies above referred to, show the relative importance of the common foods.

Wheat furnishes 18.6 per cent of the food consumed in the average American home, milk 16.5 per cent, potatoes 12.5 per cent, corn 8.9 per cent, beef 7.2 per cent, pork 7.2 per cent, sugar 5.4 per cent, eggs 2.1 per cent, fish 1.8 per cent, butter 1.6 per cent, rye 1.3 per cent, cheese .3 per cent.

After a detailed study of the important foods is made, it can be ascertained whether any improvement can be made in the diet as regards nutritive value, greater variety, and a lessening of cost. The figures show, at any rate, that certain foods have not the place in the diet which they deserve, as, for example, so wholesome, cheap, and nutritious a food as cheese furnishes but .3 per cent of the average diet, and green vegetables and succulent roots and tubers furnish but 6½ per cent.

The Object of Food Study is to learn the nutritive value of each food to the human body and its place in the diet, so that when a food is made part of a meal, it shall serve some definite purpose.

Foods differ widely. They differ in structure, composition, appearance, nutritive value, digestibility, cost, and in the effect of heat upon them. But many foods are similar in structure, composition, and food value, and they may be studied in groups. If the typical food of each group is studied in detail, the others may be compared and contrasted with it, until the exact place of each food is known.

For the purpose of detailed study, foods are classified as animal foods and vegetable foods, according to the sources from which they are derived. Animal foods are chiefly protein; they contain considerable fat and little or no carbohydrate. Vegetable foods are chiefly carbohydrate. They contain, with few exceptions, very little fat. Some, as the legumes and cereals, contain considerable protein. Generally speaking, however, animal foods are depended upon to supply protein and fat, and vegetable foods to supply carbohydrate, mineral matter, and sometimes protein.

Most of the fat supplied in the diet is added to it, not in its natural form in the food in which it occurs, but as a derived product, as butter, cheese, lard, olive oil.

From recent dietary studies it has been found that animal foods furnish 38.5 per cent of the total food material, 47.5 per cent of the protein, 88.5 per cent of the fat, 4 per cent of the carbohydrate, in the average American diet. Vegetable foods furnish 61.5 per cent of the total food material, 52.5 per cent of the protein, 11.5 per cent of the fat, 96 per cent of the carbohydrate.

Foods are Classified as —

A. Animal Foods, —
1. Meats, which include poultry and game.
2. Fish, which include shellfish.
3. Animal Products, which include milk, butter, cheese, and eggs.

B. Vegetable Foods, —
1. Cereals.
2. Legumes.
3. Roots and Tubers.
4. Green Vegetables.
5. Fruits.

Vegetable Foods. — Because vegetable foods furnish the larger part of the average diet and because they seem simpler to study, they are considered first in the detailed study of foods.

All vegetables have two things in common. They all contain valuable mineral salts or acids, and carbohydrate in the form of starch, sugar, or cellulose.

Roots and tubers are pure carbohydrate foods, containing little or no available protein.

Cereals contain protein and carbohydrate in the proportion of about 1 : 7.

Legumes contain protein and carbohydrate in the proportion of about 1 : $2\frac{1}{2}$.

Green vegetables are principally valuable for their mineral salts and cellulose, fruits for their acids and sugar.

The rank and importance of the different vegetable foods, according to use, may be judged from the following table, taken from "Food Customs and Diet in American Homes," a government bulletin prepared by Dr. Langworthy. The table shows the percentage of total food material furnished by the different foods, and the percentage of protein, fat, and carbohydrate furnished by each food.

Food	Total Food Material Used	Protein	Fat	Carbohydrate
	Per Cent	Per Cent	Per Cent	Per Cent
Cereals	30½	43	9	62
Potatoes	12½	4	½	8½
Other vegetables	6	1½	½	2
Fruits	4½	½	½	4
Legumes	1½	3½	½	2
Sugar and molasses	5½	...	..	17½

CHAPTER II

CEREALS

The cereals are the most important of all foods because they form the chief food of all peoples, the world over, and contain the proper nutritive ingredients in the right proportion to sustain life. One or more of them can be easily raised on nearly every soil. They form the cheapest of all foods, even in localities remote from their place of production, and they can be prepared for the table in many ways. They are almost the only food that can be eaten from day to day without palling the appetite.

Some idea of their importance can be gained from the fact that it is estimated that they furnish 30.6 per cent of all food consumed by the American people, 43 per cent or nearly one half of all the protein, 9.1 per cent of all fat, 61.8 per cent of all carbohydrate.

Wheat, alone, furnishes 18.6 per cent of the total American food material, corn 8.9 per cent, rye 1.3 per cent, oats .5 per cent, rice .3 per cent, buckwheat and barley .1 per cent.

From the above figures it will be seen that wheat and corn are the only cereals that form an appreciable part of the American diet, and that merit an extensive study. Their value and importance are due to the fact that they can be manufactured into a great variety of products, as flour, meal, breakfast foods, starch, glucose or corn sirup, and thus enter into the composition of many articles of food.

The reason wheat ranks first in importance among all foods is because of the character of its protein. The principal protein in wheat, commonly called gluten, which is composed of two substances, gliadin and glutenin, gives to the wheat flour its peculiar elastic, tenacious property which makes it possible to bake it into a light porous loaf. The proteins in no other cereal except rye possess this property.

In structure the cereals are similar. They consist of three parts, the skin, including the bran coats, the endosperm or body of the grain, the germ. They vary somewhat in composition, the greatest variation being in the amount of fat, mineral matter, cellulose, and character of the protein.

The following tables show the composition of the various cereals as purchased, and their relative richness in each of the food principles, though these figures are modified by milling processes :—

Atwater's Table of Composition

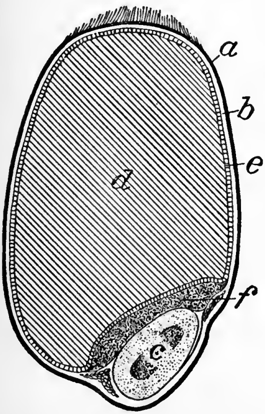
Cereal	Water	Protein	Fat	Carbohydrate	Cellulose	Mineral Matter
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Wheat . .	10.6	12.2	1.7	71.3	2.4	1.8
Corn . .	10.8	10.0	4.3	71.7	1.7	1.5
Oats . .	11.0	11.8	5.0	59.7	9.5	3.0
Rye . . .	10.5	12.2	1.5	71.8	2.1	1.9
Rice . . .	12.0	8.0	2.0	76.0	1.0	1.0
Barley . .	10.9	11.0	2.3	69.5	3.8	2.5
Buckwheat	12.6	10.0	2.2	64.5	8.7	2.0

Table showing Relative Richness of Cereals in the Different Ingredients

Protein		Fat		Carbohydrate		Cellulose		Mineral Matter	
Per Cent		Per Cent		Per Cent		Per Cent		Per Cent	
Wheat	12.2	Oats	5.0	Rice	76.0	Oats	9.5	Oats	3.0
Rye	12.2	Corn	4.3	Rye	71.8	Buckwheat	8.7	Barley	2.5
Oats	11.8	Barley	2.3	Corn	71.7	Barley	3.8	Buckwheat	2.0
Barley	11.0	Buckwheat	2.2	Wheat	71.3	Wheat	2.4	Rye	1.9
Corn	10.0	Rice	2.0	Barley	69.5	Rye	2.1	Wheat	1.8
Buckwheat	10.0	Wheat	1.7	Buckwheat	64.5	Corn	1.7	Corn	1.5
Rice	8.0	Rye	1.5	Oats	59.7	Rice	1.0	Rice	1.0

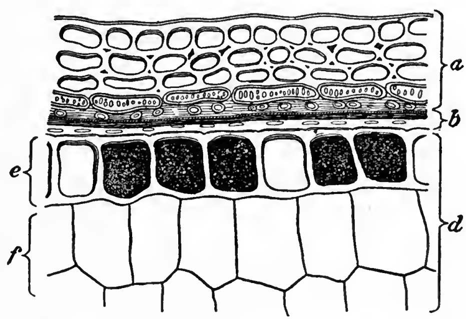
Detailed Study of Wheat. — A detailed study will be made of the wheat grain, because of its rank in importance as a food, and because its structure furnishes an interesting study of the processes necessary to prepare a cereal for market and consumption. A knowledge of its structure also enables us to see what principles of cooking must be applied to the cereals, and what changes take place during cooking. No better specimen of a vegetable cell can be found from which to study the structure, the occurrence of the different nutrients, the form of protein needed for plant development, and the changes which take place during germination. The exhaustive studies which have been made of the wheat cell add greatly to our understanding of the structure of any cell.

The Structure and Composition. — The wheat grain or seed, like all other substances, is made up of innumerable cells, alike in structure, but differing widely in composition in different parts of the seed. The grain may be said to consist of three parts. At the lower end of the seed is found the germ or embryo which contains the life principle that will develop into a wheat plant. This embryo is made up of multitudinous cells containing proportionately more fat, protein, and mineral matter than the other parts of the seed. It is 35 per cent protein, 13 per cent fat, 35 per cent carbohydrate, and $5\frac{1}{2}$ per cent mineral matter. When the germ begins to develop, the ferment diastase changes the insoluble starch to soluble maltose, and the plant feeds on the fat, protein, changed starch, and mineral matter in the embryo and other parts of the seed.



DIAGRAMMATIC SECTION OF A GRAIN OF WHEAT.

a, skin and testa; *b*, membrane; *c*, embryo; *d*, flour cells; *e*, cereal or aleurone layer; *f*, scutellum. (From Farmers' Bulletin, No. 389, U. S. Department of Agriculture.)



CELLULAR STRUCTURE OF A GRAIN OF WHEAT. (After Winton and Moeller.)

(From Farmers' Bulletin, No. 389, U. S. Department of Agriculture.)

Surrounding the embryo is a deep network of cells which contain more nourishment for the germ. It is called the endosperm and makes up 85 per cent of the wheat grain. These cells differ from the cells of the embryo in that they contain about 10 per cent protein, 75 per cent carbohydrate, less than 1 per cent each of fat and mineral matter.

The outermost layer of cells comprising the endosperm is called the cerealin or aleurone layer, and differs from the rest of the endosperm in that it is richer in protein and mineral matter than the rest.

The endosperm is surrounded by a tough covering consisting of five layers of bran coats, which protect the delicate parts and contain the coloring matter of the wheat. It is difficult to separate the aleurone cells from the bran coats in milling, and that is the reason why so much is lost. Bran contains about 16 per cent protein, 3.5 per cent fat, 43.5 per cent starch and sugar, 18 per cent cellulose, 6 per cent mineral matter.

A Single Cell. — The cells in the wheat grain are held together by an intercellular substance, cellulose, which

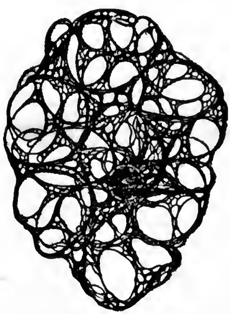


Diagram of the Protoplasmic Structure of a Flour Cell.

(From Farmers' Bulletin, No. 389, U. S. Department of Agriculture.)

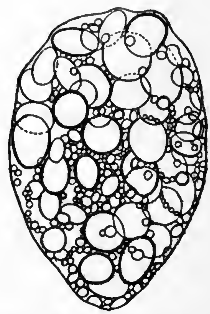


Diagram of Starch Grains in a Flour Cell.

(From Farmers' Bulletin, No. 389, U. S. Department of Agriculture.)

varies in thickness in different parts of the seed. The cells vary in size, shape, and composition, but all have certain structural points in common. A single cell consists of a network of protoplasm, or protoplasmic substance, in which are embedded starch grains, some fat, and mineral matter. Near the center is the cell nucleus, and surrounding the whole cell is the cell wall of cellulose. The amount of starch, fat, and mineral matter varies in different cells, as does the amount and character of the protein.

The protein in the aleurone layer is called cerealin, that in the endosperm is called gluten, and is composed of two proteins, gliadin and glutenin. Albumins, globulins, and compound proteins are also present in wheat. The compound proteins contain more phosphorus, iron, and other mineral matter than the simple proteins, and they are present in greatest quantities in the germ and bran coats.

The proportion of gliadin to glutenin in the gluten is said to determine the bread-making properties of the flour. Gluten consists of about two thirds gliadin to one third glutenin. Snyder describes gliadin as the material which binds the flour particles together to form a dough, giving it tenacity and adhesiveness, and the glutenin as the material to which the gliadin adheres and which prevents it from becoming too sticky and soft.

Too much gliadin makes a soft and sticky flour, while too little causes the flour to lack expansive power. Hard wheat contains a lower percentage of gliadin than soft or winter wheat. Its gluten is of a stronger and more tenacious character. It will hold greater quantities of water than soft wheat, — a very desirable characteristic in bread making.

Milling. — In the process of milling, or flour making, the germ of the wheat is usually removed because the fat in it affects the keeping qualities of the flour and darkens it. The bran coats are removed because they contain a high percentage of cellulose and coloring matter. The cellulose is said to make the bread less digestible, and people demand a white loaf of bread, even if it is not so nutritious as a darker loaf.

The endosperm, including the aleurone cells, is ground into flour and produces the various grades of the better flour found in the market. Some of the lower grades of flour contain the germ, some contain some of the bran; but the proteins in them do not make so light and porous a loaf of bread as does flour made from the endosperm, which contains so much gluten.

Graham flour is made by grinding the whole of the wheat and contains the nutritive ingredients in exactly the same proportion as in the wheat grain. Entire wheat flour, or whole wheat flour, is usually made by removing the outer bran coats and grinding the remainder.

Variations of Flours. — From the accompanying table it will be seen that flour made from the endosperm will contain less protein, cellulose, and mineral matter than flour made from the whole grain.

	Protein	Fat	Carbohydrate	Cellulose	Mineral Matter
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Whole grain	11.0	1.2	69.0	2.6	1.7
Endosperm	10.5	.8	74.3	.7	.7
Germ	35.7	13.1	31.2	1.8	5.7
Bran	16.4	3.5	43.6	18.0	6.0

The question, as to whether flour made from the endosperm is as nutritious as flour made from whole grain, has probably been as carefully considered and as thoroughly investigated as any question of nutritive values of the various foods; but it is a question as to whether mineral matter, as found in wheat, and lost in milling, is more valuable to the human body than 10 calories of protein per pound, and 80 calories of carbohydrate.

The value of any food is usually estimated by the amount of protein, fat, and carbohydrate which it contains; by the ratio of the proteins to the fats and carbohydrates; and by its digestibility. There are several other factors which influence the estimate of the nutritive value of any food. Formerly it was held that an ordinary diet would supply all the mineral matter needed by the individual. At that time, refined flour, refined meals, bread made from these products, and sugar did not furnish 32.1 per cent of the diet, and not so many experiments had been made on animals showing the effect of foods lacking in mineral matter on the tissues of the body and on general health. There is no question that people who live on foods that are lacking in mineral matter suffer from malnutrition and that physicians have to try to make up this loss, by prescribing the elements that are lacking, in an inorganic form — a form that the human body cannot so well assimilate.

People engaged in sedentary occupations need cellulose and mineral matter to help move the food along the intestine and expel it from the body. Constipation is a common trouble and much medicine is consumed to remedy it. In fact, fortunes have been made on patent pills and tablets, when the wasted cellulose in foods would keep the sluggish bowel active. The accumulation of waste matter in the large intestine leads to putrefactive fermentation, and the poisons and gases thus formed are absorbed and enter the blood, lowering the vitality and resistant power of the body. An abundance of cellulose would not harm the average individual, but would greatly benefit him, by aiding the body to rid itself of waste matter.

The question remains, what conclusions have been reached in regard to the digestibility of patent and whole wheat flour? Whole wheat and Graham flours contain the bran and cellulose in such a form as to hasten the food along the intestine so rapidly that not all the nutritive ingredients are absorbed, but some are lost with the indigestible waste matter. How much is lost, and will that loss be equalized by the gain in mineral matter and the benefits derived from a diet containing cellulose?

The figures given are all taken from bulletins showing the results of Snyder's investigations.

Composition of Flours

Kind	Protein	Fat	Carbohydrate	Mineral Matter
	Per Cent	Per Cent	Per Cent	Per Cent
Standard patent	11.99	1.61	75.36	.50
Entire wheat	12.26	2.24	73.58	1.02
Graham	12.65	2.44	74.58	1.72

Snyder's experiments show that the proportion of the nutrients digested from different flours were as follows: —

Standard patent flour: protein, 88.6 per cent; carbohydrate, 97.7 per cent.

Entire wheat flour: protein, 82.0 per cent; carbohydrate, 93.5 per cent.

Graham flour: protein, 74.9 per cent; carbohydrate, 89.2 per cent.

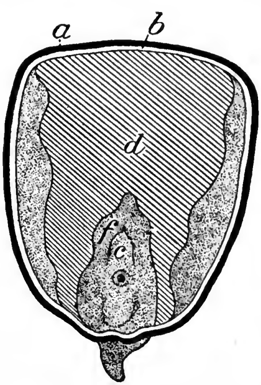
Total Calories in Food				Calories Digested	
Kind	Calories Protein	Calories Carbohydrate	Calories Mineral Matter	Calories Protein	Calories Carbohydrate
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Standard patent	223	1402	.50	197	1369
Entire wheat	228	1368	1.02	187	1289
Graham	235	1387	1.72	176	1237

By using the percentage composition, and finding the number of calories of energy in each flour, and then figuring the amount actually digested, it is found that there is available to the body but 10 calories less protein in the entire flour than in the patent flour, and over twice as much mineral matter. Five tablespoons of milk added to one pound of entire wheat flour, in breadmaking, would make the amount of protein equal to the amount in bread made from patent flour, and, in addition, there would remain the valuable mineral matter and the much needed cellulose. Skim milk could be used in place of the whole milk, for it furnishes the same amount of protein.

Figures showing the comparative amounts of iron, calcium, and phosphorus in different flours, grains, and bread.

Kind	Calcium	Phosphorus	Iron
	Per Cent	Per Cent	Per Cent
Patent flour	.025	.20	.0015
Entire wheat	.061	.902	.0053
Bread, white	.03	.20	.0009
Bread, entire	.c4	.4	.0015
Rye	.07	.81	.004
Rye flour	.018	.80	
Corn meal	.015	.3	.0011
Oatmeal	.13	.872	.0036
Rice	.12	.203	.0009

It may seem that undue emphasis is laid on the importance of mineral matter in the diet, especially in connection with this subject; but because cereals furnish 30.6 per cent of the total food material, and even a higher percentage among the poorer classes where the meal consists mostly of bread; because this book is written for girls and women who need to know the demands of a growing and maturing body; because girls and women are inclined to favor foods lacking in mineral salts,—the need for foods as nature provided them is presented. There is no question that the average girl of to-day would be greatly benefited by a diet rich in iron, calcium, and phosphorus, and other mineral substances.



DIAGRAMMATIC SECTION OF A GRAIN OF CORN.
a, skin and testa; *b*, membrane; *c*, embryo; *d*, endosperm; *f*, scutellum. (From Farmers' Bulletin, No. 389, U. S. Department of Agriculture.)

Corn.—From the standpoint of the agriculturist, no other vegetable crop has been so carefully studied as corn, for no other crop ranks with it in importance. This is not because of its importance as a human food, but because it is the chief food of farm animals; and any improvement in methods of raising it so as to improve the variety, or increase the yield per acre, means greater returns to the practical farmer, and merits consideration.

Corn is used more extensively as a food in the southern states than in the northern, but dietary studies show that it occupies an important place in all diets, furnishing 8.7 per cent of the total food material consumed.

Corn is similar in structure and composition to wheat, but it differs in the character of its protein. The principal protein in corn, called zein, has not the tenacious, elastic properties that gluten has, and it cannot be baked into a light and porous loaf. Corn contains less protein, mineral matter, and cellulose than wheat, but more fat and carbohydrates.

Like the wheat kernel, corn consists of three parts, the skin, endosperm, and germ. The skin, which is chiefly cellulose and starch, with some mineral matter, contains the coloring matter of the corn. The outer covering may be red, yellow, white, or blue, but the body of the kernel is either white or yellow. The endosperm of corn, which makes up 84 per cent of the grain, contains proportionally less protein, fat, mineral matter, and cellulose than the whole kernel. As corn contains but a small quantity of cellulose, compared to other grains (1.7 per cent), it is not necessary to remove any part of it except the skin or outer covering, and products made from the whole grain supply the food requirements of the body much better than products made from endosperm, such as fine meal, flour, and corn starch.

Corn Products.— Corn is manufactured into a great variety of products and served in many ways. Green corn, or corn on the cob, is a universal favorite as a late summer vegetable, and is also canned for winter use. Pop corn, so called because it bursts with a popping sound through the tough skin which incloses it, and comes out white and crisp, is sold extensively all over the country. It is said that the great expansion of endosperm in pop corn is due to the fact that the skin of pop corn is much tougher than other varieties, and that it does not burst until the pressure due to the expansion of the starch and water turned to steam is great enough to force it open.

Hominy was formerly the whole grain of the corn, and the skin was removed by soaking the kernel in lye. Hominy as now sold is freed from skin and germ and sometimes crushed into small pieces or flakes.

Several varieties of corn meal are prepared. Unbolted meal from the whole grain has the same composition as the whole kernel. The fine meal and corn flour are made from the endosperm after the skin and germ are removed, and are finely ground. Corn starch is refined so that it contains nothing but starch. The breakfast foods prepared from corn will be referred to later. Liquid glucose or corn sirup is becoming more familiar to us since the United States Food Laws compel manufacturers to retail it under its right name and to sell it uncolored. It is prepared by hydrolyzing corn starch by boiling it with a dilute acid, and as prepared is a wholesome product and is coming into use more extensively. It was formerly added to maple and cane sirup as an adulterant and colored with caramel. It is about three fifths as sweet as cane sugar. Cereal coffee and many liquors are also made from corn.

Corn prepared as corn meal and flour should be used extensively in the diet to furnish variety. It bakes into a granular cake and can be added to hot cakes and warm breads, where it changes the sticky or pasty character of the loaf and makes it more digestible when it is to be eaten hot. It is more easily masticated than wheat breads and can be prepared for the table in a short time. There is no possibility that it would ever supplant wheat as a breadstuff, nor would that be desirable, because wheat is better food; but since the diet should have some variety, corn well serves this purpose.

Other Cereals. — Rye and buckwheat are used principally as flour. Barley is used for malt and pearled barley. Oats are prepared as breakfast food or for porridge, and are more widely used as such than any of the other cereals. Rice is used as a breakfast food, a vegetable in place of potatoes to furnish the carbohydrate part of a meal, and for making desserts and puddings.

Macaroni. — Macaroni, spaghetti, and vermicelli are prepared from a wheat called macaroni wheat, which has a high gluten content. The gluten must be elastic, tenacious, and able to absorb and hold about 30 per cent of water. The best macaroni wheat is raised in Italy and Russia, though some of our western states are producing a high grade of macaroni wheat.

In the preparation of macaroni, the wheat is freed from the bran, and some of the starch is removed during the milling, leaving a high percentage of gluten. The part of the grain used in the manufacture of macaroni, called semolina, is mixed with water and kneaded to a stiff dough. It is then put into hollow cylindrical presses and forced out in tubes of various sizes. They are dried in the open air or in drying rooms. The largest are called macaroni, the next spaghetti, and the smallest vermicelli.

A poor grade of macaroni is made from bread flour. It contains too much starch, has not the right kind of gluten, and is sticky or pasty. Good macaroni is yellowish in color, breaks with a smooth fracture without splitting, and retains its shape when cooked in water. When macaroni is prepared with grated cheese and white sauce, as in baked macaroni, it contains so much protein that it may be used as the protein food for the meal and serve as a substitute for meat.

CEREALS ARE MANUFACTURED INTO THE FOLLOWING PRODUCTS

1. Breakfast foods, — oatmeal, rolled oats, cream of wheat, hominy, etc.
2. Starch — corn, rice, wheat.
3. Macaroni, vermicelli, spaghetti.
4. Glucose — sirup.
5. Cereal coffee.
6. Flour — wheat, rye, corn, buckwheat, rice.
7. Liquors — malted drinks, beer, whisky.
8. Alcohol.
9. Feed for animals.

Cereal Breakfast Foods. — A few years ago the market was flooded with dozens of varieties of breakfast foods that claimed all possible and impossible virtues as foods. The work done by the experiment stations over the country in making exhaustive studies of breakfast foods led to the withdrawal of many of the fraudulent claims, and the craze for the prepared breakfast foods seems to have spent its force. Where once a merchant was obliged to carry all varieties, he finds now that the demand has changed so that a half-dozen well-known foods are all that are called for.

This does not mean that breakfast foods have lost favor, but that people are using the oatmeal, corn meal, cracked or flaked wheat, and hominy, and preparations that have to be cooked at home, instead of the prepared forms. The plain cereals are more economical than the prepared foods, and a serving furnishes considerably more nutrition than the dry, cooked, flaky kinds. They can be eaten day after day without losing savor. They merit an extensive use because they are prepared from the whole grains without much loss of nutrients, and contain nearly all the protein and mineral matter found in the whole grain.

Classes of Breakfast Foods. — Breakfast foods are grouped into three classes. The first class includes those prepared by grinding the grain. In some cases the outer bran coat is removed; in others nothing is removed. With the use of the fireless cooker this is the best form to purchase them, because they are cheaper and can be cooked the night before they are to be used, and kept warm until ready to serve.

The second class includes those that have been steam-cooked, and then rolled or shredded or ground so that so much time is not necessary for their cooking. This form is best when it is not a question of economy, time, or fuel saved in preparation, because the foods are more attractive in appearance and take less thought for preparation.

The third class includes those that are sold ready to eat. Some are malted; some thoroughly cooked and shredded; some cooked in water, then dried and rolled; some have sugar, molasses, or caramel added; some are toasted or popped.

The malted foods are said to possess special virtue because they have undergone one step in digestion. This may or may not be desirable, for the normal individual can digest what starchy food he takes. It may be said, however, that all breakfast foods are good and merit an extensive use, because even the higher-priced ones are cheap when compared with other foods. They contain the mineral matter that flour does not contain, — phosphorus, calcium, and iron; and they contain a valuable amount of cellulose needed to stimulate peristaltic action, and aid in the elimination of waste. Mineral matter and cellulose together do this better than cellulose can do it alone.

Cooking of Cereals. — The amount of cooking which the cereals need depends on the size of the particles into which they are broken and the amount of cellulose which they contain. This varies greatly in the different cereals, ranging from 9.5 per cent in oats to 1 per cent in rice.

By referring to the section of a grain of wheat (p. 111), it will be seen that the protein and starch are inclosed in walls of cellulose, and that the grain must be cooked long enough to soften the cellulose and gelatinize the starch, and free it and the protein from the indigestible covering. Heat and moisture soften the wall, and cause the starch to swell and burst it. Long, slow cooking accomplishes this best. Because it saves fuel, and needs no watching to prevent burning, the fireless cooker is the best medium for cooking cereals. When cereals are cooked in water, much of the starch, mineral matter, and some protein are dissolved out and lost in the water. To prevent this loss it is best to cook cereals in a small quantity of water that will be absorbed, to steam-cook them; or to use much water and to use the water strained off for cream soup or other purposes.

Place of Cereals in the Diet. — Cereals contain the proper nutritive ingredients to supply the demands of the body for energy and tissue building. The nutritive ratio of wheat is 1 : 6, oats 1 : 7, corn 1 : 8, the ratio in every case being higher than that accepted by Chittenden, and the average would be that accepted by other authorities. The whole grains contain all the mineral matter needed by the body, in an available form.

They are used so extensively and universally that they form the chief food the world over. Rice is used in the

Orient, rye in northern Europe, buckwheat in Russia, corn in Africa and in our southern states, and wheat everywhere. Among the poorer classes in all countries they form almost the sole food. When the cereals are prepared for sale, some protein and two thirds of the mineral matter are usually removed, so people who depend on the cereals to supply over one half of their food material do not get the right amount of mineral matter. It has become the custom to say that the necessary amount of mineral matter will be supplied in a diet rich in green vegetables and fruits, and for that reason the loss in patent flour and fine meals is not important. City families who have to live on less than $1000 a year cannot purchase an abundance of green vegetables and fruits, because they are expensive, and so the loss is never made up. It would seem best to advocate the use of the breakfast foods prepared from the whole grain, and the use of unbolted meals, and whole wheat or Graham flour. When we consider how many people use nothing but bread, meat, potatoes, sugar, and some form of fat, we can see the need of foods prepared from the whole of the grain, to supply all the elements needed by the body, in the right proportion, at a low cost, and in a form so appetizing that no great effort is needed to persuade children to partake of the foods so prepared.

NUTRITIVE VALUE OF OATMEAL AND CREAM FOR CHILD OF 5

Food	Quantity	Cal. Protein	Cal. Fat	Cal. Carbohydrate
Oatmeal	2 oz.	38	37	150
Cream	2 oz.	6	93	10
Sugar	½ oz.	. . .	. . .	57
Total . . .		44	130	217

Composition of Cereals and Cereal Products

Kind	Water	Protein	Fat	Carbohydrate	Cellulose	Mineral Matter
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Oat Preparations:						
Oats, whole grain	11.0	11.8	5.0	59.7	9.5	3.0
Raw oatmeal	7.3	16.1	7.2	66.6	.9	1.9
Steam-cooked, rolled oats	8.2	16.1	7.4	65.2	1.3	1.8
Flaked and malted oats	7.9	16.2	5.2	66.7	1.6	2.4
Wheat:						
Whole grain	10.5	11.9	2.1	71.9	1.8	1.8
Cracked wheat	10.1	11.1	1.7	73.8	1.7	1.6
Steam-cooked, rolled wheat	10.6	10.2	1.8	74.1	1.8	1.5
Ready to eat, flaked and crisp	9.4	12.2	1.4	72.7	1.9	2.4
Shredded wheat	8.1	10.6	1.4	76.0	2.1	1.8
Farina	10.9	11.0	1.4	75.9	.4	.4
Patent roller process flour	12.0	11.4	1.0	74.8	.3	.5
Entire wheat flour	11.4	13.8	1.9	71.0	.9	1.0
Graham flour	11.3	13.3	2.2	69.5	1.9	1.8
Barley:						
Whole grain	10.9	12.4	1.8	69.8	2.7	2.4
Pearled barley	11.5	8.5	1.1	77.5	.3	1.1
Steam-cooked, flaked	8.8	10.6	.8	77.7	1.2	.9
Buckwheat:						
Flour	13.6	6.4	1.2	77.5	.4	.9
Farina	11.3	3.3	.3	84.6	.1	.4
Groats	10.6	4.8	.6	83.1	.3	.6

Composition of Cereals and Cereal Products — *Continued*

Kind	Water	Protein	Fat	Carbohydrate	Cellulose	Mineral Matter
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Corn:						
Whole grain	10.9	10.5	5.4	69.6	2.1	1.5
Unbolted corn meal	11.6	8.4	4.7	74.0	..	1.3
Bolted corn meal	12.5	9.2	1.9	74.4	1.0	1.0
Hominy	10.9	8.6	.6	79.2	.4	.3
Parched, flaked	7.3	10.1	1.8	77.2	1.2	2.4
Popped pop corn	4.3	10.7	5.0	77.3	1.4	1.3
Rice:						
Polished whole rice	12.3	6.9	.3	80.0	..	.5
Steam-cooked, flaked	10.2	8.3	.3	79.7	1.2	.3
Puffed rice	7.1	6.2	.6	85.7	..	.4
Popped rice	.7	8.6	.2	90.0	..	.5

CHAPTER III

LEGUMES

Legumes are a class of plants that have the power to take nitrogen from the air and put it into a form that is available as food for man and the lower animals. They include beans, peas, lentils, peanuts, clover, and alfalfa, and differ from other plants in that they have little nodules at their roots, containing bacteria that have the power to take nitrogen from the air. The plant uses this nitrogen in building proteins. The percentage of protein in the legumes is so high that they are classed with meat and cheese as tissue-building foods.

Like the cereals, legumes are used the world over for food, probably more extensively in other countries than in America, because in other countries they take the place of meat, and the people understand better how to cook them so that they can be easily digested. In the use of legumes and cheese European countries have surpassed America, and the reason, doubtless, is because the poorer classes have not been able to purchase meat and so have found substitutes and better ways of preparing them. Foreigners can teach us many things about cooking legumes and cheese. Americans do not know much about economics in food. They have spent their talents in preparing high-priced, appetizing foods for the well-to-do, and the poorer classes have lived on baker's bread and tea. The soup kitchens have a mission other than supplying food to school children. They could teach the uses of the legumes, and their preparation in the fireless cooker. Legumes furnish 1.6 per cent of the total food consumed in the American diet, 3.3 per cent of the protein, .2 per cent of the fat, 2 per cent of the carbohydrate.

Composition. — Legumes should be classed in two distinct classes because the fresh and dried forms differ so widely in nutritive value and use.

Composition of Legumes

Materials	Water	Protein	Fat	Carbohydrate	Cellulose	Mineral Matter
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Fresh Legumes:						
String beans	89.2	2.3	.3	7.4	1.9	.8
Shelled kidney beans	58.9	9.4	.6	29.1	1.7	2.0
Shelled lima beans	68.5	7.1	.7	22.0	1.7	1.7
Shelled peas	74.6	7.0	.5	16.9	1.7	1.0
Dried Legumes:						
Lima beans	10.4	18.1	1.5	65.9	?	4.1
Navy beans	12.6	22.5	1.8	59.6	4.4	3.5
Lentils	8.4	25.7	1.0	59.2	?	5.7
Dried peas	9.5	24.6	1.0	62.0	4.5	2.9
Peanuts	9.2	25.8	38.6	24.4	2.5	2.0

String beans compare with other green vegetables in nutritive value; shelled beans and peas with the roots and tubers, although they contain considerably more protein; and the dried legumes with cheese, nuts, and chocolate, all considered concentrated foods.

The nutritive ratio of the dried legumes is 1 : $2\frac{1}{2}$, which shows that they belong with the tissue-building foods. They contain from 18 to 25 per cent protein, mostly in the form of legumin, — a globulin. With the exception of peanuts they contain scarcely any fat; all except peanuts contain from 59 to 66 per cent carbohydrate in the form of starch and cellulose, the cellulose content reaching as high as 4.5 per cent in dried peas.

They contain mineral matter in the form of lime, potassium, and sulphur compounds, although they contain the other elements also. Lentils contain a high percentage of iron, and not so much sulphur as the other legumes, and for that reason they are more easily digested. It is to be regretted that they are not used more extensively in this country, although they are used to some extent among our foreign population.

From their composition, it would seem that the dried legumes could be used largely and profitably as substitutes for meat, and that if fat in some form is added they would serve as a balanced food. They contain more protein than meat, fish, eggs, milk, and as much as cheese. They contain enough carbohydrate, so that if fat is added, as in cooking beans with pork, the nutritive ratio can be adjusted to any standard. They contain cellulose for bulk and sufficient mineral matter to supply all the needs of the body.

But neither composition alone, nor composition and low cost, can make a perfect and satisfactory food. The third factor, digestibility, is even more important, because the old saying, "It is not what we eat, but what we digest, that nourishes the body," applies to this class of foods more directly than to any other class, with the possible exception of nuts.

Structure. — Dried peas, beans, and lentils are so similar in composition that a study may be made of any one of them, which will serve for all. Beans have been taken as the type because they are used more widely in the dried form, in this country, than either of the others. In the fresh form peas are the greater favorite.

Dried navy beans contain 22.5 per cent protein, 1.8 per cent fat, 59.6 per cent carbohydrate, 4.4 per cent cellulose, and 3.5 per cent mineral matter. The carbohydrate and protein are stored in cells, the walls of which are cellulose, of considerable thickness, for the cellulose makes up 4.4 per cent of the seed. This means that they are so surrounded with cellulose that it will take long, slow cooking to soften the walls and free the starch and protein, and allow the water to reach them. This is hard to accomplish, because, ordinarily, beans are cooked whole, and the heat and moisture must penetrate the whole mass. They are served whole, and it has been found that a varying percentage of the starch and protein not only escapes digestion, but also escapes cooking. To repeat, the starch and protein are so intermixed with the cellulose that in the whole seed much escapes cooking and digestion; and because of the delay in digestion, fermentation frequently sets in and causes the distress that people are subject to who find that beans do not agree with them. If the beans are ground into meal, or finely divided, they will cook more thoroughly, and will be digested more readily, without causing digestive disturbances.

Digestibility. — The coefficients of digestibility for proteins and fats are not nearly so high in vegetable foods as in animal foods. They are not so high for carbohydrate, but the difference is not so marked. Several reasons are given for the losses in digestion, among them the following:

The protein and fat in meat and fish are more like the human body in composition and so are more readily assimilated; the proteins in meat are more pleasing to the taste and call out more digestive juices, or rather, call out a greater quantity of the digestive juices; the protein, starch, and cellulose are so intermixed that cooking does not release them, and they escape digestion. The last reason is, undoubtedly, the greatest factor. The following table, taken from Farmer's Bulletin No. 142, gives the figures showing coefficients of digestibility for different foods:—

Kind	Protein Digestibility	Fat Digestibility	Carbohydrate Digestibility
	Per Cent	Per Cent	Per Cent
Meat and fish	97	95	98
Eggs	97	95	98
Dairy products	97	95	98
Cereals	85	90	98
Legumes	78	90	97
Vegetables	83	90	95
Fruits	85	90	95

Legumes have a lower coefficient of digestibility for protein than the other vegetable foods, and it is probably due to the structure of the cell, — tough walls of cellulose containing starch and protein in close combination.

Legumes are not digested to any great extent in the stomach, and they remain there longer than most foods. This is doubtless the reason why they are considered indigestible. The digestion in the intestine is fairly complete, except for the protein; but with the sulphur present and the large amount of starch and cellulose, if digestion is delayed, fermentation sets in and gases are formed which cause the discomfort occasioned by an overindulgence in baked beans.

If the skin is removed from the dried legumes, and they are ground into meal or flour, very little escapes digestion. If they are thoroughly soaked first, and then cooked for a long time at a moderate temperature so as not to make the protein harder to digest, and if eaten in moderate quantities, they are a nutritious, wholesome, and cheap food, and should be substituted occasionally for meat in the diet. The fresh legumes are universal favorites as green vegetable foods.

Peanuts, while usually considered nuts, are the seeds of a leguminous plant and when raw taste much like beans. They have not been considered a food, but merely a relish or addition to the diet, much as candy is considered, although they have high nutritive value. Several preparations are now marketed with a view to using them as a food; the commonest is peanut butter, much used for sandwiches.

Lunch or Supper for Four People

Man at sedentary occupation, woman at moderately active work, boy 13–14 years, girl 15–16 years.

LENTIL SOUP. NUTRITIVE VALUE IN CALORIES

Food	Quantity	Protein	Fat	Carbohydrate
Lentils . . .	½ lb.	234	20	539
Flour . . .	1 oz.	12	2	86
Butter . . .	2 oz.	4	430	....
Soda crackers	12 oz.	133	276	998
Total . .		383	728	1623

Cost $.17.

For 4 people: 383 Cal. Protein, 2351 Cal. Fat and Carbohydrate.
Per person: 96 Cal. Protein, 588 Cal. Fat and Carbohydrate.
One fourth of daily ration.
Supplies also iron, lime, and potash, and other mineral salts.

CHAPTER IV

ROOTS AND TUBERS

CLASSIFICATION OF ROOTS AND TUBERS

A. Starchy Roots and Tubers.

Potato.
Sweet potato.
Yam.
Tapioca.
Sago.
Arrowroot.

B. Succulent Roots and Tubers.

Onions.
Beets.
Carrots.
Rutabagas.
White turnips.
Kohlrabi.
Celeriac.
Salisfy.
Parsnips.
Radishes, etc.

COMPOSITION OF POTATOES AND SWEET POTATOES

FOOD	WATER	PROTEIN	FAT	CARBOHYDRATE	CELLULOSE	MINERAL MATTER
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Potato . .	78.3	2.2	.1	18.0	.4	1.0
Sweet potato	69.	1.8	0.7	26.1	1.3	1.1

Vegetable Foods — Roots and Tubers and Bulbs. — Roots, tubers, and bulbs are either the roots, or the thickened stems of vegetables, in which starch or sugar is stored for the nourishment of the young plant when it shall need it. They contain 70–90 per cent water; 8–26 per cent carbohydrates, in the form of starch, sugar, pectin, and cellulose; 1 per cent mineral salts; less than 2 per cent protein; and only a trace of fat. As purchased, they contain about 20 per cent refuse. From the above it will be seen that their food value depends on the carbohydrates and mineral salts.

They are easily raised, can be stored for winter use, are cheap, and furnish great variety to the diet because they can be served in many forms. They furnish about 16 per cent of the average American diet. Potatoes alone furnish 12 per cent.

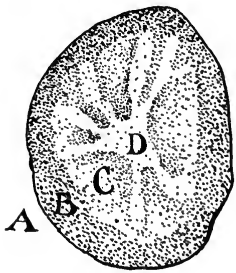
Roots and tubers should be studied in two general classes because of the variance in the amount of carbohydrates, in the amount of water, and in the rank and importance in the diet.

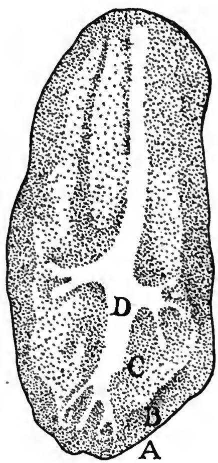
1. Starchy roots and tubers, which include potatoes, sweet potatoes, and yams, contain 18–26 per cent carbohydrates, mainly in the form of starch, and 68–78 per cent water. In this class are also included those tropical starchy foods prepared from roots and stems, such as tapioca, arrowroot, and sago. In the dry state they contain about 83 per cent starch in a form very easily digested; but when cooked, they have about the same food value as the potato, having absorbed at least eight times their weight of water.

2. Succulent roots and tubers, the commonest of which are beets, carrots, onions, turnips, rutabagas, parsnips, salsify, celeriac, radishes, kohlrabi, and garlic, contain 7–12 per cent carbohydrates, and 83–90 per cent water. The flavor and odor of these foods are due to the presence of volatile oils which may be retained or dissipated by proper cooking.

Typical Starchy Food — Potato

Structure and Composition. — The potato is a thickened underground stem or tuber in which nourishment is stored for the young plant. This stored nourishment is principally insoluble starch, and when in this form is of great value as a human food. As the plant sprouts, a ferment in the potato changes part of the starch to soluble glucose for circulating nourishment, and unfits the potato for food.





Transverse and Longitudinal Sections of the Potato.

A, skin; *B*, cortical layer; *C*, outer medullary layer; *D*, inner medullary area. (From Farmers' Bulletin, No. 389, U. S. Department of Agriculture.)

The potato consists of a network of cells held together by a framework of cellulose and surrounded by a brown corky skin which serves to retain the nourishment. The walls of the cells are also of crude fiber or cellulose, but so fine are the fibers that cellulose makes up but .4 per cent of the potato. Because of the low cellulose content, potatoes cook more quickly than some of the more woody roots and tubers. The cells, which become less dense near the center of the potato, contain water, starch, and a small amount of protein and mineral matter, and an inappreciable amount of fat.

Potatoes contain 78.3 per cent water; 18.4 per cent carbohydrate, of which about 16 per cent is starch (2 per cent dextrin, sugar, and pectose) and .4 per cent cellulose; 2.2 per cent nitrogenous matter, of which about 1.3 per cent is protein, and the remainder extractives, as, asparagin and amido acids; 1 per cent mineral matter, mostly potash salts and phosphoric acid compounds. The mineral salts greatly increase the food value of potatoes, because of their use in digestion and in aiding to preserve the alkalinity of the blood.

The nutritive ratio of the potato is above 1 : 14, which shows that it must be eaten with a protein food to serve the needs of the body. It contains about 22 per cent nutrients, and one pound has a fuel value of 375 calories. One medium-sized potato weighs one half pound. From this it will be seen that it must be eaten with a more concentrated food to supply the proper amount of fuel needed.

Selection. — Potatoes are distinguished as mealy, soggy, and waxy. The mealy potato cooks into a light, flaky mass which readily falls apart, and it is said this quality is produced by the even and abundant distribution of starch throughout the tuber. If, however, the water is more abundant in the center of the potato, it settles there and produces a soggy potato. By improper cooking, — allowing the steam to condense into water in the potato, — any potato will become soggy. Some potatoes contain more protein than others. This is especially so in young, new potatoes. During the cooking of these potatoes the protein is coagulated and forms a framework which holds the starch in place and produces a waxy, rather than a mealy, potato.

It would seem that the best method of selecting potatoes is, either to know the variety, though they differ with soil and season, or to cook some for experiment before purchasing a winter supply. Nearly all people desire a dry, mealy potato, and, as has been said, this may depend on two factors — starch content and distribution, and proper cooking.

It is best to select a medium-sized potato with a smooth skin, as there is less refuse. The flesh of a small potato is apt to be firmer than that of a large one and it cooks more evenly.

The characteristic potato flavor is due to the presence of a trace of a poisonous alkaloid, solanin, which volatilizes during cooking. Potatoes which have turned green because they have grown near the surface of the ground, old potatoes which have sprouted, and unripe potatoes contain considerable solanin and are apt to lead to digestive disturbances. For these reasons potatoes should be selected that are matured, have uniform color, and are free from blemishes.

Storage. — As the potato contains the germ of life and the nourishment for its development, it is simply waiting until conditions are favorable to sprout. Ferments present change the starch to soluble sugar and also break down the sugar. Water is lost by evaporation; the potato loses its texture and flavor, and develops a sweetish taste. To prevent as far as possible these changes, potatoes should be stored in dry, dark, well-ventilated rooms, and kept at a temperature just above freezing, between 33 and 45° F., because the ferments detrimental to potatoes are not active at so low a temperature.

Products. — Potatoes form 40 per cent of the total vegetable crop of the United States, and while most of them are consumed as an article of diet in their natural state, they also serve other uses. Potato starch is manufactured from them and is mainly used as sizing for cotton cloth and paper. Glucose is manufactured from potatoes, though not so extensively as formerly, corn having taken its place. Much is being written of the desirability of manufacturing alcohol from potatoes, though they have always been a source of its production. The reasons for developing this industry are the new uses for alcohol, and the low prices that potatoes bring in years of abundant crop, so low a price that the farmer cannot afford to haul them to market. At such a time they are used as feed for stock.

Dried or dehydrated vegetables, as they are now called, are found in the market and have value. They may be shipped from coast to coast at a low freight rate. Because of the loss of water they are not bulky and will keep for an indefinite time, regaining much of their natural flavor and appearance when soaked in water. They are used only where fresh vegetables are unobtainable.

Digestibility. — From experiments made in actual dietary studies it has been found that potatoes are easily and thoroughly digested and, under normal conditions, lead to no digestive disturbances. In comparison with other vegetables they contain a low percentage of cellulose, so but little of the carbohydrates escapes digestion. Digestion begins in the mouth with the action of ptyalin on the starch. As potatoes contain a very small amount of protein, there is practically no change in the stomach. The digestion is completed by the amylopsin and invertin in the intestine. The coefficient of digestibility for the carbohydrates in potatoes is about 98 per cent, which shows that they are as thoroughly and completely digested as any other vegetable food.

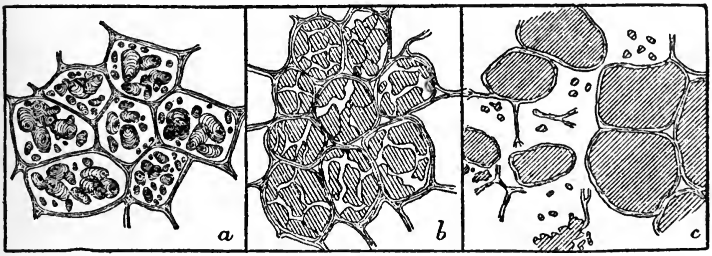
Potatoes alone furnish 12.5 per cent of the average American diet. They are the only vegetable, with the exception of the cereals, that people will use every day in the year and not tire of. They are usually served with meat and other protein foods, to bring up the carbohydrate content and balance the meal. They are almost universally eaten, and may be classed as an indispensable article of diet, and a cheap food, even in seasons when the crop has not been up to average. They are especially valuable for their mineral salts, which help to keep the blood in healthy condition.

Preparation. — Potatoes should be pared thin, as much of the protein and mineral salts are directly under the skin and are lost in deep paring. When pared potatoes are exposed to the air, they turn dark, due to the action of ferments in the plant which become active in the presence of oxygen. This may be prevented by covering the potatoes with water to exclude the air. If pared potatoes are soaked in cold water, much soluble protein and starch and mineral matter are lost. If they are plunged into boiling water, the protein is coagulated and its loss is lessened; but the loss of the mineral matter remains the same.

It will be seen that by paring the potatoes and cooking them in water there is a loss of nutrients that cannot be easily spared, and that would raise the food value of the potato.

If boiled in their jackets, steamed, or baked, potatoes lose an inappreciable percentage of nutrients and have a better flavor.

Cooking. — The object of cooking potatoes is to release the starch from the cell walls. It is stored in minute cells which contain starch, water, and some protein, and heat causes the starch to absorb the water and swell. When this is accomplished, any excess water should pass off as steam, and the result should be a flaky, mealy potato. To release the steam, baked potatoes should be pierced, and all potatoes should be served in an uncovered dish. Cooking also coagulates the protein, liberates the volatile oils,



CHANGES OF STARCH CELLS IN COOKING.

a, Cells of a raw potato with starch grains in natural condition; *b*, cells of a partially cooked potato; *c*, cells of a thoroughly boiled potato. (From Farmers' Bulletin, No. 389, U. S. Department of Agriculture.)

and may change some of the starch to dextrin. It develops the flavor and makes them palatable.

Sweet Potatoes are like potatoes in structure and very similar in composition. They contain, however, 26 per cent carbohydrates, of which about 16 per cent is starch and 10 per cent sugar, though this proportion varies greatly. The northern sweet potatoes, as the Jerseys, contain more starch (20 per cent starch) and cook drier and mealier than the southern type, in which the sugar is in greater proportion.

Sweet potatoes contain 69 per cent water, — 9 per cent less than potatoes. They contain 1.3 per cent cellulose, which accounts for the longer time that it takes to cook them. Their nutritive ratio is about 1 : 20, but the fuel value is higher than that of potatoes. They yield 570 calories per pound.

Cooking. — Because the ratio of starch to sugar varies so greatly in the different varieties, the effect of heat on them brings out different characteristics. Heat causes starch to swell, to burst the cell wall, and the whole mass to become flaky. It causes sugar to dissolve in the water and become sirupy. The sweet potato, with 20 per cent or more of starch, is dry and mealy, and slightly sweet, and suits the northern taste. The sweet potato containing 10–13 per cent sugar is moist and very sweet, and cannot be served so universally as potatoes, because many people do not care for it. Sweet potatoes are best baked, though they are often boiled and served in many other ways.

Place in the Diet. — As sweet potatoes have practically the same nutritive value as potatoes, they must supplant them in the diet in districts or countries where they are raised. In those places they are as cheap as potatoes and as well liked. In the northern market 6 pounds are sometimes sold for 25 cents, and hence they cannot take the place of potatoes selling at 1 to 1½ cents a pound. Their place, then, is to add variety to the diet.

Succulent Roots and Tubers

Average Composition of Edible Portion

Food	Water	Protein	Fat	Carbo-hydrate	Cellulose	Mineral Matter
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Beets	87.5	1.6	.1	8.8	.9	1.1
Celeriac	84.1	1.5	.4	11.8	1.4	.8
Carrots	88.2	1.1	.4	8.2	1.1	1.
Parsnips	83	1.6	.5	11.	2.5	1.4
Salsify	85.4	4.3	.3	6.8	2.	1.2
Turnips	89.6	1.3	.2	6.8	1.3	.8
Rutabagas	88.9	1.3	.2	7.3	1.2	1.1
Onions	87.6	1.6	.3	9.1	.8	.6

The succulent roots and tubers contain more water and less nutrients than the starchy roots and tubers, and hence have a lower food value. They contain 7–12 per cent carbohydrates, 1–2.5 per cent cellulose, about 1 per cent mineral salts, less than 2 per cent protein, and scarcely any fat.

They are valuable additions to the diet because of their mineral salts, large amount of cellulose, and agreeable flavor, and because they furnish variety to the diet. They also furnish some carbohydrates.

Roots and tubers should be stored in a cool, dry place to prevent them from sprouting. In the storage of all foods, the conditions favorable to growth and germination of the plant should be studied; and from this can be learned the storage conditions which best prevent germination and keep the food from undergoing changes that will unfit it for use as a food. The same thing applies to the study of bacteria which cause the decay of food. Both seeds and bacteria need moisture, warmth, and food for development. To prevent their growth we keep foods in a dry, cool, and dark place.

Selection. — The cellulose in old roots and tubers is tough and woody, and they require a much longer time for cooking than the young, tender ones. They also have lower food value. Large roots have a coarser texture also.

Preparation. — Roots and tubers should be washed clean, and pared as thin as possible to prevent the loss of nutrients. They should be cooked whole, when possible, for the same reason. If a small quantity of water is used in cooking, there is less nutrient lost than when a large quantity is used. Because roots and tubers contain starch and cellulose, they cannot be served raw, but need enough cooking to soften the cellulose and free the starch from its covering and cook it.

During cooking, vegetables undergo certain changes. The starch is gelatinized, the cellulose is softened, and the protein is coagulated. Flavors are developed and the oil is volatilized and escapes in the steam. Because of this fact, vegetables with strong flavor may be cooked in a larger quantity of water, or this water may be changed during cooking, and the flavor will be milder. If the cover is left off during the cooking, the odor is not so strong because it escapes gradually. Some vegetables seem to retain their color better when cooked uncovered. Mineral matter, some starch, and other substances are lost when food is cooked in water. There is practically no loss when they are steamed.

Place in the Diet. — Succulent roots and tubers and green vegetables together furnish but 6½ per cent of the average American diet. It would seem that with a more careful study of their low cost, wide distribution, ease of preparation, the variety they add to the diet, their importance as a source of mineral salts and cellulose for the body, they could be used more extensively.

CHAPTER V

GREEN VEGETABLES AND FRUITS

VEGETABLES have the nourishment which we take from them stored in different parts to supply food for the plant when it shall germinate. The greatest amount of this nutrition is stored in the seed, and the cereals and legumes, being the seeds of the grains and leguminous plants, contain considerable nutrition. Roots and tubers are also storehouses of nourishment, and they contain a large amount of carbohydrate in the form of starch or sugar. The leaves are the means by which the plant takes in carbon dioxide and gives out oxygen, and they contain very little nourishment, their bulk being due to the cellulose. In green vegetables, which are chiefly the leaves and stems of plants, we expect to find little nourishment. The green vegetables with which we are most familiar are asparagus, celery, cress, endive, cucumbers, squash, lettuce, spinach, and tomatoes.

COMPOSITION OF GREEN VEGETABLES

FOOD	REFUSE	WATER	PROTEIN	FAT	CARBO-HYDRATE	MINERAL MATTER
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Cabbage .	15.5	77.7	1.4	.2	4.8	.9
Celery . .	20.	75.6	.9	.1	2.6	.8
Cucumbers	15.	81.1	.7	.2	2.6	.4
Lettuce .	15.	80.5	1.0	.2	2.5	.8
Spinach .	—	92.3	2.1	.3	3.2	2.1
Tomatoes .	—	94.3	.9	.4	3.9	.6

Composition and Uses.— Green vegetables contain .7–2.1 per cent protein; .1–.3 per cent fat; 2.5–4.8 per cent carbohydrate, chiefly cellulose; .4–2.1 per cent mineral matter. The fuel value of any of them scarcely exceeds 100 calories per pound. In spite of this fact, they are valuable foods, for they contain a high percentage of base-forming elements and tend to keep the blood alkaline and to lower the acidity of the urine. Spinach, dandelion greens, cabbage, lettuce, and asparagus contain considerable iron. The carbohydrate in green vegetables is principally cellulose, and as there is little or no nutrient mixed with it, the main purpose in eating it is to furnish bulk for the intestines to act on.

Place in Diet. — With few exceptions, green vegetables should be eaten raw, because mineral matter is lost in water in which they are cooked and because the cellulose serves its purposes best in a crisp form. When green vegetables are eaten fresh, as they should be, with salad oil added, they form an agreeable addition to a meal. Except in the country where they are raised, they are not a cheap food and are extremely perishable, and when stale are of little use, as their attractiveness depends on crispness. Whenever it is possible, they should be added to the meal, because of their effect on the fluids of the body in counteracting acidity, and because they furnish mineral matter needed for other purposes.

Green vegetables differ from all other classes of foods in that they cannot be called either tissue-building or heat and energy yielding foods, for it would hardly be possible to eat one pound of them at a meal and even a pound will not yield 100 calories of heat. They show that foods are needed for other purposes, for they furnish mineral matter and cellulose, both absolutely necessary to keep the body in health.

Fruits. — Green vegetables and fruits are frequently considered together when calculating their place in the diet. Some fruits are classed with green vegetables because they are served as such, as tomatoes, cucumbers, and squash. Some fruits, like nuts, have so high a nutritive value that they are classed separately.

Fruits differ greatly in nutritive value. Some, like bananas, figs, olives, plums, prunes, and grapes, have as high a fuel value as the cereals. Muskmelons, watermelons, peaches, and pears have nearly as low a fuel value as the green vegetables.

Composition. — All fruits are alike, however, in that they contain scarcely any protein. All but olives have only a trace of fat; they all contain vegetable acids, mineral matter, and as much carbohydrate as the roots and tubers.

The nutritive value of fruits depends on the acids, which decompose in the body, forming alkaline carbonates and thus help to keep the blood alkaline and lower the acidity of the urine; it depends also on the mineral matter, and on the carbohydrates.

The carbohydrates in fruits are in the form of sugars, — cane, grape, fruit, — "pectin bodies," and cellulose. From the table showing the composition of fruits, it will be seen that they contain considerable cellulose, and to this and the mineral salts fruits owe their laxative properties.

In some unripe fruit, the carbohydrate is mainly starch and cellulose, and during ripening the acids and ferments change them to sugars. For this reason bananas, which contain a great deal of starch as they are usually marketed, are hard to digest. They should not be eaten until the skins begin to turn black, or they should be served cooked. Many fruits contain a carbohydrate called pectose or pectin, which gives to the juice its gelatinizing power. It occurs in greatest abundance just before the fruit is ripe, or when ripe, and disappears as the fruit becomes overripe. It seems to be most abundant in the skin and around the core. Apples, currants, grapes, plums, and cranberries contain more of it than the other fruits. For this reason they make the best jelly.

Preservation. — Certain oxidizing agents, as ferments, present in fruit, act on substances in it, so, when it is exposed to the air, cut fruit turns black; for the same reason bruised fruit discolors. Fruits are not attacked by bacteria because they are too acid, but molds thrive well on them. The method of packing lemons, oranges, and grapes, so as to keep them dry and prevent the growth of molds, is finding favor with apple growers. If fruits are carefully picked, so that they will have no bruised spots, and then wrapped in paper to keep them dry, their keeping qualities are enhanced 500 per cent.

Food Values and Uses of Fruit. — Although the modern methods of shipping, packing, and raising fruits have lowered the prices so that nearly all people can purchase them in season, fruits are not a cheap food. They have almost a medicinal value in the diet, and it is to be deplored that those who are able to purchase them do not make even greater use of them. They furnish 3.8 per cent of the average American diet; and if more were used, they would lower the amount of medicine consumed.

Place in the Diet. — It should be remembered that if patent flour is used in the home, fruits and green vegetables must be served in abundance, to supply the needed mineral salts and counteract the tendency to rheumatism, and uric acid formation in the blood and tissues. Fruits contain from 1 to 7 per cent vegetable acids and less than 1 per cent mineral matter in the form of phosphorus, lime, iron, and potassium salts, and together they have a great effect on controlling acidity in blood, tissues, and excretions. Because of the great amount of water, cellulose, and mineral matter they aid the large intestine to rid the system of waste. In addition to this, they have a food value equal to roots and tubers, are relished by every one, and add variety to the diet.

Nuts. — Nuts do not furnish any great part in the American diet, .1 per cent of the fat being the only figure given in the dietary studies. They are used principally in confectionery, and though much is heard of the desirability of a diet of fruit and nuts, only a few people seem to care to try it, probably because such a diet would lack savor. Nuts are a concentrated food, and not easily digested. They escape mastication, and the vegetable fat is hard to digest. It would seem that if it were not for the digestive disturbances which they cause if eaten in quantity, they would find a place in the diet. When a food so attractive, plentiful, and well liked as nuts, has found so small a place in the diet, it must be because they do not agree with the average person. As in other things, use is a good guide to determine the value of a food.

Composition of Fruits

Kind of Fruit	Water	Protein	Fat	Carbohydrate	Cellulose	Mineral Matter
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Apples	84.6	.4	.5	13.	1.2	.3
Apricots	85.	1.1	..	13.4	..	.5
Bananas	75.3	1.3	.6	21.	1.	.8
Blackberries	86.3	1.3	1.	8.4	2.5	.5
Cherries	8c.9	1.	.8	16.5	.2	.6
Cranberries	88.9	.4	.6	8.4	1.4	1.5
Currants	85.	1.5	..	12.8	..	.7
Grapes	77.4	1.3	1.6	14.9	4.3	.5
Lemons	89.3	1.	.7	7.4	1.1	.5
Muskmelons	89.5	.6	..	7.2	2.1	.6
Olives	67.0	2.5	17.1	5.7	3.3	4.4
Oranges	86.9	.8	.2	11.6	..	.5
Peaches	89.4	.7	.1	5.8	3.6	.4
Pears	80.9	1.	.5	15.7	1.5	.4
Pineapples	89.3	.4	.3	9.3	.4	.3
Plums	78.4	1.	..	20.1	..	.5
Raspberries, red	85.8	1.	..	9.7	2.9	.6
Raspberries, black	84.1	1.7	1.	12.6	..	.6
Strawberries	90.4	1.	.6	6.	1.4	.6
Watermelons	92.4	.4	.2	6.7	..	.3

Composition of Dried Fruits

Kind of Fruit	Water	Protein	Fat	Carbohydrate	Cellulose	Mineral Matter
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Apples	26.1	1.6	2.2	62.	6.1	2.0
Apricots	29.4	4.7	1.	62.5	..	2.4
Citrons	19.	.5	1.5	78.1	..	.9
Dates	15.4	2.1	2.8	74.6	3.8	1.3
Figs	18.8	4.3	.3	68.	6.2	2.4
Pears	16.6	2.8	5.4	66.	6.9	2.4
Prunes	22.3	2.1	..	71.2	2.1	2.3
Raisins	14.6	2.6	3.3	73.6	2.5	3.4
Currants	17.2	2.4	1.7	71.2	3.	4.5

Composition of Nuts

	Water	Protein	Fat	Carbo-hydrate	Cellu-lose	Mineral Matter
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Almonds . . .	4.5	21.	54.9	17.3	2.	2.
Hickory nuts .	3.7	15.4	67.4	11.4	..	2.1
Pecans	2.7	9.6	70.5	15.3	..	1.9
Walnuts . . .	2.5	18.4	64.4	13.	1.4	1.7

CHAPTER VI

BEVERAGES AND CONDIMENTS

Beverages. — Tea and coffee, the two common beverages, are alike in several respects. They have no food value except in the cream and sugar sometimes added in serving, and both contain volatile oils to which they owe their flavor and aroma and which stimulate peristalsis; both contain alkaloids that are stimulants, and that act directly on the heart, nerves, and brain. They are injurious in the same way that all other stimulants are injurious, because brain, nerves, and heart have normal action, and anything that accelerates or disturbs that action deranges the nervous system. The action may be slight, or it may be marked, but there is always some effect. During sickness or in emergencies, the heart or brain may need stimulants, but in health, especially in childhood and youth, while the body is growing and developing, the nervous system should not be unduly stimulated.

Tea consists of the leaves of a plant grown most extensively in China, Japan, and India. There are two varieties, and many grades of tea, and all may be produced from the same plant. The two varieties, green and black tea, owe their differences in color, flavor, and aroma to the methods of drying and curing. Green teas are roasted for about five minutes, then rolled and dried, the whole process taking about one hour. Black teas are spread in the open air, and when partially dried, are rolled and allowed to ferment during the slow drying process which follows. The slow drying develops flavor and color. Some teas are flavored by mixing flowers with them while drying, as the Orange Pekoe brand. The buds and small leaves produce the choicest varieties of tea.

Coffee is the seed or berry of a tropical plant. The different brands or varieties in the market have taken their names from the countries or cities from which they were first exported. The names Mocha, Java, and Rio no longer mean that those brands are produced and manufactured in the places indicated by their names, for most of the coffee comes from South America, largely from Brazil.

The differences in flavor and aroma are due to two reasons. The length of time that the berries are roasted produces a difference in color, — some being roasted to a reddish brown, some to a dark brown; this affects flavor. Some berries are picked green, some are gathered when they have turned red, some are left until they are purple or ripe. The stage of maturity at which they are gathered also affects flavor, and by the variation in time of gathering and methods of roasting, the different grades are produced.

Chocolate and Cocoa. — Unlike tea and coffee, chocolate and cocoa are foods and have high nutritive value. Like tea and coffee, they contain a milk alkaloid which has a slight stimulating effect on the nervous system.

A tropical tree, called the cacao tree, produces seeds from which chocolate and cocoa are manufactured. The seeds are called cocoa beans, and, when roasted and freed from the outside hull or covering, are the cocoa nibs of commerce.

The cocoa nibs are broken, and then ground fine and thus the unsweetened chocolate of trade is made. The sweetened brands have sugar, and sometimes flavor, added.

Cocoa is manufactured by depriving the ground chocolate of some of its fat. The fat that is removed is called cocoa butter and is used in medicine and drugs, and, to some extent, in cooking and in confectionery.

Food Value of Chocolate and Cocoa. — It will be seen from the following table that both chocolate and cocoa have a high food value and rank with the concentrated foods:

Composition of Chocolate and Cocoa

Food	Water	Protein	Fat	Carbohydrate	Mineral Matter
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Chocolate	5.9	12.9	48.7	30.3	2.2
Cocoa	4.6	21.6	28.9	37.7	7.2

Chocolate contains a high percentage of fat, and this being vegetable fat, it is harder to digest than animal fat. Unless mixed or eaten with a protein food it makes a poorly balanced product; and when manufactured into chocolate creams or candy more carbohydrate is added, which further increases the high fuel value.

It does not seem possible that a normal digestive apparatus can take care of the quantities of chocolate creams that some individuals consume. The test, probably never applied, is whether that consumer has normal health, vitality, and resistant power, or is subject to digestive disorders attributed to other causes. Over consumption of sugar and candy is an excess and is as much a menace to health as are other excesses. It leads to loss of appetite for wholesome foods, eating at irregular times, formation of acids in the stomach, indigestion, and other ills.

The subject of candy is discussed in connection with chocolate because chocolate creams are consumed to so great an extent and are harder to digest than most candies. The man working out of doors or the mountain climber may be able to digest a pound of creams with no great difficulty, but the delicate girl, who cannot digest meat and vegetables, must possess a specially designed digestive apparatus to do so and maintain health.

Chocolate is a nutritious and wholesome food, if used in moderation. It makes a very nutritious and appetizing beverage; and, if made with skim milk, the protein content can be raised so that it will form a balanced food. The fat in cocoa is usually treated so that it is emulsified more readily than that in chocolate and is more easily digested. In the manufacturing of cocoa nearly 50 per cent of the fat is removed. Cocoa is a protein food, having a nutritive ratio of 1 : 4.

Condiments are aromatic substances that are added to foods to furnish flavor and that stimulate the lining of the stomach and increase the flow of the digestive juice. They have practically no food value, and in most cases, their flavor is due to the presence of volatile oils that can be extracted and that are sold for medicinal purposes, as oil of cloves, oil of mustard, etc. The condiments in common use are cinnamon, cloves, ginger, mustard, pepper, allspice, nutmeg. Many aromatic herbs, as sage, mint, dill, and parsley, are used as condiments.

CHAPTER VII

ANIMAL FOODS

ANIMAL foods are classified as: —

1. Meats, which include poultry and game.

2. Fish, which include shellfish.

3. Animal products, which include eggs, milk, butter, and cheese.

The rank and importance of the different animal foods, according to use, may be judged from the following table compiled from the dietary studies.

USE AND COMPOSITION OF ANIMAL FOODS

FOOD	TOTAL FOOD MATERIAL USED	PROTEIN	FAT	CARBO-HYDRATE
	Per Cent	Per Cent	Per Cent	Per Cent
Beef and veal	7.2	16.7	13.2	..
Pork and lard	7.2	9.3	42.1	..
Lamb and mutton	.9	2.1	2.6	..
Poultry	.7	1.6	.9	..
Fish	1.8	3.5	1.0	..
Eggs	2.1	4.1	2.9	..
Milk and cream	16.5	8.7	8.0	3.6
Butter	1.6	.3	16.6	..
Cheese	.3	1.0	1.1	..

Milk furnishes the greatest proportion of the total food material; beef, the greatest amount of protein; pork, the greatest amount of fat. Beef and milk furnish the greatest amount of animal protein and are the two most important animal foods. Wheat is more important as a source of protein, however, than either, or than both together, for it furnishes 28.5 per cent of all protein used.

COMPOSITION OF MEATS

COMPOSITION OF MEAT	REFUSE	WATER	PROTEIN	FAT	CARBOHYDRATE	MINERAL MATTER
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
BEEF, FRESH						
Chuck, ribs .	16.3	52.6	15	14.3	. .	.6
Loin, medium	13.3	52.5	15.6	16.6	. .	.7
Ribs . . .	20.8	43.8	13.5	20.	. .	.5
Round, medium . . .	7.2	60.7	18.4	12.2	. .	.8
Shoulder and clod . . .	16.4	56.8	15.9	9.3	. .	.7
BEEF, DRIED AND SMOKED	4.7	53.7	25.6	6.6	. .	5.5
VEAL:						
Cutlets, round	3.4	68.3	19.5	7.1	. .	.8
Leg . . .	14.2	60.1	15	7.5	. .	.7
MUTTON:						
Leg . . .	18.4	51.2	14.6	14.	. .	.6
Loin . . .	16.	42.	13.1	26.9	. .	.5
PORK, FRESH:						
Loin chops .	19.7	41.8	13.	23.	. .	.6
Ham . . .	10.7	48.	13.1	24.6	. .	.6
PORK, SALTED AND SMOKED						
Bacon . . .	7.7	17.4	8.8	59.1	. .	3.1
Ham . . .	13.6	34.8	13.8	31.7	. .	3.2
Salt, fat . .	. .	7.9	1.8	81.9	. .	2.9
POULTRY:						
Fowl . . .	25.9	47.1	13.3	11.7	. .	.5
Turkey . .	22.7	42.4	15.6	17.5	. .	.6

Similarities and Differences. — Meats, which include beef, veal, mutton, lamb, pork, venison, poultry, and game, are similar in structure, composition, nutritive value, and digestibility. In fact, the different meats vary less in these factors, than do the different cuts of the same animal. There are the following differences, however: The meat of a young animal contains more bone in proportion to flesh and has more refuse than the meat of an older animal. The flesh of young animals contains more water, veal and lamb containing more water than beef and mutton. The older animals have more fat, the fat taking the place of the water in the younger animal. The amount of protein is practically the same in all. The kind of protein varies, young animals being rich in albuminoids, old animals having more nitrogenous extractives. Fat meats are harder to digest than the lean meats, because the fat interferes with the action of the gastric juice on the protein. Meats with close fibers are harder to digest than those with loose fibers, because the digestive juices cannot penetrate them readily.

Meats contain a certain amount of refuse, which consists of bone, fat, and skin, and which is usually trimmed off at the market. The amount varies from 3.4 per cent in veal cutlets to 25.9 per cent in fowl. It averages about 17 per cent in beef, mutton, and pork. As the part considered refuse is usually trimmed off after the meat is weighed, its loss increases the cost of the edible portion. The amount of water in meat varies from 42 per cent to 68 per cent, being greatest in young animals.

The amount of fat in any cut of meat as it is prepared for serving cannot easily be calculated. Some fat is always trimmed off at the market, some is trimmed off before cooking, a considerable quantity is lost, during cooking, and each individual leaves some on the plate, the amount left depending on the taste. An example of this loss may be given: A pork loin roast was purchased at the market already trimmed for sale. It then weighed $3\frac{1}{2}$ pounds. Some extra fat was removed, and when it was prepared for roasting it weighed 3 pounds. When removed from the oven it weighed 2 pounds 1 ounce, and of that amount 6 ounces were bone. The loss during cooking was due to evaporation of water and loss of fat. A rough estimate would show that, of the amount purchased, but one half was available for nutrition. The loss is even greater in other cuts or in other meats. The butcher trims the pork, before it is weighed, more closely than other meats, because the fat is more valuable to him. The protein in meat varies from 13 per cent to 19 per cent in the different cuts, and constitutes the one constant factor. In fact the nutritive value of meat may be said to depend on its protein. Meat contains less than 1 per cent mineral matter and no carbohydrate.

Structure. — Meat consists of bone, fat, and muscle. The bone of meat is about half solids and half water. The solid part consists of mineral matter, chiefly calcium phosphate, and animal matter, which is chiefly fat and ossein, — a form of albuminoids. The fat and ossein can be extracted by long boiling or by burning, and the mineral matter remains.

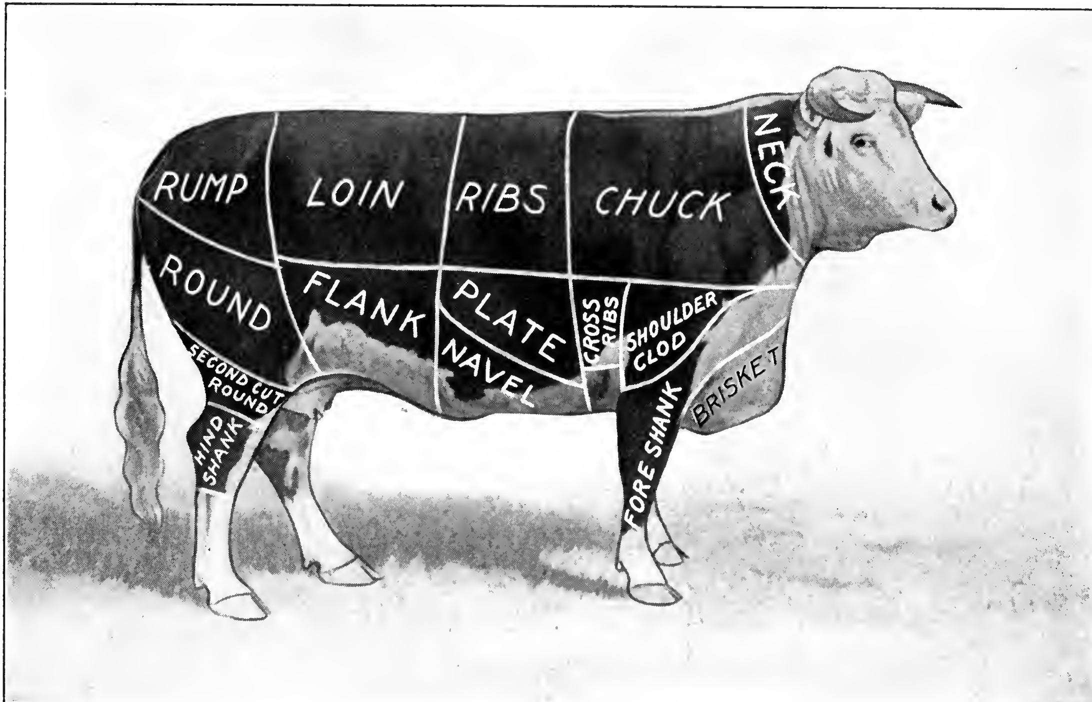
The fat is stored in cell-walls of connective tissue. In the animal it occurs around the internal organs, between the muscle fibers, and under the skin. It is harder in some animals than in others, depending on the proportion of olein and stearin in the fat. Pork fat has more olein than mutton and is softer for that reason.

Muscle fiber consists of bundles of fibers or hollow tubes bound together by connective tissue with more or less fat interspersed between the fibers. The connective tissue and the tubes are composed of collagen and elastin, forms of connective tissue, and they can be dissolved by boiling. The tubes contain various proteins, albumins, globulins, and compound proteins which are in most cases coagulated by heat, also nitrogenous extractives and water.

The single muscle tubes, freed from fat and connective tissue, are the tissue-building part of the meat and for that reason the most important. They are composed of 75.5 per cent water, and 24.5 per cent solids, which consist of myosin, albumin, collagen, extractives, salts, traces of fat and glycogen, and compound proteins. Myosin is the chief protein in meat and forms 7–8 per cent of it. The extractives vary in amount, more being present in red meat than in light-colored. They give to meat its characteristic flavor. Old animals have more than young, and beef has more than mutton.

The amount of connective tissue, which binds the muscle fibers together, and the thickness of the muscle tubes vary in different animals and in different cuts of the same animal. In muscles like those in the leg and neck, that are much used, they are very strong and tough. Along the backbone, where the muscles are not exercised much, they are thin and easily softened.

Digestibility. — If raw meat could be served in an appetizing way and if there were no possibility that it contained microörganisms injurious to health, it would be more easily digested than cooked meat, because the coagulation of the protein affects its digestibility. Flavor has much to do with appetite and digestibility, however, and cooking brings out the flavors, so that a palatable meat


RUMP
LOIN
RIBS
CHUCK
NECK
ROUND
FLANK
PLATE
NAVEL
CROSS RIBS
SHOULDER CLOD
BRISKET
SECOND CUT ROUND
HIND SHANK
FORE SHANK

CUTS OF BEEF

calls out more digestive juices than a meat lacking in flavor. Meat is not always free from parasites, and the prevalence of tuberculosis and other diseases among cattle makes the precaution of cooking necessary.

As meat is almost wholly protein, its digestion takes place in the stomach, where the pepsin changes albumins to peptones. As no fat is digested in the stomach, the amount of fat mixed with the lean meat affects the ease of digestibility. The fat surrounds the protein and retards stomach digestion.

The amount of connective tissue, regulating as it does the tenderness or toughness of the meat, is also a factor in determining the ease or quickness of digestion. Very little is known, however, as to the relative digestibility of certain meats. It is said that beef ranks first, mutton second, veal probably third, and pork last, because of the closeness of its fibers and because it contains so much fat. Absorption of meat is quite complete, its coefficient of digestibility being 98 per cent.

Food Value and Place in the Diet. — Meat is the chief and the most important tissue-building food. It is like the human body in structure and composition, and it fully supplies the needs of the tissues, and is easily and thoroughly digested and assimilated when taken in the proper amounts. Because of the nitrogenous extractives, it stimulates the cells so that people who eat animal food seem to have a more vigorous vitality than those who live solely on vegetable foods.

Meat or protein goes through various changes in the body and is finally broken down in the cells into water, carbon dioxide, and the nitrogenous waste, urea. Urea is eliminated through the kidneys, and an excess of protein food overworks the kidneys in their effort to get rid of the nitrogenous waste.

Proteins are also oxidized to yield energy, and if they are taken in excess, urea and other decomposition products of protein metabolism overload the system. The danger for the average person, then, is that, because of the attractiveness and flavor of meat, more will be consumed than is needed to repair tissue waste, and harm is done. For the poor, the problem is how to secure the needed protein from the sum which they have available for sustenance.

The nutritive ratio of meat depends on the amount of fat. This is a difficult thing to calculate, because much fat is trimmed from the meat and thrown away as waste, much fat is lost in cooking, and much is left unconsumed on serving platter and individual plates. From the same cut of meat, one individual might consume twice as much as another.

While the relative nutritive value varies from $1 : \frac{1}{2}$ to $1 : 3$, the absolute nutritive value of any meat depends on the amount of the fat eaten. The protein is a fairly constant quantity, and so meat will always rank first as the chief tissue-building food.

The food value of anything depends not only on composition and digestibility, but also on the cost. Meat is expensive food. It is the greatest item of expense in the dietary and the first thing that is struck out when economy is necessary. Even the cheaper cuts are not cheap, when we consider the time and fuel needed to make them palatable and appetizing. Then, too, the poorer classes are ignorant of ways to utilize the cheaper cuts. With the use of the fireless cooker the items of time and fuel in preparation are almost eliminated. It does not seem likely that meat will.

become cheaper, because it is a question of supply and and demand. Consumption tends to overtake production and the result is high-priced foods. The solution of the problem seems to be, to learn how to utilize the cheaper cuts of meat, to make use of cheese, milk, cereals, and legumes for protein, and to make more careful studies of bodily requirements.

The place of meat in the diet is to supply the greater part of the protein needed to make a nutritive ration of $1 : 6\frac{1}{2}$. It is best to take meat at one meal and depend on eggs, cheese, milk, cereals, and legumes to supply the remainder of the protein needed.

Beef

Beef, to be good, must come from a healthy, well nourished animal. In good beef the best cuts are fine-grained, well mottled with fat and lean, and bright red in color after being exposed to the air. If there is a thick layer of firm, light-colored fat over the loin and rib cuts, the flesh will be juicier and better flavored than when there is little or no fat over these cuts. In the latter case what fat there is, is dark-colored, and the meat is tough and dry. The animal is old, underfed, or losing flesh.

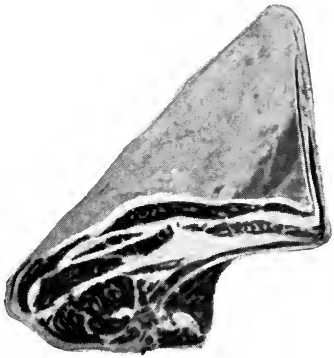
The loin and rib cuts are finer-grained and more tender than the other cuts and require less cooking. They are the finest cuts, for steaks and roasts. The other cuts are not so tender, but are juicier, and some of them contain less bone than the finer cuts, and when properly cooked are as well flavored and equal to the loin and rib cuts in palatability.

The less tender cuts require long, slow cooking to soften the connective tissue and for this reason do not make the finest steaks and roasts. As less than twenty-five per cent of the beef is contained in the loin and rib cuts, they sell for a much higher price than round, chuck, or any other cuts, because the profit must come from the finer cuts. Many people, who cannot afford it, buy these expensive cuts, because they do not know how to cook the other parts and make them attractive and appetizing. The Atwater tables show that those cheaper cuts are just as nutritious as the others. Some of them contain less bone, and they are much cheaper, and when properly cooked, are deliciously flavored and more satisfactory than the badly cooked steak or dry roast.

Tough and Tender Meats. — The amount of connective tissue in a cut of meat determines its tenderness and toughness. The acids which develop in meat that has been hung or kept for a long time, soften the connective tissue so that meat in the first stage of decomposition is fairly tender. If meat is rubbed with oil and vinegar and allowed to stand over night, the connective tissue is also softened.

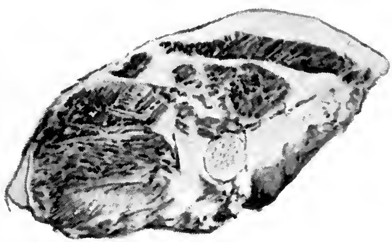
Long, slow cooking in water at or just above the simmering point also softens the connective tissue, while boiling dissolves it. For this reason tough cuts of meat should have long, slow cooking to make them tender.

The amount of fat found in muscle fiber varies greatly. Sometimes it is wholly absent. It has been found that when beef cattle are fattened for slaughter, the fat is stored in the muscle fiber, making a tender piece of meat. When dairy cattle are fattened, very little of the fat is deposited in the muscle, but is put on in thick layers around the internal organs and under the skin. Meat with some fat between the muscle fibers is more tender and delicious than the drier meat. Very few people realize that there are two



Rib

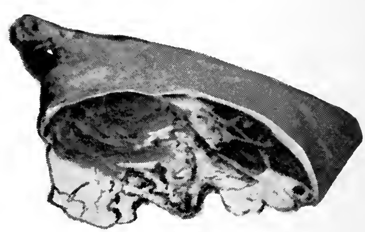
Rib



Loin

Rump

Chuck



Round

Cuts of Beef

kinds of cattle, beef cattle and dairy cattle, and while both are used as meat, the beef cattle always furnish a different meat from that of the dairy cattle.

When the animal is slaughtered, the myosin, the chief protein in meat, is more or less tender though insipid in flavor. After 24 hours the myosin becomes solid and what is known as rigor mortis sets in, the meat becomes tough and remains so until the first stage of decomposition is reached, when the developed acids, sarcolactic acid and acid phosphate, change the myosin to syntonin. These acids also soften the connective tissue and develop flavor. Meat should hang from 3 weeks to 6 months, depending on the storage accommodation.

Composition of Cuts of Beef

As Purchased

	Refuse	Water	Protein	Fat	Carbohydrate	Mineral Matter
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Chuck	16.3	52.6	15.5	15.0	..	.8
Flank	10.2	54.0	17.0	19.0	..	.7
Loin	13.3	52.5	16.1	17.5	..	.9
Porterhouse	12.7	52.4	19.1	17.9	..	.8
Sirloin	12.8	54.0	16.5	16.1	..	.9
Neck	27.6	45.9	14.5	11.9	..	.7
Ribs	20.8	43.8	13.9	21.2	..	.7
Round	7.2	60.7	19.0	12.8	..	1.0
Rump	20.7	45.0	13.8	20.2	..	.7
Shank fore	36.9	42.9	12.8	7.3	..	.6
Shoulder and clod	16.4	56.8	16.4	9.8	..	.9
Fore quarter	18.7	49.1	14.5	17.5	..	.7
Hind quarter	15.7	50.4	15.4	18.3	..	.7

Cutting of Beef. — Beef is sold to the retail dealer cut in halves, and the halves of beef are then divided into hind and fore quarters by cutting between the twelfth and thirteenth ribs, leaving one rib in the hind quarter. The flank is cut from the hind quarter, leaving the loin, rump, round, and shank. The loin includes the porterhouse, sirloin, and tenderloin cuts. The fore quarter is cut across the ribs. The lower part includes the plate, clod, and shank. The upper part includes the rib, chuck, and neck.

Loin. — This cut includes short steaks, porterhouse, sirloin, and tenderloin. The tenderloin is a long muscle that may be stripped from beneath the loin, but when it is removed it destroys the value of the porterhouse steak. The first few cuts from the loin are called short or club steaks because they contain no tenderloin. Steaks cut from the beginning of the tenderloin to the hook bone are called porterhouse. They are the choicest and highest-priced cuts in the beef. The remaining cuts in the loin are the sirloin.

The tenderloin, when sold separately, is deficient in fat and hence must be larded and then roasted or broiled. The loin is cut into steaks and broiled, occasionally sold as roasts, though more expensive than the rib cuts and no finer for roasting.

Rib. — This cut consists of seven ribs, called prime ribs. The cut is made close to the shoulder blade and separates it from the chuck. It is sold as roasts, being cut into one, two, or three rib pieces. A one rib piece usually weighs about four pounds. The ribs are removed and the piece rolled and called a rolled roast. If the ribs are left in, it is called a standing roast. Dealers sometimes remove the ribs from the cut and sell it as steaks, called small steaks.

Round. — This cut consists of a very juicy, lean muscle and but little bone. It is sold as steaks, roasts, and for beef tea and beef juice. It is excellent for pot roast, stews, braizing, and casserole of beef, and for beef loaf.

Rump. — This cut contains the end of the hip bone and joint. There is considerable bone, but the remainder makes very good steaks and roasts. It is also excellent for pot roasts, braizing, stews, and mincemeat.

Chuck. — This cut is next to the prime ribs and similar to it, but contains more bone and gristle and is not so tender. It makes a very good, though large, roast and is sometimes sold as steaks and by some preferred to the round, because it is mottled with fat. It is excellent for stews, pot roast, boiling, braizing, and mincemeat.

Clod. — This cut is back of the brisket and below the chuck. It is sold for boiling, stews, braizing, and mincemeat.

Flank. — This cut comes from below the loin. It is boneless and coarse, but of good flavor. Flank steak is sometimes cut from the lean muscle on the inside of the flank. This steak may be scored across the grain and broiled. It is also rolled and braized. Flank cut is used for stews and boiling, and is rolled and corned.

Neck. — This cut contains juicy, tough meat. It is used in stews, soup, and Hamburg steaks.

Plate. — This cut comes from below the ribs. It has layers of fat and lean and the ends of the ribs. It is used for boiling and corning.

Shank. — These cuts are the fore and hind legs. They are tough and contain bone and tendons. They are used for soup and mincemeat.

NITROGENOUS FOODS IN MEAT

1. TRUE PROTEIN.
   Albumin.
      Serum in blood, muscle in muscle.
      Soluble in cold water, coagulates at about 160° F.
   Globulin.
      Myosin, myogen, fibrin.
      Soluble in dilute salt and alkali.
   Nucleoalbumin.
   Compound proteins.
      Nucleoprotein, chromoprotein.
2. ALBUMINOIDS.
   Ossein in bone.
   Collagen in connective tissue.
   Elastin in tubes.
      Dissolved by moist heat, softened by acid.
      Hydrated to gelatin.
3. NITROGENOUS EXTRACTIVES.
   Kreatin, kreatenin, etc.

EFFECT OF HEAT ON MEAT

Dry Heat (that is, heat in dry air), applied to tender meat. Broiling, Roasting.	Coagulation of albumin. Retention of juices. Hardening of connective tissue.
Moist Heat (that is, heat in moist air). Boiling, Stewing.	Coagulation of albumin. Softening of connective tissue. Retention of juices.
Cold water and slow heat, Soup making.	Softening and dissolving of connective tissue. Extraction of juice and soluble proteins.

Principles Involved in the Cooking of Meat. — While meats may be cooked in many ways, there are but three principles involved in the cooking of all meats.

1. Meat may be first subjected to heat strong enough to coagulate the albumin; this forms a crust which will retain the juices in the meat. The meat then cooks in its own juices; and if this is continued long enough, it will soften the connective tissue also. This method is usually employed in broiling and roasting, and if the heat is too strong, the tendency is to dry the meat.

2. Meat may be cooked in water at temperature 170°–185° F. for several hours, to soften the collagen and elastin found in the connective tissue and cell walls. This method is applied to tough meat and makes it tender. If it is cooked in a small quantity of water, it is called a pot roast; if cut into small pieces, it is a stew; if left in one piece, it is called boiled. Meat should never cook in boiling water longer than 10–15 minutes, which is sufficient to sear over the outside, because boiling dissolves the collagen and leaves the meat stringy, while simmering softens it. The fireless cooker is best for cooking the tougher cuts of meat, because the temperature is below 212° F., and that softens, but does not dissolve, the albuminoids, and does not coagulate the proteins so hard.

3. For soups, beef tea, beef juice, and flavor, the object is to draw out the extractives. Meat should be placed in cold water and allowed to stand for some time and then gradually heated to about 160° F.; then the juice is pressed out or the meat is soaked for several hours, depending on the use to which it is to be put. Cold water draws out the blood which contains hæmoglobin, the soluble albumin and extractives, — a very small percentage of the nutritive ingredients in meat. Gradual heating dissolves some albuminoids and fat. The longer this is continued, the more gelatin and fat are obtained.

An important reason for cooking meat is to kill bacteria and other parasites found in meat. Some kinds of meat are more liable to be diseased than others. Tuberculosis germs may attack the muscles of beef and other animals. Pork often has embedded in the muscles a parasite, trichina, which produces a disease often fatal to human beings. For this reason, pork should be thoroughly cooked, as cooking kills the parasite.

Diseased meat should never be eaten on the assumption that cooking kills the bacteria and renders the meat harmless. The bacteria, while alive, produce toxins and decomposition products that act as poisons to the system. This is called ptomaine poisoning, and also occurs in cheese, ice cream, and shellfish, and is not caused by bacteria themselves, but by the products of bacterial action on the food; and no cooking can destroy them.

Effect of Heat on Meat. — Dry heat coagulates the albumin on the outside of the meat and forms a crust which tends to retain the juices and flavor. Moist heat softens and dissolves the connective tissue which forms the muscle tubes and holds the fibers together. Heat softens the fat so that it is freed from its albuminous envelope and becomes liquid; meat loses much fat in cooking. Dry heat at a high temperature decomposes fat and liberates irritating substances. By the shrinkage of the muscle fibers meat loses much water in cooking. Heat develops flavor. It causes a loss of nitrogenous extractives. Low heat draws out soluble albumin, extractives, and some albuminoids.

Fish

Fish are usually grouped in two classes; fish proper, or vertebrates, and shellfish. The former includes all the common sea, lake, river, and brook fish, as salmon, trout, mackerel, whitefish, etc.; the latter includes oysters, clams, lobsters, shrimps, etc.

Fish are like meat in composition, structure, and nutritive value and may be substituted for it in the diet. They are protein foods. Fish proper contain no carbohydrate, and most of them contain very little fat. Shellfish contain some carbohydrate. In oysters it is in the form of glycogen.

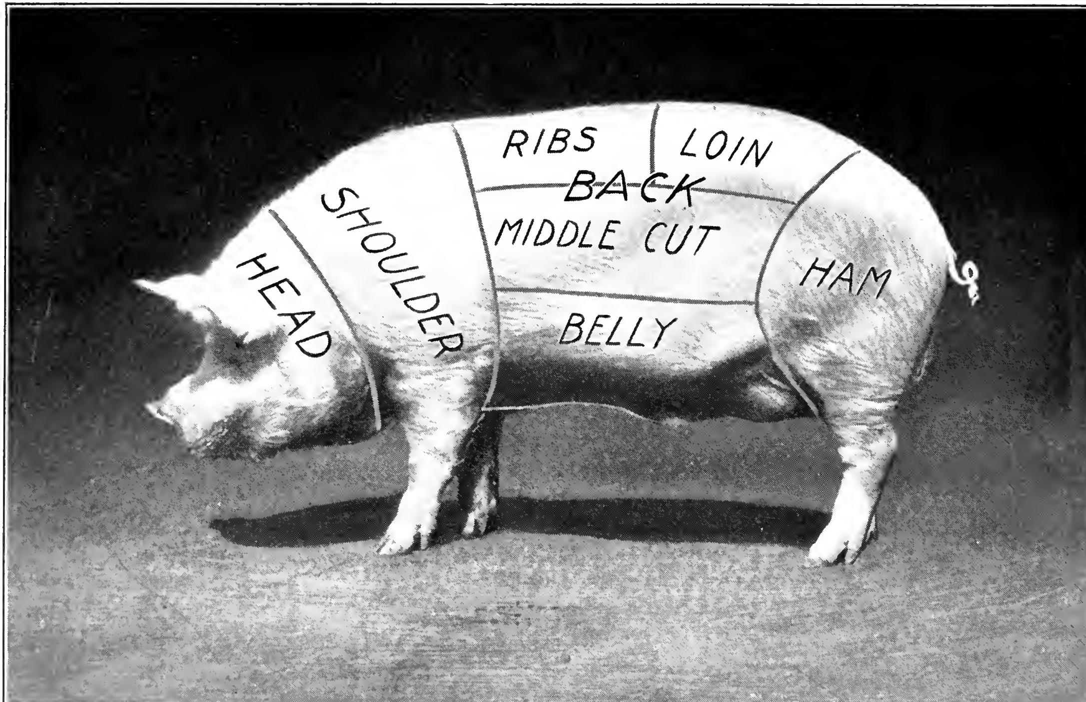
Even when dressed for market, fish contain a high percentage of refuse, from 30 to 50 per cent, and for that reason cannot be called cheap foods. They are never plentiful except in seaport towns or near the lakes and rivers where they abound, and they are extremely perishable and must be shipped in refrigerator cars, or frozen, or preserved in some other way. The commonest methods of preservation are salting, smoking, drying, and canning. Many fish are preserved in oil. For these reasons the price of fish is never very low, and their use cannot be urged except to add variety to the diet or to furnish delicacies.

Fish contain from 35 to 60 per cent water, and from 8 to 16 per cent protein. They contain less extractives than meat and more albuminoids. The amount of fat is not very great; those containing over 2 per cent fat are classed as fat fish, those containing less than 2 per cent as lean fish. The fuel value of one pound of fish is about one third that of meat.

Digestibility. — Fish contain but a small amount of extractives when compared with meat, and more albuminoids. The connective tissue is tender and easily dissolved in cooking, and care must be taken that the flesh does not fall apart. For this reason, fish are seldom boiled, but are baked, broiled, or fried.

There is disagreement among authorities on the subject of the digestibility of fish. Some contend that, because of the absence of extractives, it is not so easily digested as meat, because the extractives call out the digestive juices and aid digestion. Other authorities say that because the muscle fibers are tender and there is little connective tissue, it is more easily masticated and digested. The digestibility is probably the same as of meat.

Because of the closeness of the muscle fibers, lobsters, clams, and shrimps are harder to digest than fish. The danger from ptomaine poisoning is greater in fish than in other foods because they decompose so quickly; this is especially true with shellfish, and, when possible, they should be shipped alive. Many cases of typhoid fever have been traced for their cause to the consumption of raw oysters. Oysters live near the shore; and if rivers carrying contaminated sewage empty their water into the bay where the oyster beds are located, typhoid germs may be found in the oysters.



Cuts of Pork

Composition of Fresh Fish Dressed for Market

	Refuse	Water	Protein	Fat	Carbo-hydrate	Mineral Matter
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Black bass . . .	46.7	41.9	10.3	.5	..	.6
Cod	29.9	58.5	10.6	.2	..	.8
Mackerel	40.7	43.7	11.4	3.5	..	.7
Perch	54.6	34.4	8.7	1.8	..	.5
Pickerel	35.9	51.1	11.9	.2	..	.9
Pike	30.5	55.4	13.	.4	..	.7
Salmon	23.8	51.2	14.6	9.5	..	.9
Trout, brook . .	37.9	48.4	11.7	1.3	..	.7
Trout, lake . . .	35.2	45.	12.4	6.6	..	.8
Whitefish	43.6	39.4	10.3	3.6	..	.9
Preserved Fish:						
Cod, salt . . .	24.9	40.2	16.	.4	..	18.5 (salt)
Herring, smoked	44.4	19.2	20.5	8.8	..	7.4
Canned Fish:						
Caviare . . .	..	38.1	30.	19.7	7.6	4.6
Salmon . . .	..	63.5	21.8	12.1	..	2.6
Sardines . . .	5.0	53.6	23.7	12.1	..	5.3
Shellfish:						
Oysters . . .		88.3	6.0	1.3	3.3	1.1
Clams . . .		80.8	10.6	1.1	5.2	2.3
Lobsters . . .	61.7	30.7	5.9	.7	.2	.8
Shrimps . . .		70.8	25.4	1.	.2	2.6

CHAPTER VIII

EGGS

Eggs and milk are sometimes referred to as the two perfect foods. They are perfect foods for the chick and the calf in that they contain all the elements needed for their development and growth, up to a certain period.

While cow's milk contains the nutritive ingredients in the right proportion for the calf, its nutritive ratio being 1 : 4, it differs widely from human milk, not in composition, but in the relation of the tissue building to heat and energy-yielding ingredients, the ratio of human milk being 1 : 10. Eggs are a perfect food for the chick until it is hatched, when it begins to eat carbohydrate foods immediately.

The egg is a unique food substance, in that it contains every element that goes into the bone, muscle, and blood of the chicken, and, as it is easily analyzed, it furnishes valuable information as to what substances are needed for these tissues and in what form the substances occur. From the time the embryo starts to develop until the chicken is hatched, no other food goes into the making of its tissues; the heat is secured from outside sources. In the development of the calf this cannot be studied so easily.

Composition. — Eggs contain about 74 per cent water, 14.5 per cent protein, 10.5 per cent fat, and 1 per cent mineral matter.

The nutritive ratio is 1 : 1.6, which shows that it ranks with meat as a concentrated tissue-building food. Eggs are even better than meat as tissue-building material, because they contain more kinds of proteins, and hence more mineral matter in organic form, than meats. Their great food value has been learned in the feeding of people suffering from tuberculosis, and their gain in health and weight.

The white of egg contains albumins, globulins, and glycoproteins, the great bulk of the white consisting of albumin in the form of ovalbumin.

The yolk contains albumin and nucleoalbumin in the form of vitellin and lecithin, the two latter probably in combination. The mineral matter in egg consists of phosphorus, calcium, iron, lime, sulphur, potassium, and magnesium, occurring in the organic compounds. The fat is found in the yolk and occurs in combination with the proteins in a sort of emulsion.

When bacteria enter the egg through the porous shell, the albumin is decomposed and sulphureted hydrogen and phosphureted hydrogen are formed, causing the odor of stale eggs.

From the variety of proteins and the abundance of mineral salts it is seen that eggs are a valuable tissue-building food as well as a source of iron for the blood, calcium for bone, and phosphorus for cell growth.

Structure. — In structure, eggs consist of a porous shell, lined with a thin membrane. Beneath the shell is the white, and in the center is the yolk, which has attached to it the embryo. The yolk, with its nucleoalbumin, fat, lecithin, calcium, iron, and phosphorus, furnishes the first food for the developing chick and shows in what form and proportion these elements are needed for the young animal. It is said that by the term strictly fresh egg, is meant an egg not over twenty-four hours old. When the egg is laid, it is alkaline; but microörganisms enter through the porous shell, and changes in the albumin take place very soon. For this reason some method should be used to exclude the air or to keep the eggs at so low a temperature that the microörganisms cannot develop. The latter method is the most successful.

Storage. — In the home, eggs are packed in sawdust, ashes, sand, oats, or wrapped in paper. They are also coated with fat, oil, varnish, or vaseline, or immersed in water glass (silicate of soda) diluted with water. Care must be taken that the packing or coating is clean and has no odor, for eggs take both flavor and odor very readily and are then unfit for use. It has been found, by repeated experiment, that vaseline coats the shell thoroughly and preserves the eggs, but that water glass is more satisfactory for keeping qualities and also for ease in applying.

Cold Storage. — Few people realize that eggs will never be what is termed cheap again, because with the development of the cold storage industry and improved shipping facilities, they have changed from a perishable commodity, that must be marketed and consumed within a limited time, to a commodity that may be stored and kept until times of scarcity. This is true of many foods that were once cheap in season. Cold storage keeps the price up and makes it possible to procure eggs throughout the year. The eggs are packed in cases and placed in cold storage, and kept at a temperature just above freezing, 32–40° F. and not removed from cold storage until they are to be used. In this way they may be kept a year.

Ham

Loin

Ribs

Cuts of Pork

Test for Freshness. — Some of the common tests for freshness are by no means always to be relied upon, but, while they do not always tell the stage of deterioration, they are an index of freshness. The water in eggs evaporates, and air takes its place. Therefore a fresh egg is heavier than a stale one. Fresh eggs sink in water when immersed, old ones float. If an old egg is shaken, it rattles, showing that evaporation has taken place. The usual method employed in stores to test the freshness of eggs is by candling. A paper is rolled until the diameter is that of the egg. The egg is placed at one end and held toward the light. Examined through the other end of the paper, a fresh egg looks clear and unclouded, a stale egg shows dark spots or it is dark clouded throughout.

Effect of Heat on Eggs. — The protein in egg is mostly pure albumin, and this is coagulated at about 160° F. into a flocculent and tender mass, that may be readily broken up. If the temperature is increased to the boiling point (212° F.), the albumin becomes hard and tough and easily escapes mastication and is not so easily digested in the stomach. The yolk of the egg coagulates at a lower temperature than 160° F. Eggs may be coagulated throughout in a soft jellylike mass at a temperature between 160°–170° F. Cooking above that temperature makes the albumin tough and leathery. This point should be noted in cooking all dishes where egg is used as a thickening agent, as in custards, puddings, etc. It should be noted also that when albumin is cooked at a high temperature it shrinks and spoils the appearance of the dish, which it should have made smooth and velvety. When corn starch is also used in a pudding, the milk should be boiled first. After the mixture has thickened, the egg should be added and the food cooked at a low temperature.

The best method of cooking eggs seems to be the following: Place them in a tightly covered saucepan in boiling water — 212° F.; then remove the saucepan from the fire and allow 8 minutes for soft-boiled eggs and 30 minutes for hard-boiled. By this method the heat coagulates the albumin into a soft and tender mass and also thickens the yolk. When eggs are boiled, the albumin is coagulated so quickly into a tough coating that the heat does not penetrate to the yolk. The white is hard and leathery, while the yolk is soft.

Digestibility. — As has been stated before, digestibility may mean ease of digestion or thoroughness of digestion. For the invalid or inactive person the factor ease of digestion counts for much; for the average working man completeness of digestion, or how much of a food the body assimilates and makes use of, is the all-important factor.

Eggs cooked at a temperature below the boiling point are more easily and quickly digested in the stomach than those cooked at boiling point. This is because gastric juice can more readily act on the soft, flaky albumin than on the tough, leathery albumin. Experiments on the individual and experiments in the laboratory bear out this statement. As to intestinal digestion and absorption there seems to be no great difference. The digestion coefficient seems to be the same in all cases, no matter how the eggs are cooked. It may be said that eggs have a high coefficient of digestion. If absorption is delayed, decomposition ensues and sulphureted hydrogen and ammonia are formed.

Uses of Eggs. — Eggs have so many varied uses in the diet and in cooking, that it is well to enumerate some of them.

Eggs, being rich in protein and fat, are a tissue-building food and a substitute for meat, when for any reason meat is not used. They serve as a food for the sick, because they furnish the material to replace the tissues in available form. When properly prepared, they are easily digested and may be served in many appetizing ways.

The albumin in egg gives it many uses in cooking. Food is dipped in egg before frying because the albumin coagulates quickly and forms a crust, and this retains the juices and keeps the fat from reaching the food. When eggs are blended with milk or any other liquid, the whole mass thickens and becomes smooth, as in the making of custard. Eggs are used to hold the particles of flour together and form hollow shells, as in making of cream puffs and popovers. They can be used to clarify foods by entangling the solid particles, as in making coffee. They are used extensively to make foods light and fluffy, as in cake and omelet. When heat is applied, the tiny air bubbles expand and the albumin coagulates, and this leaves the food light and porous. The heat must be gentle, because if the albumin sets before the bubbles expand the food will be tough.

The use to which the egg is to be put governs the amount of beating that is needed. In custards, white and yolk should be merely blended, because the presence of air is undesirable. In a light cake the eggs should be beaten stiff and dry, to make the cake light by inclosing all the air possible.

CHAPTER IX

MILK AND ITS PRODUCTS

COMPOSITION OF MILK AND ITS PRODUCTS

	WATER	PROTEIN	FAT	CARBO-HYDRATE	MINERAL MATTER
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Whole milk . . .	87.0	3.3	4.0	5.0	.7
Skim milk . . .	90.5	3.4	.3	5.1	.7
Buttermilk . . .	91.0	3.0	.5	4.8	.7
Condensed milk .	26.9	8.8	8.3	54.1	1.9
Cream	74.0	2.5	18.5	4.5	.5

Chemical Composition. — Milk is an opaque white, or yellowish white, fluid of sweetish taste, and when freshly drawn has an alkaline reaction. It is an animal product containing fat, proteins, lactose, mineral matter, and water. The fat is held in suspension in the form of minute globules. When the milk stands for any length of time these globules rise to the surface as cream. The amount of fat in milk varies with age, feeding, breed of cow. It ranges from 3.5 per cent to 5 or 6 per cent. Milk containing less than 2.5 per cent fat is declared by state law as unfit for use.

The chief fats in milk are stearin, palmitin, and olein. The proteins in milk (about 3.5 per cent) are in the form of lactalbumin, serum globulin, and casein. The albumin and globulin are in solution, and the casein is in combination with the phosphate of lime. It is precipitated by the presence of acid, or by the addition of acid, as when lactic acid is formed in the souring of milk. The ferment rennin also causes the coagulation of the casein. The casein forms about six sevenths of the proteins in milk.

The albumin and the globulin are coagulated by heat, 158°–167° F., casein is coagulated by acid or ferment. The carbohydrate of milk, about 5 per cent, is in solution in the form of lactose or milk sugar. Part of it is changed to lactic acid by the bacteria which cause the souring of milk. The mineral salts in milk are phosphates and chlorides, of lime, potash, and soda. The lime salts are valuable for bone material for the infant, and are essential for coagulation.

Nutritive Ratio and Fuel Value. — The nutritive ratio of milk is 1 : 4, which shows that it ranks as a tissue-building food. It is, however, 87 per cent water, and 1 pound of it will yield but 310 calories of heat. In order to live on milk alone the average man would have to consume about 5 quarts of milk daily to supply the energy which he would need. Milk should not be considered as a beverage, however, but should be reckoned as part of the nutritive ingredients of any meal, for it furnishes a means of adding protein and fat to the diet.

Effect of Heat on Milk. — Heat (212° F.), coagulates the lactalbumin and globulin in milk, and this entangles some of the casein and fat globules, and they rise to the surface, forming the skin of boiled milk. It also melts the fat so that the globules coalesce and form a cream of peculiar appearance.

Effect of Bacteria on Milk. — Probably no other food takes up odors and impurities so readily as does milk. For this reason great care must be taken to see that it does not become contaminated. Milk, as freshly drawn from the cow, is probably free from bacteria; but, in spite of careful handling, hair, dust, and dirt from the cow's udder, or from the milker, or impurities from pail or cans may enter the milk and bring with them numbers of bacteria. These bacteria grow with astounding rapidity. Not all the bacteria found in milk are harmful; some are even desirable under certain conditions, as in cheese and butter making; a very few kinds may produce disease. But even though the bacteria may not be harmful from the standpoint of health, milk should be handled in a way to make it a clean and wholesome product and to prevent its souring. The ordinary bacteria found in milk thrive best at a temperature of 75°–90° F.; they are probably all killed at temperatures between 150° F. and 160° F. They are rendered inert if milk is held 40° F. The ideal handling of milk, then, would consist of having clean cows, clean milkers, and clean stables, bottling it in sterilized bottles, and keeping it at a temperature of less than 50° F. until ready to use. Methods of rendering milk sterile will be considered later.

Souring of Milk. — The bacteria which cause the souring of milk are called the lactic acid bacteria because they feed on the sugar in the milk and change it to lactic acid. The acid precipitates the casein or renders it insoluble, forming what is called the curd of sour milk. Many bacteria cannot grow in an acid medium, and hence it is safe to say that the activity of the lactic acid bacteria checks the growth of other forms, less desirable.

When sour milk stands, or is shaken, the curd breaks up into small particles and a clear liquid called whey separates from it. These particles of curd are easily acted upon by the gastric juice, and so sour milk and buttermilk are more easily digested than fresh milk.

Digestion of Milk. — The digestion of milk begins in the stomach, where the ferment rennin coagulates the casein in a solid clot. The clot differs from that formed in souring in that it is tougher and harder for the digestive juices to act upon, while the curd in sour milk is flaky. It is thought that rennin chemically changes the casein by splitting it into two proteins, while the lactic acid simply precipitates it. The pepsin in the gastric juice acts on the proteins, and digestion is completed in the small intestine, where the protein, fat, and sugar are all acted on by the pancreatic ferments. The coefficient of digestibility depends on several factors.

With infants and young children, the digestion of milk is fairly complete, probably because it is the natural food for the young animal and contains the nutrients in the right proportion and form to supply the needs of the body at this time. Not only does it contain the right amount of protein, fat, and carbohydrate, but also the right amount of mineral matter needed for bone, muscle, and blood; the only noticeable lack is in a proper supply of iron. The lack of iron is not important to the infant, because it has an excess of iron stored in its body at birth; but it should be considered when milk is given to older children, and foods containing iron should be given, because iron is needed for blood and muscle tissue.

For the adult, milk contains too much water. It has too high a protein ratio, and has no indigestible fiber to stimulate peristalsis. It is constipating for this reason, If taken with other foods, or as an ingredient in foods, it has a high nutritive value. When milk is taken alone by the adult, only 90 per cent of it is digested; if taken with bread and other foods, nearly 99 per cent is assimilated. This is probably due to the fact that taken alone milk clots in a firm leathery clot which tends to resist digestion. If mixed with other foods, the clot is smaller and less firm, and juices can penetrate it more easily. For this reason milk is often diluted with barley water or oatmeal water. Milk should never be taken in large mouthfuls, but should be slowly sipped.

Adulteration of Milk. — Milk varies so greatly in the amount of solids or nutritive ingredients which it contains (from 10 to 16 per cent) that there is a great chance for adulteration. The fat is so valuable for cream or butter making, that there is a great temptation to remove all or part of it, and sell what is left as whole milk. The difficulty or cost of handling it in such a way that the number of bacteria are reduced to minimum, and the milk kept sweet until it is ready for consumption, has led to the employment of various means of checking the growth of organisms, some legitimate, others, as the use of chemical preservatives, harmful, at least to children. Finally the importance of milk and its products as food, and the enormous quantity consumed (furnishing one sixth of the total food of an average family), have led to a desire to profit by placing an inferior article on the market. On the other hand, because milk furnishes almost the sole food for infants and because the percentage of infant mortality depends in a great measure upon the pureness of the milk supply, many laws have been passed to secure a pure and wholesome product.

The commonest method of adulteration is to add water, and thus reduce the solids. The specific gravity of milk is

1.029–1.034. If water is added, that will lower the specific gravity and the adulteration can be detected. Cream is lighter than milk, however, and if part of the cream is also removed, the specific gravity will remain the same.

Professor Babcock, of the University of Wisconsin, discovered a way in which the amount of fat can be readily found, and, as the amount of fat is a most valuable index of the amount of other solids also, it is a very reliable test and universally used by the farmer to test his herd, and at the creameries as a standard for purchasing milk. With the Babcock test, the sample of milk is put into a pipette and sulphuric acid is added to dissolve all the solids except the fat. The fat is then separated by centrifugal action, and, as it rises in the stem of the pipette, it may be easily and accurately measured.

The chemical preservatives added to milk to kill or retard the growth of bacteria are boric acid, formalin, and salicylic acid. They may not affect the digestion of the grown person, but they are injurious to infants, and what is worse, they conceal filth and filthy methods of handling the milk.

Keeping Milk Sweet and Wholesome. — The first consideration is to see that the milk comes from healthy cows that are kept in sanitary stables, and that nothing comes in contact with it that will pollute it in any way. It should be distributed in sterilized bottles so that no dust or dirt may enter it before it reaches the consumer. The vessels in which the housewife keeps the milk should be clean and should be kept covered, so as to exclude air and odors. It should be kept at a temperature below 50° F., and should be used the same day it is purchased. Pure milk will not keep much longer than two days. Milk that keeps longer should be regarded with suspicion.

The best method of securing a pure supply of milk is to see that it is produced under sanitary conditions and from healthy cows. When there is danger that the milk is not pure, two methods are employed to keep it sweet for children, or to render it safe in case of danger from pathogenic bacteria. Epidemics of scarlet fever, diphtheria, and typhoid have been traced to a polluted milk supply, and precautions should be taken to avoid danger to infants and children.

Pasteurization. — The first and probably the better method is called pasteurization. It consists of heating the milk to a temperature of from 155° to 167° F., for twenty minutes and then rapidly cooling it to 50° F. or less, and then bottling it. By this method no chemical changes take place in the constituents of the milk, and all bacteria, except the spore-producing kind, are killed. Undesirable bacteria grow more rapidly in pasteurized milk than in raw milk, because the lactic acid bacteria, which would destroy them or hold them in check, have been destroyed by heat. The objection to pasteurized milk is that dealers are not so careful in securing a pure product because they rely on pasteurization to destroy bacteria.

Sterilization. — The second method, sterilization, consists in boiling the milk for fifteen or twenty minutes, and by repeating the process if it is deemed necessary. This method practically destroys the bacteria, but changes the milk to boiled milk and is objectionable for that reason.

Condensed Milk. — To secure a supply of milk where it is impossible to get fresh milk, milk is evaporated in vacuum pans to one third or one fourth its original bulk, and sealed in air-tight cans in which it will keep indefinitely. Sometimes cane sugar is added to increase the amount of solids and also to enhance its keeping qualities. When it is to be used, twice or three times its bulk of water is added, and it serves practically the same purposes as fresh milk. The unsweetened brand serves as a better food for infants than the sweetened varieties, because so much cane sugar is undesirable.

Cream and Skim Milk. — When milk is allowed to stand undisturbed, the fat globules separate from the rest of the constituents and come to the surface in the form of cream, which may be removed by skimming. This separation of fat is now accomplished by the use of the separator. It is a machine which causes the milk to rotate rapidly. The milk, being heavier, is thrown outward and the cream is forced to the center. Separating is done as soon as the milk is drawn, while by the other method the milk is allowed to stand in open pans.

Pasteurized cream and separated cream do not whip so readily as hand-skimmed cream, probably because some of the calcium salts are lost in the process. This may be overcome by the addition of viscogen, a solution of lime and sugar that seems to add viscosity to cream. Cream contains from 15 to 30 per cent fat. Most state laws require that it shall contain 18 per cent. It should contain 25 per cent for whipping purposes.

Skim Milk. Composition and Nutritive Value. — Skim milk contains all the nutritive ingredients found in whole milk, except the fat, and in nearly the same proportion. Animal protein is the most expensive of all food nutrients and the most valuable. Skim milk contains 3.4 per cent protein, which makes it a cheap tissue-building food, if it can be purchased as skim milk. If the average housewife had any idea of the food value and uses of skim milk, it could be marketed, because, when the cream is separated from the milk, every dairyman has skim milk as a by-product. Better still, the whole milk could be purchased and the cream removed for use as cream, and the remainder used where whole milk was formerly used. This would materially decrease the cost of milk in the average family, for cream is an expensive food.

Uses of Skim Milk. — Where milk enters into the composition of any food in cooking, fat in some form is usually added also, and no account is taken of the fat already present in the milk, as in white sauce, cream soups, cakes, etc. These foods could all be prepared from skim milk because the loss of the cream is made up in the fat used. As will be seen from the study of dietaries, too much fat is invariably taken, and by the use of skim milk in cooking this amount could be reduced without loss in flavor and it would give a better-balanced food.

Place of Milk in the Diet. — Milk contains the four classes of nutrients in nearly the right proportion to supply the needs of the body; but it lacks enough carbohydrate to make it a balanced food, and it needs bulk to stimulate peristalsis. With the addition of some carbohydrate food it forms a valuable food at a low cost.

To show how the food requirements for lunch or supper may be supplied by milk and potato, the nutritive value of potato soup is given below. The quantity here given will furnish one fourth of all food required for an average person for one day. Celery, or asparagus, or any cream soup, prepared from roots, tubers, or green vegetables, may be substituted for potato soup, but rice should be added as a thickening agent and to bring up the carbohydrate content.

Nutritive Value of Potato Soup

Food	Weight	Calories Protein	Calories Fat	Calories Carbohydrate
Potato	½ lb.	20	2	164
Milk	1 lb.	60	162	91
Butter	½ oz.	1	107	...
Flour	¼ oz.	3	1	21
Salt and onion juice	...	..	...	...
Bread	1 oz.	10	3	60
Total		94	275	336

Protein, 94 calories; fat and carbohydrates, 611 calories.

COMPOSITION OF PRODUCTS OF MILK

Whole milk: (Per Cent)
- Water . . 87.
- Protein . . 3.3
- Fat . . . 4.
- C. H. . . . 5.
- M. M. . . .7

(Butter making.)

Cream: (Per Cent)
- Water . . 74.
- Protein . . 2.5
- Fat . . . 18.5
- C. H. . . 4.5
- M. M. . . .5

Butter: (Per Cent)
- Water . . 11.
- Protein . . 1.
- Fat . . . 15.
- C. H. . . . ...
- M. M. . . 3.

Buttermilk:
- Water . . 91.
- Protein . . 3.
- Fat 5
- C. H. . . 4.8
- M. M. . . .7

Skim Milk:
- Water . . 90.
- Protein . . 3.4
- Fat 3
- C. H. . . 5.1
- M. M. . . .7

Casein curd:
- Water . . 72.
- Protein . . 20.9
- Fat . . . 1.
- C. H. . . 4.3
- M. M. . . 1.8

Whey:
- Water . . 93.
- Protein . . 1.
- Fat 3
- C. H. . . 5.
- M. M. . . .7

COMPOSITION OF PRODUCTS OF MILK — *Continued*

Whole Milk: (Cheese making.)	Cheese:	
	Water	33.5
	Protein	26.
	Fat	35.5
	C. H.	1.5
	M. M.	3.5
	Whey:	
	Water	93.
	Protein	1.
	Fat	.3
	C. H.	5.
	M. M.	.7

Products of Milk

Butter Making. — Cream can be separated from the skim milk. It is sold for table use or is churned into butter. In butter making the cream separates into butter fat and buttermilk.

Skim milk can be separated into curd and whey.

Cheese Making. — Generally, in cheese making the whole milk is used. It is coagulated by rennet and after it is firm enough the curd is cut and the whey is drawn off. The fat and casein are in the cheese curd.

Butter is the most valuable of all forms of fat because it is the most easily digested of all fats. This is probably due to the fact that it contains a high per cent of olein, the form in which fat occurs in the human body.

Butter contains 11 per cent water, 1 per cent protein, 85 per cent of fat, and 3 per cent mineral matter. Its fuel value is 3400 calories. The amount of water and fat vary in different samples of butter. Some butter may contain as high as 40 per cent of water. United States food laws, however, make it unlawful to sell butter containing less than 82.5 per cent butter fat and not more than 16 per cent water.

The 3 per cent mineral matter, which is added to help preserve the butter from decomposition and to flavor it, is common salt.

Some people like butter without salt. In this case the butter must be eaten soon after it is made, as it spoils quickly. Butter owes its peculiar flavor to the fatty acids which it contains, principally butyric and caproic.

Nutritive Value. — Because of lack of protein, butter is not a tissue-building food. Because of the high percentage of fat, its fuel value being 3400 calories per pound, it is a valuable source of energy, easily available, easily digested, and the amount ordinarily consumed by the average person would supply all the fat needed in the diet. At present prices, however, it is an expensive food, and other fats must be relied upon as sources of energy.

Butter Making. — When cream is removed from the milk, the fat is in minute globules. The cream is churned or beaten to cause the globules to coalesce. The cream is usually allowed to stand until it ripens or until enough lactic acid bacteria have developed to give it the desired flavor. The churn is scalded to get rid of undesirable bacteria, and cooled. The proper temperature of cream for churning is between 52° and 62° F. If the cream is cool, less fat is lost in churning and the butter will have a better texture and there is less labor in making. As soon as the butter forms it should be removed from the buttermilk and washed with water at a temperature 45°–50° F. The washing removes the buttermilk and also hardens the fat. If the buttermilk remains in the butter, the casein in it decomposes and the butter spoils.

After one or more washings, salt is added to preserve and flavor the butter. It must be thoroughly worked in so that the butter will not be streaked. Butter is usually colored with anatto or some other harmless coloring, because a colored butter markets better than an uncolored.

Butter is often made from fresh cream, or sweet cream. It is more delicately flavored than that made from ripened cream and there is a growing demand for it. Probably no other article of food affects the character of a meal as does the quality of butter, and probably no other article of food has been so ignorantly and carelessly made as butter, at a great loss to producers and distributors. Rancid butter should never be used in cooking. It is best to use pure lard or a mixture, or oleomargarine. Modern dairies have supplanted the home dairies, and the result is a cleaner product, produced under state supervision.

Renovated Butter. — Poor or rancid butter is sometimes subjected to a process called renovating. The butter is melted, and this separates the fat from the curd and brine. The fat is then removed and aerated to get rid of odors, mixed with fresh milk again to get the milk flavor, drained, salted, worked, and repacked.

Buttermilk is the part of cream left in the churn after the butter is removed. It has the same composition as skim milk and the same nutritive value, being a cheap tissue-building food. Because the lactic acid bacteria are present, the casein is precipitated in fine curd and so it is easily digested. It is also thought that the presence of the lactic acid bacteria in the stomach retards the growth of other undesirable bacteria and to this are due some of the benefits derived from the use of buttermilk. It is much used in diseases of stomach, etc., where milk in an easily digested form is desired. It has the same nutritive ratio as skim milk and can be used in place of it in cooking.

Oleomargarine. — Oleomargarine is a manufactured product much like butter in physical properties and chemical composition. It is considered more wholesome than poor butter. It is made from beef suet, leaf lard, and milk. The beef suet is treated so as to separate the olein from the palmatin and stearin, and the olein, a granular yellow substance, forms the basis for the oleomargarine. Leaf lard is treated in the same way and yields a fat called *neutral.* The olein and neutral are melted, and mixed with milk to give a butter flavor. It is then salted, and sold as oleomargarine. If butter is added in place of milk to give the butter flavor, the compound is called butterine.

Cheese

Composition of Cheese

Kinds of Cheese	Water	Protein	Fat	Carbohydrate	Mineral Matter
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Cheese, cheddar .	27.4	27.7	36.8	4.1	4.0
Cheese, full cream	34.2	25.9	33.7	2.4	3.8
Roquefort . . .	39.3	22.6	29.5	1.8	6.8
Swiss	31.4	27.6	34.9	1.3	4.8
Neufchâtel . . .	50.0	18.7	27.4	1.5	2.4
Cottage	72.0	20.9	1.0	4.3	1.8

Composition and Nutritive Value. — From its composition, cheese ranks first as a tissue-building food, for no other food has so high a nutritive value. Beef from the round contains 18 per cent protein, mutton 13 per cent, chicken 15 per cent, dried beans 22 per cent, bread 10 per cent, mackerel 17 per cent, while cheese contains 22 per cent. The protein in cheese is ready for consumption, while in many foods, as beans and peas, the figures show the amount of protein in the food in a dry state, and during cooking much water is absorbed so the proportion of protein is decreased. In vegetable foods the protein is surrounded by cellulose, and some of it escapes digestion and cannot be counted as available nutrition. No other food contains so much protein in so compact form and is so cheap a tissue-building food as is cheese. If more cheese were used as the principal protein in a meal, it would lessen the consumption of meat and cheapen the cost of the meal. The reason why, in this country at least, cheese has not found its true place is because we have not had to consider seriously the cost of meat as yet, and because we have not learned how to serve cheese in a form that makes it easily digested.

Digestibility. — The value of any food depends not only on its nutritive ratio and cost, but also on its digestibility. It is on this point that cheese compares unfavorably with other protein foods. Cheese is a concentrated food. It has but 33 per cent water. It contains no refuse, and has no starch or cellulose to furnish bulk and stimulate the walls of the stomach and intestines, so that the digestive fluids will be secreted, or to hasten the passage of foods along the intestines. Fats and carbohydrates in nearly equal proportion are so thoroughly mixed that the gastric juice cannot act on the protein. A ferment in the gastric juice may act on emulsified fat, but it cannot act on the fat in cheese. It is difficult for the digestive juices to act on any food so concentrated; but, in addition to this, it is a soft food and is apt to escape mastication and be swallowed in lumps. Not alone that, but in some cheese the protein has not been broken down, or made more soluble, and it is hard to digest. The main work of the digestion of cheese is done in the small intestine; and if it reaches the intestine without creating any disturbances in the stomach, it will be thoroughly digested. Experiments made by Snyder show that cheese is completely digested and has a high coefficient of digestibility, 93.36 per cent protein, and 94.50 per cent fat. It is said that bicarbonate of soda added to cheese increases the ease of digestibility because the alkali neutralizes the fatty acid and makes the casein soluble. It should be said, then, that while cheese is hard to digest in the stomach, it is not indigestible, but is fairly well digested by the average person.

The difficulty, then, is more apt to be due to the consumer than to any fault in the food. It becomes a question of how to prepare the cheapest and most concentrated form of protein food so that it will leave the stomach before fermentation sets in.

Well-ripened cheese, cheese in which the proteins have been partially broken down by bacterial action, is the best kind. It should be thoroughly masticated, or, better still, grated and mixed with a carbohydrate food to give it bulk. It should not be eaten in too great quantities, because it is a concentrated food, and it would overtax the digestive powers of the individual. Europeans who consume great quantities of cheese as their main source of protein food, because meat is too expensive, have learned how to prepare it. With us it is too often considered a condiment and is eaten at the end of a meal which has already contained too much protein and fat. Toasted cheese is hard to digest because some of the water evaporates, the fat melts, and the casein becomes hard.

Place of Cheese in the Diet. — Cheese furnishes but .3 per cent of the total American food materials. This figure shows that it is not used so much as it should be. It should often serve as the protein portion of a meal in place of meat. It may be added to omelet, macaroni, any creamed vegetable, or soup or cereal. It may often be served as cheese fondu or souffle or rarebit, when mixed with milk, bread crumbs, and eggs. Care must be taken to cook the cheese dishes at a low temperature because heat toughens the casein and melts and sometimes decomposes the fat.

Classification of Cheese. — No one classification would include all kinds of cheese. They may be classified as hard and soft, depending on the amount of water in them; as cream, full cream, or skimmed milk cheese, depending on whether some fat has been removed or added to the milk; they may be named because of the peculiar fermentation that takes place during ripening and brings about the distinctive flavor; or they might be classified under the name of the country where they are produced, as Edam in Holland, Roquefort in France, and Parmesan in Italy. Whatever the difference may be, the process of cheese making is practically the same in every case, and includes the addition of rennet and coagulation, cutting the curd, removal of water, and ripening by bacterial action.

The cheese most extensively used, most widely known, the cheapest and best for all purposes, is the Cheddar. There are two varieties made in this country, American Cheddar for export trade, and American for home consumption.

They are practically the same except that the cheese for home consumption is softer, milder, does not keep so well, contains more water, and has not so good flavor because it is not so well cured. It is to be deplored that the American consumer does not appreciate and demand the better cheese.

Manufacture. — Cheddar cheese is made from whole fresh milk which is allowed to ripen slightly, and then coagulated by the addition of rennet. Rennet acts best at a temperature of 86°–90° F., and must be thoroughly mixed throughout the milk so as to form an even coagulum. It is stirred gently at first so that the fat will not rise to the surface but will be mixed thoroughly with the casein. After it begins to coagulate, it is allowed to stand until the curd is firm enough to cut.

Formerly the curd was broken into pieces with the hand or with a sort of rake, but now it is cut with a cutter, and then slowly heated to 98°–100° F., to separate the curd from the whey. Part of the whey is then drawn off, and part is left in until a certain amount of lactic acid is developed, and then the rest is drawn off. The next process, called cheddaring or matting, consists of cutting the curd into blocks and piling them so as to expel any traces of the whey. It is then ground into pieces small enough for salt to penetrate, salted, and put into the press ready to shape. The pressing expels water and unites the particles of curd into a solid mass.

It is then ready for curing, which is the most important process in cheese making, because it makes or mars the cheese. Curing or ripening of cheese is brought about by the action of certain bacteria which decompose the insoluble casein into soluble proteins and break them down into amido compounds, peptones, and albumoses. The casein in fresh cheese is in an insoluble condition and very difficult to digest; the bacteria convert it into a more soluble form. The differences in odor and flavor of cheese are due to the peculiar kind of bacteria introduced during ripening. Cheese should ripen at a low temperature at least from 2 to 4 months, before it is fit for consumption. The fresh India rubber variety so common in our markets is not well cured and is hard to digest. Cheese ripened at too high a temperature or containing undesirable bacteria has a strong flavor. Good cheese should crumble, have a sharp biting taste, and have uniform holes.

Cheese curd should contain practically all the nutrition in milk except sugar and mineral matter. It contains all the protein and practically all of the fat, a small quantity of carbohydrate and mineral matter, and is one third water. Whey contains the sugar and mineral matter. From this it will be seen that cheese contains most of the valuable constituents of milk in concentrated form.

Kinds of Cheese

Hard Cheese. — Most of the forms of cheese are either Cheddar or American in slightly different form. The small cheeses are called picnic or Young America and are mild in flavor. Pineapple cheese is an American Cheddar pressed firm and solid in the shape of a pineapple. Sage cheese is American Cheddar with sage incorporated into the cheese. Cheese sold in glass jars is Cheddar reduced to a soft pulp with fat and flavor added. Limburger depends for its odor and flavor on the form of bacteria introduced during ripening, and this ripening is allowed to continue until the whole mass is soft. Limburger is made from whole and skim milk and is ripe when it is about one third soft. It has a reddish yellow rind. Swiss cheese owes its peculiar texture and flavor to a special kind of fermentation, the gas generated producing the characteristic holes. Edam is round like a cannon ball and the rind is stained red. It is made from partly skimmed milk and as firm and hard as possible. It is not ripe until 6 to 8 months old. It is made in Holland. Parmesan, a very hard Italian cheese, is made from skim milk. It is usually sold grated. It is so hard that it will keep indefinitely in any climate. Stilton is an English cheese which is allowed to ripen until blue mold grows from the interior throughout the cheese.

Soft Cheese. — Neufchâtel is a soft cheese made from uncured curd. It is smooth, mildly acid, and will not keep long. It is packed in little cylindrical pieces covered with tin foil. Roquefort is a soft cheese formerly made from goat's milk. The bacteria which bring about the peculiar fermentation are cultivated on bread crumbs, and these crumbs are mixed with the curd. The curing is done in limestone caves of uniform temperature, to develop the right fermentation. It is soft and permeated with mold. Camembert is a soft cheese, and when ripe is coated with reddish brown mold, and is of a soft, pasty consistency with a characteristic odor and flavor. Cottage cheese is soft home-made cheese. It is made from sour skim milk. The milk is heated to about 100° F., and allowed to stand until the curd and whey separate. The curd is salted, and cream is often added to give the cheese flavor and to soften it.

There are hundreds of varieties of cheese which the connoisseur is familiar with. Those given above are the best-known varieties, and serve to show that they differ mainly in the amount of water, and in the peculiar fermentation which develops the characteristic flavor and odor. Any fermentation which makes the proteins more soluble improves the character of the cheese. They differ also in the amount of fat, which depends on whether they are made from whole or skim milk.

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