enters largely into the composition of various diets. It is constituted essentially of four elements—albuminoid, fatty, saccharine, and saline—and therefore contains all the materials necessary for the growth and nutrition of tissues. The nitrogenous constituent is *casein*, an albuminoid substance, but which differs from ordinary albumen in that it is combined with a larger proportion of alkali, and is not coagulable by heat. The fatty element is *butter*, which contains several neutral fats. The composition of butter is not exactly the same in all kinds of milk, the difference being due chiefly to a volatile principle upon which the special taste of each variety depends. The saccharine element is a crystallizable sugar, known as *lactin* or *lactose*, a substance which easily decomposes into lactic acid by a process of fermentation in which the casein plays the part of a ferment. The mineral constituents of milk are, chlorides of sodium and potassium, phosphates of lime, soda, magnesia, and iron. The most important of these is the phosphate of lime. The amount of these salts varies from ·5 to ·8, and rarely exceeds one per cent (Parkes). The French commission, appointed by the Prefect of Police of Paris, reported upon the analysis of milk made in various countries, and concluded that the following figures represent the composition of this fluid when of good quality (Tardieu) :

Water	87
Total solids	13

	Casein, extractive matters, and salts.	Butter.	Lactin.
Solids	4·00	4·00	5

The commission fixed the minimum standard of good milk at—

Water	88·50		
Solids	11·50	Casein, extractives, and salts	4·00
		Butter	2·70 to 3·00
		Lactin	4·50

When perfectly fresh, milk is usually neutral in reaction, or it may be a little alkaline. After a short time—especially in summer—it becomes acid by a process of fermentation in which the lactin is converted into lactic acid, and the casein coagulates. The fluid portion is called *whey*, and the semi-solid casein *curds*. By the fermentation of mare's-milk an alcoholic liquor, named *koumiss*, is prepared in Tartary, and has been introduced into medical practice as a remedy for phthisis.

The proportion of cream in good milk ranges from 10 to 15 per cent by volume. By churning, the fat of the cream is collected and is then known as *butter*. This important article of food has the following composition (Fonssagrives) :

Margarin	68
Butyrolin	30
Butyrin, caprin, and caproin	2

Butter readily undergoes decomposition—becomes *rancid*—capric and butyric acids separating from the base glycerin. This process is one of fermentation, and is favored by air, light, and imperfect separation of milk in the process of churning. Rancid butter, it need hardly be observed, is not suitable for food.

After the process of churning, which separates the butter, the resultant liquid, known as *buttermilk*, contains the casein, lactin, and the salts, and is therefore a nutritious article of food.

As the milk of other animals than the cow is sometimes prescribed in medical practice, the comparative chemical constitution of this fluid should be studied. The following table (Pereira) shows at a glance the difference in composition of the milk from several animals :

CONSTITUENTS.	Cow.	Ass.	Goat.	Woman.
Casein	4·48	1·82	4·02	1·52
Butter	3·13	0·11	3·32	3·55
Lactin	4·77	6·08	5·28	6·50
Salts	0·60	0·34	0·58	0·45
Water	87·02	91·65	86·80	87·98

Whenever fresh and pure milk can be procured, this only should be prescribed for the sick, but in large cities it is not always practicable to obtain it. Under these circumstances "condensed milk" must be used. This preparation is made by evaporation of the water of the milk and the addition of some sugar. It is found in two forms, dependent on the extent to which the abstraction of water is carried : as a granular solid and as a soft semi-solid. The addition of warm water to the condensed milk furnishes a palatable fluid, of the appearance and composition of fresh warm milk.

Fresh milk, boiled and corked up in bottles to exclude the air, will keep for a considerable length of time. To prevent fermentation, some sulphite of lime may be added to it. For temporary preservation of milk in the summer-time, especially when intended for food for infants, a little bicarbonate of soda and sugar may be used.

Cheese contains all the constituents of milk, except the water and some salts and lactin removed by expression. In the preparation of cheese the casein of the milk is coagulated by *rennet*, the butter and a portion of the lactin and salts are entangled in the meshes of the casein, and the mass is subjected to powerful compression. The peculiar flavor and quality of the cheese depend upon the nature and richness of the milk, and upon certain fermentative changes which take place, developing volatile, odorous, and sapid constituents. The following table of the composition of cheese illustrates its nutritive qualities :

Water	36·8
Albuminates	33·5
Fats	24·3
Salts	5·4

It is evidently a concentrated food. The digestibility of cheese depends in part on its freshness, in part on its composition. When fresh and of good quality, it does not ordinarily disagree with the stomach. A small quantity of cheese taken after dessert in some cases assists digestion ; but many dyspeptics and persons of weak digestion can not make use of it under any circumstances.

Koumiss.—This is a fluid obtained from mare's-milk by fermentation, and constitutes the principal part of the food of the people inhabiting a portion of Tartary. It contains alcohol, lactic acid, sugar, casein, fat, salts, carbonic acid, and water. In addition to these constituents, ascertainable by chemical analysis, koumiss contains fragrant compounds, volatile, the product, probably, of the decomposition of the fat and the reaction of the acids on the alcohol, forming ethers. Koumiss of good quality may also be prepared from cow's-milk by the process of fermentation, but, as mare's-milk is more nearly allied to human milk in composition, it is to be preferred in the preparation of this aliment. By variations in the method of preparation, different kinds of koumiss are produced, as, for example, thick koumiss, whey-koumiss, skimmed-koumiss. According to the different stages to which the process of fermentation is carried, there result three degrees of quality, No. 1, No. 2, and No. 3. No. 2 differs from No. 1 in containing more alcohol and carbonic acid, and less sugar and casein. These constituents, especially the carbonic acid, impart a liveliness to the fluid, so that it effervesces like champagne. In No. 3, the fermentation having proceeded further, butyric, succinic, and acetic acids are produced, and the sparkling quality is enhanced.

Koumiss is prepared from milk, by the addition of a ferment—some koumiss obtained from a previous fermentation or dried koumiss. It is allowed to ferment three days at a temperature of from 70° to 80° Fahr. It is then a bluish-white liquid, having a sharp, acidulous taste, and none of the characteristics of ordinary milk. If heated to 100° Fahr., fermentation is definitely arrested. If before being heated it is bottled, products corresponding to 1, 2, and 3, named above, are the result. Allowed to stand after three days' fermentation, it separates into three layers : the inferior, caseous ; the middle, an acid water ; and the uppermost, a whitish fluid, the best koumiss. The alcoholic strength is of course determined by the stage of fermentation. The koumiss of two days' fermentation is feeble in strength, and hence the product of three days' fermentation is preferable for medicinal use.

The quantity of koumiss administered depends on the condition of the patient. In cases of feeble digestion, this being the only article of food, an ounce every hour will be a sufficient quantity. With increased facility in its digestion and assimilation, from a quart to a gallon a day may be taken. When it is used in connection with

other food, a tumblerful may be administered after each meal. It is estimated that each quart of koumiss contains four ounces of solid food.

The tolerance of the stomach to koumiss is remarkable, even in cases of gastralgia. It improves the appetite, and excites the action of the kidneys. The patients experience a pleasing exhilaration, due probably to the combined action of the carbonic acid and the alcohol. Decided intoxication undoubtedly may result from the use of a large quantity by any one unaccustomed to it. It also causes somnolence during the day, and favors sleep at night without leaving any after-headache. Its most important action is the increase of the body nutrition ; and hence its utility in the treatment of phthisis, indigestion, and the various cachexiæ. Jagielsky says that he has had patients gain as much as ten pounds a month when no other food was taken.

Fish.—A great many varieties of fish are used as foods to which it is necessary to allude in general terms only. Salted fish is not a suitable article of food for the sick : it is difficult of digestion, and possesses but slight nutritive value. Fresh fish, however, properly cooked, is, as a rule, easy of digestion, and furnishes a pabulum of a valuable kind in diseases of certain textures. The following is the composition of fish as compared with beef, according to the analysis of Fr. Schulze :

CONSTITUENTS.	Beef.	Fish.
Fibrin, cellular tissue, nerves, and vessels	15·0	12·0
Albumen	4·3	5·2
Alcoholic extract and salts	1·3	1·0
Aqueous extract and salts	1·6	1·7
Phosphates	traces.	traces.
Fats and loss	1·0	"
Water	77·5	80·1

The commonly-received opinion, that fish is a more highly-phosphorated food than beef, does not receive support in this analysis. Whitefish, shad, bass, and fresh mackerel, are more suitable for the sick than cod, salmon, or eels. They should be prepared and eaten as soon as possible after being taken from the water, and should be either broiled or boiled. Only at the time of the ripening of the milt and roe are fish in a suitable condition for the dietary of invalids. At the time of spawning, and immediately after, the flesh of fish is watery and semi-gelatinous.

Oysters rank among the most digestible of foods, and are usually easily borne by the most delicate stomach. According to Fonssagrives the French oyster contains about 12·6 parts of solid matters, consisting of osmazome, chlorides of sodium and magnesium, sulphates of lime and magnesia, fibrin, albumen, and gelatin. They are more easily

and quickly digested when eaten raw, or broiled, but stewed is the most common form for use in disease. In cases of great irritability of the stomach, the most easily borne oyster-soup is prepared by the addition of the liquor to boiling milk.

Vegetable.—The most important members of this class of foods are the cereal grains—wheat, rye, corn, rice, buckwheat, oats, and barley. The universality of its consumption and its nutritive value place wheat-bread in the first position as an article of diet. The composition of wheat-flour is as follows :

Water	14·0
Fatty matters	1·2
Gluten	12·8
Albumen	1·8
Dextrin, sugar	7·2
Starch	59·7
Cellulose	1·7
Salts (potash, soda, lime, magnesia, phosphoric acid, etc.)	1·6

In the preparation of wheat-flour, the bran is separated. Important constituents of the wheat are thus removed, as the following analysis of the bran shows :

Water	10·3
Fatty matters	2·82
Gluten	10·84
Albumen	1·64
Dextrin, sugar	5·8
Starch	22·62
Cellulose	43·98
Salts	2·52

The internal envelope of the wheat-grain contains also a ferment, know as cerealin, which has very active properties. As the proportion of bran to flour is as sixteen to eighty, it is obvious that considerable loss accrues in the preparation of superfine flour. Wheat-bread made from superfine flour is easy of digestion, owing to its lightness and sponginess permitting a rapid effusion of the gastric juices through every part of it. Most of it is also available for nutrition ; there is little residuum ; hence the constipation which attends its use in large proportion relatively to the other constituents of the diet. When flour is unbolted (bran not separated), an increase of nutritive value is obtained, at the expense, however, of digestibility. A large part of the bran, probably, resists the action of the gastric juice, and hence, irritating the mucous membrane, increases by reflex action the secretions and peristaltic movements.

Whole wheat-grains, under the name of "*cracked wheat*," is frequently prescribed as an article of diet for invalids. It is boiled until

the envelope of the grain is burst open, and is eaten with cream and sugar. Obviously such a combination forms a food of great excellence. The special advantage which it possesses, besides its nutritive value, is its laxative action.

Ordinarily, wheat-bread made of superfine flour is to be preferred for the use of invalids. To obviate the constipating action of such bread, and to obtain a laxative effect, various expedients are adopted. Bran, rye, and corn meal, and, in some kinds of bread, molasses, are added to the dough, forming those varieties known as Graham bread, brown bread, and Boston brown bread.

The important quality of lightness is imparted to wheat-bread by thorough incorporation of carbonic-acid gas with the dough. Two processes are employed for this purpose : By the addition of yeast, fermentation takes place at the expense of a portion of the starch, and carbonic acid and alcohol are produced. By mechanical means, carbonic acid obtained from other sources is mixed with the flour. The latter is known as "aërated bread." Obviously, the mechanical process is more economical because there is no loss of flour. It furnishes usually a lighter and drier bread, and is more easily digested. Bread made by the fermentation process is not unfrequently moist and heavy, and sour, because the fermentation has proceeded beyond the alcoholic stage. "French bread" is lighter, drier, and better baked, than ordinary baker's fermented bread. Warm, fresh bread is not suitable for invalids. It can not be so perfectly masticated as older bread, and, not reaching the stomach in a state to permit diffusion through the mass of the gastric juices, lies unchanged for hours.

According to Smith, the ultimate composition of wheat-bread is as follows :

Water	37·0
Starch	47·4
Sugar	3·6
Fat	1·6
Salts	2 3

Macaroni stewed in milk is sometimes prescribed for the sick. Prepared with butter, cheese, and condiments, it is not an appropriate food for invalids. In composition it consists chiefly of gluten, and of course starch—but in less proportion than in bread—and of fat. The cylindrical tubes in which it occurs are formed by passing the paste of flour (gluten) through perforated plates.

Bread requires from three and a half to four hours for complete digestion. Brown bread digests somewhat more slowly.

Barley is but rarely used as food in this country. It is occasionally prescribed for the sick in the form of infusion—a demulcent drink—and is frequently added to soup. It has the following composition (Smith) :

Water	15·0
Starch	69·4
Sugar	4·9
Fat	2·4
Salts	2·0
Albuminous substances	6 3

Rice is one of the most digestible of vegetable foods, requiring, when boiled, about one hour. Its nutritive value is not equal to wheat, because it consists chiefly of starch. The following is its proximate constitution:

Water	13·0
Nitrogenous matter	6·3
Starch	79·1
Sugar	0·4
Fat	0·7
Salts	0·5

Rice-water, or decoction of rice, like the corresponding preparation of barley, is used as a demulcent drink in fevers and intestinal disorders. Boiled rice is frequently prescribed as a diet for invalids with weak digestion, and is enriched by the addition of milk and cream, and eggs (rice-pudding).

A comparison of its chemical composition with that of wheat or corn will show that it is by no means equal to them in nutritive value. It is obviously unfitted to sustain life alone, and hence in rice-eating countries it is mixed with fat or other foods supplying principles in which it is deficient.

Corn has the following composition (Letheby, Smith) :

Water	14·0
Nitrogenous matter (albumen)	11·0
Starch	64·7
Sugar	0·4
Fat	8·1
Salts	1·7

It is not so readily digested as starch, requiring about three hours. Corn, when green, is prepared for the table by boiling, and is eaten with salt and butter, or milk. If young and tender, and sufficiently cooked, it is a digestible and nutritious food ; but, if the grain is too mature, it resists the action of the intestinal juices, and passes unchanged.

The mature grain, deprived of the heart and husk, is known as *hominy*. Thus prepared and thoroughly boiled it is an esteemed article of diet, ranking in nutritive value a little above boiled starch. *Mush* is boiled corn-meal, and is eaten with milk, and is sometimes fried. It is important that mush be well cooked. Corn-meal is also eaten in the form of bread and cakes. These various preparations of

corn are liable to cause intestinal disorders, and are hence improper in cases of irritable mucous membrane, and in diarrhœal diseases. For this reason corn-bread is sometimes prescribed in cases of constipation dependent on diminished secretion of the intestinal mucous membrane, and torpor of the muscular layer of the bowel. The starch of corn is not unfrequently prepared for invalids in the form of *blanc-mange*.

Oatmeal corresponds in physical qualities and composition to corn-meal. Its proximate composition, according to Smith, is as follows :

Water	15·0
Nitrogenous matter	12·6
Starch	58·4
Sugar	5·4
Fat	5·6
Salts	3·0

It is not at all generally used as an article of diet in this country. It is prescribed in the form of gruel as a delicate food. Boiled for a long time, the oatmeal swells up and thickens, forming a *blanc-mange*, which may be eaten with milk, or butter, or cream, and sugar and aromatics.

The Potato, next to wheat, is the most important food derived from the vegetable kingdom. Its composition is affected by its source and variety, and by the soil in which it is grown. The specific gravity of the potato affords an index of its nutritive value, for, the heavier, the greater the quantity of starch it contains. For the sick, watery potatoes are unsuitable. When cooked, the tuber should be mealy and dry. The following is the composition of the potato :

Water	75·0
Nitrogenous matter	2·1
Starch	18·8
Sugar	3·2
Fat	0·2
Salts	0·7

According to some authorities, the potato contains free citric acid. The salts are rich in potash. According to Letheby, the composition of the *sweet-potato* is as follows :

Starch	16·0
Sugar	10·0
Albumen	1·5
Gum	1·1
Fat	0·3
Salts	2·9
Water	68·2

These analyses indicate that the sweet-potato possesses the higher nutritive value.

Starch, *Sago*, *Arrowroot*, and *Tapioca*, differ from the preceding

vegetable foods, in that they contain no nitrogen. They are digested in from one to two hours. They are largely used in the preparation of diets for the sick, but are insufficient in themselves to maintain for any considerable period the vital functions. Hence they are prepared and eaten with sugar, milk, cream, butter, and aromatics.

Turnips, Parsnips, Carrots, Onions, Asparagus, Beets, Cauliflower, and *Cabbages,* are but rarely prescribed for the sick. Nevertheless, some information in regard to their composition and digestibility may not be misplaced. According to Smith, the following represents the composition of

Turnips.		Carrots.		Parsnips.	
Water	91·0	Water	83 0	Water	82·0
Sugar	2·1	Sugar	6·1	Sugar	5·8
Nitrogenous matter	1·2	Nitrogenous matter	1·3	Nitrogenous matter	1·1
Fat	—	Fat	0·2	Fat	0·5
Starch	5·1	Starch	8·4	Starch	9·6
Salts	0·6	Salts	1·0	Salts	1·0

Beets differ from the above chiefly in the quantity of sugar. The following is the analysis of Payen :

Water	83·5	Nitrogenous matter	1·5
Sugar	10·5	Pectose, etc.	0·8
Salts and pecten			3·7

All of the members of this group are deficient in nutritive value, and are besides slow and difficult of digestion, requiring from three to five hours for complete solution.

Ripe fruits, as grapes, apples, pears, peaches, oranges, lemons, etc., possess but little nutritive value, as they contain only about 10 to 15 per cent of solid matters. In composition they are represented by sugar, free acid (tartaric, citric, etc.), nitrogenous matters, and salts. They differ, of course, in the peculiar flavoring matters which give to each fruit its special taste. Dried fruits, as dates, figs, and raisins, are relatively much more nutritive, because they contain a larger percentage of sugar. Under the head of dietetic management of diseased states, some further remarks will be made on the use of the fresh and dried fruits.

SPECIAL PLANS OF DIET.

The food-supplies to the organism may be so managed as to secure very definite therapeutical results. By increasing or diminishing the whole amount of foods ingested, by variations in the quality and character of them, and by the employment of some special and restricted methods of feeding, cures are effected not attainable by medicinal treatment.

Denutrition.—The amount of food necessary for bare subsistence has been pretty accurately determined. During the siege of Paris the

daily ration was at one time reduced to less than ten ounces of bread and one ounce of meat daily. Dr. Edward Smith ascertained that the daily amount of food barely sufficient to maintain life among the factory operatives must contain 2·84 ounces of nitrogenous matter, and 19·25 ounces of carbonaceous. Pettenkofer and Voit give, as the necessary amount of food required by an adult when at work, 5·22 ounces of nitrogenous and 22·38 of carbonaceous matter. Letheby furnishes the following table as the result of his investigations on this point :

Daily diet for	Nitrogenous, ozs.	Carbonaceous, ozs.
Idleness	2·67	19·61
Ordinary labor	4·56	29·24
Active labor	5·81	34·97

The ration of the United States soldiers imprisoned at Andersonville consisted of one third pound of bacon and one pound and a quarter of unbolted corn-meal. This amount and quality of food were insufficient to maintain the bodily functions in a healthy state, and hence vast numbers died of scorbutus, diarrhœa and dysentery, and hospital gangrene. From these data we are enabled to form an estimate of the amount and kind of food necessary to maintain life in those cases of disease in which it is desirable to apply the method of denutrition.

Physiological Effects of Insufficient Food.—Intestinal uneasiness, more or less pain, borborygmi, and a feeling of hunger, are among the first symptoms of an insufficient supply of food. The secretions of the intestinal canal diminish, digestion becomes difficult, and constipation results. The respiratory movements are diminished in frequency and volume, and the exhalation of carbonic acid notably declines. According to Dr. Edward Smith, while under an ordinary diet the daily excretion of carbonic acid amounts to thirty-four ounces, under an almost complete abstinence it falls in twenty-four hours to twenty-two ounces. The blood suffers a notable diminution in its amount ; the quantity of water augments, and the number of blood-globules greatly diminishes. Meanwhile the blood loses its plasticity, and a tendency to hæmorrhagic extravasations is developed. The urinary secretion also lessens in amount ; the urea and uric acid diminish, but the hippuric acid rather increases ; the chlorides after some days almost disappear, but the sulphuric and the phosphoric acids persist. As a result of the very obvious decline in the function of assimilation, the temperature of the body falls some degrees below the normal. The functions of the nervous centers undergo a marked derangement. Giddiness, vertigo, hallucinations, ensue, and are coincident with a fatty degeneration of the cells of the gray matter. The subcutaneous fat disappears ; the muscles lose a considerable part of their substance. The muscular substance of the heart diminishes proportionally. The