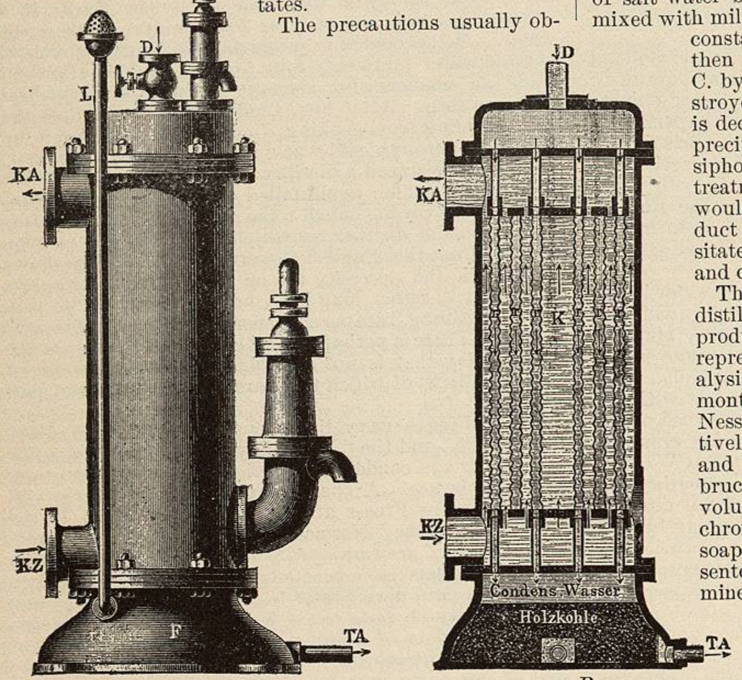
system, steam from the boilers is used to evaporate the water in the first set of evaporators; this evaporated steam is used to heat and evaporate the water contained in the second set of evaporators, and this in turn is made to evaporate the water contained in a third set. This last steam is finally condensed to water in a distiller of the above description. This system more than doubles the actual thermal efficiency of the distilling apparatus, but it is not installed except in very large ships, on account of the complications in mechanical fittings which it necessitates.



A. B.

FIG. 3508.—(From Kirchner.) The Transatlantic liners of the North German Lloyd are equipped with distillers of the "Acme" patent. These were preferred on account of their combining great efficacy, small space and ease with which they can be handled and worked. The condenser is shown in the adjoining two figures *A* and *B*. The steam generated in an auxillary boiler is made to enter, at *D*, into the condenser, which consists of a vertical cylinder, 110 cm. long and 36 cm. in diameter. The steam now passes into a number of tubes, made of thin copper *r r*, outside of which a constant and rapid stream of cold sea water passes from below upward, entering at *KZ* and leaving the cooler at *KA*. The distilled water, at the lower end of the condenser, enters a charcoal filter, *F*, where it is purified, and, at the same time, aërated by the air coming in through the tube *L*, with which it is here in communication. The water, both filtered and aërated, is finally collected at *TA*. The apparatus furnishes 18 cubic metres of good potable water in twenty-four hours. The warships of the imperial German navy are all equipped with distillers made on the same principle as those of the "Acme" patent.

The precautions usually observed are as follows: (1) The plant is operated only when pure sea water is obtainable. (2) For drinking-water, the plant is not operated to its full capacity, in order to reduce priming or carrying salt water directly over into the distillate. (3) Tests of the complete plant are made daily to insure tightness of all the joints. (4) The water level in the evaporators is kept low. (5) When the ship is under way and rolling heavily, the plant is worked at its lowest capacity. (6) The pressure of the cooling water in the distiller is limited by departmental order to thirty pounds, which is to minimize the danger of salt water leaking into the distillate. (7) Tests of the distillate are made every fifteen minutes.

The process of distillation, however, always involves an expense which sometimes may be considerably greater than the price at which good drinking-water can be bought on shore, and then it becomes the duty of commanders of vessels to secure such water when of good quality and whenever practicable. Besides, the process of distilling is not always faultless and the product occasionally needs looking into.

Water Distilled from Sea Water.—Although the water obtained from sea water by distillation may not be absolutely pure, it has nevertheless stood the test of many years' practical experience, and hence must be considered to be harmless. The mineral salts, contained in sea water, sodium and magnesium chloride, lime, alkalies, acids, bromine, iodine, etc., especially magnesium chloride, in decomposing during the process of distillation, vitiate the product to a certain degree. In order to obviate these objectionable features, Rubner ("Lehrbuch d. Hygiene") proposes the following preliminary treatment of salt water before distilling: The salt water is to be mixed with milk of lime in special tanks and kept, being constantly stirred up, for fifteen minutes; it is then heated up to a temperature of about 60° C. by steam. All organic matter is thus destroyed and coagulated. Magnesium chloride is decomposed by the lime and the magnesia is precipitated. After all has settled the water is siphoned off and distilled. This preliminary treatment, if it could be carried out practically, would no doubt result in a more uniform product of distillation; it would, however, necessitate a reconstruction of all the evaporators and condensers at present in use.

That sea water under the present system of distillation does not furnish a uniformly pure product may be seen from Table XIV., which represents an almost daily though partial analysis of such water, continued for nearly a month. Free ammonia was determined with Nessler's reagent; the nitrites were qualitatively determined with the sulphanilic acid and naphthylamine test; the nitrates with brucine and sulphuric acid; chlorine with a volumetric solution of silver nitrate, potassium chromate as indicator; hardness with standard soap solution; and the organic matter, represented in milligrams of oxygen, was determined by a standard solution of potassium permanganate. All these solutions were made on board ship and according to the methods given in Harrington's excellent manual of "Practical Hygiene." The analyses show that the water produced in our distillers always contains quite appreciable quantities of chlorine, lime, and magnesium salts (represented by hardness), and also organic matter; less frequently ammonia, and still less frequently nitrites and nitrates. All these, in the above quantities, must be considered harmless. With few exceptions the water was free from odor and perfectly colorless.

An important point, to which it is necessary to call attention in connection with the chemical composition of water distilled on board ship, is the hygienic significance of it. It will be seen at once that we must judge this from a standard entirely different from the one in accordance with which we would judge a surface or a ground water. Ammonia, nitrites, nitrates, as also chlorides, when found in a properly collected sample of river or well water, would justly arouse great suspicion, while the same chemical compounds in the water distilled from sea water arouse no such suspicion. These stand simply for a certain amount of nitrogen in different stages of oxidation and are otherwise perfectly harmless in the quantities in which they appear. No living organism, neither an animal nor a vegetable parasite, capable of producing disease could possibly survive such a process of distillation.

The following table is interesting from quite another point of view; it shows that, while a small quantity of organic matter is constantly present in the distillate, ammonia, nitrates, and nitrites are almost as constantly absent. This would indicate an almost absolute absence

of all oxidation during distillation. When, however, we consider that the salt water, from which our distillate is obtained, does not come directly from the sea, but has already been used as condense water and gone through the distiller in which it has been heated up to a high temperature, then this is easily explained. By the time such water arrives in the evaporator as feed water, all the air has been driven out.

TABLE XIV.—TABULATED RESULTS OF TWENTY-TWO ANALYSES OF WATER DISTILLED FROM SALT WATER BY THE UNITED STATES STANDARD EVAPORATOR.

U. S. S. *Prairie*, Gulf of Paria. January, 1902.	Free ammonia.	Nitrites.	Nitrates.	Chlorine, in milligrams per litre.	Hardness, in milligrams calcium chloride.	Organic matter, represented in milligrams of oxygen per litre.
3	+	0	0	220	10.0	0.0
4	0	0	0	30	5.0	2.0
5	+	0	0	20	4.0	3.5
6	+ +	0	0	10	6.0	1.7
7	+	0	0	50	11.0	3.6
8	+ +	0	0	20	16.0	2.0
9	+	0	0	24	7.0	3.2
10	0	0	0	130	13.0	6.5
13	+	0	0	8	4.0	2.0
14	+	0	0	12	4.0	3.0
16	+	0	0	20	5.5	3.0
17	+	0	0	20	6.0	3.0
18	+ +	+ +	+	160	10.0	4.0
20	0	0	0	30	4.5	4.5
21	0	0	0	30	5.0	5.0
22	0	0	0	20	5.0	3.0
23	0	+ +	0	90	10.0	2.5
25	0	0	0	12	7.0	2.0
26	0	0	0	20	8.0	3.0
27	0	0	0	32	6.0	2.0
28	0	0	0	80	8.0	120.0
30	0	0	0	32	5.0	3.0

The Stowage and Distribution of Water on Board.—If, notwithstanding the fact that, as we have seen, no reasonable objections can be entertained from a sanitary point of view against the water distilled on board ship, complaints, and very pressing ones, are still often heard against the drinking-water supplied to officers and men, what are they due to? In almost every instance to unclean tanks and faulty pipe connections, as perhaps the following instance from my own experience will best serve to illustrate. It was not many days after our ship had been placed in commission and her officers and men had begun to live on board, that the presumably pure and distilled water was found absolutely non-potable and everybody refused to drink of it. The water was undoubtedly and indescribably bad. A sample of it was immediately collected from one of the spigots in the galley, under the usual precautions, and analyzed, with the following results:

November 26th, 1901, sample of water supposedly distilled:

1. *Color.*—Distinctly yellowish, very turbid, depositing on standing a brownish flocculent sediment.
2. *Odor.*—On being heated in a flask and shaken, a very perceptible, strong, musty odor is present.
3. *Residue.*—On evaporation grayish-white, turning black on being heated to redness.
4. *Free* as well as *albuminoid* ammonia present in large amounts, forming brownish precipitate.
5. *Nitrites.*—Positive reactions with the starch iodine test as well as with the sulphanilic acid and naphthylamine test.
6. *Chlorine.*—NaCl, 2.5 gm. per litre.
7. *Hardness.*—Equal to ninety parts of calcium chloride in ten thousand parts.
8. *Nitrates.*—Positive reaction with brucine.
9. *Lead.*—Grayish discoloration with hydrogen sulphide and acetic acid.
10. *Organic Matter.*—In abundance and not determined quantitatively.

Based upon the results of the above analysis, the probable source of contamination was put down as being dirty salt water from the harbor in which the ship was lying; also improperly cleaned tanks and pipes, as was made apparent by the water giving reactions for lead. When the result of this analysis and the inevitable conclusions it led to were communicated to the commanding officer, an immediate inspection of the entire water-supply system of the ship was made, and the source of the contamination quickly and decidedly traced to a very faulty system of pipe connection existing between the sweet and the salt water reservoirs on board. Owing to this connection, it was impossible to draw either sweet or salt water from any of the spigots without getting a mixture of both in varying proportions.

The bacteriological examination of a sample of this water, made at the Bacteriological Laboratory of the Harvard University College of Medicine, showed the presence of liquefying bacteria in large numbers, while that of a sample of water collected from the distiller proved absolutely sterile.

A more common source of lead in ship's drinking-water is found in the pipe joints, especially in newly made ones, of which several instances have recently come to our notice. The red lead used for the purpose of making joints water-tight should be forbidden and asbestos used instead, in all pipes used for water distribution. Early in the history of distilling water on board ship and the laying of pipes for its convenient distribution, A. Le Fèvre, of the French navy, discovered lead in the water; and quite recently Dr. Cautellauve (1891–92), also of the French navy, has again reported several cases of lead poisoning from the same cause, during his cruise in the East on board the *Troude*.

Time and space do not permit here to go into a detailed description of the various methods of modern water analysis. Nor is it necessary to mention the characters that a good drinking-water should possess. These are matters of general hygiene and can easily be found in every work on that subject. There is no doubt that the naval surgeon, equipped with a practical knowledge of the laboratory methods used in water analysis, will be well able to make such a selection of apparatus and reagents, before going to sea, as will enable him to make a very satisfactory water analysis, wherever and whenever called upon to do so. There may be some difficulties as regards accommodations on board some ships, but there are none that cannot be overcome. His difficulties certainly cannot be greater than are those of the army surgeon in the field.

The water-supply systems and the chemical composition of the water supplied by them, of every one of the islands near our coast, including all the Antilles, should be systematically investigated. The composition of every important well in common use and out of use on every island should be known, recorded, and plotted on geographical maps for immediate reference. With some encouragement and the necessary means and apparatus, this work could easily be done by naval medical officers.

III. THE RATION.

FOODS AND NUTRITION IN GENERAL.—While it cannot be expected, in the limited space allotted to this paper, that we enter at all into the special physiology of nutrition or into the chemistry of foods, it is, on the other hand, absolutely necessary and unavoidable briefly to touch upon those of the leading principles and methods according to which the nutritive values of those of the food substances in common use on board all sea-going vessels and included in the navy ration, are ordinarily determined.

Daily experience and observation have sufficiently acquainted us with the fact that the physical part of our existence consists in a perpetual and constant effort on the part of the living organism to adapt itself to an ever-changing series of outside conditions. In this supreme effort the organism uses up constantly part of its own organized substance, expending it as, or converting it into, mechanical work and heat. If the body weight is to be maintained and the life of the organism is to continue successful in the struggle, this expenditure in organized substance must be made good. The products of wear and tear incident to the process must also be promptly removed.

Since the source of the energy thus expended by a living animal organism can be restored only through the introduction and the assimilation of certain definite quantities of organic and inorganic food substances, their supply, preservation, preparation, digestion, assimilation, and dissimilation have been among the principal subjects of study and investigation on the part of physiologists. Since, moreover, the supply of these substances and their assimilation must vary directly with the energy expended by the organism in a given time and under varying conditions of environment, a balance between supply and expenditure must be maintained and the influence upon it of different conditions be known, as well as the relative value of the food itself. We must be able to measure the energy expended and to ascertain its food equivalent, if we are to make no mistake in our provisions.

Since, finally, it is of coequal importance to the life of the organism that the products of wear and tear should be as promptly and as completely eliminated as new material is appropriated, the maximum working efficiency of the living machine is conditioned not only by a proper balance between supply and demand, in accordance with different environmental and subjective conditions, but is, moreover, determined by the individual capacity for maintaining a high balance between assimilative and dissimilative functions. The latter determine the difference between two individuals and between different races of mankind. This functional capacity on the part of both the individual and the race can be developed and increased through systematic training.

According to Verworn, tissue metamorphosis (Stoffwechsel) comprises a long series of complicated chemical processes, beginning with the entry of nutritive substances into the living cells of the body and ending with their exit. These processes follow each other like the links of an unbroken chain, and might not inaptly be represented by a binomial curve. In this curve the ascneding arm would then represent all those processes which lead to the repair of living matter; the top of the curve, those highly complicated processes leading to the synthesis of protoplasm itself; and the descending arm, the processes leading to, and finally ending in, the decomposition of living matter into the simplest end-products (urea, carbonic acid, water, etc.). With the beginning and the ending of the highly complicated process and the materials found at these two points we are fairly well acquainted; the rest is as yet wrapped in darkness.

Foods, in the physiological sense, are classified into nitrogenous, also called proteids, and non-nitrogenous, in which are included the fats and carbohydrates. While fats and carbohydrates may, to a certain extent, be substituted for one another, non-nitrogenous substances can never be made to take the place of proteids in nutrition. The latter must be regarded as by far the most important food substances and as absolutely indispensable parts of a complete and perfect diet.

The *proteids* form the chief components of the cells in the tissues of all plants as well as animals, and, according to the researches of Voit and Pettenkofer, the absorption and ozonization of oxygen and its effect upon all the chemical processes within the cells, are entirely under the direct control of the nitrogenous part of their tissues. Without the participation of the nitrogenous tissues, neither oxidation nor any manifestation of energy is possible. Mechanical motion and heat may be evolved through the oxidation of both fats and carbohydrates, but the initiative to the manifestations of these must be given by the tissues containing nitrogen. Proteids have, moreover, been found to produce fats and possibly also carbohydrates under certain conditions.

Fats are chemical compounds consisting of a trivalent alcohol, glycerin, and three molecules of a monobasic acid, chiefly stearic acid, palmitic acid, and oleic acid in different proportions. They all contain hydrogen and oxygen as well as carbon, but no nitrogen, their general formula being represented by $C_{10}H_{18}O$. The formula suggests that the fats need oxygen in large quantities for their complete conversion into water and carbon dioxide.

The *carbohydrates* comprise the sugars and the starches which are for the most part of vegetable origin. It has been shown that the formation of starch granules in the green plant goes on hand-in-hand with the decomposition of carbon dioxide by the chlorophyl granules, under the influence of sunlight. On the hypothesis of von Baeyer, the carbon (C) of the carbon dioxide, the moment it is set free, combines with the water (H_2O), taken up by the roots of the plant, and forms one molecule of formaldehyde (CH_2O). Six of these molecules of formaldehyde now link together by polymerization and form one molecule of a monosaccharid ($C_6H_{12}O_6$) and through further polymerization of the monosaccharids thus formed, and with the loss of one molecule of water by each, starch finally results ($C_6H_{10}O_5$). This hypothesis has met with the most general acceptance. In the group of the carbohydrates also belong cellulose and pectin. Cellulose forms the solid skeleton and, when boiled with dilute sulphuric acid, it gives dextrin and glucose. Pectin is the vegetable jelly found in various ripe fruits.

All living organisms must, moreover, have a certain amount of *oxygen*, without which life is impossible; and, lastly, *water* and *salts*. Indispensable are sodium, potassium, magnesium, calcium, and iron, and their combinations with phosphoric, sulphuric, carbonic, and hydrochloric acids.

Food Value.—The food value of an eatable substance is generally expressed by the number of calories or heat units which 1 gm. or any other definite quantity of it will develop, when completely burned in a calorimeter. The amount of heat that is developed during the combustion of, for instance, 1 gm. of substance in a calorimeter is exactly the same as that which is produced when 1 gm. of the same substance is completely oxidized within the body. In a living organism about thirty per cent. of this value can be put out in the form of mechanical work, while the remainder passes off in the form of heat. We know, thanks to the researches of Voit, that an average adult laborer, performing his daily work, puts out in mechanical work and heat the equivalent of about three thousand calories. In order, therefore, that the man shall not lose in weight, his daily diet must be such as to balance his loss and have a combined caloric value of at least three thousand units. If we, furthermore, will take into calculation that about four hundred of the units at least must come from proteids, five hundred from fats, and the remainder from carbohydrates, we have the most necessary data for the calculation of the man's diet. Thanks to the labors of Voit and Rubner and their numerous pupils, these determinations have been greatly simplified in recent years.

Outside conditions, personal and racial habits, climate, age, and sex may alter the relative proportions of proteids, fats, and carbohydrates in a certain diet, but the above proportions must stand as answering to the average requirements of an adult workingman in a temperate climate. In calculating the dietary value of a ration, we must also allow for an unavoidable loss in the preparation of the different parts of it. In meats, a loss of twenty per cent. of the raw material is generally allowed for bones; with salted herrings, thirty-seven per cent.; pickled herring, twenty-nine per cent.; potatoes boiled and then peeled, seven per cent.; potatoes peeled raw, thirty per cent.; if eggs be used, ten per cent. in weight is deducted for the shell, etc. Another source of loss from the gross weight is in the different degrees of digestibility of foods, for which allowance must also be made. As a general rule, animal foods are much more completely digested than foods of vegetable origin. Rubner has shown that proteids from meat and milk disappear almost entirely, while those from bread and espe-

TABLE XV.

Name.	In 100 Parts are Contained:					Nutrient Unit in:			Sum Nutrient Units in:	
	Proteids.	Fats.	Carbo-hydrates.	Ash.	Cellul.	Proteids.	Fats.	Carbo-hydrates.	100 gm.	1 ounce.
Beef, very fat	17.0	29.5	....	1.0	....	59.5	259.5	....	319.0	95.0
Beef, medium fat	21.0	5.5	....	1.0	....	73.5	48.4	....	122.0	37.0
Beef, lean	20.5	1.5	....	1.0	....	71.7	13.2	....	85.0	25.0
Mutton, very fat	16.5	29.0	....	1.0	....	57.7	255.2	....	313.0	94.0
Mutton, medium	17.0	6.0	....	1.0	....	59.5	52.8	....	112.0	34.0
Mutton, average	17.0	18.0	....	1.0	....	59.5	158.4	....	218.0	65.0
Pork, fat	14.5	37.5	....	1.0	....	50.7	330.0	....	380.7	114.0
Pork, lean	20.5	7.0	....	1.0	....	71.7	61.6	....	133.3	40.0
Pork, grease from	.5	98.2	....	....	....	1.7	864.2	....	865.9	260.0
Beef tallow	.5	98.2	....	....	....	1.7	864.2	....	865.9	260.0
Veal, fat	19.2	7.2	....	.8	....	67.2	63.4	....	103.6	31.0
Veal, lean	20.2	6.8	....	1.1	....	60.9	59.9	....	120.8	36.4
Poultry, medium	21.0	2.0	....	1.0	....	73.5	17.6	....	91.1	27.3
Horseflesh	21.7	2.6	....	1.1	....	76.0	22.9	....	98.9	29.7
Meat powder	69.5	5.8	....	1.1	....	243.2	51.4	....	294.6	88.4
Carne secca	51.7	13.4	....	....	....	181.0	117.9	....	298.9	89.7
Carne secca, boiled	34.5	8.9	....	....	....	121.0	78.3	....	199.3	59.8
Bacon	9.5	76.0	....	5.4	....	33.2	668.8	....	702.0	210.6
Bacon, roasted	1.7	94.5	....	5.4	....	6.0	831.6	....	837.6	251.3
American canned meat	29.0	11.5	....	4.0	....	101.5	101.2	....	202.7	60.7
Chicago corned beef	23.3	14.0	....	4.0	....	81.5	123.2	....	204.7	61.4
Corned beef	38.8	6.4	....	1.8	....	135.8	56.3	....	192.1	57.6
Preserved beef	29.5	8.0	....	....	....	103.2	70.4	....	173.6	52.0
Pickled beef	25.9	.2	....	21.0	....	80.6	2.0	....	82.6	24.8
Pemmican	35.4	55.2	....	1.8	....	123.9	485.8	....	609.7	182.9
Pork, pickled	9.7	75.7	....	5.3	....	34.0	666.2	....	700.2	210.0
Ham, smoked	24.5	36.5	....	10.5	....	85.7	321.2	....	406.9	122.0
Ham sausage	12.87	24.43	10.52	3.3	....	45.0	215.0	38.9	298.9	89.7
Beef sausage	27.31	19.88	15.1	5.5	....	95.6	174.9	55.9	326.4	97.9
Cervelat sausage	17.5	40.0	....	5.5	....	61.2	352.0	....	413.2	124.0
Herring, pickled	19.0	17.0	....	16.5	....	66.5	150.0	....	216.5	64.9
Sardines	23.0	2.0	....	24.0	....	80.5	1.8	....	82.3	24.7
Pike	18.42	.53	....	1.0	....	64.0	4.7	....	68.7	20.6
Carp	21.86	1.0	....	1.33	....	76.5	8.8	....	85.3	25.6
Salt cod	27.42	.36	....	22.0	....	96.0	3.2	....	99.2	29.8
Salt mackerel	18.88	25.17	....	10.4	....	60.0	221.5	....	281.5	84.4
Smoked haddock	33.68	.17	....	2.06	....	117.9	1.5	....	119.4	35.8
Smoked halibut	20.57	15.03	....	12.96	....	72.0	132.3	....	204.3	61.3
Smoked herring	36.44	15.82	....	11.66	....	127.6	139.2	....	266.8	80.0
Canned salmon	20.06	15.7	....	1.04	....	70.2	138.1	....	208.3	62.5
Canned mackerel	19.91	8.68	....	1.93	....	69.7	76.4	....	140.1	42.0
Canned tunny	21.52	4.05	....	1.69	....	75.3	35.6	....	110.9	33.3
Eel	18.3	9.1	....	1.0	....	64.0	80.0	....	144.0	43.2
Pompano	18.7	7.5	....	1.0	....	65.4	66.0	....	131.4	39.4
Salmon	21.2	12.8	....	1.4	....	74.2	112.6	....	186.8	56.0
Shad	18.6	9.5	....	1.3	....	65.1	83.0	....	148.1	44.4
Shad roe	20.9	3.8	2.6	1.5	....	73.1	33.4	9.6	116.1	34.8
Smelts	17.3	1.8	....	1.7	....	60.5	15.8	....	76.3	22.9
Spanish mackerel	21.0	9.4	....	1.5	....	73.5	82.7	....	156.2	46.9
Trout	18.9	2.1	....	1.2	....	66.1	18.5	....	84.6	25.4
Caviare	30.0	19.7	7.6	4.6	....	105.0	173.4	28.1	306.5	91.9
Clams	8.6	1.0	2.0	2.6	....	30.1	8.8	7.4	46.3	13.9
Clams, little neck	2.1	.4	4.2	2.7	....	7.3	3.5	15.5	26.3	7.9
Crabs	16.6	2.0	1.2	3.1	....	58.1	17.6	4.4	80.1	24.3
Lobster	16.4	1.8	.4	2.2	....	57.4	15.8	1.5	74.7	22.4
Oysters	6.2	1.2	3.7	2.0	....	21.7	16.6	13.7	52.0	15.6
Scallops	14.8	.1	3.4	1.4	....	51.8	.8	12.6	65.2	19.6
Shrimps	25.4	1.0	.2	2.6	....	88.9	8.8	.6	98.3	29.5
Peas	22.85	1.79	52.36	2.58	5.43	70.8	15.7	212.8	299.3	89.8
Peas, dried and boiled	7.0	.5	16.9	1.0	....	21.7	4.4	62.5	88.6	26.6
Peas, canned	3.6	.2	9.8	1.1	....	11.2	1.7	36.3	49.2	14.8
Beans, broad	24.27	1.61	49.01	3.26	7.09	75.2	14.2	207.4	296.8	89.0
Beans, kidney	23.21	2.14	53.67	3.69	3.55	71.9	18.8	211.7	302.4	90.4
Sago, fresh	2.3	.3	7.4	.8	....	7.1	2.6	27.4	36.1	10.8
Sago, canned	1.1	.1	3.8	1.3	....	3.5	.8	14.0	18.3	5.5
Soja bean	30.4	17.7	29.1	4.1	....	94.2	155.8	107.7	357.7	107.3
Lentils	25.7	1.89	53.46	3.57	3.04	79.6	16.6	181.0	277.2	83.2
Potatoes	2.2	.1	18.4	....	1.0	6.8	.8	69.7	77.3	23.2
Potatoes, sweet	1.8	.7	27.4	....	1.0	5.6	6.1	105.4	117.1	35.1
Beets	1.6	.1	9.7	....	1.1	4.9	.8	39.9	45.6	13.7
Carrots	1.1	.4	9.3	....	1.0	3.4	3.2	38.1	44.7	13.4
Oyster plant	1.0	.5	17.1	....	1.0	3.1	4.4	67.0	74.5	22.3
Parsnips	1.6	.5	13.5	....	1.4	5.0	4.4	55.1	64.5	19.3
Radishes	1.3	.1	5.8	....	1.0	4.0	.9	25.2	30.1	9.0
Turnips	1.3	.2	8.1	....	.8	4.0	1.7	32.9	38.6	11.6
Asparagus	2.1	3.3	2.2	....	.8	6.5	28.2	11.1	45.8	13.7
Cabbage	1.6	.3	5.6	....	1.0	5.0	2.6	24.4	32.0	9.6
Cauliflower	1.8	.5	4.7	....	.7	5.6	4.4	20.0	30.0	9.0
Sprouts	4.7	1.1	4.3	....	1.7	14.6	9.7	22.2	46.5	14.0
Celery	1.1	.1	3.3	....	1.0	3.4	.9	16.0	20.3	6.1
Lettuce	1.2	.3	3.2	....	2.1	3.7	2.6	20.0	26.3	7.9
Spinach	2.1	.3	3.2	....	.9	6.5	2.6	15.1	24.2	7.3
Onions	1.6	.3	9.9	....	.6	5.0	2.6	38.8	46.4	14.0
Apples	.36	....	8.26	4.3	.31	1.2	....	31.7	32.9	9.9
Pears	.36	....	7.22	1.51	.49	1.2	....	28.5	29.7	8.9
Peaches	.65	....	4.48	6.06	.69	2.0	....	19.1	21.1	6.3
Apricots	.49	....	4.69	5.27	.82	1.5	....	20.4	21.9	6.6
Plums	.4	....	3.56	4.34	.66	1.2	....	15.6	16.8	5.0
Prunes, dried	2.3	.5	65.0	1.5	1.4	7.1	4.4	245.7	257.2	77.2
Cherries	.67	....	10.24	6.07	.73	2.1	....	40.6	42.7	12.7
Oranges	.8	.2	11.6	....	.5	2.5	1.8	44.8	49.1	14.7
Grapes	.59	....	14.36	3.6	.53	1.8	....	55.2	57.0	17.1
Melons	.92	.18	9.05	1.04	.72	2.8	.9	36.1	39.8	11.9

TABLE XV.—*Continued.*

Name.	In 100 Parts are Contained:					Nutrient Unit in:			Sum Nutrient Units in:	
	Proteids.	Fats.	Carbohydrates.	Ash.	Cellul.	Proteids.	Fats.	Carbohydrates.	100 gm.	1 ounce.
Figs	4.0	....	50.0	....	3.0	12.4	....	19.6	32.0	9.6
Cranberries	.12	....	7.8	6.27	.15	.4	....	29.4	29.8	8.9
Strawberries	1.07	....	6.28	3.25	.81	3.3	....	26.2	29.5	8.8
Blackberries	.51	....	4.44	6.97	.48	1.6	....	18.2	19.8	5.9
Raspberries	1.42	....	3.86	8.1	.48	4.4	....	16.8	21.2	3.4
Dates	6.6	.2	59.6	1.9	1.6	20.5	1.76	226.4	248.7	74.6
Rhubarb	.9	....	3.2	....	.4	2.8	....	13.3	16.1	4.8
Egg without shell	12.5	12.0	.5	1.0	....	43.5	105.6	1.8	150.9	45.3
Milk, cow's	3.5	4.0	4.9	.7	....	12.2	35.2	18.1	65.5	19.6
Milk, skimmed	3.1	.7	4.8	.7	....	10.8	6.1	2.6	19.5	5.8
Milk, goat's	4.29	4.7	4.6	.7	....	15.0	41.4	20.7	77.1	23.1
Milk, condensed	12.0	8.4	50.8	2.0	....	42.0	73.9	31.0	146.9	44.0
Milk, condensed, Swiss	12.3	11.0	48.7	2.4	....	43.0	96.8	180.2	320.0	96.0
Milk, condensed, sweet	11.35	11.25	13.35	2.0	....	39.7	99.0	49.4	188.1	56.4
Cream	2.7	26.7	....	1.8	....	9.4	23.49	....	244.3	73.3
Butter, fresh	2.0	85.0	....	1.0	....	7.0	748.0	....	755.0	226.5
Butter, salted	....	80.0	....	3.0	....	....	704.0	....	704.0	211.2
Cheese, Dutch	28.25	22.78	....	7.1	....	98.9	200.5	....	299.4	89.8
Cheese, American	29.64	38.24	....	3.49	....	103.7	336.5	....	440.2	132.0
Cheese, Roquefort	32.9	32.3	....	4.4	....	115.1	284.2	....	399.3	119.8
Cheese, Camembert	18.9	21.0	....	4.7	....	66.1	184.8	....	250.9	75.3
Cheese, Cheshire	26.93	30.68	....	4.42	....	94.2	270.0	....	364.2	109.3
Cheese, Edam	27.0	28.3	3.0	5.0	....	94.5	249.0	11.1	354.6	106.4
Cheese, caraway	31.5	12.0	9.3	3.3	....	110.2	105.6	34.4	250.2	75.0
Bread, rye	6.0	1.0	48.0	1.5	....	20.0	8.8	177.6	206.4	61.9
Bread, wheaten	7.0	.5	52.5	1.0	....	21.7	4.4	194.2	221.3	66.4
Biscuit, navy	10.9	1.6	75.0	1.1	....	33.8	14.0	277.5	325.3	97.6
Biscuit, milk	7.18	9.28	73.1	.83	....	21.5	81.6	270.5	373.6	102.1
Flour, wheaten	11.0	2.0	71.2	.8	....	34.1	17.6	263.4	315.1	94.5
Flour, barley	12.7	2.0	71.0	3.0	....	39.4	17.6	262.7	319.7	95.9
Flour, corn	9.7	3.8	69.6	1.3	1.4	30.0	33.4	257.5	320.9	96.3
Corn, grains	10.0	6.7	64.5	1.4	....	31.0	59.0	238.6	328.6	98.6
Starches	1.0	....	82.0	....	....	3.1	....	303.4	306.5	92.0
Sugar cane	.5	....	96.5	1.0	....	1.6	....	357.0	358.6	107.6
Molasses	....	....	62.0	2.8	....	....	....	229.4	229.4	68.8
Honey	1.2	....	73.6	2.8	....	3.7	....	272.3	276.0	82.8
Buckwheat	10.75	2.0	62.75	1.25	....	33.3	17.6	332.1	383.0	114.9
Oatmeal	12.6	5.6	63.0	3.0	....	38.0	49.2	233.1	320.3	96.0
Macaroni	9.0	.3	76.8	.8	....	27.9	2.6	284.2	314.7	93.4
Rice	6.5	1.0	78.5	1.0	....	20.1	8.8	290.5	319.4	95.8
Prunes, dried	2.3	.5	65.0	1.5	1.4	7.1	4.4	240.5	252.0	75.6
Raisins	....	....	62.0	1.7	....	....	....	229.4	229.4	68.8
Sauerkraut	1.0	.2	7.6	.5	1.0	3.7	1.7	17.0	21.8	6.5
Coffee, unroasted	12.0	12.3	42.3	4.0	18.2	37.2	108.2	156.5	301.9	90.6
Tea	24.5	7.1	41.7	5.6	11.6	75.9	62.5	154.3	292.7	87.8
Chocolate	6.2	21.0	67.6	1.9	1.4	19.2	184.8	250.1	444.1	133.2
Beef heart	16.0	20.4	....	1.0	....	56.0	179.5	....	235.5	70.6
Beef kidney	16.0	4.8	.4	1.2	....	56.0	42.2	1.5	99.7	29.9
Beef liver	20.7	4.5	1.5	1.6	....	72.4	39.6	5.5	117.5	35.2
Beef marrow	2.2	92.8	....	1.3	....	7.7	816.6	....	824.3	247.3
Beef tongue	18.9	9.2	....	1.0	....	66.1	81.0	....	147.1	44.1
Beef tripe	11.7	1.2	.2	.3	....	40.9	10.1	.7	51.7	15.5
Beef tripe, canned	16.8	8.5	....	.5	....	58.8	74.8	....	133.6	40.0
Beef tongue, pickled	12.8	20.5	....	4.7	....	44.8	180.4	....	225.2	67.6
Beef tongue, canned	19.5	23.2	....	4.0	....	68.2	204.2	....	272.4	81.7
Pork, feet	8.3	17.4	....	.4	....	29.0	153.1	....	182.1	54.6
Pork, kidney	15.5	4.8	....	1.2	....	54.2	42.2	....	96.4	28.9
Pork, liver	21.3	4.5	1.4	1.4	....	74.5	39.6	5.2	119.3	35.8
Veal heart	16.8	9.6	....	1.0	....	58.8	84.5	....	143.3	43.0
Veal kidney	16.9	6.4	....	1.3	....	59.1	56.3	....	115.4	34.6
Veal liver	19.0	5.3	....	1.3	....	66.5	46.6	....	113.1	33.9
Mutton kidney	16.9	12.6	....	.9	....	59.1	110.8	....	169.9	51.0
Mutton liver	23.1	9.0	....	1.7	....	80.8	79.2	....	160.0	48.0
Broiler chickens	21.5	2.5	....	1.1	....	75.2	22.0	....	97.2	30.0
Fowls	19.3	16.3	....	1.0	....	67.5	143.4	....	210.9	63.3
Young goose	16.3	36.2	....	.8	....	57.0	318.6	....	375.6	112.7
Turkey	21.1	22.9	....	1.0	....	73.8	201.5	....	275.3	82.6
Chicken liver	22.4	4.2	2.4	1.7	....	79.4	37.0	8.9	126.3	37.6
Goose liver	19.6	5.8	....	1.0	....	68.6	51.0	....	119.6	35.9

cially vegetables reappear in the fæces in quite considerable proportion.

A simple and approximately accurate method for calculating the nutritive value of a diet has recently been published by Schumburg. Schumburg makes a slight difference in the food value between animal and vegetable proteids, giving the former a value of 3.5 and the latter a value of 3.1 per gram. The fats have a value of 8.8 and the carbohydrates one of 3.7. Given, then, the various constituents of a diet, expressed in proteids, fats, and carbohydrates, their weight stated in grams, multiplied by their respective values, the several amounts added together would give a sum corresponding to the total food value of a diet in numbers of calories or nutrient units. Remembering that a sufficient diet for an adult workingman must have at least 3,000 nutrient units, and that the proportion of proteids, fats, carbohydrates, and salts in a complete diet should be as 150, 100, 500, and 35, we would have an easy and simple method of ascertaining and controlling the dietary value of any meal.

The adjoining Table XV. has been compiled from many sources, notably, Koenig, Rubner, Kirchner, Schmidt, Plumert, Ranke, Notter, Harrington, Munson, the reports of the United States Fish Commission and of the United States Department of Agriculture. The first five columns give the percentage composition of each food in proteids, fats, carbohydrates, etc.; the next three columns give the number of nutrient units contained in 100 parts; the next two columns give the sum of nutrient units in 100 gm. and one ounce respectively.

There are a few food substances of vegetable origin,

not included in this list, such as the tomato, cucumber, squash, pumpkin, egg plant, and vegetable marrow; they have about the same nutritive value as celery and lettuce. The jellies and jams are semi-solid glutinous preparations, made by boiling fruit juices with sugar and allowing to cool; jams are similar preparations which include the pulp of the fruit as well as the juice. Their nutritive value must be determined by taking their ingredients separately in each case. Tea, coffee, and chocolate owe their nutritive value more to the stimulating effect of the alkaloids which they contain than to anything else; they are condiments rather than nutritious substances.

The caloric values, originally assigned to the several proximate principles of foods, by Rubner and Stohmann, were as follows: 1 gm. of proteids, 4.8 calories; 1 gm. of fats, 9.5 calories; 1 gm. of carbohydrates, 4 calories. It was soon found, however, that, while the fats and the carbohydrates were as completely oxidized within the tissue cells as they were when burned in a calorimeter, namely, into water and carbon dioxide, the proteids left an unconsumed remnant. If, for instance, 1 gm. of proteid material is decomposed within the organism, it leaves a remnant of urea, uric acid, and a few other nitrogenous substances, excreted by the kidneys and the intestines. The 4.8 calories, therefore, that were assigned to 1 gm. of proteids, as their food-value in calories, represent only a part of that value in calories which we would obtain if 1 gm. of proteids was burned in a calorimeter, where it would, of course, be completely consumed by oxidation. According to Rubner, the unconsumed remnant amounts to 22 to 28 per cent. of the original quantity of proteids ingested. In other words, if 1 gm. of proteid material is decomposed within the body, is converted into water, carbon dioxide, urea, etc., only so much of its potential energy is converted into heat as will raise the temperature of 4.8 kgm. of water 1° C., while if 1 gm. of proteid is completely assimilated within the organism, the amount of energy added to the latter is equal to 5.7 calories, or its full caloric value. The above values for proteids, fats, and carbohydrates, in their practical application to the calculation of the food values of a certain diet or ration, have had to be modified still further. Allowance had to be made for a certain percentage amount of indigestible matter peculiar to the different articles of food, as well as for the energy that had to be expended on their digestion, in order not to overestimate their net value. After making these necessary deductions, Schumburg gives, as the net values, the following numbers in calories: 1 gm. proteids (animal), 3.5 calories; 1 gm. proteids (vegetable), 3.1 calories; 1 gm. fats, 8.8 calories; 1 gm. carbohydrates, 3.7 calories. It is on the basis of Schumburg's figures that the food values in table XV. have been calculated.

Voit's original standard requirements in proteids, fats, and carbohydrates, for a moderately hard-working adult man, are: 118 gm. of proteids, 56 gm. of fat, and 500 gm. of carbohydrates. These standard requirements have stood the test of many years of scientific controversy and have proved themselves practically unassailable.

The following table is intended to show the number of calories obtained from Voit's standard by using both Rubner's and Schumburg's figures:

TABLE XVI.

Name.	Grams.	Multiplied by—	
		Rubner's figures.	Schumburg's figures.
Proteids	118	× 4.8 = 566	× 3.5 = 413
Fats	56	× 9.5 = 532	× 8.8 = 492
Carbohydrates	500	× 4.0 = 2,000	× 3.7 = 1,850
		Total, 3,098	Total, 2,755

(In a paper on the "Hygiene of the Navy Ration," published by me in the Proceedings of the United States Naval Institute, vol. xxv., No. 3, the total caloric value of the ration was estimated as amounting to 2,696 calories. This number was obtained after making all due allowance for indigestible matters as well as taking into account the losses incurred in cooking and the general preparation of the food; it agrees so nearly with Voit's standard, multiplied by Schumburg's figures, that this agreement is considered an additional proof of its correctness. Unfortunately, the proof of this paper not having been submitted to the writer, a few errors have crept in, owing to the wrong position of the decimal points in the numbers there given; they are, however, so easily perceived as hardly to need any correction.)

From the point of view of their digestibility, food substances vary quite considerably, and, since only that portion of a food substance which is absorbed is of any good to the organism, it cannot be immaterial in what form food is taken. The following table XVII. by Rubner is intended to show the indigestible and, consequently, unabsorbed remnant in per cent., of some of the more common articles of food.

TABLE XVII.

Remained unabsorbed.	Dry substance.	Proteids.	Fats.	Carbohydrates.
Meat, dried	5.3	2.6		
Fish	4.3	2.5		
Eggs, hard-boiled	5.2	6.6	4.4	
Milk	8.8	7.1	5.3	
Bread, baker's, wheaten	4.2	21.8	....	1.1
Bread, inferfor quality	6.7	24.6	....	2.6
Bread, coarse meal	12.2	30.5	....	7.4
Bread, peasants' rye	15.0	32.0	....	10.9
Macaroni, poor in egg	4.3	17.1	....	1.2
Rice (Risotto)	4.1	20.4	....	0.9
Corn (Palenta)	6.7	15.5	....	3.2
Peas (dried)	9.1	17.5	....	3.6
Beans (dried)	18.3	30.2		
Beans, fresh	15.0			
Potatoes mashed	....	19.5	....	0.7
Potatoes, mashed, different preparations	9.4	30.5	....	7.4
Carrots	20.7	39.0	....	18.2

The table shows that those articles of a diet which have an animal origin and upon which we mostly depend for the necessary proteid part of our diet, such as meat, fish and eggs, are best digested and absorbed. Of the vegetables, rice, corn, and macaroni seem to be much more digestible than the vegetables properly so-called. The digestion and absorption of all kinds of fats is generally favorable.

The different composition of foodstuffs, as regards proteids, fats, and carbohydrates, in itself makes it necessary that an appropriate mixture of them be taken in order to maintain a certain necessary equilibrium in the composition of our own bodies.

For, although Pflüger has kept dogs alive and in a thriving state of health and activity for long periods at a time, man cannot live forever on an exclusively animal diet, much less on one of fats and carbohydrates to the exclusion of all proteids.

Volume of a Diet.—Regarding, as we must, our digestive organs as muscular as well as secretory organs, we shall have to admit, that, like other muscles, their strength in grinding up and propelling food material must have a maximum limit, beyond which they become liable to fatigue and exhaustion. This limit has been reached whenever we become conscious of a feeling of overfulness after taking a meal. While a feeling of satiety is, up to a certain limit, stimulating to digestion, overfulness has the very opposite effect and ought to be avoided. Experience and experimentation have shown that the volume of an average diet should not exceed 2,100 gm. nor fall below 1,500 gm. The daily volume is, of course, to be distributed among the several customary meals.

It has been found a most suitable plan, in a temperate climate at any rate, to make the following distribution of the daily ration between the different meals of the