this kind, it has been shown than an animal diet is much more favorable to the development of the physical forces than one consisting mainly of vegetables.

Climate has an important influence on the quantity of food demanded by the system. It is generally acknowledged that the consumption of all kinds of food is greater in cold than in warm climates, and almost every one has experienced in his own person a considerable difference in the appetite at different seasons of the year. Travelers' accounts of the quantity of food taken by the inhabitants of the frigid zone are almost incredible. They speak of men consuming more than a hundred pounds (45·36 kilos.) of meat in a day; and a Russian admiral, Saritcheff, gave an instance of a man who, in his presence, ate at a single meal a mess of boiled rice and butter weighing twenty-eight pounds (12·7 kilos.). Although it is difficult to regard these statements with entire confidence, the general opinion that the appetite is greater in cold than in warm climates is undoubtedly well founded. Hayes stated, from his personal observation, that the daily ration of the Esquimaux is twelve to fifteen pounds (5·443 to 6·804 kilos.), of meat, about one-third of which is fat. On one occasion he saw an Esquimau consume ten pounds (4·536 kilos.) of walrus-flesh and blubber at a single meal, which lasted, however, several hours. The continued low temperature he found had a remarkable effect on the tastes of his own party. With the thermometer ranging from $-60°$ to $-70°$ Fahr. ($-51°$ to $-57°$ C.), there was a persistent craving for a strong animal diet, particularly fatty substances. Some members of the party were in the habit of drinking the contents of the oil-kettle with evident relish.

Necessity of a Varied Diet.—In considering the nutritive value of the various alimentary substances, the fact that no single one of them is capable of supplying all the material for the regeneration of the organism has frequently been mentioned. The normal appetite, which is the best guide as regards the quantity and the selection of food, indicates that a varied diet is necessary to proper nutrition. This fact is exemplified in a marked degree in long voyages and in the alimentation of armies, when, from necessity or otherwise, the necessary variety of aliment is not presented. Analytical chemistry fails to show why this change in alimentation is necessary or in what the deficiency in a single kind of diet consists; but it is nevertheless true that after the organic constituents of the organism have appropriated the nutritious elements of particular kinds of food for a certain time, they lose the power of effecting the changes necessary to proper nutrition. This fact is particularly well marked when the diet consists in great part of salted meats, although it sometimes occurs when a single kind of fresh meat is constantly used. After long confinement to a diet restricted as regards variety, a supply of other matters, such as fresh vegetables, the organic acids, and articles which are called generally antiscorbutics, becomes indispensable; otherwise, the modifications in nutrition and in the constitution of the blood incident to the scorbutic condition are almost always developed.

It is thus apparent that adequate quantity and proper quality of food are

not all that is required in alimentation; and those who have the responsibility of regulating the diet of a large number of persons must bear in mind the fact that the organism demands considerable variety. Fresh vegetables, fruits etc., should be taken at the proper seasons. It is almost always found, when there is of necessity some sameness of diet, that there is a craving for particular articles, and these, if possible, should be supplied. This was frequently exemplified in the civil war. At times when the diet was necessarily somewhat monotonous, there was an almost universal craving for onions and raw potatoes, which were found by army surgeons to be excellent antiscorbutics.

With those who supply their own food, the question of variety of diet generally regulates itself; and in institutions, it is a good rule to follow as far as possible the reasonable tastes of the inmates. In individuals, particularly females, it is not uncommon to observe marked disorders in nutrition attributable to want of variety in the diet as well as to an insufficient quantity of food as a matter of education or habit.

A full consideration of the varieties of food and of the different methods employed in its preparation belongs properly to special works on dietetics. Among the ordinary articles of diet, the most important are meats, bread, potatoes, milk, butter and eggs; and it is necessary only to treat of these very briefly.

Meats.—Among the various kinds of muscular tissue, beef has been found to possess the greatest nutritive value. Other varieties of flesh, even that of birds, fishes and animals in a wild state, do not present an appreciable difference, as far as can be ascertained by chemical analysis; but when taken daily for a long time, they become distasteful, the appetite fails, and the system seems to demand a change of diet. The flesh of carnivorous animals is rarely used as food; and animals that eat animal as well as vegetable food, such as pigs or ducks, acquire a disagreeable flavor when they are not fed on vegetables. Soups, broths, and most of the liquid extracts of meat really possess but little nutritive value and they can not replace the ordinary cooked meats. The following is the composition of roasted meat, no dripping being lost, according to the analysis of Ranke, quoted by Pavy:

Nitrogenous matters	27·60
Fat	15·45
Saline matters	2·95
Water	54·00
	100·00

Bread.—Bread presents a considerable variety of alimentary constituents and is a very important article of diet. The constituents of flour undergo peculiar changes in panification, which give to good bread its characteristic flavor. Bread, especially coarse, brown bread, as a single article of food, is capable of sustaining life for a long time. It contains a large proportion of starch, but its important nitrogenized constituent is gluten, which is not a simple substance but contains vegetable fibrin, vegetable albumin, a peculiar substance soluble in alcohol, called glutine, with fatty and inorganic matters. The following is the composition of bread, according to Letheby:

Nitrogenized matters	8·1
Carbohydrates (chiefly starch)	51·0
Fatty matters	1·6
Saline matters	2·3
Water	37·0
	100·0

Potatoes.—Potatoes are very useful as an article of diet, especially on account of the agreeable form in which starchy matter is presented; for they contain but a small proportion of nitrogenized matter and do not possess as much nutritive value as exists in bread. They are selected for description from the vegetable foods for the reason that they are almost universally used in civilized countries throughout the year. They are usually cooked thoroughly, but the raw potato is a valuable antiscorbutic. The following is the composition of potato, according to Letheby:

Nitrogenized matter	2·1
Starchy matters	18·8
Sugar	3·2
Fat	0·2
Saline matters	0·7
Water	75·0
	100·0

Milk.—Milk, and articles prepared from milk, such as butter, cheese etc., are important articles of food. In the treatment of disease, milk is frequently used as a single article of diet. On account of the great variety of alimentary matters which it contains, including a great number of inorganic salts and even a small quantity of iron, milk will meet all the nutritive demands of the system, probably for an indefinite time. It is largely used in the preparation of other articles of food by cooking. Pure butter, which represents the fatty constituents of milk, contains, in 100 parts, 30 parts of oleine, 68 parts of palmitine, and 2 parts of other fats peculiar to milk (Bromeis). The following is the composition of cow's milk, according to Letheby:

Nitrogenized matters	4·1
Fatty matters	3·9
Sugar	5·2
Inorganic matters	0·8
Water	86·0
	100·0

In connection with the composition of human milk, to be given farther on, the great variety of its constituents will be more fully considered.

Eggs.—As regards nutrition, the analogy between eggs and butter is evident when it is remembered that the constituents of eggs furnish materials for the growth of the chick, to which must be added certain saline matters

absorbed from the shell during the process of incubation. Among the inorganic constituents of eggs, there is always a small quantity of iron. The following is the composition of the entire contents of the egg, quoted from Pavy:

Nitrogenized matters	14·0
Fatty matters	10·5
Inorganic matters	1·5
Water	74·0
	100·0

A number of different nitrogenized and fatty matters, a small quantity of saccharine matter, as well as a great variety of inorganic salts, exist in eggs.

The physiological effects of a diet restricted to a single constituent of food or to a few articles have been closely studied both in the human subject and in the inferior animals. Animals subjected to a diet composed exclusively of non-nitrogenized matters die in a short time with all the symptoms of inanition. The same result follows when dogs are confined to white bread and water; but these animals live very well on the military brown bread, as this contains a greater variety of alimentary matters (Magendie). Facts of this nature were multiplied by the "gelatine commission," and the experiments were extended to nitrogenized substances and articles containing a considerable variety of alimentary matters. In these experiments, it was shown that dogs could not live on a diet of pure myosine, the appetite entirely failing at the forty-third to the fifty-fifth day. They were nourished perfectly well by gluten, which is composed of a number of different alimentary substances. Among the conclusions arrived at by this commission, which bear particularly on the questions under consideration, were the following:

"Gelatine, albumin, fibrin, taken separately, do not nourish animals except for a very limited period and in a very incomplete manner. In general, these substances soon excite an insurmountable disgust, to the point that animals prefer to die of hunger rather than touch them.

"The same substances artificially combined and rendered agreeably sapid by seasoning are accepted more readily and longer than if they were isolated, but ultimately they have no better influence on nutrition, for animals that take them, even in considerable quantity, finally die with all the signs of complete inanition.

"Muscular flesh, in which gelatine, albumin and fibrin are united according to the laws of organic nature, and when they are associated with other matters, such as fat, salts etc., suffices, even in very small quantity, for complete and prolonged nutrition."

In Burdach's treatise on physiology, is an account of some interesting experiments by Ernest Burdach on rabbits, showing the influence of a restricted diet upon nutrition. Three young rabbits from the same litter were experimented upon. One was fed with potato alone and died on the thirteenth day, with all the appearances of inanition. Another fed on barley alone died in the same way during the fourth week. The third was fed alternately day by day with potato and barley, for three weeks, and afterward with potato and barley given together. This animal increased in size and was perfectly well nourished.

In 1769, long before any of the above-mentioned experiments were performed, Dr. Stark, a young English physiologist, fell a victim at an early age to experiments on his own person on the physiological effects of different kinds of food. He lived for forty-four days on bread and water, for twenty-nine days on bread, sugar and water, and for twenty-four days on bread, water and olive-oil; until finally his constitution became broken, and he died from the effects of his experiments.

CHAPTER VII.

DIGESTION—MASTICATION, INSALIVATION AND DEGLUTITION.

Prehension of food—Mastication—Physiological anatomy of the teeth—Anatomy of the maxillary bones—Temporo-maxillary articulation—Muscles of mastication—Action of the tongue, lips and cheeks in mastication—Parotid saliva—Submaxillary saliva—Sublingual saliva—Fluids from the smaller glands of the mouth, tongue and fauces—Mixed saliva—Quantity of saliva—General properties and composition of the saliva—Action of the saliva on starch—Uses of the saliva—Physiological anatomy of the parts concerned in deglutition—Mechanism of deglutition—First period of deglutition—Second period of deglutition—Protection of the posterior nares during the second period of deglutition—Protection of the opening of the larynx and uses of the epiglottis in deglutition—Third period of deglutition—Deglutition of air.

INORGANIC alimentary substances are, with few exceptions, introduced in the form in which they exist in the blood and require no preparation or change before they are absorbed; but organic nitrogenized substances are always united with more or less matter possessing no nutritive properties, from which they must be separated, and even when pure, they always undergo certain changes before they are taken up by the blood. The non-nitrogenized matters also undergo changes in constitution or in form preparatory to absorption.

Prehension of Food.—Prehension of food in the adult is a process so simple and well known that it demands little more than a passing mention. The mechanism of sucking in the infant and of drinking is a little more complicated. In sucking, the lips are closed around the nipple, the velum pendulum palati is applied to the back of the tongue so as to close the buccal cavity posteriorly, and the tongue, acting as a piston, produces a virtual vacuum in the mouth, by which the liquids are drawn in with considerable force. This may be done independently of the act of respiration, which is necessarily arrested only during deglutition; for the mere act of suction has never anything to do with the condition of the thoracic walls. The mechanism of drinking from a vessel is essentially the same. The vessel is inclined

so that the lips are kept covered with the liquid and are closed around the edge. By a gentle, sucking action the liquid is then introduced. This is the ordinary mechanism of drinking; but sometimes the head is thrown back and the liquid is poured into the mouth, as in "tossing off" the contents of a small vessel.

MASTICATION.

In order that digestion may take place in a perfectly natural manner, it is necessary that the food, as it is received into the stomach, should be so far comminuted and incorporated with the fluids of the mouth as to be readily acted upon by the gastric juice; otherwise, gastric digestion is prolonged and difficult. Non-observance of this physiological law is a frequent cause of what is generally called dyspepsia.

Physiological Anatomy of the Organs of Mastication.—In the adult, each jaw is provided with sixteen teeth, all of which are about equally developed. The canines, so largely developed in the carnivora but which are rudimentary in the herbivora, and the incisors and molars, so fully developed in the herbivora, are, in man, of nearly the same length. Each tooth presents for anatomical description a crown, a neck and a root, or fang. The crown is that portion which is entirely uncovered by the gums; the root is that portion embedded in the alveolar cavities of the maxillary bones; and the neck is the portion, sometimes slightly constricted, situated between the crown and the root and covered by the edge of the gum. Each tooth presents, on section, several distinct structures.

Enamel of the Teeth.—The crown is covered by the enamel, which is by far the hardest structure in the economy. This is white and glistening and is thickest on the lower portion of the tooth, especially over the surfaces which, from being opposed to each other on either jaw, are most exposed to wear. It here exists in several concentric layers. The incrustation of enamel becomes gradually thinner toward the neck, where it ceases. The enamel is made up of pentagonal or hexagonal rods, one end resting upon the subjacent structure, and the other, when there exists but a single layer of enamel, terminating just beneath the cuticle of the teeth.

The exposed surfaces of the teeth are still farther protected by a membrane, $\frac{1}{30000}$ to $\frac{1}{15000}$ of an inch (0·8 to 1·7 μ) in thickness, closely adherent to the enamel, called the cuticle of the enamel (Nasmyth's membrane). The cuticle presents a strong resistance to reagents and is useful in protecting the teeth from the action of acids which may find their way into the mouth.

Dentine.—The largest portion of the teeth is composed of dentine, or ivory. In many respects, particularly in its composition, this resembles bone; but it is much harder and does not possess the lacunæ and canaliculi which are characteristic of the true osseous structure. The dentine bounds and encloses the central cavity of the tooth, extending in the crown to the enamel, and in the root, to the cement. It is formed of a homogeneous, fundamental substance, which is penetrated by a large number of canals radiating from