their conduct after operation, which only proves that, as in other departments of surgery, fair results may be obtained in a variety of ways. And, while I have obtained good results by the course I have pursued, which may be said to be midway between these extremes, I am free to admit that it would give me the greatest pleasure to be able to observe minutely the progress from day to day of the patients treated by both the methods described, as certainly Dr. Landolt's reports indicate a higher standard of final results than is claimed by many operators, and under such circumstances it is becoming that we should at least hold our minds open to conviction.

In conclusion, I would state as my conviction that, in the correction of strabismus, advancement, or resection combined with a very limited tenotomy, should, as a rule, be substituted for simple tenotomy.

ARTIFICIALLY PREPARED FOODS, THEIR NUTRITIVE VALUE AND DIETETIC APPLICATION.

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The history of the scientific production of artificially prepared foods, like that of the subjects of digestion, nutrition and metabolism, is nothing more than a summary of the achievements of the experimental sciences relating to general biology and the science of medicine.

Investigation of the various empiric dietetic systems, from the time of Aristotle up to the end of the eighteenth and the beginning of the nineteenth century, shows that, while various grain decoctions, ptisan, almond, egg and sugar-water and probably a few other dietetic preparations were used for invalids, no preparation existed which might lay claim to being an artificially prepared food in the sense that the term is used to-day. Far reaching and revolutionary were the discoveries which ushered in the birth of the exact knowledge of nutrition and dietetics!¹ On the one hand we had the discovery of oxygen by Priestly and Scheele in 1774, and the subsequent development of the theory of oxidation by Lavoisier in 1780; on the other hand was the investigation of Spallanzani and Reaumur, in 1752, on the subject of digestion.

Let us here rapidly sketch the outlines of the growth of our subject and review the fundamental principles by which the nutritive value of foods may be judged and the nutritive demands of the human individual adjusted. In this manner we shall be able to appreciate the status of our subject and to determine the applicability of artificially prepared foods to the diet of man in health and disease.

Although from the time when Lavoisier defined the processes of oxidation, up to, and even beyond, the first quarter of the nineteenth century, considerable work had been done on the subject of nutrition, little was really accomplished until the theories of Liebig, the greatest chemist of that century, were shown to be incorrect. As late as 1842 very little was known of the nutritive and physiologic significance of albumin, fat and carbohydrates. It was during this period that Liebig believed that the destruction of albumin served the purpose of furnishing the organism with energy for the

execution of mechanical work, while the oxidation of fats and carbohydrates was supposed to furnish heat to the body and protect the albumin from unnecessary oxidation. It was very soon shown, however, that this explanation was incorrect, for experimental evidence was brought forward which proved that the increased ingestion of albumin by an animal at rest was accompanied by a corresponding increase of nitrogen excretion. Important as was the demonstration of this fact, its exact significance was unfortunately misconstrued, and, in consequence, gave rise to much controversy and years of laborious experimentation. It was now taught that the minimum quantity of albumin necessary to the animal organism was expressed by the quantity of albumin disintegrated during inanition. Finally, during the years 1857-60, Bischoff, Voit and Pettenkofer published the results of their experimental work, and it was at this time really that the cornerstone of nutrition, as an exact science, was laid.

For the continued normal expressions of the functions of an organism, the ingestion of a certain and definite quantity of food is requisite. This general biologic law manifests itself, irrespective of theoretical speculation or scientific observation, in the expression of the instinctive impulse which guides every organic entity in its selection of the requisite quantity and quality of food. However, not until Helmholtz and Meyer formulated the theory of the conservation of energy, did we fully appreciate the philosophy of this law.

Every organic function is accompanied by the production of heat, which finds its origin in the oxidation of definite chemical combinations, the absorbed and assimilated products resulting from the digestion of substances termed foodstuffs. The amount of heat which an organism gives off is equivalent to the calorimetric value of the food which it requires in a given period of time. The food which the system requires is represented by the nutrient principles, albumin, carbohydrates and fat, each one of which may substitute or replace the other, but only, as we shall point out later, within the limit of their minimum nutritive or physiologic quantity. Irrespective of the relative proportions of each one of these food principles, the total heat requirement of the organism remains the same.

Every foodstuff possesses a certain caloric value, which is expressed by the term calorie, and each represents that quantity of heat necessary to raise one kilogram of water from 0 to 1 C. It is customary to express the total quantity of nutriment necessary to maintain the nutritive demands of an organism by the caloric value of the food introduced into the system. Instead of simply stating that the system requires so much each of fat, albumin and carbohydrates, we express it by the number of calories which the system requires in a given period of time under definite circumstances, presupposing always that these three foodstuffs be contained in certain proportions and in definite relationship to each other. Although this is a very convenient method and the one now generally followed, it is not strictly logical, because it neither embraces the valuation of the nutriment required to rebuild the wasted tissue of the body, nor, in the organism at rest, the amount of energy expended in the carrying on of circulation, heart beat, respiration, gastro-intestinal and glandular activity.

Expressing, therefore, only partly the metabolic significance of a given food, the caloric method is, nevertheless, the most convenient we have at our disposal at the present time. This method is founded upon the fact, to

1. Breisacher: The Principles of Metabolism and Nutrition.

which we have already alluded, that the amount of heat given off by an organism is practically equivalent to the calorimetric value of the food which has been introduced into it. When fat, albumin, carbohydrates or gelatin is subjected to calorimetric estimation it is found that each has a definite caloric value, thus one gram each of these foods equals the following: Albumin, 5.7 calories; gelatin, 5.5; fat, 9.3; starch, 4.1; cane sugar, 4.0, and glucose, 3.7 calories.

The method of calorimetric estimation of foodstuffs consists in introducing a given quantity of food material into a specially constructed bomb, which is filled with oxygen under a pressure of from fifteen to twenty-five atmospheres. After the bomb has been submerged in water, the substance under examination is ignited by means of electricity and an estimation made of the heat imparted to the water.

It has been shown that fats and carbohydrates when introduced into the system are oxidized into carbonic acid gas and water, and further, that when subjected to the action of a calorimeter they undergo a like change. With albumins, however, the matter is somewhat more complicated, for, while they are oxidized into nitrogen, carbonic acid gas, water and a small quantity of sulphuric acid in the calorimeter, in the animal organism they are split up into urea, uric acid, kreatin, kreatinin, hippuric acid, etc. To determine, therefore, the caloric value of albumin to the system it is necessary to subtract the caloric value of these organic oxidation products.

By this method of calculation we find that the physiologic nutritive value of albumin is 4.1, compared with its calorimetric value of 5.7. The physiologic heat or caloric value of fat and carbohydrates is identical with the calorimetric value. The physiologic or nutritive caloric value, therefore, of one gram of fat is 9.3, of one gram of carbohydrates, 4.1, and of one gram of albumin it is also 4.1. Fat, albumin and carbohydrates form the three chief nutrient principles which enter into the diet of a human individual. The necessary quantity of each one of these separate nutrient principles required by the system, and the relationship of one to the other, is dependent upon varying circumstances. The relationship of fat, carbohydrates and albumin in the diet of an infant is not identical with that in the diet of an adult, neither is the required relative quantity of these nutrient principles, estimated per kilogram body weight, the same in the mature as in the immature organism. Further, the demands of a weakly developed inactive organism are different from those of a laborer or an athlete. In accordance with the law of substitution, each nutrient principle may be substituted for the other, within its minimum physiologic limit, as recent experiments have conclusively shown.²

A thorough comprehension of these laws, which I shall define more particularly later on, is absolutely necessary in the rational feeding of both healthy individuals and invalids. The fundamental principles, upon which our entire knowledge of the subject of nutrition is founded, are the result of experiments made upon human individuals and animals. Among the most important are those experiments made upon fasting individuals. When food is absolutely withheld from a man weighing about 70 kilograms—154 pounds—for a period lasting from twenty-four hours to a number of weeks, it is found that the system loses from 50 to 80 grams of albumin and from 200 to 250 grams of fat, each day.

In a single twenty-four-hour period the loss of water is from 800 to 1000 c. cm.; in longer periods, the subject of the experiment is usually given a sufficient amount of water to cover this loss.

The execution of a certain amount of mechanical labor during a period of fasting increases the fat consumption and water exhalation while the albumin waste remains the same as in the fasting individual at rest. It has further been shown that persons provided with an abundant supply of adipose tissue withstand the influence of fasting more effectually than lean individuals, for the reason that in the former the adipose tissue furnishes the major percentage of caloric demand of the organism, thus protecting the albumin supply from excessive waste.

The size or bulk of an individual also determines the total fat and albumin consumption of the system, and it has been demonstrated that, while the absolute quantity of albumin and fat may be greater in the larger individual than in the smaller one, the relative quantity of both of these foodstuffs, estimated per kilogram body weight, is greatly in excess in the smaller or less bulky individual, than in the larger one. This law is equally invariable, irrespective of whether the food consumption refers to a fasting or normally fed individual, or whether it be applied to an infant or an abnormally large or small adult. The nutritive demand per kilogram body weight, therefore, is in an inverse proportion to the size or bulk of the organism.

If an animal from which food has been withheld for a certain period of time, i. e., a number of days or weeks, be fed meat it will be found that the nitrogen excretion, as expressed by the nitrogen in the urine, is increased, and, with each additional increase of albumin (meat) to the diet, the excretion of nitrogen is increased proportionately. This increase of nitrogen excretion continues until sufficient amount of albumin (meat) has been added to the diet to effect a nitrogen balance, that is, a nutritive condition in which the nitrogen income is equal to the nitrogen outgo. It was taught by Voit that the quantity of albumin necessary to cover the albumin loss of the system was two and one-half times greater than the loss resulting during a period of fasting. This, however, is not strictly correct, as the writer and several other investigators showed in a series of nutrition experiments.³

In addition to the loss of albumin, the fasting individual suffers a distinct loss of fat from his organism, and it has been found that, by insuring the absorption of fat equivalent to the loss of adipose tissue during fasting, the fat consumption may be checked while the albumin destruction remains unchanged. It follows from this that the ingestion of fat by a fasting animal may prolong life, but not prevent ultimate death from starvation. The exclusive feeding of carbohydrates, like that of fat, does not prevent the occurrence of death by starvation, although they protect the system from albumin destruction more effectually than fat.

If a definite quantity of fat and albumin is given to an individual who has been subjected to a period of fasting, it will be noticed that the loss of organic or body albumin is arrested. This does not occur when simply fat or carbohydrates are given and which can not be practically achieved in the human being by an exclusively albumin diet. Fat, whether existing in the system as adipose tissue or introduced into the system as food, protects the organic albumin from undue waste.

2. Breisacher: (a). Eiweissbedarf beim Menschen: (b). Principles of Metabolism and Nutrition.

3. Breisacher: Eiweissbedarf beim Menschen.

When along with a requisite amount of albumin, more fat is introduced into the system than the total caloric demand requires, an increase in the supply of adipose tissue is achieved. When carbohydrates, in the form of sugar, starch or dextrin, are added to a diet composed simply of albumin, the destruction of the latter is lessened, and, as in the case of fat and albumin, if a sufficient quantity of carbohydrates be added to a requisite amount of albumin, the loss of organic albumin is arrested. Likewise, when carbohydrates are added to a combined fat and albumin diet, the total consumption of both of the latter is lessened. The effect, however, of like quantities each of fats and carbohydrates, in retarding albumin consumption, is not identical. Notwithstanding the fact that a gram of fat represents a caloric value, which is 5.2 greater than a gram of carbohydrates, it has less influence in checking albumin waste than the latter. As we have already pointed out, when an excess of fat is fed to an individual, a deposit of fat, in the form of adipose tissue, is effected; when an excess of carbohydrates is fed, an elaboration of fat, with a resulting increase of adipose tissue, takes place.

Gelatin is a nitrogenous substance resembling albumin in its atomic arrangement, in its conversion into peptone by the gastric and pancreatic secretions, and in its **final oxidation into urea**. When gelatin is added to an albumin diet, it has an influence in lessening organic albumin and fat dissipation similar to that possessed by both fat and carbohydrates. It is of interest to note that while gelatin has a more pronounced effect in lessening organic albumin destruction than both fats and carbohydrates, in reducing the organic fat dissipation it is less effectual than either fat or carbohydrates. Despite the chemical resemblance of gelatin to albumin it can not replace that substance, nor are we acquainted with any substance which can substitute the minimum physiologic nutritive quantity of albumin necessary to an animal organism.

These then are, in brief, the primary fundamental principles by which we must be guided in nourishing individuals, both in health and in disease. These principles emphasize the fact that of the three chief nutrients—albumin, fat and carbohydrates, to which a fourth, gelatin, may be added—albumin is the substance which requires the foremost consideration in the selection of a diet. This is true because it can not be replaced by any other known nutrient, irrespective of whether it belongs to the nitrogenous or non-nitrogenous group of chemicals or foodstuffs.

These principles further teach us that one or preferably both of the non-nitrogenous food principles, carbohydrates and fats, should be added to an albumin diet for the maintenance of the healthy functions of the organism. To these two non-nitrogenous nutrients we may add gelatin, which, as we have seen, has an influence similar to that of both fat and carbohydrates.

Let us here consider the exact quantity in which each one of these nutrient principles must be contained in the daily diet, and the circumstances which determine a variation in the quantitative demands of the system upon these substances. The nutritive demands of the human organism, from the period of infancy to that of adolescence and from the latter to that of maturity and decline, are subject to varying fluctuations. Again, different degrees of bodily activity, both physical and psychical, during sleep and the waking state, thermic and climatic influences, body weight and size, and finally various pathologic conditions, all make definite nutritive demands upon the system. For instance, in infancy there is

more nutriment required, estimated per kilogram body weight, than during the period of maturity; the body weight and size has an influence, as we have already pointed out, in so far that a smaller organism requires relatively more nutriment than a larger one; during sleep or absolute rest, compared with the waking state, the albumin metabolism remains unchanged, while the fat and carbohydrate consumption is reduced; bodily exercise is accompanied by an increased carbohydrate and fat consumption, while the albumin metabolism remains uninfluenced. Heat and cold affect the organism differently—increased body temperature raises the total carbohydrate and fat consumption, while the reduction of external temperature increases, and an increase of external temperature reduces, both the fat and carbohydrate metabolism.

Finally, in pathologic conditions, such as fever, dyspnea, anemia, diabetes, Bright's disease, icterus uric acid diathesis, etc., various nutritive abnormalities are discernible, and it behooves us at this point to determine the normal nutritive mean of the organism and its practical application to pathologic conditions. In this way we shall be enabled to logically appreciate the dietetic demands in pathologic conditions and estimate the applicability of artificially digested foods to the dietary of invalids. We indicated in our foregoing remarks that the preferable diet for a normal individual is one consisting of certain quantities of albumin, fat and carbohydrates.

Determined by methods which consisted in estimating the nitrogen and carbon output in individuals subsisting upon an ordinary indefinite diet, it was originally estimated that the average individual of 70 kilograms—154 pounds—body weight, at rest and during moderate and severe physical labor requires for every twenty-four hours, 100 to 140 grams of albumin, 50 to 100 grams of fat and 400 to 500 grams of carbohydrates. Practical observation has shown that some individuals subsist upon as little as 75 to 80 grams of albumin in twenty-four hours, and experimentally these figures can be materially reduced for a considerable length of time, as the writer showed in a series of experiments covering a period of 33 days.³ In ordinary cases, however, unless prompted by some particular reason to materially reduce the albumin quantity, it will be preferable to adhere to the 90 to 100 grams of albumin ration for the average individual at rest or during light exercise. Figured in calories, the average individual requires during absolute rest from 30 to 34 calories per kilogram body weight, during light exercise 34 to 40, for a medium amount of work 40 to 45, and during severe labor 45 to 60 per kilogram body weight, for every twenty-four hours.

A diet consisting of 100 grams of albumin, 50 grams of fat and 400 grams of carbohydrates would equal: Albumin 100 grams $\times$ 4.1 = 410 calories; fat 50 grams $\times$ 9.3 = 465 calories; carbohydrates 400 grams $\times$ 4.1 = 1640 calories—a total of 2515 calories. This number of calories represents a sufficient amount of heat or food, for an individual weighing about 74 kilograms, or 163 pounds, at rest. To further elucidate this method of estimation I append a diet list, which I used in a series of experiments made upon myself².

Materials.	Quantity	Albumin.	Carbohydrates.	Fat.
		(Nitrogen 6.25.)		
Meat	75 grams	15.40	....	1.33
Rice	200 "	12.36	149.60	0.66
Potatoes	225 "	5.49	45.00	....
Bread	200 "	17.92	120.00	....

Materials.	Quantity	Albumin. (Nitrogen 6.25)	Carbohydrates.	Fat.
Starch	70 grams.	0.28	69.72	....
Eggs	50 "	6.27	....	6.05
Milk	150 "	5.60	7.39	6.75
Sugar	40 "	....	40.00	....
Butter	50 "	0.43	....	....
Beer	700 "	3.67	62.51	....
Tea	760 "	0.58	....	....
		67.80	494.22	60.49

Albumin $67.80 \times 4.1 = 277.98$ calories; carbohydrates $494.22 \times 4.1 = 20.26$ calories; fats $60.49 \times 9.3 = 562.56$ calories—a total of 2866.84 calories.

In the foregoing table the quantity of fat, albumin and carbohydrates is accurately accounted for as is also the total caloric value. The number of heat units, 50.22 per kilogram body weight, is greater than was really necessary, but I chose this number for the reason that I was reducing my albumin ration far below the usual quantity, as I determined by a great number of total nitrogen estimations while on an indefinite diet.

ARTIFICIALLY PREPARED OR PREDIGESTED FOODS.

This brings us then to the actual consideration of the subject of artificially digested foods, and their application to the diet of invalids.

Until 1843, when Graves published his observations upon the diet of fever patients, there existed a dictum in the practice of medicine, which read, that to successfully treat fever patients the diet must needs be reduced to a minimum quantity, and this was successfully accomplished by resorting to cereal water and various broths, which were practically destitute of nutritive value. Following the writings of Graves, in which it was urged that "fevers be fed," the observations of Chossat on the effect of inanition were published, and these two writings then, in conjunction with the experimental observations of Liebig, Voit, Pettenkofer, et al, acted as an incentive to the research upon which our present knowledge of invalid feeding is founded.

Although as early as 1752 Reaumur and Spallanzani discovered the digestive action of gastric juice, it was not until 1824 that Prout discovered the gastric hydrochloric acid, and 1850 that Lehman first applied the term of peptone to the products of albumin digestion. The diastatic action of saliva was not discovered until 1831, although Payen had discovered grain diastase thirty-six years previous to this time.

We have evidence that in ancient times grain water was added to milk to render it more easily digested, and other methods were resorted to in attempting to make food more acceptable to invalids, yet the first important attempt to produce artificially prepared foods was made subsequent to the discoveries which we summarized in the preceding pages. As in other matters pertaining to nutrition, Liebig was a pioneer in the department of artificially prepared foods. Liebig's efforts resulted in the production of these two foods which bear his name: 1, Liebig's extract of beef,⁴ known, we dare say, to every civilized race; 2, Liebig's infant soup, which while it is remembered by but few to-day nevertheless deserves the distinction of being the preparation which has given rise to the almost countless numbers of so-called baby foods.

When one considers the havoc which many of these improperly prepared invalid and baby foods have occasioned and the misuse to which numerous really praiseworthy preparations have been subjected, the thought

involuntarily arises as to whether it would not perhaps have been far better had the idea of artificially preparing foods for invalids and babies never occurred to any one. The subject of the feeding of artificially prepared foods is in the same deplorable condition as that of nutrition in general, but whereas ignorance and neglect of the subject of nutrition, as applied to feeding the average individual and using the term in a general sense, affects simply healthy or somewhat indisposed individuals, lack of proper knowledge to correctly adjust the administrations of artificially prepared foods affects both the helpless infant and the invalid, who really are in need of proper nourishment.

The medical world is justified in insisting that the manufacturer produce an artificially prepared food which answers the requirements of the nutritive demands of invalids. Further, the manufacturer should be compelled to print upon the package of each preparation of artificially prepared food an exact quantitative and qualitative analysis. This is a duty which the manufacturer owes to the medical world, and the duty which the latter owes to the manufacturer is that it sufficiently comprehend the principles of nutrition, thereby insuring the rational application of reliable preparations to the dietary of invalids. With these points observed it simply remains to be determined, in selecting an artificially prepared food, whether it be palatable to the patient and whether it possess the nutritive and therapeutic value required of it.

In selecting an artificially prepared food for an invalid, we are guided by the same principles of nutrition and metabolism as in feeding an individual in health. An invalid, like a healthy individual, requires a definite quantity each of albumin, fat and carbohydrates to furnish the necessary total caloric demand of the organism. We find a deviation from the above statement in certain pathologic conditions, in which it is necessary to reduce the quantity of one nutrient principle and substitute in its place another. I have reference to the reduction or entire withdrawal of carbohydrates in diabetes, the reduction of albumin in uric acid diathesis, etc. Irrespective of a reduction of particular food principles, the total caloric supply must remain unaltered or at least as little changed as is compatible with the condition of the patient. The dream of the medical profession, from the very dawn of the science of nutrition, has been to prepare an artificially digested food which would relieve the gastro-intestinal tract of its usual digestive labor, but, like the illusion of an elixir of everlasting youth, it has resulted only in idle and futile search.

With the newly acquired knowledge of some of the more pronounced phases of digestion, it is comprehensible why the trend of scientific aim should have led experimenters and clinicians in this direction. The artificial conversion of albumin, fat and carbohydrates into their respective end products has, it is true, been accomplished, but, despite this, the subject of the feeding of artificially digested foods is still far from being solved. While the artificial preparation and dietetic application of fats and carbohydrates have given fairly satisfactory results, the same can not be said of predigested albumin, since peptones and albumoses have proved to be stubborn and unyielding in the extreme.

It is not so many years ago that Voit, along with Bruecke and other celebrated physiologists, supported the old view of Tiedeman and Gmelin, according to which peptone was considered to be a decomposition

4. Prout as early as 1821 produced meat extract, but the credit of the practical manufacturer of it really belongs to Liebig.

product and one that could not be regenerated into albumin. It was thought that the peptone resulting from the digestion of albumin in the gastro-intestinal tract was absorbed by the circulation as such, and was oxidized in the system in a similar manner to carbohydrates and fats, while the albumin necessary to rebuild the wasted tissues of the organism was thought to be dependent upon the absorption of unaltered albumin from the gastro-intestinal tract. Lehman, on the other hand, contended that the conversion of albumin into peptone was a definite physiologic process, which served the purpose of rendering the latter more easily absorbed, to again be converted into albumin in the circulation. The great authority of Bruecke, however, had its influence, and as late as 1877 peptone was looked upon as being a product of decomposition. Further exact experimental research has indeed proved that many albumins, such as serum albumin, egg albumin, acid albumin and globulin, may reach the circulation without first undergoing peptonization, but it has also been demonstrated that the end products of albumin digestion, instead of being products of decomposition, are reconverted into albumin in the mucous membrane of the gastro-intestinal tract to circulate as such in the system, which fact definitely disposes of the older contention of Voit, Bruecke and others. Two or three years previous to this period the first peptone feeding experiments were instituted, and, while the results of several experimenters made it appear very probable that peptone, so-called, did possess nutritive worth, the proof was not sufficiently conclusive to prevent Voit, as late as 1881, from offering experimental data in support of his earlier contention. Up to this time peptone was considered a simple or elementary compound, but the famous investigations of Kuehne and Chittenden and other of his pupils proved that peptone was really a mixture of many different substances and that the so-called peptone—preparations of manufacturers—consisted principally of albumoses, bodies intermediate between albumin and true peptone.

Several experiments instituted with albumoses and pure peptone apparently proved that the former could serve as a substitute for albumin, while peptone usually acted as a violent irritant, causing vomiting and diarrhea. Following these preliminary observations it was then finally proved that a number of preparations, consisting chiefly of albumoses, together with varying quantities of true peptone and insoluble albumin, could be substituted for the ordinary unaltered albumin, such as is contained in the daily food ration. Still more convincing and decisive are the experiments made with pure albumoses, which prove that their nutritive worth is equivalent to unaltered albumin, while anti-peptone, resulting from pancreas digestion at least, seems to be destitute of this power of substitution.

With this problem of the nutritive role of peptone and albumoses fairly well decided, the question arises whether artificially digested albumin is really applicable to the diet of invalids. We have seen that true peptones have not given satisfactory results as dietetic agents, and, if we bear in mind the comparatively recent discovery that true peptones are formed only in very small quantities in the stomach and that albumoses very likely represent the digestive products which enter the circulation, it becomes evident why concentrated quantities of peptone disagree with patients in the manner noted above. Dismissing, therefore, the idea of utilizing pure peptone as a dietetic agent, and recognizing the clinical and experimental evidence of the nutritive worth of albumoses, we must further ask our-

selves what advantage we hope to obtain and what effect we really produce by the feeding of artificially digested albumin. To begin with, most of these preparations have rather a disagreeable taste, which is a disadvantage in a food, making the addition of either meat extract or some other taste-disguising agent necessary. Further, contrary to the general belief, predigested albumin does not possess a higher nutritive worth than ordinary native albumin.

A claim which is often emphasized by manufacturers and accepted by many as being true, is that artificially digested albumin is more easily absorbed than native albumin. But here also abundant experimental and clinical data disprove these claims. The worth of an artificially digested food like that of an ordinary food-stuff is estimated by the manner and degree in which it is utilized in the gastro-intestinal tract.

Let us begin with the stomach. We are in possession of data which prove that the rate of peptone absorption from the stomach is extremely slow and considerably slower than either alcohol or the different forms of sugar. Further, it has been shown that a solution of artificially digested albumin is not absorbed more rapidly from the stomach than a nutritive equivalent of powdered meat measured in calories. The absorptive maximum of the stomach, as one would expect, bears a relation to its degree of digestive activity, and, beyond this degree, the absorption can not be forced. In regard to the intestinal absorption of artificially digested albumin, our experience is as unsatisfactory as in regard to the gastric absorption. Ellinger, for instance, has shown in some comparative tests with meat and somatose that, when each was separately given in quantities representing 8.92 grams of nitrogen, with meat the excreta contained but one gram of nitrogen, while with somatose they contained 10.6 grams of nitrogen. By still another method, that of estimating the degree of intestinal decomposition as expressed by the urinary sulphuric acids, it has been shown that somatose, a representative artificial albumin product, possesses no advantage as a nutrient over native albumin.

It will be seen, therefore, that the supposition that peptones and albumoses are more readily and more perfectly utilized than native albumin does not bear the test of careful investigation. Closely linked to this idea is the supposition that predigested albumin taxes the digestive functions less severely than unaltered albumin. This, like the other statements, is erroneous, for it is clear that the expenditure of energy lies in the secretion of the digestive fluid, not in the digestion of food after the digestive fluid has been secreted.

One might be led to contend that artificially digested albumin does not excite the glandular activity to the same degree as does native albumin. But here again we are confronted with investigations which show that the gastric acid secretions, as determined by exact chemical analysis, may be as great as and even much greater in the case of albumoses and peptones than in the case of unaltered or native albumin.

The second pronounced expenditure of energy of the digestive organs, that of motility, by which food is propelled onward from the stomach into the intestines, is as great, as we have already seen, in the case of predigested as in the case of native albumin. In particular pathologic conditions of the gastro-intestinal tract the results of the application of artificially digested albumin are not materially different from those which have been already mentioned. If we group the distinctive chemical fea-

tures of the stomach cases, we find that in one class we may have an absolute absence of acid, and in another class a normal or excessive quantity of acid. Between these two extremes we find cases with varying degrees of acidity, which we need not here define more particularly. In addition to the acidity of the stomach, the motility is of the greatest importance, for it is this muscular mechanism which determines the onward propulsion of food from the stomach into the intestines. Irrespective of the acid condition of the stomach the motility may be abnormally accelerated, slowed or entirely inhibited. It is clear that in cases of absolute cessation of motility, resulting, for instance, from a dilatation, dislocation or a pyloric stenosis, it is as useless to introduce artificially digested albumin into the stomach as it is to resort to native albumin. So also, when the motility and acidity are normal it is unnecessary to resort to artificially digested albumin. Even when the hydrochloric acid and peptone digestion is much reduced, or entirely absent, as in acute and chronic fevers, true gastritis, etc., the unaltered albumins may be perfectly utilized, as is clinically seen every day, and which both the clinical and experimental cases of total gastric extirpation have conclusively proved. It may be remarked, however, that certain particularly selected cases of an acidity with normal motility do not offer any direct objection to the use of artificially digested albumin, provided it does not prove too irritating to the gastro-intestinal canal.

Large quantities of many of the artificially digested albumins usually act as a laxative, and it is this action which recommends its moderate use in some cases or absolutely condemns its use in others. The great majority of artificially digested albumins are to be looked upon as gastro-intestinal stimulants, rather than nutrients which can be substituted for the maximum requisite quantity of albumin for any great period of time. Peptones and albumoses may be temporarily employed alone or as adjuncts to other foods in cases where there exists either a repugnance to ordinary food, where the mastication of food is difficult or impossible, or where there exists an incomplete mechanical obstruction in the esophagus, and where it is necessary to relieve the stomach entirely from mechanical irritation. In gastric ulcer, hyperacidity and in all cases where an over-production of the gastric secretion and hydrochloric acid is to be avoided, irrespective of the condition of motility, the artificial albumin preparations are not to be used. The other contraindications have already been referred to and need not be gone over again.

The subject of the feeding of artificially prepared fats and carbohydrates, while not exactly identical with that of predigested albumin, is nevertheless very similar to it, and many of the difficulties encountered in connection with the predigested albumins are also common to both the carbohydrates and fats. Various attempts have been made to increase the ordinary rate of fat absorption by mixing it with foodstuffs and chemicals and by emulsifying it in various ways. It has been found, however, that when the motility of the stomach is unimpaired and the pancreatic and biliary secretions are normal, the absorption of unaltered, native fat, such as is contained in milk, cream, eggs, butter, etc. is very satisfactory indeed. It has been shown that as high as 300 grams (about 10 ounces) of fat, representing 2790 calories, may be absorbed from the intestinal canal in twenty-four hours.

Practically no progress has been made in the direction of fat alimentation and this subject is now generally

looked upon as belonging to impenetrable territory. However unpromising as the present outlook may appear for an advance in this problem, especially in conditions of general marasmus and in hepatic and pancreatic difficulties, the future may, nevertheless, offer a means for the eventual solution of the difficulty.

The logical, artificial conversion of starch into sugar for specific, dietetic purposes dates from the time when Liebig first prepared his infant's soup, although the empirical dextrinization and saccharification of starch has been practiced from time immemorial. When native starch is introduced into the mouth it undergoes a chemical conversion into maltose. Usually, however, this conversion is not completed until it reaches the stomach, and not even then if the contents of the stomach are decidedly acid. In the latter case the conversion is not completed until it reaches the small intestine. To insure the complete conversion of unaltered starch into sugar and the absorption of the latter into the circulation, it is necessary to prepare it in a very finely powdered form. Various preparations in which this precaution has been taken are to be found on the market and give very satisfactory results. The starch contained in these preparations may either be converted into dextrin by heat during their special preparation for the invalid, or into maltose by some particular malt solution or diastase. Investigation shows that from 500 to 700 grams of unaltered starch, representing 2050-2870 calories, may be almost completely converted into sugar and absorbed by the gastro-intestinal canal in twenty-four hours.

In infants in whom, as is now generally recognized, the diastatic functions of the salivary and pancreatic glands are but imperfectly developed, it is necessary to first convert the starch into dextrin and maltose, or preferably entirely into maltose in cases where it is thought advisable to feed with artificially digested foods of this variety. In adults good results are obtained from these foods in various salivary, gastric and intestinal disturbances in which unaltered starch is not properly utilized in the organism. Both dextrin and sugar are absorbed by the stomach as well as by the intestines, and, as one would expect, the diffusibility and absorptive rate of sugar is considerably greater than that of dextrin.

Just as in the case of the ingestion of predigested albumin, much depends upon the motility and absorptive condition of the stomach as to whether or not the converted starch or native sugar is properly utilized. Large quantities of converted starch or native albumin induce very decided gastro-intestinal irritation with fermentation and diarrhea. Although the ingestion of enormous quantities of starch never induces in the healthy individual an appearance of sugar in the urine, quantities of dextrose ranging from 100 to 250 grams are sufficient to induce a decided transient glycosuria. In the rational application, however, of dietetic preparations containing native sugar or converted starch, this undesirable effect is hardly to be feared. I simply wish to emphasize these circumstances to show the physiologic limitations of forced carbohydrate alimentation.

At times cases may arise in which it is desirable to substitute honey, cane sugar, milk sugar, glucose or fruit sugar for either native or predigested starch, and, when properly selected and carefully applied, these aid very materially in increasing the total caloric value of the diet of the invalid. To this class we may add the various malt preparations, which, in connection with their diastatic properties, possess a certain nutritive value.

On the whole, artificially prepared starches given alone or mixed with specially prepared milk foods have given good results in my hands. They offer a convenient form in which to exhibit this class of dietetic preparations, and, as a change from the various other food-stuffs, are generally very much relished by patients.

It is not my object, nor would it here be in place, to attempt a criticism on the value of these and other especially prepared foods in infant feeding. When used with judgment and discretion they undoubtedly often render valuable service; when they are indiscriminately prescribed, however, they give correspondingly bad results. From all this it will be seen with what difficulty every attempt is beset which strives to lessen the labor of the gastro-intestinal canal by the exhibition of artificially digested foods.

Unfavorable as this criticism may appear to the subject of artificially prepared albumins, I trust that it will not be construed as being intended as a reflection upon the efforts of manufacturers of artificially prepared foods. There are many who are honestly and sincerely interested in the production of a superior dietetic preparation and to them this is offered as a friendly criticism, which I hope may act as a stimulus to further efforts to produce a perfect artificially digested food—one free from the untoward secondary actions we have discussed. Much remains to be said on this subject, and it might have been of interest to have included a careful analysis of every class of artificially prepared foods in our discussion. Lack of time and space did not, however, admit of this, and I dwelt upon the albumins particularly, for the reason that they are so difficult of application and so universally misunderstood.

THE SOMATIC SIGNS OF BRAIN SYPHILIS.*

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This paper takes no cognizance of inherited syphilis or of the degenerative diseases in some way caused by specific infection, but is limited to the signs of histologically definable specific invasion of the brain.

Before entering upon the details of my subject, I beg indulgence while I enunciate half a dozen postulates relating to the clinical history and more general symptomatology of cerebral lues, which seem to me so important as to be inevitable as a preface.

1. Brain syphilis is most frequent in the first year after infection, next most frequent in the second year, less frequent in the third year and so on, about 50 per cent. of all cases occurring within three years after the primary sore. After ten years of quiescence, therefore, the appearance of cerebral syphilis is exceptional.

2. In reaching a diagnosis of a brain case, absence of a history of specific infection should have no weight in the case of women, and in the case of men relatively slight importance.

3. Syphilis of the brain is not synonymous with gumma. I do not know how the myth became current in the profession, but the average practitioner works in the obscurity of the tenet that brain syphilis means gumma and is utterly oblivious of the fact that this is the least frequent form of cerebral specific lesion.

4. Most frequently brain syphilis means syphilitic arteritis. Next in frequency come syphilitic meningitis and syphilitic infiltration of the cranial nerves, while a gumma comparable to a brain tumor is least frequent.¹

5. Paralysis from brain syphilis (excluding paralysis of the cranial nerves) is most frequently caused neither by the pressure of a gumma nor by hemorrhage, but by thrombosis due to syphilitic arteritis.

6. Consequently, many cases of syphilitic paralysis are no more amenable to treatment than are those of cerebral thrombosis due to ordinary arteriosclerosis and atheroma (influence of age excepted), which means that the important symptomatology is that which precedes and presages paralysis, because it is at such time that prompt treatment obtains brilliant, almost miraculous, results.

7. Syphilis is never a "system disease." As the Anglican sage, Sir William Gowers, puts it: "As a general rule, if we find certain structures of common function selected for isolated impairment from among others of different function, we may be sure that we have not to deal with a true specific process."

In what follows mention is made only of those symptoms deemed by the writer to be most important by reason of their frequency or diagnostic importance or because, having been overlooked or forgotten by the average practitioner, they need to be called to his attention. No categorical enumeration of symptoms is possible in compass less than a brochure and a concise grouping of them is impracticable because the only systematic thing in the symptomatology of brain syphilis is the utter want of system, which suggests the first trait.

1. *Lack of Type.*—So strikingly consistent is brain syphilis in the production of apparent inconsistencies, that any brain case having an odd mixture of psychic and somatic disorder, a sequence of signs illogical as regards either time or localization, or a bizarre appearance, disappearance, reappearance, amelioration and aggravation of symptoms, should at once awaken suspicion of lues. For cerebral syphilis nothing is impossible. Insomnia, somnolence or an alternation of them; pain without anesthesia, anesthesia without pain or painful anesthesia; spasm without paralysis, paralysis without spasm or the two combined; monoplegia, paraplegia, hemiplegia, crossed paralysis, single or multiple cranial nerve paralysis, and any imaginable grouping of them; focal signs rivaling in neatness the most dexterous work of experimental pathology or a hodge-podge of symptoms carrying only confusion to the brain anatomist and physiologist; half-way manifestations, scarcely inflammatory, more than neoplastic; these are a few of the tricks of specific lesions within the cranium. A few years ago, when the London police found the remains of a mysterious murder, the body showing inexplicable mutilations, they said "Jack the Ripper." When the neurologist meets a brain case conformable to no rule, abounding in inconsistencies, ignoring anatomy, a clinical outlaw, he is very apt to say "brain syphilis."²

2. *Headache.*—In about 75 per cent. of all cases of cerebral syphilis headache is present. Notoriously nocturnal in its exacerbations, it may be vesperal, or even

1. The foregoing is not to be understood as an attempt to controvert the fact that nearly all syphilitic lesions are histologically almost identical, i. e., granulomata—cellular accumulations—but merely as a protest against the baseless popular impression that brain syphilis simply means syphilitic tumor of the brain, and that the symptomatology of brain syphilis is simply the symptomatology of brain tumor.

2. The only organic disease which can compete with syphilis in polymorphism, fluctuation and melange of types is multiple sclerosis.

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